3 AFFECTED ENVIRONMENT

This chapter describes the resources of the Chehalis Basin Study Area that could be affected by construction and implementation of the EIS action elements and combined alternatives. The Study Area encompasses the entire Chehalis Basin (WRIAs 22 and 23); however, the geographic extent to which each resource could be affected (affected environment) may vary. For example, the affected environment could be limited to the mainstem Chehalis River and its floodplain, or be expanded to include a broader geographic area to capture the migratory patterns of fish and wildlife throughout the Chehalis Basin. For each environmental resource discussed in this chapter, the extent of the affected environment is described at the beginning of that section.

The level of detail provided in this chapter varies depending on the resource. More information is provided for those resources with the most potential to be substantially affected by implementing elements of the alternatives. A site-specific and more detailed description of environmental resources would be prepared during subsequent project-level environmental review and prior to implementing specific actions or projects.

3.1 Water Resources

This section describes the current precipitation, surface water (including streamflow, flooding, and water quality), groundwater, water use, and water rights conditions within the Chehalis Basin. An understanding of the quantity and quality of surface water and groundwater is important for considering the effectiveness of the alternatives as well as their potential impacts. High river flows result in flooding, while low river flows and impaired water quality currently affect aquatic species.

3.1.1 Precipitation

Water resources in the Chehalis Basin are strongly influenced by precipitation, and while the Chehalis Basin is mostly rain-dominated, the Wynoochee and Satsop River sub-basins are somewhat influenced by high, snow-dominated areas in the Olympic Mountains. The Newaukum and Skookumchuck River sub-basins are affected by some rain-on-snow floods.

Precipitation varies within the Chehalis Basin and ranges from an annual average of 43 inches along the low-lying valley areas near Centralia and Chehalis to more than 250 inches in the Olympic Mountain watersheds (Gendaszek 2011). In the Chehalis River headwaters, the Willapa Hills average more than 120 inches of precipitation per year (see Figure 3.1-1; WSE 2014b). Previous studies estimate an average rainfall of 73 inches for the entire Chehalis Basin, including its tributaries. The lower Chehalis Basin (WRIA 22) typically has higher average precipitation than the upper Chehalis Basin (WRIA 23); however, the upper sub-basins of WRIA 23 (Chehalis River headwaters, South Fork Chehalis

River, and Elk Creek) all have average rainfalls above the 73-inch Chehalis Basin average (Tetra Tech/KCM 2002). The summer months are considered to be the dry season, during which precipitation drops to nearly zero (Northwest Area Committee 2015).

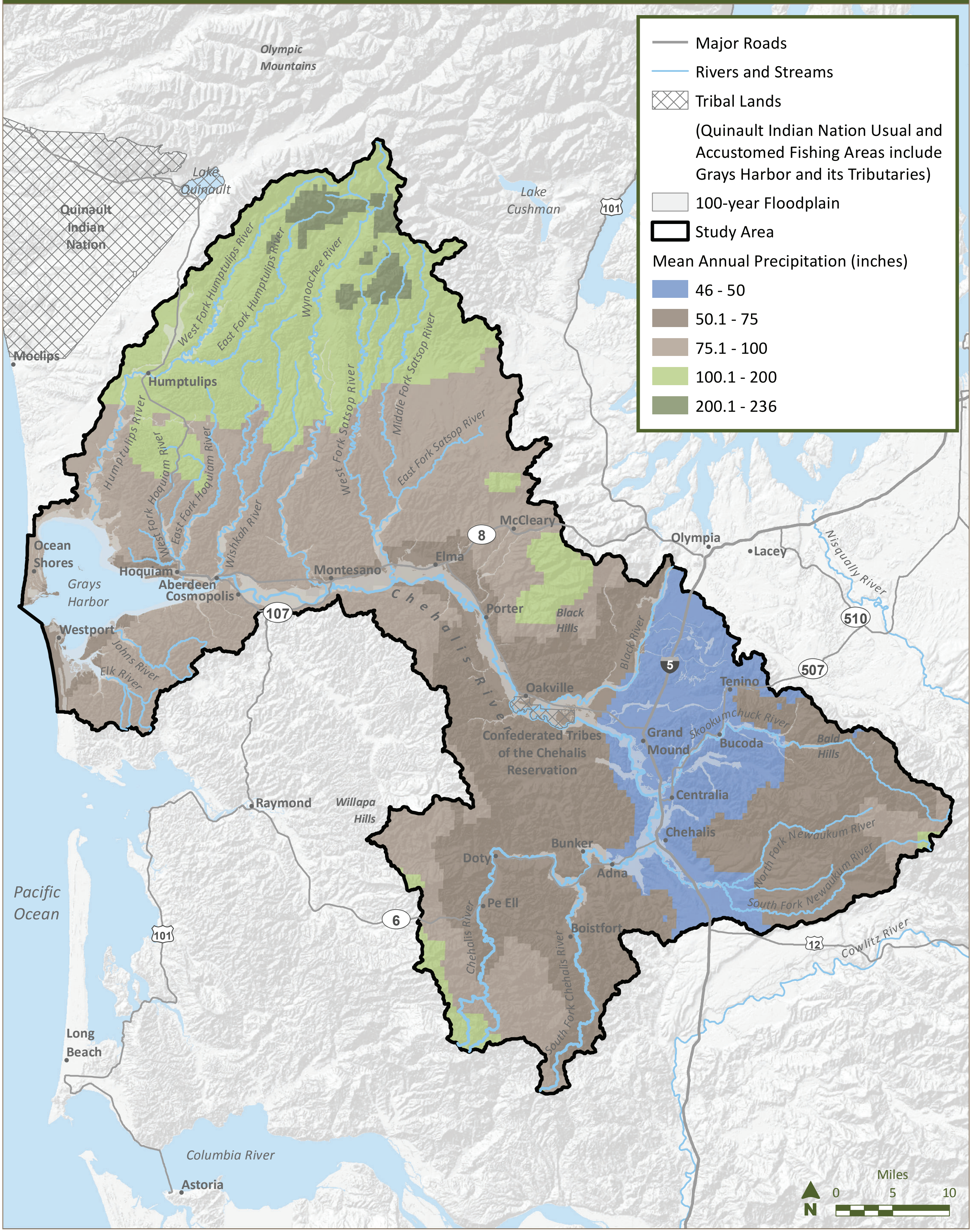
Peak precipitation events in the Chehalis Basin are typically caused by atmospheric river (also termed "Pineapple Express") weather systems, which funnel moisture from the tropics to locations in Western Washington, resulting in heavy precipitation and major flooding in the Chehalis Basin (Neiman et al. 2011). These events typically happen between November and February. In the 2007 flood, which was caused by an atmospheric river, rainfall in the Willapa Hills headwaters of the Chehalis River ranged from 12 to 26 inches in a 4-day period (December 1 to December 4, 2007; WSE 2014a).

Due to the size and geographic variation of the Chehalis Basin, the effects of atmospheric river events may be concentrated in one area, but the area and amount of precipitation will depend on the orientation of the event as it arrives in the Chehalis Basin. The strongest effects of any given event could be centered on the Willapa Hills, the Cascade Range foothills, or the southern Olympic Mountains.

As the Earth's climate changes, precipitation patterns may also change. Section 3.7 includes a discussion of projected future changes in precipitation within the Pacific Northwest and the Chehalis Basin associated with climate change.

Figure 3.1-1

Mean Annual Precipitation



Source: United States Average Annual Precipitation, 1981-2010, published in 2012 by PRISM Climate Group, Oregon State University

3.1.2 Surface Water

The primary surface water features in the Chehalis Basin are the Chehalis River and its tributaries, other rivers that drain directly into Grays Harbor (e.g., Humptulips River), lakes, and Grays Harbor. In the last few decades, the Chehalis Basin has experienced both major flooding and drought conditions (low streamflows in rivers during summer months), which has affected both water quality and habitat conditions. The following sections describe surface water resources for the mainstem Chehalis River (including high flows and flooding, low flows and instream flows, and water quality), tributaries to the Chehalis River, and tributaries to Grays Harbor.

3.1.2.1 Streamflow

There are nine active U.S. Geological Survey (USGS) gages (see Figure 3.1-2) on the Chehalis River that provide information on streamflow rates and water surface elevations. Additionally, there are 15 other active USGS gages and five active Ecology gages in the Chehalis Basin on other rivers and streams. Multiple other gages collected streamflow data in the past, but are currently inactive. Three of the active gages, which have been measuring streamflows for more than 60 years, are referred to as primary USGS gages and are typically used to define the flow of the Chehalis River. These three gages are identified as follows:

- Doty – USGS Gage No. 12020000
- Grand Mound – USGS Gage No. 12027500
- Porter – USGS Gage No. 12031000

Figure 3.1-3 presents a series of hydrographs, which illustrate the annual range of average weekly flows in the Chehalis River using data from the three primary gages at Doty, Grand Mound, and Porter. The hydrographs show that river flows are typically highest from November to February, and lowest from July to September. The average weekly flows from July to September range from 30 to 80 cfs at Doty, 200 to 500 cfs at Grand Mound, and 400 to 800 cfs at Porter. Average weekly flows from November to February range from 640 to 1,360 cfs at Doty, 2,600 to 6,700 cfs at Grand Mound, and 3,400 to 10,000 cfs at Porter.

Figure 3.1-2

Streamflow Monitoring Locations

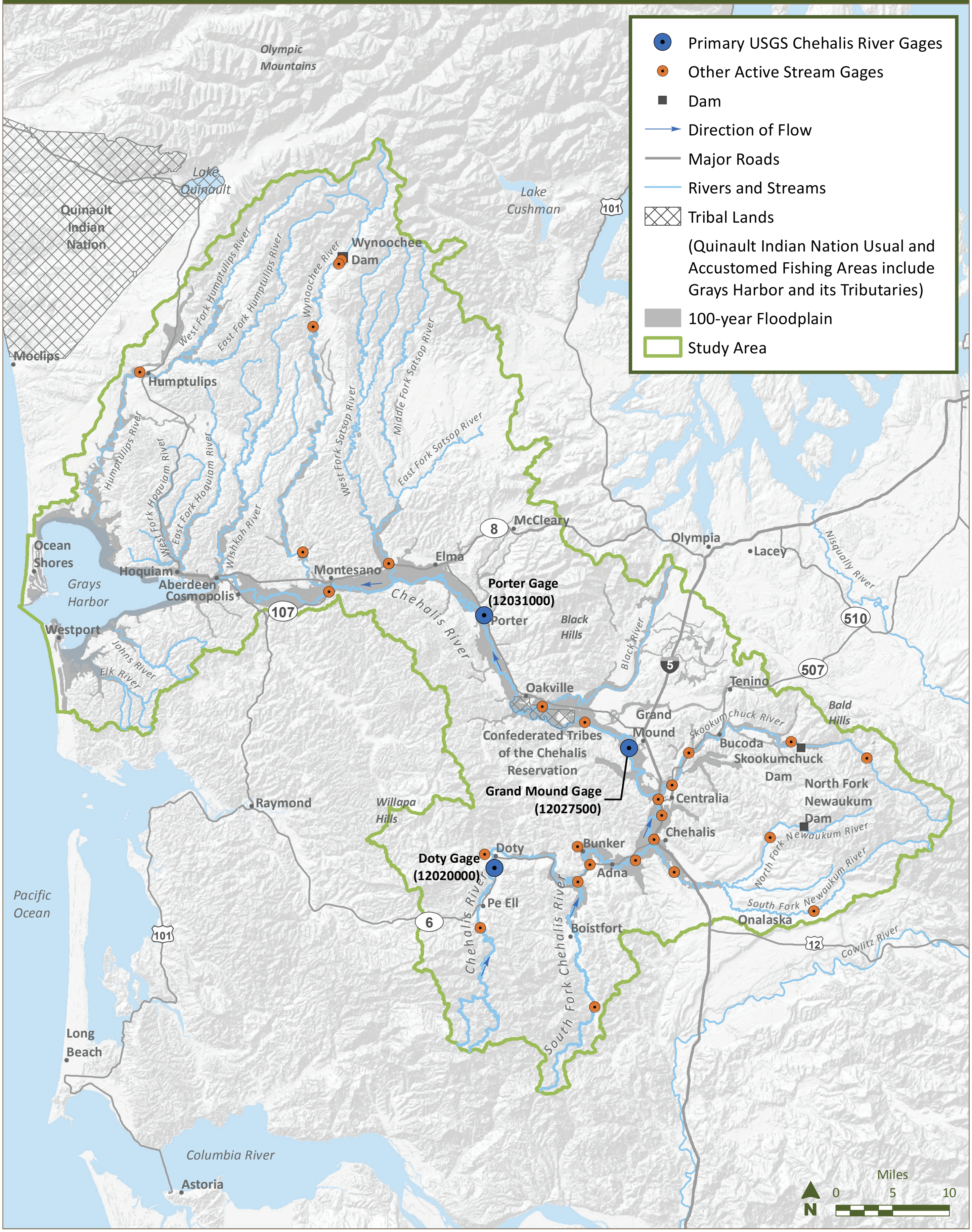
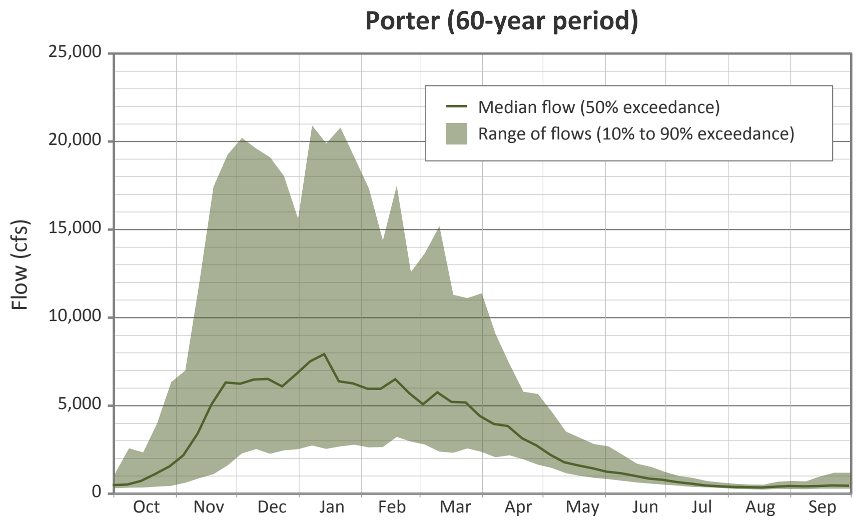
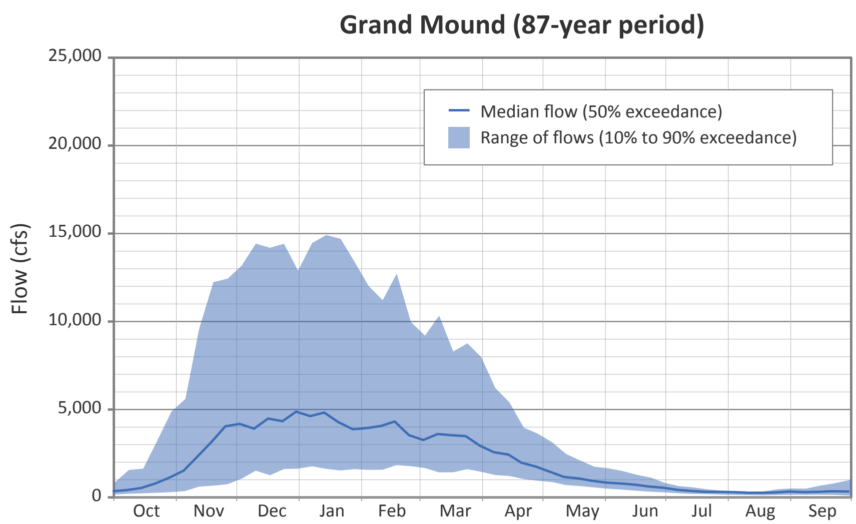
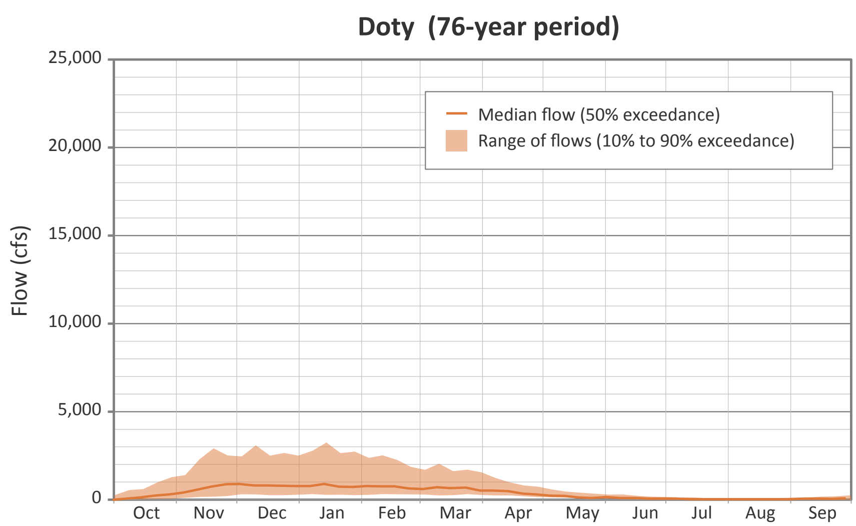


Figure 3.1-3

Chehalis River Streamflow History







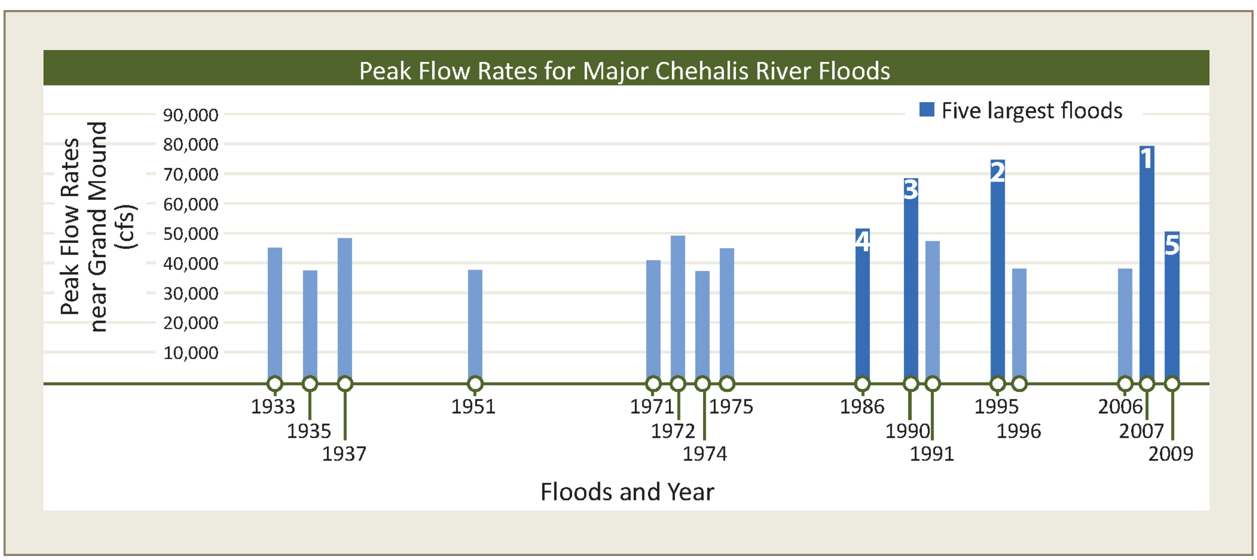
3.1.2.2 Flooding and Floodplains

Flood Definitions

- **10-year flood** – 10% chance of occurrence in any given year
- **100-year flood** – 1% chance of occurrence in any given year
- **500-year flood** – 0.2% chance of occurrence in any given year

Flooding is a frequent occurrence in the Chehalis Basin. Major floods have affected Lewis, Thurston, and Grays Harbor counties in 1972, 1975, 1986, 1990, 1996, 2007, and 2009, causing the disruption of lives and commerce and millions of dollars of flood damage. Flooding closed I-5 through Chehalis and Centralia for multiple days during the 1996, 2007, and 2009 floods (CRBFA 2010). Since 1980, Lewis County has experienced 16 federally declared disasters, 13 of which were caused or exacerbated by flooding. Floods have affected major infrastructure (such as roads and bridges), commercial and residential property, and public health and safety, including blocked roadway access and emergency response (CRBFA 2010).

Many factors affect the frequency and magnitude of floods. In Western Washington, atmospheric rivers are the primary contributor to extreme flooding (see Section 1.2). Research into other potential contributors to flooding in the Chehalis Basin has been performed for the Chehalis Basin Strategy. The effects of forest practices on peak flows have been evaluated through a literature review by the University of Washington (see Appendix A). In small basins, forest practices increase channel-forming flows (corresponding to return periods of about 1.5 to 5 years) and low flows, but there is limited agreement in the literature on the effects forest practices have on extreme flows in large watersheds such as the Chehalis Basin (Perry et al. 2016). Climate change effects have been documented in a recent study by the CIG (Mauger et al. 2016) and various other studies, as described in Section 3.7. Rain-on-snow events can also add to flooding, particularly in streams in the Chehalis Basin originating in the snow-dominated areas of the Olympic Mountains and Cascade Range foothills (Perry et al. 2016).



Floods that cause substantial damage in the Chehalis Basin are typically associated with a 10-year flood, with increasing damage for larger events (WSE 2014b). Table 3.1-1 lists the estimated peak flows of the 10-year, 100-year, and 2007 floods at the three primary USGS gages. The chart on the prior page shows the highest recorded peak flows at the USGS gage near Grand Mound since 1933. The five largest peak flows in the past 87 years (all above 50,000 cfs) have occurred since 1986 (December 2007, February 1996, January 1990, November 1986, and January 2009). Widespread flooding and damage were associated with each of these events (WSE 2014b).

Table 3.1-1
Peak Flows at Primary Gage Locations During Major Floods

FLOOD	DOTY	GRAND MOUND	PORTER
10-year	18,760	45,350	51,680
100-year	37,000	75,000	89,500
December 2007	52,600	79,100	86,500

Note: Flows are in cubic feet per second.
Sources: WSE 2014b; USACE 2003

A one-dimensional hydraulic model (HEC-RAS), used for estimating flood levels, has been developed for the Chehalis River extending from upstream of Pe Ell to the mouth of the river at Grays Harbor and for the lower reaches of key tributaries (WSE 2014c). The following tributaries were analyzed with the hydraulic model:

- South Fork Chehalis River
- Stearns Creek
- Newaukum River
- Dillenbaugh Creek
- Salzer Creek
- Skookumchuck River
- Hanaford Creek
- Lincoln Creek
- Independence Creek
- Black River
- Satsop River
- Wynoochee River

The hydraulic model was developed using highly accurate topographic data obtained through recent Light Detection and Ranging (LiDAR) mapping, topographic data obtained from river channel surveys, and data from recent floods to ensure it accurately depicts flood levels and floodplain areas to the extent feasible. The model has been used to analyze and map flood conditions and floodplain areas, and was most recently updated for the purpose of evaluating benefits and impacts of flood damage reduction alternatives (WSE 2014c). The model was also used to determine the extent of the 100-year floodplain along the Chehalis River and in lower reaches of the listed tributaries affected by the Chehalis River. The 100-year floodplain represents the extent of area that would be flooded during an event that has a 1% chance of occurrence in any year, otherwise referred to as the Chehalis River floodplain for this analysis.

Chehalis River Floodplain

There are many different floodplain maps that illustrate the extent of flooding in the Chehalis Basin, the most common being the FEMA floodplain maps. However, to determine impacts from Large-scale Flood Damage Reduction Actions on the Chehalis River 100-year floodplain, a model by Watershed Science and Engineering (WSE 2014c) was used. This Chehalis River floodplain differs from the FEMA flood maps in that the floodplain extent and elevation has been refined based on observed and modeled floods in the Chehalis Basin.

In some cases, the Chehalis River floodplain continues upstream on some tributaries. The floodplain associated with these tributaries represents modeled surface water elevations in these tributaries during a 100-year flood on the Chehalis River.

Figure 2.2-2 in Section 2.2 shows a map of the Chehalis River floodplain and the listed tributaries. On the Chehalis River, floodplains are generally narrow in the upper part of the Chehalis Basin where gradients are steeper and the river channel is more incised. Floodplains are much wider in the low-lying Chehalis River valley, which allows a major flood to spread out, thus storing water and reducing the peak flow (WSE 2014b). The lowest 13 miles of the Chehalis River (starting near Montesano) are tidally influenced (GHLE 2011), meaning the tidal elevation directly affects the flood level along the Chehalis River. In communities adjacent to Grays Harbor (Aberdeen, Hoquiam, South Aberdeen, and Cosmopolis) and those adjacent to the Pacific Ocean (Ocean Shores and Westport), coastal flooding is caused by high tides and strong winds from winter storms that produce storm surges. Weather fronts that produce storm surges also bring heavy rains, which can worsen flooding when combined with high tides (FEMA 2011).

Chehalis and Centralia both have urbanized areas within the floodplain, as do several other towns, unincorporated areas, and tribal communities within the Chehalis Basin. An estimated 1,385 residential and commercial structures are located within the Chehalis River floodplain. Additional structures exist in tributary floodplains. An estimated 2,040 structures were flooded during the December 2007 flood. An estimated 73 structures in the Chehalis River floodplain are predicted to flood with more than 5 feet of water during a 100-year flood (WSE 2014d). The Chehalis-Centralia area has the highest concentration of residential and commercial structures in the Chehalis River floodplain, and sustains the most damage during a major flood. In the communities adjacent to Grays Harbor and the Pacific Ocean that are subject to coastal flooding (Aberdeen, Hoquiam, Ocean Shores, Westport, and unincorporated Grays Harbor County), there are an estimated 5,041 structures within the coastal floodplain. All of these structures could experience coastal flood damage to some extent during a 100-year flood (Franklin 2016).

3.1.2.3 Minimum Instream Flows

Minimum instream flows were established for the Chehalis Basin in 1976 by Ecology (Washington Administrative Code [WAC] 173-522) to protect and preserve instream resources and uses such as fish and wildlife, aesthetics, water quality, navigation, livestock watering, and recreation. Instream flow is established as a streamflow (in cfs) at a specific location on a river or stream. It is a water right to protect the quantity of flow for instream resources, which is often defined as a range (or regime) and usually changes from month to month (Ecology 2015a). Minimum instream flows were established for 31 locations in the Chehalis Basin, 5 of which are located on the mainstem Chehalis River.

In addition to establishing minimum instream flows under WAC 173-522, four streams in the Chehalis Basin were closed to further consumptive appropriation during late spring and summer. This additional closure increased the total number of closed streams in the Chehalis Basin to 24. The five minimum instream flow control locations on the Chehalis River are at its confluence with Elk Creek and with the Newaukum River, at Grand Mound and Porter, and below its confluence with the Satsop River. At Grand Mound, minimum instream flows range from 165 cfs in August and September to 1,300 cfs from December to April (Anchor QEA 2016a). At this location, instream flows have been below the minimum for up to 42% of the days in a year (Anchor QEA 2016a). Minimum instream flows have also been less likely to be met from May through August.

Tributaries for which minimum instream flows were also established for are as follows:

- Elk Creek
- South Fork Chehalis River
- South Fork Newaukum River
- North Fork Newaukum River
- Newaukum River
- Salzer Creek
- Skookumchuck River
- Black River
- Cedar Creek
- Porter Creek
- Cloquallum Creek
- East Fork Satsop River
- Decker Creek
- Middle Fork Satsop River
- Satsop River
- Wynoochee River
- Wishkah River
- East Fork Wishkah River
- West Fork Hoquiam River
- Middle Fork Hoquiam River
- East Fork Hoquiam River
- Humptulips River
- Elk River
- Johns River
- Newskah Creek
- Charley Creek

During the period of time when instream flows are below the minimum established for the Chehalis Basin, the holders of water rights issued after March 10, 1976 (junior water rights), may be required to stop withdrawing water. The first curtailment orders in the Chehalis Basin were issued on June 5, 2007. On July 30, 2015, Ecology issued curtailment orders to 93 water users with irrigation water rights from a surface water source in the Chehalis Basin to stop diverting water because of the low streamflow experienced (Gallagher 2015). Curtailment orders were also issued on May 20, 2016. Curtailment orders for junior irrigation water rights extend through the end of the irrigation window (October 1), although a handful extend to October 15. Section 3.1.4 provides more information about water rights in the Chehalis Basin.

3.1.2.4 Chehalis River Water Quality

A variety of factors influence the water quality of the Chehalis River, including land use, land cover and vegetation, changes in flow regimes, hydromodification (such as levees and bank armoring), and pollutant discharges from discrete or point sources (such as WWTPs) and nonpoint sources (such as stormwater runoff). In the undeveloped upstream areas of the watershed with good forest cover, little to no development, and limited impervious surfaces, the water quality of the Chehalis River is generally good (Anchor QEA 2014; Ecology 2016a). Downstream—in areas dominated by agricultural lands that lack riparian forest cover, in cities, and in towns—water quality is generally moderate to poor (Anchor QEA 2014; Ecology 2015b).

Water Quality Assessment

Washington's Water Quality Assessment (Ecology 2016a) is administered by Ecology and identifies the water quality status of surface waterbodies in the state. This assessment is required by the Clean Water Act Sections 303(d) and 305(b). The Water Quality Assessment identifies the following five water quality categories:

- **Category 1** – Meets tested standards for clean waters
- **Category 2** – Waters of concern
- **Category 3** – Insufficient data
- **Category 4** – Polluted waters that do not require a TMDL and have pollution problems that are being solved in one of three of the following ways:
    - **Category 4a** – Has a TMDL
    - **Category 4b** – Has a pollution control program
    - **Category 4c** – Is impaired by a non-pollutant, such as low water flow
- **Category 5 –** Polluted waters that require a TMDL or other water quality improvement project; Category 5 waters are placed on the 303(d) list of waters whose beneficial uses (e.g., aquatic life uses, recreation, water supply) have been impaired by pollution

The primary water quality parameters that are discussed in this EIS are temperature, DO, pH, turbidity, nutrients, chlorophyll-a, and fecal coliform bacteria. Other water quality constituents, such as concentrations of metals and organic compounds, are also important; however, these are not generally a concern in the Chehalis River and are not discussed further in this section, with the exception of the Black River. The potential for spread of toxic contaminants during floods is discussed in Section 3.15.

The evaluation of the existing water quality conditions in the Chehalis Basin was compiled based on the following sources:

- Ecology's ambient and long-term water quality monitoring stations in the mainstem Chehalis River (at Dryad and Porter) and its tributaries
- TMDLs (see Section 2.4.4.1; Collyard and Von Prause 2010; Ahmed and Rountry 2004; Graber and Stoddard 2003; Ecology 2001; Rountry and Pelletier 2002; Pelletier and Seiders 2000; Jennings and Pickett 2000; Pickett 1994a, 1994b; Coots 1994)
- Other state-funded and cooperative studies (Anchor QEA 2012, 2014; Green et al. 2009)
- *Chehalis Basin Watershed Management Plan* (CBP 2004)

The applicable water quality standards for the Chehalis River and its tributaries are identified in Appendix D, Table D-1. These standards identify designated beneficial uses, establish specific numeric and narrative criteria that must be maintained to support the designated use, and establish policies for anti-degradation to protect the state's surface waterbodies. The beneficial uses in the Chehalis River that would be affected by actions in the Chehalis Basin Strategy are aquatic life uses and recreation.

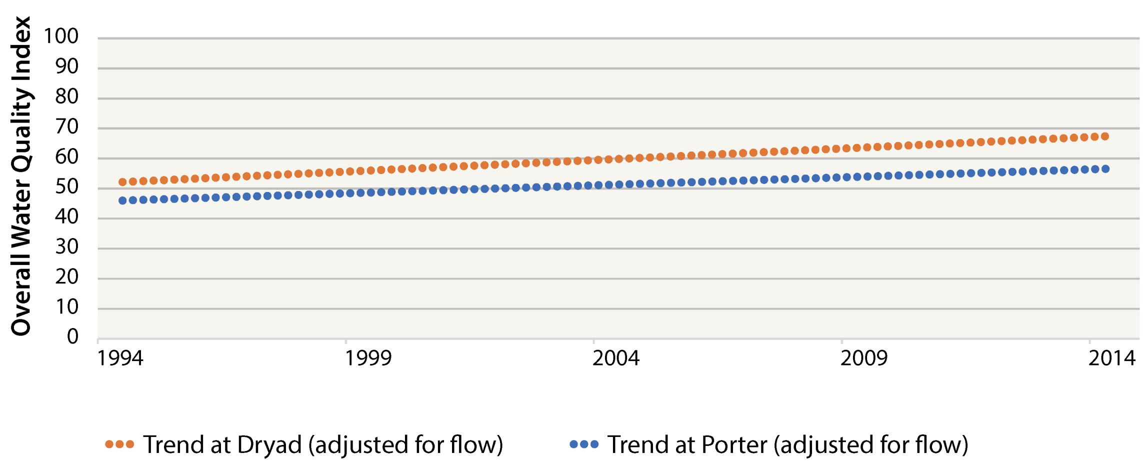
3.1.2.4.1 Long-term Water Quality Trends

Ecology has developed a water quality index (WQI) record to summarize and present water quality data in a general, easily interpreted, and numeric format for rivers and streams in Washington. A WQI ranges numerically from 1 to 100. The higher the WQI, the better the quality of the water. In general, a score of 80 and above is of the lowest concern and represents good water quality, scores 40 to 80 indicate areas of moderate concern, and scores below 40 do not meet expectations and are of the highest concern with the poorest water quality (Ecology 2015c).

Ecology maintains long-term water quality monitoring stations at Dryad (RM 97.8) and Porter (RM 33), and calculates annual WQIs for the Chehalis River at these two locations. WQI is determined on an annual and monthly basis using multiple physical and chemical parameters for a 20-year record (1994 to 2014). For the following discussion, the overall WQI was used, which combines the various parameters measured (e.g., turbidity, water temperature, DO, fecal coliform bacteria). During the 20-year record, there was a trend of improvement in the overall WQI for the Chehalis River at Dryad. Based on the 2014 results, the water quality was of moderate concern (see Figure 3.1-4; Ecology 2015d). There was also a trend of improvement in overall WQI downstream at Porter; however, the water quality was not as good as it was upstream at Dryad. Ecology has listed water quality at Porter to be of moderate concern (see Figure 3.1-4; Ecology 2015e).

The station WQI rating represents an overall categorization of the water quality at these two Chehalis River locations based on data from the combination of numerous water quality parameters. However, Ecology's sampling results show lower or degraded water quality for specific water quality parameters (such as water temperature and DO), which are discussed in the following sections.

Figure 3.1-4
Overall Water Quality Index Trends for Chehalis River (1994 to 2014)



Source: Ecology 2015d, 2015e

3.1.2.4.2 *Temperature*

Water quality in the mainstem Chehalis River is degraded during summer months when water temperatures are high and DO concentrations are low (Anchor QEA 2014). Because most of the extent of the mainstem Chehalis River downstream of Pe Ell is wide, lacks a viable riverbank (riparian) forest that provides shade, and has shallow water depths, direct solar heating of the water surface occurs and results in warm water temperatures. Water temperatures routinely exceed the water quality standards criteria for applicable aquatic life-designated uses (see Appendix D, Table D-1). The spawning and incubation temperature criteria along the upper mainstem that apply from September 15 to July 1 have also reported exceedances (see Appendix D, Figures D-1 and D-2; Ecology 2011a). Based on data collected by Ecology, the lower mainstem is identified in Ecology's Water Quality Assessment as a water of concern (Category 2) for temperature (Ecology 2016a).

Based on Ecology's continuous data collected at its long-term station at Dryad, the highest daily water temperature recorded at this station was 28°C on July 29, 2009—well above the maximum temperature criterion of 16°C for core summer salmonid habitat, which is applicable upstream of RM 90 on the mainstem Chehalis River. The earliest routine monthly water temperature data available for Dryad is from 1978, which indicated that high peak summer water temperatures also occurred that year.

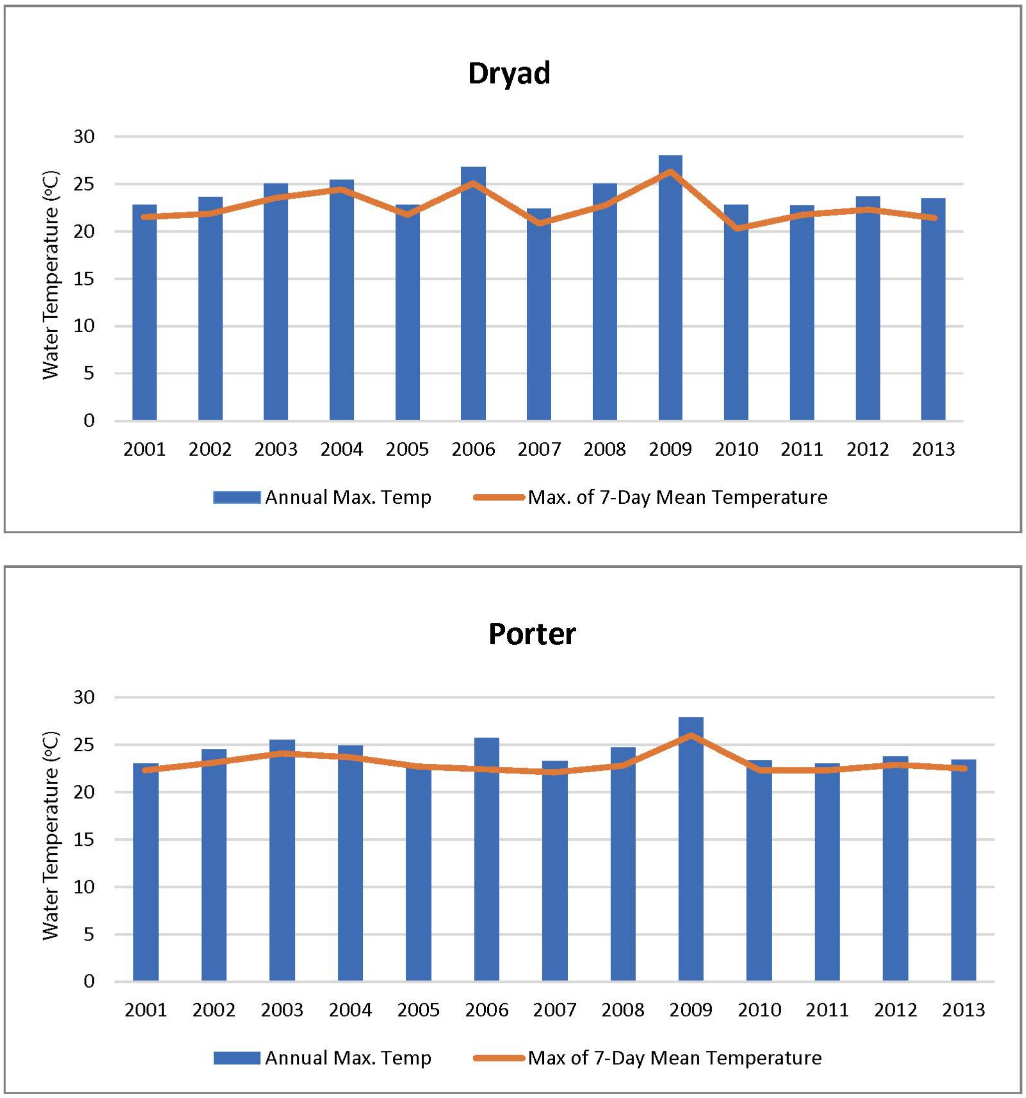
By 1978, the upper watershed had been logged and the lands adjacent to portions of the mainstem Chehalis River had been cleared for agricultural and rural residential uses, which likely contributed to the elevated temperatures. The Chehalis River most likely had cooler water temperatures prior to land clearing and timber harvesting because a mature, vegetated, riparian corridor and adjacent valley forestlands would have limited direct solar heating of the water surface. Water temperature data was collected by Ecology from May 19 to September 15, 2015. The mainstem Chehalis River exceeded the temperature criterion of 16°C throughout the study period, with the peak water temperature of 26.5°C recorded on July 5, 2015 (Ecology 2016b).

Similar to Dryad, Ecology records continuous water temperatures at Porter (RM 33). Based on these data, water temperatures are consistently warm and exceed applicable aquatic habitat temperature criterion in the late spring and fall (see Figure 3.1-5). Based on data collected by Ecology at Porter since 2001, the peak water temperature was recorded on July 29, 2009 (27.9°C)—the same date as the recorded maximum temperature at Dryad.

High summer water temperatures occur along the entire mainstem downstream of Pe Ell (Anchor QEA 2014; Ecology 2016b, 2015d, 2015e; Green et al. 2009). In the upper Chehalis River (above Centralia), results from other water temperature monitoring programs (Anchor QEA 2014; Ecology 2016b) show similar results of high summer water temperatures. Areas of slightly lower water temperatures do occur throughout the mainstem where tributaries and groundwater provide cool-water inputs.

Because of these high temperatures and the previous Water Quality Assessment Category 5 listing for water temperature in the upper Chehalis Basin, a TMDL for water temperature was developed and approved in 2001 (Ecology 2001). The temperature TMDL for the upper Chehalis River was partially based on the development of a functional riparian corridor to limit heating and help improve conditions for aquatic species, including salmonids (Ecology 2001). However, a Basin-wide functional riparian corridor would take decades to develop as trees are planted and reach the necessary heights to provide a shading function. Based on Ecology's latest water quality assessment, the lower mainstem Chehalis River is listed as a water of concern for temperature (Category 2), and as a water requiring a TMDL for temperature (Category 5) due to peak elevated water temperatures (Ecology 2016a). The Category 5 listings are based on water temperature exceedances measured immediately upstream of the confluence of the Satsop River near Elma (Ecology 2016a).

Figure 3.1-5
Chehalis River Maximum Water Temperature (2001 to 2013)



Source: Ecology 2015d, 2015e

3.1.2.4.3 Dissolved Oxygen

DO, the measure of oxygen concentration in water, is an important factor in water quality because it is necessary for aerobic (oxygen-requiring) aquatic species, including fish species such as salmon. DO is affected by wind, water temperature, flow, water depth, aquatic species respiration (primarily plankton, attached algae, aquatic vegetation, and sediment bacteria), and other biological and chemical processes. Past studies have identified biochemical oxygen demand (oxygen required by organisms in water to break down organic materials including pollutants), eutrophication (nutrient enrichment), and resulting algal growth as probable causes of low DO problems in the Chehalis River (Pickett 1992).

High water temperatures result in low DO concentrations because as water temperatures increase, water's capacity to hold DO decreases. Seasonal DO patterns in the Chehalis River follow changes in flow, temperature, and biological activity. DO levels are lower in summer when flow is low, waters are warmer, and biological activity is high; and are higher in winter when flows are higher, water is cooler, and biological activity is subdued. Low flows and warm temperatures cause the "Twin Cities Reach" of the Chehalis River (between the Newaukum and Skookumchuck rivers) to stratify, allowing cooler, anoxic (DO-depleted) pockets to form in deeper areas. Findings from different studies have indicated that the upper Chehalis River does not meet the minimum DO criterion for areas designated as core summer salmonid habitat during summer months under water quality standards (Collyard and Von Prause 2010; Anchor QEA 2012, 2014). DO criteria for the Chehalis River are greater than 9.5 milligrams per liter (mg/L; upstream of the confluence with the South Fork Chehalis River), and greater than 8.0 mg/L downstream of this confluence. In an effort to improve these conditions, a TMDL is currently in place to restrict the inputs of oxygen-demanding substances such as ammonia and organic carbon, during the dry period (summer low-flow conditions; Pickett 1994a; Jennings and Pickett 2000). Inputs can be from point sources such as WWTPs, or distributed sources such as groundwater discharge or agricultural runoff. Both the lower (near Elma) and upper mainstem (near Dryad) Chehalis River are listed as Category 5 (requiring a TMDL) for DO (2016a). Based on data collected at Porter, a segment of the mainstem Chehalis River is identified in Ecology's Water Quality Assessment as a water of concern (Category 2) for DO (Ecology 2016a).

3.1.2.4.4 pH

pH is a measurement of the acidity or alkalinity (basicity) of water. It is primarily affected by photosynthesis and respiration cycles of phytoplankton, attached algae and aquatic plants, and chemical reactions in the sediments. Higher and lower pH values, if not caused by natural processes, are likely associated with other pollution problems, such as nonpoint organic sources in the winter and eutrophication in the summer (Pickett 1992). The upper Chehalis River (near Dryad) is identified in Ecology's 2014 Water Quality Assessment as a water of concern (Category 2) for pH based on measurements collected at Ecology's ambient water quality sampling station at Dryad (Ecology 2016a). More recent data indicate that nearly all sections of the upper and lower Chehalis River meet the applicable water quality criterion for pH (Anchor QEA 2014; Green et al. 2009).

3.1.2.4.5 Turbidity and Total Suspended Solids

Turbidity is a measurement of the water clarity and is affected by surface runoff events and instream water quality. Precipitation events in the watershed mobilize solids to the stream and produce higher streamflow, which in turn can erode and resuspend sediments (as total suspended solids [TSS]), affecting the water's transparency. TSS is not a regulated parameter in state water quality standards, but elevated TSS levels contribute to high water turbidity. Turbidity can also be increased by algal blooms. Turbidity in the upper Chehalis River generally peaks in January and has been documented during winter storm events (Collyard and Von Prause 2010). Landslides also contribute to elevated turbidity in the river (Green et al. 2009). The upper Chehalis River is on the Ecology 303(d) list (Category 5) for turbidity (Ecology 2016a). In addition, a segment of the upper Chehalis River is identified in Ecology's Water Quality Assessment as a water of concern (Category 2) for turbidity at the Prather Road Bridge (approximately RM 60 near Grand Mound; Ecology 2016a).

3.1.2.4.6 Nutrients and Chlorophyll-a

Nutrients in the water, primarily ammonia, nitrate, and dissolved phosphorus, contribute to algal growth. Nutrient loadings can occur from a variety of sources, including forest and agricultural runoff, groundwater sources, on-site septic systems, industrial and municipal treatment plants, and stormwater. Chlorophyll-a, a green photosynthetic pigment found in plants and algae, is used as an indicator of potential photosynthetic activity and algal levels in a river. Excessive chlorophyll-a is indicative of algal blooms, which are detrimental to water quality—most notably to water clarity (turbidity), DO, and pH. Some algal blooms can also be toxic to aquatic life.

Previously high discharges from WWTPs and industrial point discharges degraded water quality, but have now been addressed as part of TMDLs limiting these nutrient loads to the river (Pickett 1994a; Jennings and Pickett 2000). Recent water quality data collected throughout the upper Chehalis River indicated that nutrient and chlorophyll-a levels were generally low throughout the system (Anchor QEA 2014), likely because of the lower nutrient loads from the implementation of the TMDLs. The upper Chehalis River DO TMDL limits ammonia loads to the upper Chehalis River during the summer and the fall (Pickett 1994a; Jennings and Pickett 2000). A review of Ecology's long-term monitoring stations at Dryad and Porter showed that ammonia loading to the Chehalis River was largely within the allocations in the TMDL between 2002 to 2010 (Collyard and Von Prause 2010).

3.1.2.4.7 Fecal Coliform Bacteria

Fecal coliform is bacteria that lives in the digestive tracks of warm-blooded animals and is introduced into the Chehalis River from sources such as industrial and municipal stormwater, livestock operations, farm runoff, leaky septic systems, and animal feces. Data collected at Ecology's long-term station at Dryad indicated that the highest fecal coliform loads to the upper Chehalis River occur during the first rain events in September and October, whereas data from Ecology's station at Porter showed that the lower reaches receive their highest bacterial loads in November (Ahmed and Rountry 2004). The upper Chehalis River is also a contributor of bacterial loads to Grays Harbor (Pelletier and Seiders 2000).

A TMDL is currently in effect to control bacterial loads in the upper Chehalis River (Ahmed and Rountry 2004), the lower Chehalis River, and Grays Harbor (Pelletier and Seiders 2000). Recently collected water quality data showed that considerable improvements have been achieved in reducing bacterial levels in the upper Chehalis River since implementation of the upper Chehalis River TMDL (Ecology 2016a, 2015e; Collyard and Von Prause 2010). However, the upper Chehalis River is still identified in Ecology's 2014 Water Quality Assessment as a water of concern (Category 2) for fecal coliform bacteria concentrations that exceed the criteria at specific locations (Ecology 2016a).

3.1.2.5 Tributary Water Quality

Several tributaries represent the larger flow contributors to the mainstem Chehalis River and Grays Harbor. Flow information and water quality conditions in the major tributaries to the Chehalis River and Grays Harbor are described in this section, and information on other tributaries is presented in Tables 3.1-2 through 3.1-4. In both the text and in Tables 3.1-2 through 3.1-4, tributary information is presented in order from upstream to downstream along the mainstem Chehalis River, and from east to west along the boundary of Grays Harbor.

3.1.2.5.1 South Fork Chehalis River

The South Fork Chehalis River has a drainage area of 48 square miles. Its headwaters start in the Willapa Hills and the river continues for 27 miles until it joins the Chehalis River near Curtis and Ceres (RM 88.3). Stillman Creek is a major tributary to the South Fork Chehalis River that joins at RM 5.1 of the South Fork Chehalis River. One active USGS gage (No. 12020800 near Wildwood) has collected flow data seasonally from October to April since 1999. The highest peak flow recorded in the South Fork Chehalis River was 12,200 cfs in December 2007. The lowest flow recorded was 4.7 cfs in October 2002 and October 2006. An Ecology gage (No. 23K060) on the South Fork Chehalis River (at RM 0.1) has been active since July 2015, and collects streamflow and river stage data, as well as water quality parameters including water temperature, DO, pH, and conductivity.

The South Fork Chehalis River is identified in Ecology's 2014 Water Quality Assessment as a Category 4A water (TMDL in place) for water temperature, fecal coliform bacteria, and DO (Ecology 2016a), and is included in the upper Chehalis River TMDLs for these parameters (Jennings and Pickett 2000; Ecology 2001; Ahmed and Rountry 2004). However, a segment of the South Fork Chehalis River is identified in Ecology's 2014 Water Quality Assessment as a Category 5 water (requiring a TMDL) for water temperature upstream Curtis (Ecology 2016a); Continued elevated fecal coliform counts have resulted in the South Fork Chehalis River being identified as a water of concern (Category 2) in Ecology's Water Quality Assessment (Ecology 2016a). Sampling results from multiple studies documented peak summer water temperatures well above the applicable criteria, as well as low DO concentrations that have not met the applicable aquatic habitat criterion (Anchor QEA 2014; Collyard and Von Prause 2010; Green et al. 2009). Based on data collected by Ecology near RM 0.1, the peak water temperature recorded during the summer of 2015 (monitoring start date of August 13, 2015) was 25.1°C on August 13 (Ecology 2016c). Turbidity was low and pH was near neutral, which met applicable criteria (Anchor QEA 2014; Green et al. 2009). The South Fork Chehalis River contributes moderate amounts of phosphorus, nitrogen, and TSS to the mainstem Chehalis River (Anchor QEA 2014).

3.1.2.5.2 Newaukum River

The Newaukum River has a drainage area of 155 square miles. It starts at the confluence of the North Fork Newaukum River and the South Fork Newaukum River in the Newaukum Prairie, and continues for 11 miles until it joins the Chehalis River near Chehalis (RM 75.2; GHLE 2011). The headwaters for both the North Fork Newaukum River and the South Fork Newaukum River start in the foothills of the Cascade Range. One active USGS gage (No. 12025000 near Chehalis) has been collecting flow data since 1929. The Newaukum River has an average annual discharge of 1,600 cfs; its peak flow was recorded as 13,300 cfs in February 1996 and its lowest flow was recorded as 14 cfs in September 1949 and August 1951.

The North Fork Newaukum River is 17 miles long and has one active USGS gage (No. 12024400 above Bear Creek near Forest) that has collected flow data seasonally from October to April since 1999. The North Fork Newaukum River originates in steep hills and flows into a broad valley, causing a high stream gradient in the upper portion and a moderate stream gradient in the lower portion. The North Fork Newaukum River has a dam located at RM 12.5 to allow water to be diverted for Centralia and Chehalis, which is still used by the City of Chehalis as part of their water supply (GHLE 2011).

The South Fork Newaukum River is about 26 miles long and has one active USGS gage (No. 12024000 near Onalaska) that collected flow data year-round from 1945 to 1949 and from 1958 to 1971, and has collected flow data seasonally from October to April since 1999.

The Newaukum River is identified in Ecology's 2014 Water Quality Assessment as a Category 4A water (has a TMDL) for water temperature, fecal coliform bacteria, and DO (Ecology 2016a), and is included in the upper Chehalis River TMDLs for these parameters (Ecology 2001; Ahmed and Rountry 2004; Jennings and Pickett 2000). The Middle Fork Newaukum River continues to have elevated fecal coliform counts and is identified as a water of concern (Category 2) for fecal coliform bacteria, pH, and temperature (Ecology 2016a). The Middle Fork Newaukum River is included in the upper Chehalis TMDL for DO (Jennings and Pickett 2000). The South Fork Newaukum River is a water of concern (Category 2) for temperature and fecal coliform bacteria and is included in the upper Chehalis River TMDL for temperature and DO (Ecology 2001; Jennings and Pickett 2000). The North Fork Newaukum River is included in the upper Chehalis River TMDL for temperature and DO (Ecology 2000).

Sampling results from multiple studies documented peak summer water temperatures well above the applicable aquatic habitat criteria, as well as low summer DO concentrations that did not meet the applicable criterion (Anchor QEA 2014; Collyard and Von Prause 2010; Green et al. 2009). During the summer of 2015, Ecology's water temperature data collected in the Middle Fork, South Fork, and mainstem Newaukum River show that from May 19 to September 15, 2015, waters exceeded the temperature criterion of 16°C a total of 98, 111, and 112 days, respectively (Ecology 2016b). This represents 86%, 97%, and 98%, respectively, of the time period measured. The peak water temperatures recorded for the Middle Fork, South Fork, and mainstem Newaukum River were 22.8°C (on July 3, 2015), 25.8 °C (on July 5, 2015), and 27.9°C (on July 5, 2015), respectively (Ecology 2016b).

During sampling, pH met applicable water quality criteria (Anchor QEA 2014; Green et al. 2009). During these studies, turbidity was low to moderate (Anchor QEA 2014; Green et al. 2009). The Newaukum River is a major contributor of nitrogen, phosphorus, and suspended solids to the mainstem Chehalis River and had the highest suspended solids load of any of the mainstem tributaries included in the Anchor QEA (2014) study. Sampling by Ecology indicates that the Newaukum River mainstem fecal coliform counts are low and meet the provisions of the upper Chehalis Basin TMDL (Collyard and Von Prause 2010).

3.1.2.5.3 Skookumchuck River

The Skookumchuck River has a drainage area of 181 square miles. Its headwaters are in the Mount Baker-Snoqualmie National Forest foothills, and the river continues for 35 miles until it joins the Chehalis River near Centralia (RM 67.3). Its flow regime is captured by an active USGS gage (No. 12026400 near Bucoda) that has collected flow data since 1968. The peak flow recorded on the Skookumchuck River was 11,600 cfs in February 1996. The minimum flow recorded was 15 cfs in July 2015. Flow has been regulated by the Skookumchuck Dam since January 1971. An average of 30 cfs, and up to 54 cfs, is diverted for consumptive use at the Centralia Steam Electric Project. The Skookumchuck River also has two active gages (No. 12025700 near Vail and No. 12026150 below Bloody Run Creek near Centralia) that have been collecting flow data since 1970. The river has a steep stream gradient until Bucoda, where the gradient lessens (GHLE 2011).

The Skookumchuck Dam is located at RM 22 of the Skookumchuck River and has a storage capacity of 34,800 acre-feet. The dam is primarily for water supply, but also provides a small amount of power generation and water for a fish-rearing facility. The dam is not managed for flood control, but can provide some flood control benefits if reservoir capacity is available at the time of a storm event. Additionally, the dam contributes up to 50 cfs when natural flow drops below 95 cfs to compensate for the previously mentioned diversion (GHLE 2011).

The Skookumchuck River is identified in Ecology's 2014 Water Quality Assessment as a Category 4A water (has a TMDL) for water temperature, fecal coliform bacteria, and DO (Ecology 2016a), and is included in the upper Chehalis River TMDLs for water temperature, fecal coliform bacteria, and DO (Ecology 2001; Ahmed and Rountry 2004; Jennings and Pickett 2000). The river is identified in Ecology's 2014 Water Quality Assessment as a water of concern (Category 2) for fecal coliform bacteria, pH, temperature, and DO along additional segments not covered by an applicable TMDLs (Ecology 2016a). Sampling results from multiple studies documented that peak summer water temperatures exceeded applicable criterion on occasion. DO concentrations near the Skookumchuck River mouth also did not meet the applicable criterion (Anchor QEA 2014; Collyard and Von Prause 2010; Green et al. 2009). During sampling, water turbidity ranged from meeting background to somewhat turbid (Anchor QEA 2014; Green et al. 2009). The Skookumchuck River is a moderate contributor of nutrient and biochemical oxygen demand loads, but is a major contributor of suspended solids loads to the mainstem Chehalis River (Anchor QEA 2014). Recent studies found that the fecal coliform counts in the Skookumchuck River were elevated and did not meet the requirements of the upper Chehalis Basin TMDL (Collyard and Von Prause 2010). Ecology's water temperature data collected during the summer of 2015 (at RM 0.6) indicated that from May 19 to September 15, 2015, river waters exceeded the temperature criterion of 16°C a total of 110 days (97% of the days), and the peak water temperature was 24.7°C on July 13 (Ecology 2016b).

3.1.2.5.4 Black River

The Black River has a drainage area of 129 square miles. The Black River originates in a wetland complex located downgradient of Black Lake and flows for 25 miles until it joins the Chehalis River near Oakville (RM 47). Downstream of Black Lake, the Black River generally has a low gradient and gradual meanders. The valley along the Black River is a broad floodplain that contains numerous wetlands, lakes, ponds, swamps, and bogs (GHLE 2011). One active Ecology gage (No. 23E060 at US 12) has collected flow data since 2005, with a peak flow of 1,650 cfs measured in December 2007 and a low flow of 31 cfs measured in August 2015.

The Black River is identified in Ecology's 2014 Water Quality Assessment as a Category 4A water (has a TMDL) for water temperature, fecal coliform bacteria, and DO (Ecology 2016a). Two of the TMDL studies specifically applicable to the Black River are the wet season nonpoint source TMDL and the DO and phosphorus TMDL (Coots 1994; Pickett 1994b), which were incorporated into the upper Chehalis DO TMDL that was approved by the U.S. Environmental Protection Agency (USEPA) in 1996, and later revised and approved in 2000 (Jennings and Pickett 2000). The Black River is identified in Ecology's 2014 Water Quality Assessment as a Category 5 water for pH downstream of Waddell Creek (based on data collected by Thurston County) and a water of concern (Category 2) for pH along two segments (2016a). Sampling results from multiple studies documented peak summer water temperatures and DO concentrations that did not meet the applicable aquatic habitat criteria due to these elevated water temperatures (Anchor QEA 2014; Collyard and Von Prause 2010; Green et al. 2009). Based on data collected by Ecology near RM 2 on the Black River, the peak water temperature recorded during the summer of 2015 was 23.3°C on July 2 and July 3 (Ecology 2016c). These studies indicated that that the turbidity and pH met applicable water quality criteria (Anchor QEA 2014; Green et al. 2009). The Black River was reported to have the highest nitrogen load (as nitrate + nitrite nitrogen and Total Kjeldahl Nitrogen) to the mainstem Chehalis River of any of the tributaries included in the Anchor QEA (2014) study. Sampling results indicated that the Black River had low fecal coliform counts and met applicable primary contact recreation criterion (Collyard and Von Prause 2010; Green et al. 2009).

3.1.2.5.5 Humptulips River

The Humptulips River has a drainage area of 132 square miles. It starts at the confluence of the East Fork and West Fork in the Olympic Mountains, and the river continues for 27 miles until it flows directly into the north part of Grays Harbor, northeast of Ocean Shores. The East Fork extends 30 miles above the confluence, and the West Fork extends 32 miles above the confluence. Additional major tributaries to the mainstem Humptulips River include Big Creek, Stevens Creek, and Deep Creek. The Humptulips River and its tributaries have 320 stream miles. An active USGS gage (No. 12039005 below US 101 near Humptulips) has collected flow data since 2002, and was previously active from 1933 to 1935 and from 1942 to 1979 (previously published as USGS gage No. 12039000 near Humptulips). The mean annual flow is 1,365 cfs and the peak flow recorded was 41,600 cfs in November 2006. The minimum flow recorded was 93 cfs in August 2015.

The mainstem Humptulips River is on Ecology's 303(d) list as impaired (Category 5) for DO and pH based on data collected at Ecology's long-term ambient water quality monitoring station (Station No. 22A070 located at RM 23.6 on the mainstem of the Humptulips River; Ecology 2016a). The Humptulips River is identified in Ecology's 2014 Water Quality Assessment as a Category 4A water (has a TMDL) for temperature (Ecology 2016a). However, based on continued elevated water temperatures, the river is included in Ecology's 2014 Water Quality Assessment as a water of concern (Category 2; Ecology 2016a). In addition, the Humptulips River is listed as a water of concern (Category 2) for DO (Ecology 2016a). The Humptulips River is included in the TMDL for fecal coliform bacteria for WRIA 22 (Rountry and Pelletier 2002), but the most recent 303(d) list does not indicate any violation for fecal coliform bacteria (all listed as Category 1). In addition, a separate TMDL is in place for the Humptulips River for water temperature along the mainstem, East Fork, and West Fork to address peak summer water temperatures (Graber and Stoddard 2003). The TMDL for water temperature is based on exceedances recorded at Ecology's Station No. 22A070 (mainstem station), as well as unpublished water temperature data collected within the boundaries of the Olympic National Forest on the East Fork and West Fork (Ecology 2016a).

3.1.2.5.6 Additional Tributaries

Hydrology and water quality information for additional tributaries in the Chehalis Basin is summarized in Tables 3.1-2 and 3.1-3. These tributaries generally have moderate to good water quality, with the exception of where elevated summer water temperatures have been measured. Based on summer 2015 water temperature monitoring by Ecology (2016a), numerous tributaries have elevated peak water temperatures that exceed the applicable standards (see Table 3.1-4).

Table 3.1-2
Chehalis Basin Tributary Characteristics and Water Quality Assessment Information

TRIBUTARY NAME	ACTIVE GAGE INFORMATION	DRAINAGE AREA (SQUARE MILES)	RIVER/STREAM LENGTH (MILES)	CHEHALIS RIVER CONFLUENCE (RM)	WATER QUALITY ASSESSMENT CATEGORIES[1,2]	PARAMETERS INCLUDED IN APPROVED TMDLS
Elk Creek	• No. 12020525 (USGS) • Seasonal flow data (October to April) since 2012 • 5,970 cfs peak flow • 12 cfs minimum (October 2012 and October 2015)	58	15	102	• Category 2: Fecal coliform bacteria • Category 4A: Fecal coliform bacteria, DO	• Fecal coliform bacteria • DO
Hope Creek	None	6	6	94.7	None	None
Bunker Creek	None	36	15	84.3	• Category 2: DO, temperature • Category 4A: Fecal coliform bacteria, temperature, DO	• Fecal coliform bacteria • DO • Temperature
Stearns Creek	• No. 23J070 (Ecology) • Stage and temperature (since July 2015)	36	10	78	• Category 2: pH, temperature • Category 4A: Fecal coliform bacteria, temperature, DO	• Temperature • Fecal coliform bacteria • DO
Dillenbaugh Creek	None	17	8	74.5	• Category 4A: Temperature, DO, fecal coliform bacteria • Category 5 (Tissue): Dioxin	• Temperature • DO • Fecal coliform bacteria
Salzer Creek	• No. 23H060 (Ecology) • Flow, stage, and temperature (since July 2015) • <0.2 cfs minimum (July 2015)	24	12	69.4	• Category 4A: Temperature, DO, fecal coliform bacteria	• Temperature • DO • Fecal coliform bacteria

TRIBUTARY NAME	ACTIVE GAGE INFORMATION	DRAINAGE AREA (SQUARE MILES)	RIVER/STREAM LENGTH (MILES)	CHEHALIS RIVER CONFLUENCE (RM)	WATER QUALITY ASSESSMENT CATEGORIES[1,2]	PARAMETERS INCLUDED IN APPROVED TMDLS
Lincoln Creek (including North Fork Lincoln Creek)	None	43	11	61	• Category 2: Temperature (mainstem) • Category 4A: Temperature (mainstem and North Fork), DO (mainstem)	• Temperature (mainstem and North Fork) • DO (mainstem) • Fecal coliform bacteria (mainstem)
Scatter Creek	None	42	20	55.2	• Category 2: pH • Category 4A: Temperature, fecal coliform bacteria, DO	• Temperature • Fecal coliform bacteria • DO
Independence Creek	None	18	10	51.5	• Category 4A: DO	• DO
Garrard Creek	None	28	11	44.8	• Category 2: DO • Category 4A: DO	• DO
Rock Creek	None	26	13	39	• Category 4A: Fecal coliform bacteria, DO	• Fecal coliform bacteria • DO
Cedar Creek	None	39	15	38.8	• Category 2: pH, DO • Category 4A: DO	• DO
Porter Creek	None	40	6	33.3	• Category 2: Temperature, DO • Category 4A: DO	• DO
Cloquallum Creek	None	68	24	25.2	• Category 2: Temperature • Category 5: DO	None
Wildcat Creek (tributary to Cloquallum Creek)	None	22	4		• Category 2: Temperature • Category 4A: Ammonia-N, fecal coliform bacteria, chlorine, DO, temperature	• Ammonia-N • Fecal coliform bacteria • Chlorine • DO • Temperature

TRIBUTARY NAME	ACTIVE GAGE INFORMATION	DRAINAGE AREA (SQUARE MILES)	RIVER/STREAM LENGTH (MILES)	CHEHALIS RIVER CONFLUENCE (RM)	WATER QUALITY ASSESSMENT CATEGORIES[1,2]	PARAMETERS INCLUDED IN APPROVED TMDLS
Satsop River	• No. 12035000 (USGS) • Flow (since 1929) • 63,600 cfs peak • 147 cfs minimum (September 1994)	300	6 (mainstem) 47 (West Fork) 32 (Middle Fork) 36 (East Fork)	20	• Category 2: Temperature (mainstem, West Fork, Middle Fork); DO (mainstem, Middle Fork) • Category 5: Temperature (East Fork); DO (mainstem, East Fork, Middle Fork, West Fork)	• Fecal coliform bacteria[3]
Wynoochee River	• No. 12037400 (USGS) • Flow (since 1957) • 25,600 cfs peak • 3 cfs minimum (August 1967 [prior to dam]) • 108 cfs minimum (September 1992 [after dam]) • No. 12036000 (USGS) • No. 12035400 (USGS) • Flow (since 1926)	155	63	13	• Category 2: Temperature, DO	• Fecal coliform bacteria[4]

Notes:
1. Listings are based on the 2014 Water Quality Assessment categories, which represent the last approved list by USEPA. Definitions of assessment categories can be found in Appendix D.
2. Category 5 waters are considered the 303(d)-listed waters that require a TMDL.
3. Category definitions are included in the sidebar in Section 3.1.2.4.
4. Load allocations are included as part of the Grays Harbor TMDL even though subsequent data show the river meets tested standards for clean water (Category 1).

Table 3.1-3

Grays Harbor Tributary Characteristics and Water Quality Assessment Information

TRIBUTARY NAME	ACTIVE GAGE INFORMATION	DRAINAGE AREA (SQUARE MILES)	LENGTH (MILES)	GRAYS HARBOR DRAINAGE LOCATION	ECOLOGY 303(d) CATEGORIES[1,2]	PARAMETER(S) INCLUDED IN APPROVED TMDLS
Wishkah River	None	102	37	North side near Aberdeen	• Category 2: Temperature; DO • Category 4A: Fecal coliform bacteria	Fecal coliform bacteria
Hoquiam River	None	90	7	North side near Hoquiam	• Category 2: Temperature (mainstem), DO (West Fork) • Category 5: DO (East Fork)	Fecal coliform bacteria[3]
Elk River	None	18	10	South Bay zone near Bay City	• Category 2: Fecal coliform bacteria (West Branch and Middle Branch) • Category 4A: Fecal coliform bacteria	Fecal coliform bacteria
Johns River	None	31	8	South Bay zone near Markham	• Category 2: Temperature • Category 4A: Fecal coliform bacteria	Fecal coliform bacteria

Notes:
1. Listings are based on the 2014 Water Quality Assessment categories, which represent the last approved list by USEPA. Definitions of assessment categories can be found in Appendix D.
2. Category 5 waters are considered the 303(d)-listed waters that require a TMDL.
3. Category definitions are included in the sidebar in Section 3.1.2.4.

Table 3.1-4

Summer 2015 Tributary Water Temperature Data Collected by Ecology

STREAM NAME	STREAM MILE LOCATION	PERIOD OF DATA	TEMPERATURE STANDARD (7-DADMAX)[5,6]	NUMBER OF DAYS EXCEEDED (% OF TIME)	PEAK WATER TEMPERATURE (DATE)
Elk Creek[1]	0.6	May 19 – September 15	16°C	95 (83%)	22.3°C (July 5)
Hope Creek[1]	0.6	May 19 – September 15	16°C	91 (88%)	24.2°C (August 19)
Bunker Creek[2]	0.7	July 7 – September 30	16°C	64 (79%)	22.2°C (July 7, July 8)
Stearns Creek[3]	0.6	July 8 – September 30	17.5°C	52 (65%)	23.1°C (July 19)
Salzer Creek[4]	0.5	July 7 – September 30	17.5°C	52 (63%)	22.7°C (July 20)
Scatter Creek[1]	7.1	June 16 – September 17	16°C	80 (91%)	22.1°C (July 2)
Independence Creek[1]	0.4	June 16 – September 17	17.5°C	36 (50%)	21.2°C (July 5)
Garrard Creek[1]	1.1	June 16 – September 17	17.5°C	60 (68%)	20.7°C (July 5)
Rock Creek[1]	0.9	June 16 – September 17	16°C	75 (85%)	20.7°C (July 5)
Cedar Creek[1]	1.2	June 16 – September 17	16°C	74 (84%)	21.1°C (July 3, July 5)
Porter Creek[1]	0.4	June 16 – September 17	16°C	82 (93%)	22.3°C (July 2)

Notes:
1. Water temperature data collected by Ecology (via Tidbits) during the summer of 2015 (Ecology 2016b)
2. Water temperature data collected from Ecology Gage No. 23I070 (Ecology 2016c)
3. Water temperature data collected from Ecology Gage No. 23J070 (Ecology 2016c)
4. Water temperature data collected from Ecology Gage No. 23H060 (Ecology 2016c)
5. 16°C corresponds to 60.8°F
6. 17.5°C corresponds to 63.5°F

3.1.2.6 Grays Harbor

Grays Harbor is the second largest estuary in Washington, covering more than 90 square miles from its mouth at Westport to Montesano, and supports a large number of commercial shellfish aquaculture operations. It encompasses the tidally influenced lower reaches of the Chehalis, Humptulips, Hoquiam, Wishkah, Johns, and Elk rivers. Six zones have been established within Grays Harbor: Surge Plain, consisting of the lower Chehalis River; Inner Estuary, where the Wishkah and Hoquiam rivers drain; North Bay, where the Humptulips River drains; South Bay, where the Johns and Elk rivers drain; Central Estuary; and Estuary Mouth (Sandell et al. 2015). Grays Harbor has a tidal station at Westport (No. 9441102).

Washington State's marine water quality standards apply to Grays Harbor and are listed in Appendix D, Table D-1. Grays Harbor is identified in Ecology's 2014 Water Quality Assessment as a water of concern (Category 2) for fecal coliform bacteria, copper, DO and temperatures (Ecology 2016a). Grays Harbor was included in the WRIA 22 TMDL for fecal coliform bacteria; however, elevated fecal coliform counts continued resulting in the harbor being identified as a water of concern (Category 2) by Ecology (Ecology 2016a). Upstream sources are a major contributor to the fecal coliform loads in Grays Harbor (Rountry and Pelletier 2002). The harbor is also on Ecology's 303(d) list (Category 5, impaired water) for the insecticide dieldrin (tissue; Ecology 2016a).

A Marine Water Conditions Index (MWCI) was developed to assess the water quality trends in Washington marine waters (by region) and is based on long-term water quality data. This index is based on trends for select water quality parameters collected from 2005 to 2014 (Ecology 2015f). Over this time period, Grays Harbor was identified as having an "improving tendency" for both the outer harbor and inner harbor. An annual numeric index has been determined for each region (from 2005 to 2014) and can range from -50 to +50. A positive index score indicates a good change in water quality and a negative index score indicates a bad change. Based on the 2014 results (the most recent year for which results are available), the outer harbor's MWCI score was +7 and the inner harbor's MWCI score was -9. MWCI scores may change from year to year based on the fluctuation of natural conditions in response to climatic and oceanographic influences. To consider whether the changes are continuous and represent a significant change, yearly index scores over a 10-year time period are statistically tested. The changes in MCWI scores for both portions of Grays Harbor did not indicate significant 10-year trends.

Based on the sampling collection that occurred from 1997 to 2000 at Ecology's ambient monitoring stations, Grays Harbor (inner and outer harbor areas) had persistently high fecal coliform counts (Newton et al. 2002). The highest fecal coliform counts were measured during the winter months when tributary runoff is generally high. The inner harbor also had high ammonium concentrations, while the outer harbor station had low ammonia-N concentrations. Based on the results of this monitoring, Grays Harbor ranked among the areas of highest water quality concern based on the five indicators of marine water quality (strong stratification, low DO, limiting nutrients, high fecal coliform bacteria, and high ammonium; Newton et al. 2002).

3.1.3 Groundwater

Groundwater is present throughout most of the Chehalis Basin, and previous studies have found that groundwater moves toward marine waterbodies and larger surface water drainages in the Chehalis Basin (Drost et al. 1998). Saturated and permeable subsurface layers or geologic units that yield groundwater in recoverable quantities (via wells or springs) are called aquifers. Groundwater occurs in both unconfined and confined (bounded by impermeable material above and below) aquifers. Unconfined aquifers have a water table that is in equilibrium with atmospheric pressure and rises and falls in response to surface recharge (adding water to the groundwater system) and discharge (taking water from the groundwater system). Confined aquifers are bounded by impermeable material above and below, which prevents the groundwater from equilibrating with atmospheric pressure. Groundwater in the Chehalis Basin is often connected to surface water; the flow of water between groundwater aquifers and surface water affects surface water quantities and quality (mostly temperature), which in turn affects habitat for aquatic species.

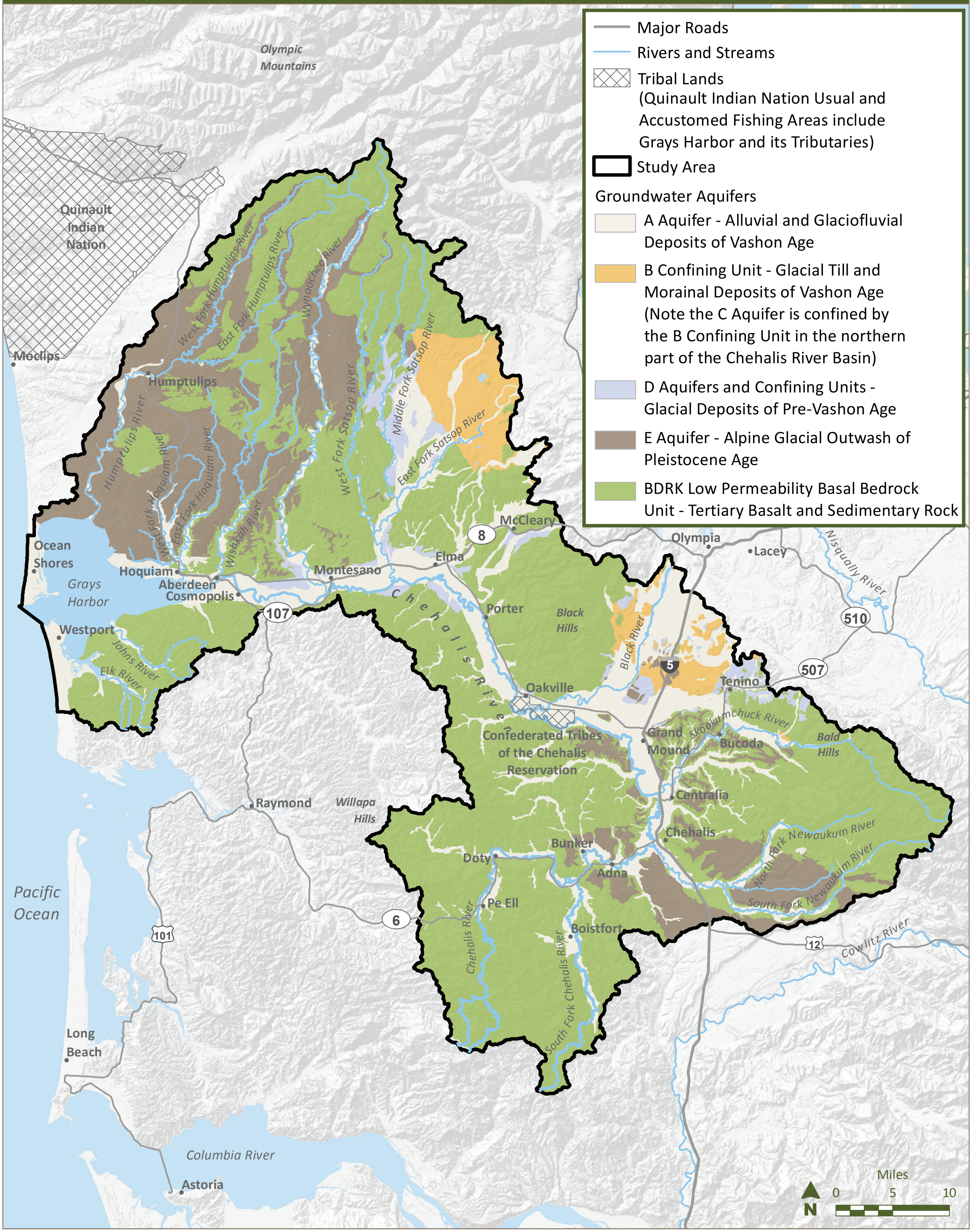
Groundwater studies for the tributaries to the lower Chehalis River (i.e., Satsop and Wynoochee) and the rivers that flow directly into Grays Harbor (i.e., Humptulips and Wishkah) are limited. Previous studies (Envirovision 2000) characterized shallow groundwater conditions for the major Chehalis River tributaries. In these tributary basins, groundwater occurs within the glacial and surficial deposits within the valleys, and is more limited where bedrock occurs in basin headwater areas (Envirovision 2000).

3.1.3.1 Hydrogeology

The groundwater within the Chehalis Basin is primarily contained within the well-sorted sands and gravels of the unconsolidated (loose) deposits of glacial outwash streams and rivers (Gendaszek 2011). These materials are capable of yielding water in significant quantities and are classified as aquifers (Gendaszek 2011). Groundwater in the shallow aquifer system in the Chehalis Basin is in close hydraulic connection to the rivers throughout most of the valley (Pitz et al. 2005). High-flow and flood conditions likely recharge the shallow groundwater table throughout the Chehalis Basin. During periods of low flow (summer conditions), the shallow aquifer(s) recharge the surface water streams and rivers.

A recent study by Gendaszek (2011) defined hydrogeologic units that characterize aquifers in the Chehalis Basin. These five hydrogeologic units were identified for the purposes of a Basin-wide groundwater and surface water interaction study. The five units include aquifers within unconsolidated (loose) and consolidated (solid) material of glacial and alluvial origin, in addition to a Tertiary bedrock unit, and are described here based on the identification and classification by Gendaszek (2011). Figure 3.1-6 illustrates the locations of these groundwater aquifers in the Chehalis Basin.

Figure 3.1-6
Groundwater Aquifers



Source: USGS

3.1.3.1.1 A Aquifer

The A aquifer is the most spatially extensive aquifer identified throughout the greater Chehalis Basin and is composed of both glacially derived and non-glacially derived materials. This aquifer is characterized as unconfined and is the shallowest or surficial aquifer found throughout the Chehalis Basin. The A aquifer comprises silt, sand, gravel, and coarser alluvial materials, with the youngest sediments consisting of the coarse-grained channel and overbank deposits of modern rivers (alluvium). Modern alluvium overlays the glacial deposits and is in direct hydrologic connection with these older units. These deposits are coarse and well sorted. South of Centralia, the aquifer is composed of older, poorly sorted, and fine-grained material, weathered from alpine glacial outwash of the Hayden Creek that comprises terraces along the Chehalis River and Newaukum River.

3.1.3.1.2 B Confining Unit

The B confining unit is mostly composed of unsorted and unstratified clay to boulder-sized particles that occur only in the northern portion of the Chehalis Basin. Within this larger unit, the fined-grained layers act as the confining unit. This B confirming unit was deposited during the last glacial advance.

3.1.3.1.3 C Aquifer

The C aquifer comprises glacial advance outwash that consists of well-sorted sand, gravel, and cobble-sized materials that were deposited during the last glacial advance. The C aquifer unit is confined by the B confining unit (in the northern part of the Chehalis Basin). In addition, pre-Vashon-Stade-age outwash in hydrologic connection is also included in the C aquifer.

3.1.3.1.4 D Undifferentiated Aquifers and Confining Units

The D aquifer comprises pre-glacial advance tills and outwash sequences deposited in the northern Chehalis Basin and the Centralia area to the north. The groundwater in this unit occurs under confined conditions within coarse-grained outwash sequences that are separated from stratigraphically higher A and C aquifers by thin till (confining) layers. Multiple aquifers and confining layers may exist within this unit where they are not differentiated (specifically identified) and laterally continuous throughout.

3.1.3.1.5 E Aquifer

The E aquifer consists of glacial outwash that consists of rocks derived from Tertiary volcanic and sedimentary rocks found in the Cascade Range and Olympic Mountains. The E aquifer occurs on the bedrock uplands of the Chehalis Basin and is derived from the alpine glacial outwash emanating from the Cascade Range and Olympic Mountains. Sedimentary rocks include siltstones, sandstones, and conglomerates. This aquifer has confining conditions where the top portions of these deposits have weathered into clay and is saturated.

3.1.3.1.6 Low Permeability Basal Bedrock Unit

The Tertiary bedrock unit consists of marine and non-marine siltstones, sandstones, and conglomerates, as well as intrusive and extrusive volcanic rocks. This Tertiary bedrock forms the underlying basal groundwater-confining unit throughout the Chehalis Basin. Limited groundwater occurs (as fracture flow) in this unit and supports local domestic water use. However, in the southern portion of the Chehalis Basin, larger quantities of groundwater can be found in the sandstone interbeds of the inferred non-marine Miocene Wilkes Formation.

3.1.3.2 Groundwater Movement and Fluctuation

Throughout the Chehalis Basin, horizontal groundwater flow follows the contours of the surface water drainage of the Chehalis River and its tributaries, and flows from the river and stream headwaters to Grays Harbor. Gendaszek (2011) studied the interaction between the groundwater and surface water in the Chehalis Basin during low-flow conditions. As part of this study, streamflow gaging and well monitoring were conducted to determine the magnitude and timing of seasonal fluctuations in groundwater levels in relation to exchanges with surface waterbodies and recharge from precipitation. In addition, a water table map was developed with generalized flow directions.

Gendaszek (2011) identified gaining (input from groundwater) and losing (loss to groundwater) reaches along the mainstem Chehalis River. Individual gains and losses ranged from 30.9 to -48.3 cfs per mile. Based on streamflow measurements, the overall gain along 32.8 miles of river (entire length of the study reach) was 56.8 ±23.7 cfs, with an average gain of 1.7 cfs per mile. The uppermost unconfined aquifer (A aquifer) exchanges water with the Chehalis River and its tributaries. The A aquifer recharges the Chehalis River during the summer when baseflow is low, and receives recharge from the surface water interface during the wet winter months. Water levels in the surficial aquifer in the upper watershed respond to stream stage due to storms, and in the lower watershed downstream of the Satsop River, water levels are influenced by Pacific Ocean tides. An earlier seepage study conducted under much lower flow conditions showed more surface water-to-groundwater interaction upstream of RM 58.8 (Ely et al. 2008). The differences between the two studies indicate temporal variability in the surface water to groundwater within the central Chehalis Basin during summer low-flow conditions (Gendaszek 2011).

3.1.3.3 Groundwater Quality

Multiple studies have characterized the groundwater quality throughout the Chehalis Basin. The most recent study undertaken by Ecology characterized the groundwater in the shallow aquifer in the vicinity of Centralia (Pitz et al. 2005). Sampling results indicate groundwater is generally cool, and is generally of good quality, with the exception of elevated nitrate + nitrite nitrogen concentrations (Pitz et al. 2005; Sinclair and Hirschey 1992). Arsenic is also naturally occurring in the groundwater within the Chehalis Basin (Pitz et al. 2005). The results of two recent groundwater studies are summarized here.

3.1.3.3.1 Hydrology and Quality of Groundwater in the Centralia-Chehalis Area Surficial Aquifer

From 2003 to 2005, Ecology undertook a hydrogeological assessment of the Centralia-Chehalis area surficial aquifer to test a standardized technical approach for a new Washington State groundwater assessment program (Pitz et al. 2005). The objectives of this study were to characterize the hydrogeological setting of the area studied, monitor and describe local groundwater and surface water interactions, and monitor and describe current ambient groundwater quality and water level conditions. The study concluded that the groundwater quality is generally good and met applicable state groundwater quality standards.

The study also concluded that there was a distinct difference in the groundwater geochemistry between the north and south areas where a difference in oxidizing/reducing conditions occurs (Pitz et al. 2005). Elevated nitrate concentrations were measured in the north area; concentrations were above 5 mg/L in the vicinity of Ford's Prairie—an area of historically high nitrate concentrations. The state groundwater criterion (WAC 173-201A) for nitrate-nitrogen is 10 mg/L (Ecology 1990). No exceedances for chloride, total dissolved solids, sulfite, or lead were recorded during the sampling duration, and volatile organic compounds were essentially absent. Sodium was found at concentrations exceeding the 20 mg/L health advisory limit in 20% of the sampled wells. Iron and manganese concentrations exceeded the secondary (aesthetic) drinking water criteria (0.3 and 0.05 mg/L, respectively) and were attributed to the reduction in conditions in portions of the aquifer system. Arsenic concentrations exceeded the state groundwater criterion of 0.05 microgram per liter (µg/L) in multiple wells throughout the sampling duration. In the area studied, the background arsenic concentration of 1 µg/L was present and represented natural conditions. One well had high concentrations of arsenic with concentrations exceeding the drinking water standard of (10 µg/L).

3.1.3.3.2 Anchor QEA Groundwater Temperature Study

A water quality characterization report was completed as part of the Chehalis Basin Strategy (Anchor QEA 2014). Groundwater temperatures were sampled during three low-flow surveys throughout the upper Chehalis Basin (September 2013, October 2013, and July 2014). Results generally showed that groundwater temperatures were significantly cooler than surface water (by up to 6°C), with an exception in October 2013 when the groundwater temperatures were slightly warmer. During the summer, the groundwater temperature in the upper reaches (above Elk Creek at RM 104) and immediately downstream of the South Fork Chehalis River confluence (RM 87) were warmer than other locations, but still cooler in the summer and warmer in October than the surface water at both locations.

3.1.4 Water Use and Water Rights

There are more than 2,500 water rights (permits and certificates) in the Chehalis Basin. Approximately 1,100 are surface water rights and 1,400 are groundwater rights. About 1,730 water rights are agricultural water rights. Of the 2,500 water rights, 2,100 are senior to minimum instream flows and

400 are junior to minimum instream flows (CBP 2004). Senior water rights are those issued before March 10, 1976, the effective date of the Chehalis Instream Flow Regulation (WAC 173-522), which set minimum instream flows to protect and preserve instream resources and uses (see Section 3.1.2.3 for further discussion on minimum instream flows). Tribal water rights are considered time immemorial and are not quantified. Next in seniority are water rights, which have been established in the upper and lower Chehalis watersheds since the adoption of the State Surface Water Law of 1917 (Revised Code of Washington [RCW] 90.03), then the State Groundwater Law of 1945 (RCW 90.44), followed by those issued prior to the adoption of the Chehalis Instream Flow Rule (WAC 173-522) in March of 1976. Junior water rights are those issued after adoption of the Chehalis Instream Flow Rule. Junior water right holders are subject to curtailment (order from Ecology to stop diverting water) when minimum instream flows are not being met

The authorized withdrawal for water rights is about 3,000 cfs. The Wynoochee Power water right consists of 1,200 cfs of this total. Approximately 620 cfs are authorized for agricultural withdrawals. In addition to the water rights, there are more than 8,400 water right claims in the Chehalis Basin, as well as around 17,000 exempt domestic wells (CBP 2004).

Actual water uses for domestic, municipal, irrigation, and livestock purposes are unknown. Very little water measurement data are available to determine actual water use, and older water right certificates perfected in the 1940s through the early 1980s generally only have the instantaneous quantity rather than the annual quantity perfected. Estimates of water use were made for the *Chehalis Basin Watershed Management Plan* (CBP 2004), which at the time showed allocated rights for the above purposes total 570 cfs in the upper Chehalis Basin (WRIA 23), though actual use is estimated to be 113 cfs (about 20% of allocated rights). In the lower Chehalis Basin (WRIA 22), allocated rights for the above purposes total 1,011 cfs, but actual use is estimated to be 42 cfs (about 4% of allocated rights). While the *Chehalis Basin Watershed Management Plan* (CBP 2004) suggested lower actual uses than water rights allocated, actual uses are unknown and may have changed over the long period of time since water rights were first issued in the Chehalis Basin. Water rights with the highest withdrawal rates are used for irrigation, fish propagation, and power generation.

3.2 Geology and Geomorphology

This section describes the geology and geomorphology of the Chehalis Basin with a focus on areas that could be affected by the EIS alternatives, which are primarily along the Chehalis River. The information in this section is largely based on data from state agencies, scientific journal articles and reports, and reports prepared for the Chehalis Basin Strategy.

3.2.1 Geology

The Chehalis Basin encompasses approximately 2,700 square miles and is one of the largest river basins in Washington. The Chehalis Basin contains both Tertiary-aged volcanic and sedimentary rock and glacially and alluvially deposited Quaternary-aged sediment. Tertiary rocks are typically basalts formed on the oceanic floor overlain by marine and nearshore sandstones and siltstones. Quaternary sediments were deposited by a variety of processes: continental glaciers, alpine glaciers, rivers, and landslides (see Figure 3.2-1).

The Willapa Hills in the area of the proposed Flood Retention Facility are primarily composed of two formations: the volcanic-derived Crescent Formation and the seafloor and nearshore sedimentary McIntosh Formation rock. The McIntosh Formation is composed of siltstone, shale, and sandstone with interbeds of basalt flows and basaltic sandstone. Coal seams are found within these units. North of the Willapa Hills, Grande Ronde Basalt (part of the Columbia River Basalt Group) overlies these older rocks. Uplift of the volcanic and sedimentary rocks resulted in the higher topography of the Willapa Hills.

The eastern side of the Chehalis Basin is bounded by the foothills of the Cascade Range. The foothills are composed of Tertiary volcanic rocks and continental (not deposited in marine environment) sedimentary rocks, typically coarse sandstone and conglomerate. Some of the sedimentary formations, most notably the Skookumchuck, are coal-bearing (DNR 2010).

Geologic Terms

- **Tertiary period –** part of the geologic time scale and ranges from 66 to 2.6 million years ago
- **Quaternary sediments –** geologically recent (younger than 2.6 million years old) unconsolidated sediment from a variety of depositional environments—loose, "young" material covering the underlying bedrock in a thin veneer
- **Cordilleran Ice Sheet –** a continental ice sheet originating in western Canada that covered large parts of Washington (as well as Idaho and Montana) and shaped its topography during the Pleistocene epoch (approximately 2 million to 10,000 years ago)
- **Puget Lobe –** part of the leading edge of Cordilleran Ice Sheet that covered lowland areas between the Olympic Mountains and the Cascade Range
- **Terminal moraine deposits –** form at the edge of the glacier and mark the maximum advance of the glacier; they consist of unconsolidated glacial debris (soil and rock), and generally form continuous curving ridges

The Olympic Mountains along the northern edge of the Chehalis Basin are similar in composition to the Willapa Hills. The core of the Olympic Mountains is composed of Tertiary marine sedimentary rocks. The sedimentary rocks consist of sandstone and siltstone, claystone, shale, mudstone and locally derived conglomerates and breccias (DNR 2010).

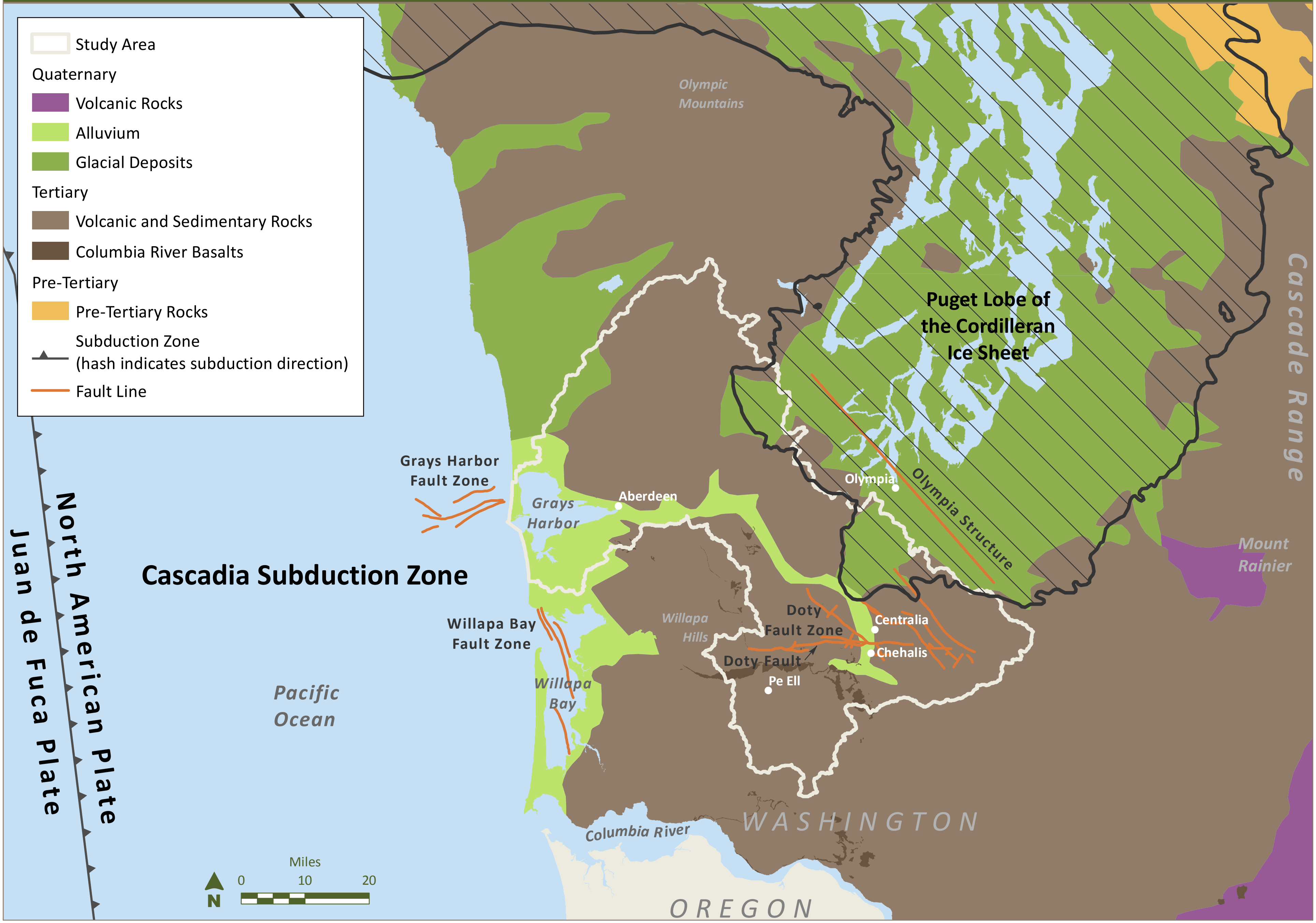
In the northern and eastern portions of the Chehalis Basin, the current landscape was mostly formed by the alpine and continental glaciations that occurred during the last ice age. The Chehalis Basin was subject to both the continental Cordilleran Ice Sheet from the north and the alpine glaciations from the Olympic Mountains and the Cascade Range.

At least twice, the Puget Lobe of the Cordilleran Ice Sheet extended into the northern portion of the Chehalis Basin (see Figure 3.2-1; Gendaszek 2011 and references therein). The last advance of the Puget Lobe occurred approximately 17,000 years ago and reached the Chehalis Basin, with the southern extent of the glacier marked by the terminal moraine deposits located north of Rochester (Gendaszek 2011). As the Puget Lobe retreated to the north (starting approximately 16,000 years ago), glacial meltwaters drained to the south through the current Chehalis River valley and deposited large sequences of recessional outwash (Gendaszek 2011).

As the Puget Lobe retreated, meltwater channels were routed through the terminal moraine creating a series of spillways and valleys, and depositing recessional glacial outwash in the Chehalis River and its tributaries (Skookumchuck River, Black River, Satsop River, and Scatter Creek; Gendaszek 2011). These recessional outwash deposits from the Cordilleran Ice Sheet were deposited as far south as Centralia and created a natural blockage that formed glacial Lake Chehalis. This lake extended from the Chehalis River and Skookumchuck River confluence to the Chehalis River and Newaukum River confluence. Alpine glaciers from the Cascade Range and the Olympic Mountains also advanced into the Chehalis Basin and deposited several sequences of drift in headwaters and valleys. It is thought that advances from glaciers from the Olympic Mountains have occurred at least four times, with the deposition of glacial till and outwash across the northwestern portion of the Chehalis Basin (Gendaszek 2011).

Figure 3.2-1

Geologic Features



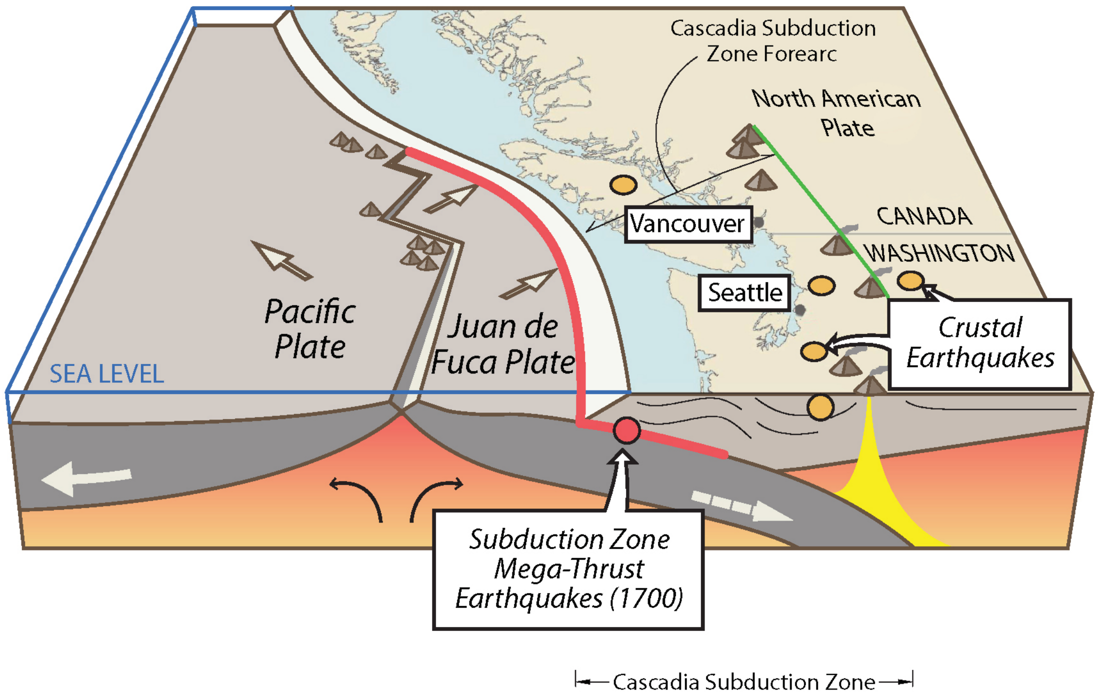
3.2.2 Seismicity

The seismic characteristics of the Chehalis Basin are important when evaluating the proposed Flood Retention Facility. The seismic characteristics are dominated by the Cascadia Subduction Zone (CSZ). There are two tectonic convergence regimes that deform the Chehalis Basin and the rest of Western Washington: the east-west contraction across the CSZ and the north-south shortening from the Juan de Fuca Plate that is subducting at an oblique northeast direction relative to the Washington coast (see Figures 3.2-1 and 3.2-2). The combined effects of the two tectonic motions produce complex and diverse deformation and can trigger large, damaging earthquakes within the Chehalis Basin.

The subduction of the oceanic Juan de Fuca Plate beneath the continental North American Plate triggers earthquakes in three sources: at the subduction plate interface; within the subducting slab; and within the shallow, overriding continental crust. At the subduction plate interface, the two plates are locked together by friction. The potential for a 9.0-magnitude (mega-thrust) earthquake exists if the frictional strength of the fault is exceeded and the fault slips (Wang et al. 2003; Atwater and Hemphill-Haley 1997; Goldfinger et al. 2003). Along the coast, this fault slip can trigger sudden land subsidence, strong ground shaking, tsunami inundation, liquefaction, and submarine landsliding.

The Doty Fault Zone is an east-west trending crustal fault zone that initiates about 5 kilometers (km) northwest of Doty and extends east to just north of Chehalis. It is the closest fault in proximity to the proposed Flood Retention Facility and is the only fault zone suspected of being active in the Chehalis Basin (HDR and Shannon & Wilson 2015). The extension of the fault zone disappears beneath the Chehalis River valley and then continues east for another 10 km for a total length of 40 to 50 km. The Doty Fault Zone is capable of producing a 6.9-magnitude earthquake (Wells and Coppersmith 1994). Other fault zones are present in the vicinity of the Chehalis Basin and include the Grays Harbor Fault Zone, Willapa Hills Fault Zone, and the Olympia Structure (see Figure 3.2-1).

Figure 3.2-2
Cascadia Subduction Zone Typical Geologic Cross Section



Source: Shannon & Wilson, Inc.

3.2.3 Landslides and Mass Wasting

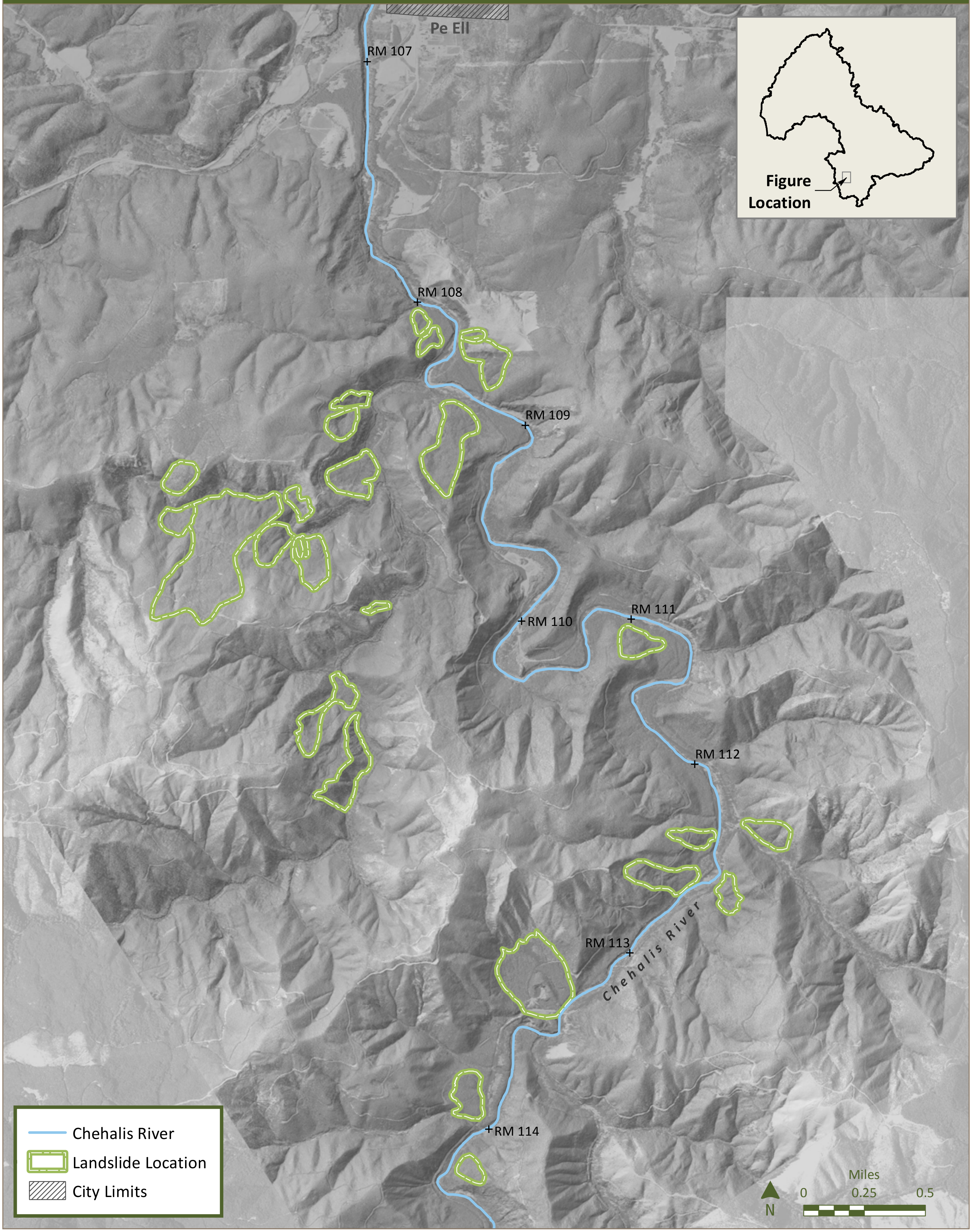
Most landslides in the forestlands of Western Washington occur during high-intensity storms when rain—often in combination with melting snow (i.e., rain-on-snow events)—saturates surface soil layers or contributes to streamflow, which can undercut the toes of adjacent landslide areas. Forest practices could contribute to the increase in landslides during storm events when rain, often in combination with melting snow (e.g., rain-on-snow events), saturates surface soil layers or contributes to streamflow, which can undercut the toes of adjacent landslide areas. For example, harvested areas or poorly designed roads on marginally stable slopes are more likely to result in landslides during normal storm events until harvested areas gain sufficient root strength to help stabilize the slope. However, changes in forest practices over recent years to avoid harvesting and road-building on unstable ground has improved the management of areas to reduce the potential of landslides (Watershed GeoDynamics 2016). The contribution of forest practices to landslides during extreme storm events continues to be debated. Additional information on the effects of forest practices on landslides during normal and extreme storm events is provided in Appendix E.

Within the Chehalis Basin, landslides and other mass wasting deposits are present in the Willapa Hills, Cascade Range foothills, and the Olympic Mountains and foothills. There are many mapped, Quaternary-aged, deep-seated landslides, and also many mapped and unmapped surficial landslides. Quaternary landslide deposits are made of heterogeneous, mostly unsorted and unstratified debris that is often identified by the presence of hummocky topography, closed depressions, springs or seeps, and an elongated form with the base wider than the top of the landslide (Shannon & Wilson 2009). Landslides are commonly triggered by above-normal precipitation or by undercutting of the slope, but can be exacerbated by human disturbance such as clearing vegetation and building roads. During the 2007 storm event, where 12 to 26 inches of rain fell in a 4-day period in parts of the Chehalis Basin (WSE 2014a), more than 1,000 landslides occurred (Sarikhan et al. 2008).

Existing landslides in the upper Chehalis Basin were mapped for geology reports completed for the proposed Flood Retention Facility (Shannon & Wilson 2015). These landslides were examined to determine whether they could become active as a result of reservoir water level operations. The location of those landslides is shown in Figure 3.2-3.

Figure 3.2-3

Landslides Near Upper Chehalis River



Source: Shannon & Wilson

3.2.4 Geomorphology

Geomorphology is the study of the formation and evolution of landforms on the Earth's surface. The movement and processes of the many rivers (fluvial geomorphology) in the Chehalis Basin play a key role in shaping the landscape, providing habitat for aquatic species, and influencing flooding and floodplain characteristics. Within the Chehalis Basin, several other factors contribute to the shape of the land, including tectonic movement, rain, snow, and wind. This section provides highlights of the key features of the Chehalis Basin related to geomorphology and fluvial geomorphology.

3.2.4.1 Chehalis River

The Chehalis River is a long, slow-moving river that drains a large watershed. The river extends for approximately 125 miles from its headwaters in the Willapa Hills downstream to Grays Harbor at Hoquiam. The Chehalis Basin ranges in elevation from approximately 3,114 feet above sea level at its headwaters in the Willapa Hills to sea level at Grays Harbor. The river downstream of Pe Ell has a low gradient, which means the elevation change of the river is relatively low (approximately 400 feet between Pe Ell and Grays Harbor).

3.2.4.1.1 Reach Characteristics

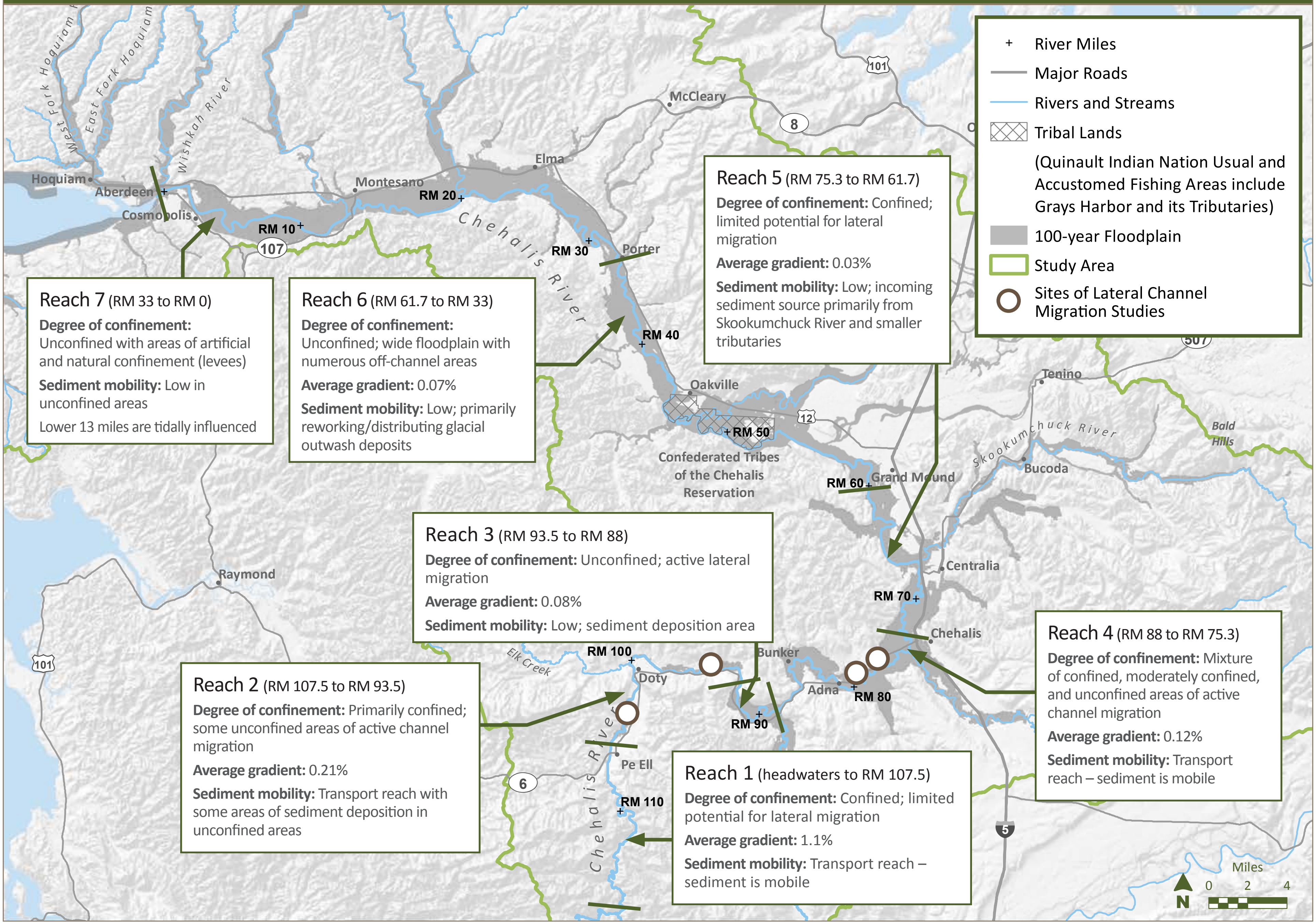
A recent study prepared for the Chehalis Basin Strategy identified six distinct reaches (i.e., segments) of the mainstem Chehalis River (see Figure 3.2-4) from its headwaters in the Willapa Hills downstream to near Porter (RM 33; Watershed GeoDynamics and Anchor QEA 2014). Each of these reaches has distinct geomorphic characteristics, detailed in the figure, related to degree of confinement within the valley, river gradient/steepness, and location of major tributary junctions. Figure 3.2-4 also provides similar information for another reach (Reach 7), the extent of which is the lower Chehalis River downstream of Reach 6 (RM 33) to Grays Harbor (RM 0).

3.2.4.1.2 Lateral Channel Migration

The Chehalis River experiences lateral channel migration (movement), which is a natural occurrence in unconfined reaches of meandering rivers with erodible banks. Channel migration occurs as a river channel migrates (or moves) within the floodplain. The force of the river’s flow has the ability to erode its banks, allowing for movement of the channel. Erosion is typical along the outside of river bends (meanders) where water velocities are high (see Figure 3.2-5). Channel migration generally occurs laterally, but migration associated with meanders often occurs in the down river (valley) direction as well.

Figure 3.2-4

Geomorphic Characteristics of the Chehalis River



A study of the Chehalis River measured lateral channel migration along the mainstem of the river at four sites between Pe Ell and Chehalis (RM 113 to 67.5; Reaches 2 and 4), which are depicted in Figure 3.2-4 (Watershed GeoDynamics and Anchor QEA 2014). The lateral channel migration was observed from a review of aerial photographs, dated from 1945 to 2013, where movement of the channel boundary could be seen. Average annual channel migration rates ranged from 0.5 to 20 meters (m) per year (net movement) during the duration of the photographic record. Channel migration rates were highest at the four sites between 2006 and 2008, where rates ranged from 2.9 to 20 m per year. The high migration rate observed during the 2006 to 2008 timeframe at the four sites is likely attributed to the 2007 flood. The most active site was located just downstream of Pe Ell (RM 104 to 105)—the first unconfined reach downstream of the confined mainstem channel segment in the upper watershed. During the 2007 event, at least one channel-spanning logjam was reported to have formed between RM 104 and 105, resulting in the formation of a new meander pattern that caused substantial bank erosion and deposition as the river cut a new channel around the logjam. The analysis concluded that the channel migration takes place mostly during small floods (1- to 2-year), in areas that are not confined by bedrock, bank protection, or infrastructure.

Figure 3.2-5
Channel Migration Illustration

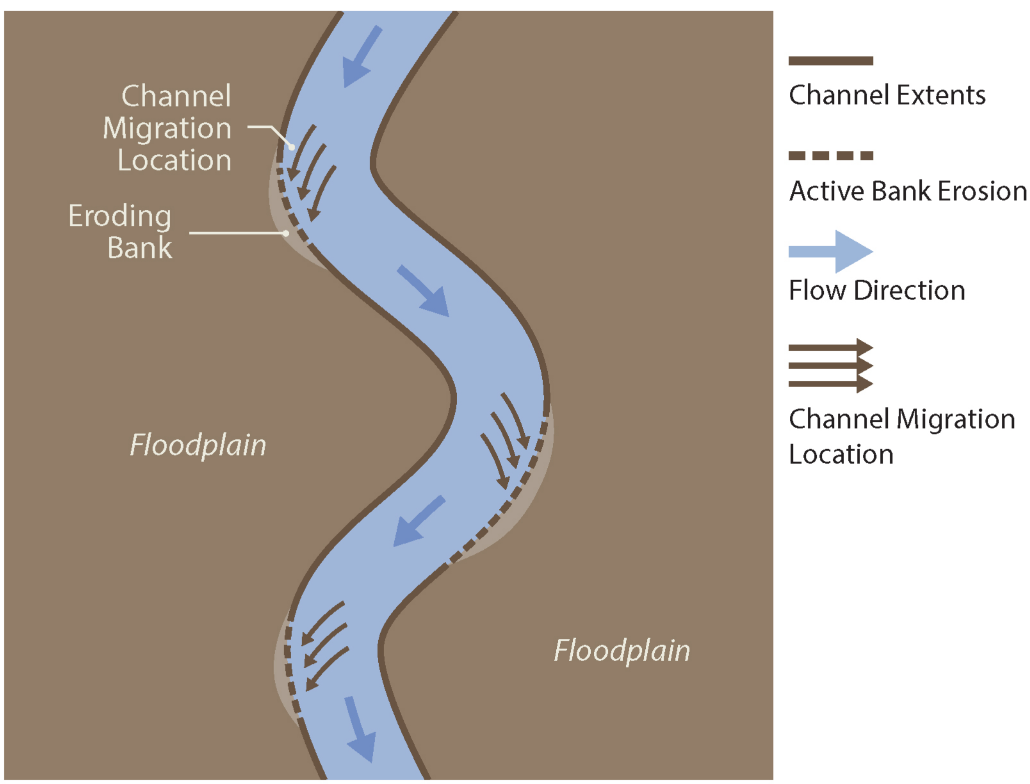


Figure based on King County 2016

3.2.4.1.3 Channel Incision

Stream and river channels are dynamic features that adjust over time to changes in watershed conditions. Stable channels could migrate within the valley, eroding sediment from one side of the channel and depositing material on the opposite side to create new bars, yet retain a consistent size, shape, and gradient over the long term. Changes in watershed conditions that trigger an increase in peak runoff or gradient of the channel can result instream channel incision, or down-cutting that disconnects the alluvial floodplain surface, which is a common mechanism of geomorphic adjustment.

Many miles of the mainstem Chehalis River have eroded below the channel's former riverbed elevation. As a result, the river has become isolated from its floodplain (see Figure 3.2-6). This down-cutting of the river, commonly called "incision," is a naturally occurring process of erosion and stream evolution; however, it can also be exacerbated by land use actions such as forest practices, urban-area stormwater runoff, and riparian zone clearing.

One of the historical practices that contributed to channel incision in forested watersheds of the Pacific Northwest was the use of splash dams to transport logs from harvest areas in the upper watershed to mills downstream. Splash dams were timber structures used to block channels and pond water for the temporary storage of logs. Such dams were widely used in the Chehalis River watershed (see Figure 3.2-7), with some dams exceeding 40 feet in height and 200 feet in width (Wendler and Deschamps 1955). Splash gates were constructed at the top of the structure and would be opened to release a sudden rush of water that sluiced the logs over the apron and carried them downstream. The sudden release of water, combined with active practices to clear the channel of any logjams that could trap the logs enroute to the mill, resulted in bed scour and channel incision. Research on the geomorphic legacy of splash dams in the Oregon Coast Range (where similar logging practices to those used in the Chehalis River watershed could be assumed) showed that splash dam releases were comparable to a 100-year flood in mainstem channels and exceeded the 100-year flood magnitude in headwater regions (Phelps 2011).

Figure 3.2-6

Example of Historically Forested Floodplain Wetland Isolated from the Chehalis River over Time

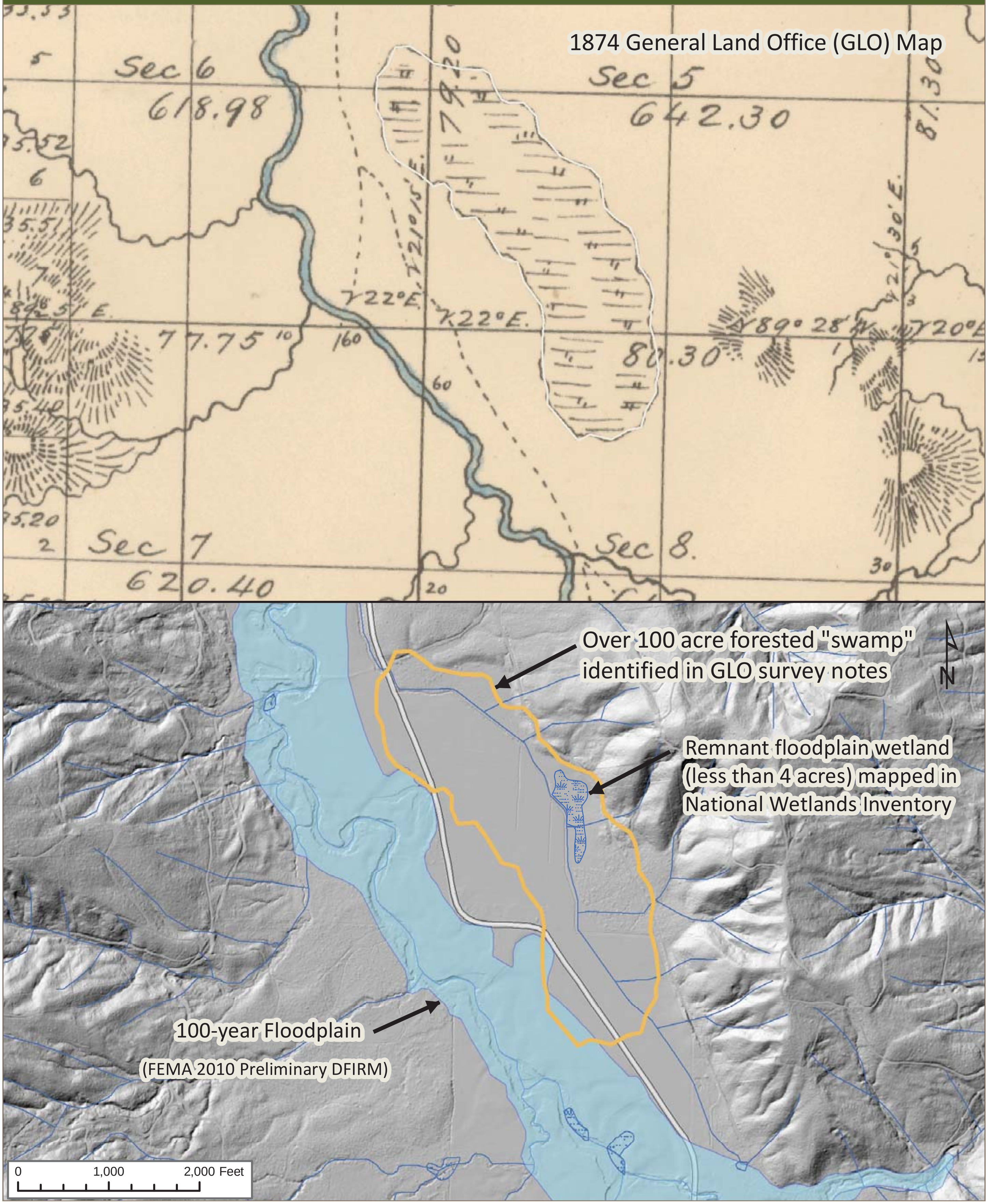
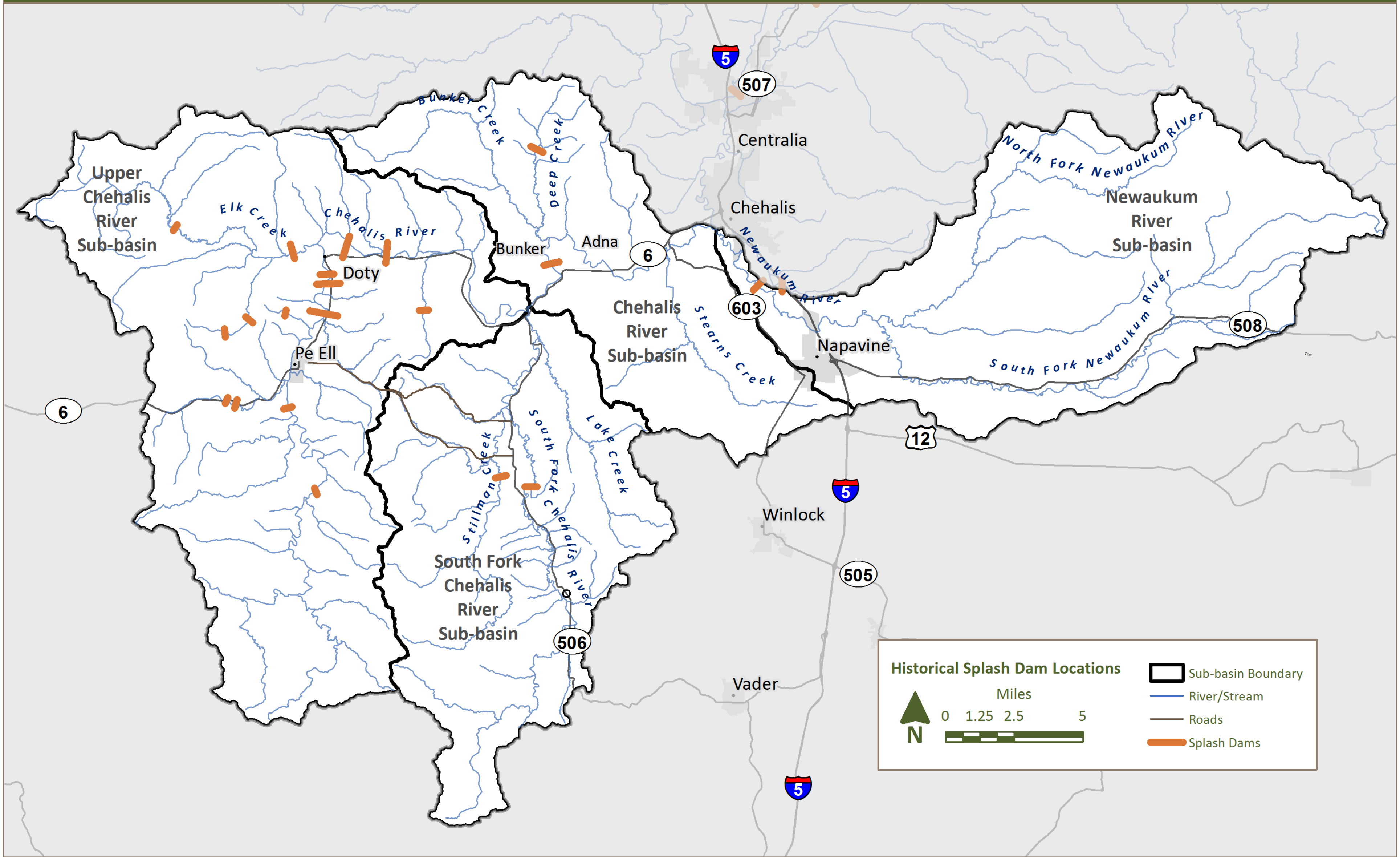


Figure 3.2-7

Locations of Splash Dams in the Restorative Flood Protection Treatment Area



Source: Modified from Wendler, Heny O. , and Gene Deschamps. 1955. Logging dams on coastal Washington streams. In *Fish. Res. Pap.* Olympia, Washington: Washington Department of Fisheries.

3.2.4.1.4 Major Floods

Floods also contribute to changes in the landscape, with a major flood providing the most dramatic changes. For example, the 2007 flood on the Chehalis River was estimated to be a 500-year flood at the Doty gage and a 100-year flood in the vicinity of Centralia and Chehalis (WSE 2014a, 2014b). The large volume of rain that came during the 2007 flood resulted in thousands of landslides within the Chehalis Basin, which provided an estimated 5.7 to 8.7 million tons of sediment to the Chehalis River system (Sarikhan et al. 2008). Of this sediment, 2.7 million tons was coarse sediment delivered in the Chehalis River headwaters, 180,000 tons was delivered between the headwaters and just north of Pe Ell (Doty gage), and 934,000 tons was delivered in the South Fork Chehalis River watershed. The combination of the largest peak flows on record, large inputs of sediment (via landslides), and wood from the headwaters of the Chehalis and South Fork Chehalis basins resulted in changes in the channel's geomorphology. In the mainstem, gravels filled the channel upstream of RM 104 and combined with large logjams to cause the river to leave its channel and create a new one around that area (called an avulsion). The deposited gravel was much finer than the cobbly material present in the channel and more suitable for salmon spawning. These deposits will continue to be transported downstream until the river reaches dynamic equilibrium. Eventually, the gravels will be transported out of that reach and the riverbed will return to cobbly conditions similar to those that existed prior to the 2007 flood. Downstream of Pe Ell, the river continues to transport this gravel as bedload. This gravel is then deposited mostly in areas where the channel is unconfined and where the river loses its ability to carry gravel-sized sediment.

3.2.4.2 Tributaries

Tributaries to the mainstem Chehalis River include the South Fork Chehalis, Newaukum, Skookumchuck, Black, Satsop, and Wynoochee rivers. These rivers can be generally characterized as having headwater areas that that are mostly composed of bedrock, with the lower reaches occupying wider valleys that have channels and floodplains consisting of alluvium and glacial deposits (mostly outwash). These generally unconsolidated deposits include cobble, gravel, sand, and finer material.

Tributaries to Grays Harbor include the Wishkah and Humptulips rivers that drain from the Olympic Mountains on the north side of Grays Harbor and the Johns and Elk rivers on the south of Grays Harbor. The Humptulips River headwater areas comprise units of the Crescent Formation basalt (DNR 2010), while the river channel and valley consist of alluvium (clay, silt, sand, and gravel), with higher valley areas consisting of glacial outwash deposited by glacial meltwaters. The Wishkah River valley consists of alluvium, glacial outwash, glacial drift, and bedrock.

The Johns and Elk rivers are low-lying rivers that drain the foothills to the south of Grays Harbor. These river basins were not subject to the alpine or continental glaciations. The channel and floodplains consist mostly of alluvium, with the higher basin areas mapped as river terrace deposits (DNR 2010).

3.2.4.3 Sediment and Sediment Transport

Sediment movement and deposition play a large role in the Chehalis Basin's geomorphology. The characteristics of the reaches and watersheds within the Chehalis Basin are often distinguished by sediment properties. Typically, alluvial river beds become finer downstream and often have an abrupt transition from gravel to sand (identified as the gravel-sand transition; Vendetti et al. 2010). Sediment sources include landslides that reach a river, erosion of river beds and banks (including lateral channel migration), and inflows of sediment from tributaries. Additionally, forest practices can increase channel-forming flows, which could cause erosion and siltation (Perry et al. 2016). There are limited sediment supply and transport data for the Chehalis Basin. A number of studies have been performed examining sediment supply and transport for the Chehalis River in geomorphic Reaches 1 through 5 as a result of the December 2007 flood (Watershed GeoDynamics and Anchor QEA 2014; Anchor QEA 2012). The lack of data and information in other reaches of the Chehalis River and in the tributaries limits the level of detail and overall understanding of sediment transport along the entire river length and the overall sediment balance in the Chehalis Basin.

In 2010, sediment sampling along the mainstem Chehalis River (approximately RM 33 to 114) found that sediment bars within the river consist primarily of gravel-sized particles with sand and cobble as the secondary substrate. Sediment size declines with distance downstream of the sediment source (as referenced in Vendetti et al. 2010). The cobble-sized sediment supply that originates in the upper watershed is transported to near Littell (approximately RM 80) and the gravel is transported to near Chehalis (RM 73). This point in the river marks the gravel-sand transition where the gravel is deposited (upstream), and only sand-sized and smaller material is transported downstream. Along the mainstem Chehalis River, this transition point occurs in Reach 5, where the gradient is very low and, under most flow conditions, the river does not have the hydraulic energy to transport larger-sized particles (gravel and cobble; Watershed GeoDynamics and Anchor QEA 2014). The low gradient a result of bedrock outcroppings which control the elevation at the downstream end of Reach 5. Downstream of the bedrock outcroppings at the Reach 5/6 transition zone, the channel gradient is steeper and the river is located in glacial deposits with readily available gravel and transport of gravel substrate.

The Chehalis River transports sediment as both bedload that moves along the bed of the river and suspended load that is carried throughout the river cross section. Bedload material is coarser (usually coarse sand, gravels, and cobbles) and is deposited within the river channel, while suspended load (usually sand, silt, and finer material) is deposited in overbank areas during floods (Watershed GeoDynamics and Anchor QEA 2014). USGS conducted studies of both bedload and suspended load along the Chehalis River based on data collected from 1962 to 1965 (Glancy 1971). These studies estimated that the bedload in the Chehalis River varied (upstream to downstream) from 6,152 tons per year at Doty, 7,066 tons per year at Grand Mound, and 6,674 tons per year at Porter—compared to suspended load estimates of 55,370 tons per year at Doty, 134,250 tons per year at Grand Mound, and 126,812 tons per year at Porter (Glancy 1971). Glancy (1971) concluded that the majority of the suspended sediment transported during peak flows came from the reworking of the river beds and bank erosion, with episodic inputs from mass wasting in the upper watershed.

The ability of the Chehalis River to transport bedload varies considerably in the reaches described in this section. The sediment transport capacity was higher in areas identified as transport reaches (areas of sediment movement), as opposed to depositional reaches (sediment depositional areas).

3.2.4.4 Large Woody Material

LWM is an important factor in fluvial geomorphology and fisheries habitat. LWM and logjams help maintain side channels, pools, forested islands, and floodplains, which are all important features for maintaining key aquatic habitats and biological diversity in rivers and streams (Abbe and Montgomery 1996; Collins et al. 2002). LWM in rivers within the Chehalis Basin is recruited during a major flood or extreme rainfall events that cause landslides and debris torrents in the upper Chehalis Basin. Less LWM is supplied from local bank erosion and channel migration. Based on an aerial photograph interpretation, the reaches of the mainstem Chehalis River with the most active channel migration (Reaches 2 and 4) also have the potential for active LWM recruitment. Based on current conditions throughout the Chehalis Basin, LWM inputs are expected with storms and associated floods with recurrence intervals of 10 to 25 years. During the 2007 flood, an estimated 115 acres of wood (as logjams in the lower river) that was 2 feet thick was deposited into the Chehalis River and adjacent floodplain, mostly from landslides in the upper Chehalis Basin (Watershed GeoDynamics and Anchor QEA 2014). Although landslides and large inputs of LWM occur in 10- to 25-year floods, the LWM deposited in the river can be mobilized during more frequently occurring high-flow events. Based on 2014 field observations, logs begin to mobilize at flows starting at 9,000 to 10,000 cfs, which is close to the 2-year recurrence peak flow at the Doty gage (Watershed GeoDynamics and Anchor QEA 2014). Although the 2007 flood produced a tremendous amount of LWM, recent surveys of LWM in the mainstem Chehalis River above its confluence with the Newaukum River showed very little LWM present in the river channel. This is due to wood removal efforts after the 2007 flood and the mobility of wood in the Chehalis River during high flows.

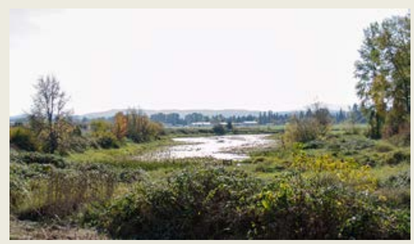
3.3 Wetlands and Vegetation

This section describes the types of wetlands and vegetation found throughout the Chehalis Basin, including plant species listed under ESA as threatened or endangered, and Washington State-listed rare plant species. There are a large variety of natural habitats within the Chehalis Basin, which include different combinations of plants, trees, and other vegetation. Wetlands are also found in several locations, and include a unique mix of plants that thrive in water or saturated soils. To identify these resources within the Chehalis Basin, scientists reviewed existing agency and tribal reports, resource maps, and aerial photographs; they also visited the Chehalis Basin to gain familiarity with the information collected from these resources.

3.3.1 Wetlands

Wetlands are transition zones between terrestrial and aquatic systems that provide a number of important ecosystem functions, including fish and wildlife habitat, water quality improvement, flood protection, shoreline stabilization, and groundwater recharge. Wetlands can occur in stream and river channels, on floodplains, in low-lying areas and depressions, around the edges of ponds and lakes, on slopes, and in estuaries and coastal areas. The Chehalis Basin also has wetlands with special characteristics including bogs, interdunal wetlands, and large wetland complexes. The primary wetlands present in the Chehalis Basin are discussed in more detail in Section 3.3.2.

Potential wetlands were identified in the Chehalis Basin using Ecology's 2011 *Modeled Wetlands Inventory* (Ecology 2011b). The *Modeled Wetlands Inventory* was completed for Ecology by the National Oceanic and Atmospheric Administration Coastal Services Center and in partnership with WDFW under a grant from USEPA. It was prepared as a state-wide update to the National Wetland Inventory (NWI), which is nearly 40 years old and considered out-of-date given the extent of land use change that has occurred in the state since the NWI maps were produced (Ecology 2015g). Wetlands identified in the 2011 *Modeled Wetlands Inventory* are classified using a variation of USFWS' *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979), which



Wetlands and Flood Storage

Wetlands provide some measure of flood protection by holding the excess runoff after a storm, and then releasing it slowly. The size, shape, location, and soil type of a wetland determine its capacity to reduce local and downstream flooding. While wetlands cannot prevent flooding, they do lower flood peaks by temporarily holding water and by slowing the water's velocity. Wetland soil acts as a sponge, holding much more water than other soil types. Even isolated wetlands can reduce local flooding; if the wetlands were not there to hold stormwater runoff, backyards and basements might end up under water.

Source: Ecology

is commonly referred to as the Cowardin system. Based on the 2011 *Modeled Wetlands Inventory* mapping, the existing wetlands in the Chehalis Basin are grouped into five major types: open water, estuarine wetlands, palustrine wetlands, unconsolidated shores, and potentially (previously) disturbed wetlands. These are further broken out into the following ten wetland cover classes:

- Open water
- Unconsolidated shore
- Potentially (previously) disturbed wetland
- Palustrine scrub-shrub wetland
- Palustrine forested wetland
- Palustrine emergent wetland
- Palustrine aquatic bed wetland
- Estuarine scrub-shrub wetland
- Estuarine emergent wetland
- Estuarine aquatic bed wetland

It should be noted that wetland classification based on aerial photograph interpretation has some degree of uncertainty and a potential for misclassification without on-site verification. For example, many of the wetlands adjacent to the Chehalis and Black rivers are classified in the EIS as palustrine forested, and might be more accurately classified as palustrine scrub-shrub based on tree height, which is difficult to determine with great accuracy on aerial photos. Additionally, the Cowardin classification does not take into account the hydrogeomorphic position of a wetland in the landscape. For example, again using the palustrine forested wetlands adjacent to the Chehalis and Black rivers, a wetland would likely be classified as riverine forested or scrub-shrub using a hydrogeomorphic classification instead of Cowardin. However, for the purposes of the EIS, the Cowardin-based Ecology mapping has been used and no effort to classify using a hydrogeomorphic system will be completed at this time.

Table 3.3-1 provides a summary of the total areas mapped by the 2011 *Modeled Wetlands Inventory* for each of these wetland cover classes within the Chehalis Basin. Figures 3.3-1 through 3.3-3 illustrate the locations of these wetland cover classes.

Table 3.3-1
Wetland Cover Classes Mapped in the Chehalis Basin

WETLAND TYPE/ WETLAND COVER CLASS	AREA IN WRIA 22	AREA IN WRIA 23	TOTAL AREA
Open water	75,266	4,113	79,379
Unconsolidated shore	27,114	176	27,290
Potentially (previously) disturbed wetland	3,398	13,545	16,943
PALUSTRINE WETLANDS			
Palustrine scrub-shrub wetland	14,722	12,112	26,834
Palustrine forested wetland	22,824	16,124	38,948
Palustrine emergent wetland	9,882	10,855	20,737
Palustrine aquatic bed wetland	97	114	211
ESTUARINE WETLANDS			
Estuarine scrub-shrub wetland	1	0	1
Estuarine emergent wetland	3,037	0	3,037
Estuarine aquatic bed wetland	3,335	0	3,335
Total Area	**159,676**	**57,039**	**216,715**

Note: Area is represented in acres
Source: Ecology 2011b

The five major wetland types and the associated cover classes, shown in Table 3.3-1 and illustrated in Figures 3.3-1 through 3.3-3, are briefly described in Appendix F with their typical locations, physical characteristics, and primary water sources. The ecological functions commonly provided by each type of wetland, the vegetation commonly found in each wetland type, and the general location and appearance of each wetland type in the Chehalis Basin are also summarized in Appendix F.

3.3.2 Wetland Complexes

Several wetland complexes occur in the Chehalis Basin. Many of these areas represent remnants of wetland systems that were once more widespread in the Chehalis Basin, but have been modified by various disturbance activities (such as agriculture, urban development, mining, and other industrial activities). For example, there are remnant wet prairies (unique glacial outwash prairies) in the Scatter Creek floodplain. The location of some of the larger and unique wetland complexes is shown in Figures 3.3-1 through 3.3-3, and described in the following sections.

3.3.2.1 Black River Wetlands

Throughout its course, the Black River meanders through a dense mosaic of riparian areas and palustrine forested, scrub-shrub, and emergent wetlands that represent one of the largest remaining undisturbed freshwater wetland systems in the Puget Sound region (USFWS 2015a).

3.3.2.2 Chehalis River Surge Plain Natural Area Preserve

This unique type of wetland system is characterized by tidal sloughs, intermittently flooded areas, and regularly flooded areas. The variety of water regimes provided in this area supports a diverse array of palustrine forested, scrub-shrub, and emergent wetlands, including the largest Sitka spruce-dominated coastal surge plain wetland in Washington (DNR 2009).

3.3.2.3 Grays Harbor Estuary

This large, relatively undisturbed estuary includes a variety of estuarine habitats, including subtidal open water areas and intertidal wetlands. The estuarine wetland types present here include low and high saltmarshes, large eelgrass and macroalgae beds, and extensive mudflats. Palustrine emergent, forested, and scrub-shrub wetlands are also present around the perimeter of Grays Harbor.

3.3.2.4 Elk River Natural Resources Conservation Area

As the largest, highest quality estuarine system remaining in Washington, this conservation area supports a wide variety of estuarine and palustrine wetland systems, including intertidal mudflats, sloughs, five types of saltmarshes, and freshwater emergent, scrub-shrub, and forested wetlands (DNR 2015a).

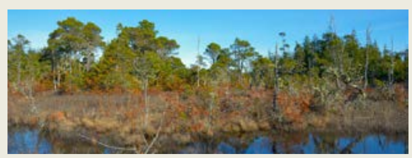
3.3.2.5 North Bay Natural Area Preserve

This preserve contains one of the highest quality coastal freshwater and sphagnum bog systems remaining in Washington (DNR 2015b).

Chehalis River Surge Plain Natural Area Preserve

Grays Harbor Estuary

Elk River Natural Resources Conservation Area



North Bay Natural Area Preserve

Photo credits: www.dnr.wa.gov

3.3.3 Wetland Mitigation Banks

In addition to the state- and federally managed wetland complexes, the Chehalis Basin also contains three wetland mitigation bank sites where state and private entities have created, restored, or enhanced wetlands and riparian systems to provide compensatory mitigation credits for various projects that have unavoidable, authorized impacts on wetlands and riparian systems. The locations of these banks (North Fork Newaukum Mitigation Bank, Chehalis Basin Mitigation Bank, and Weatherwax Wetland and Habitat Mitigation Bank) are shown in Figures 3.3-1 through 3.3-3, with a brief description of the banks provided in Appendix F.

Figure 3.3-1

Wetlands - Upper Chehalis Basin

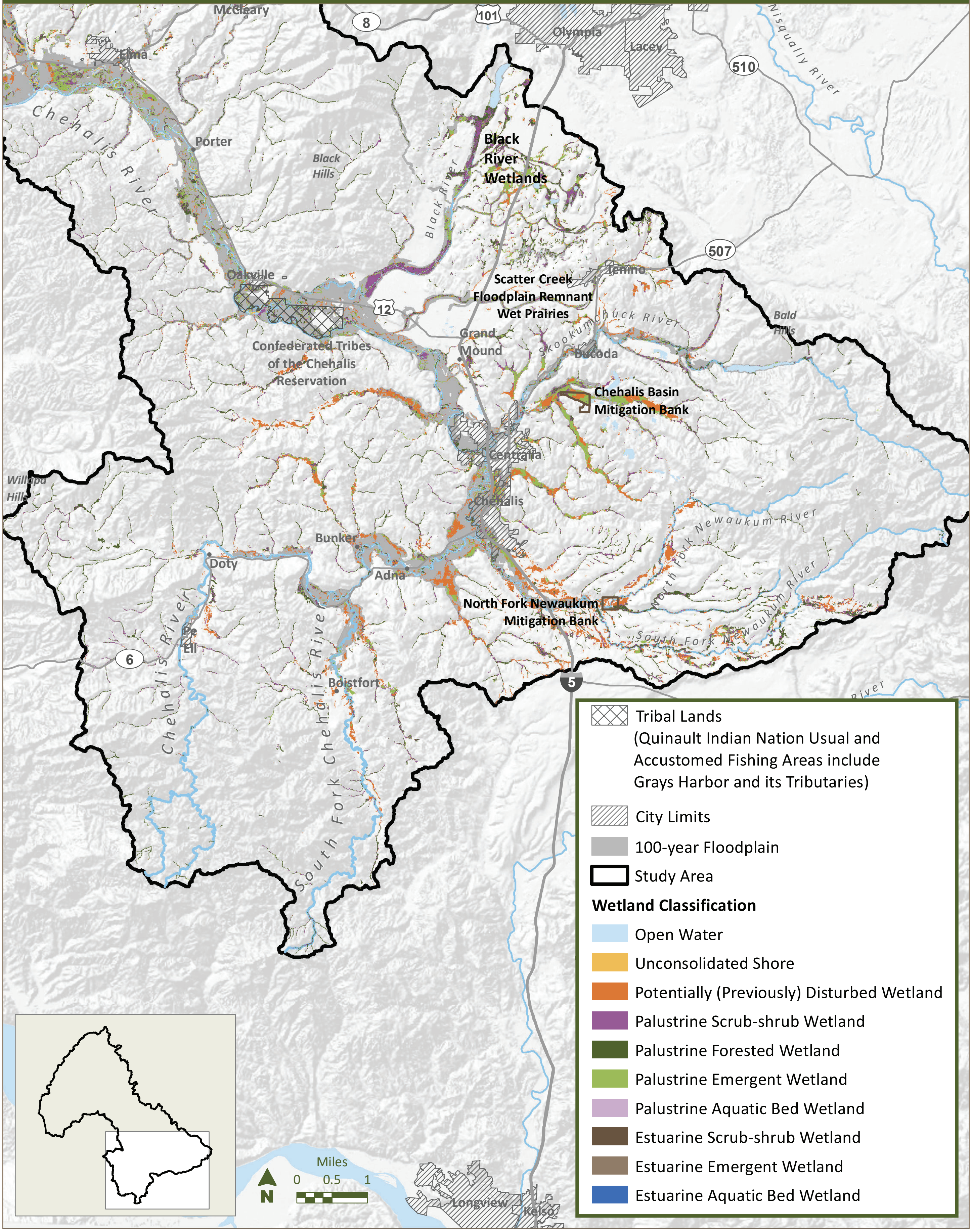


Figure 3.3-2
Wetlands - Middle Chehalis Basin

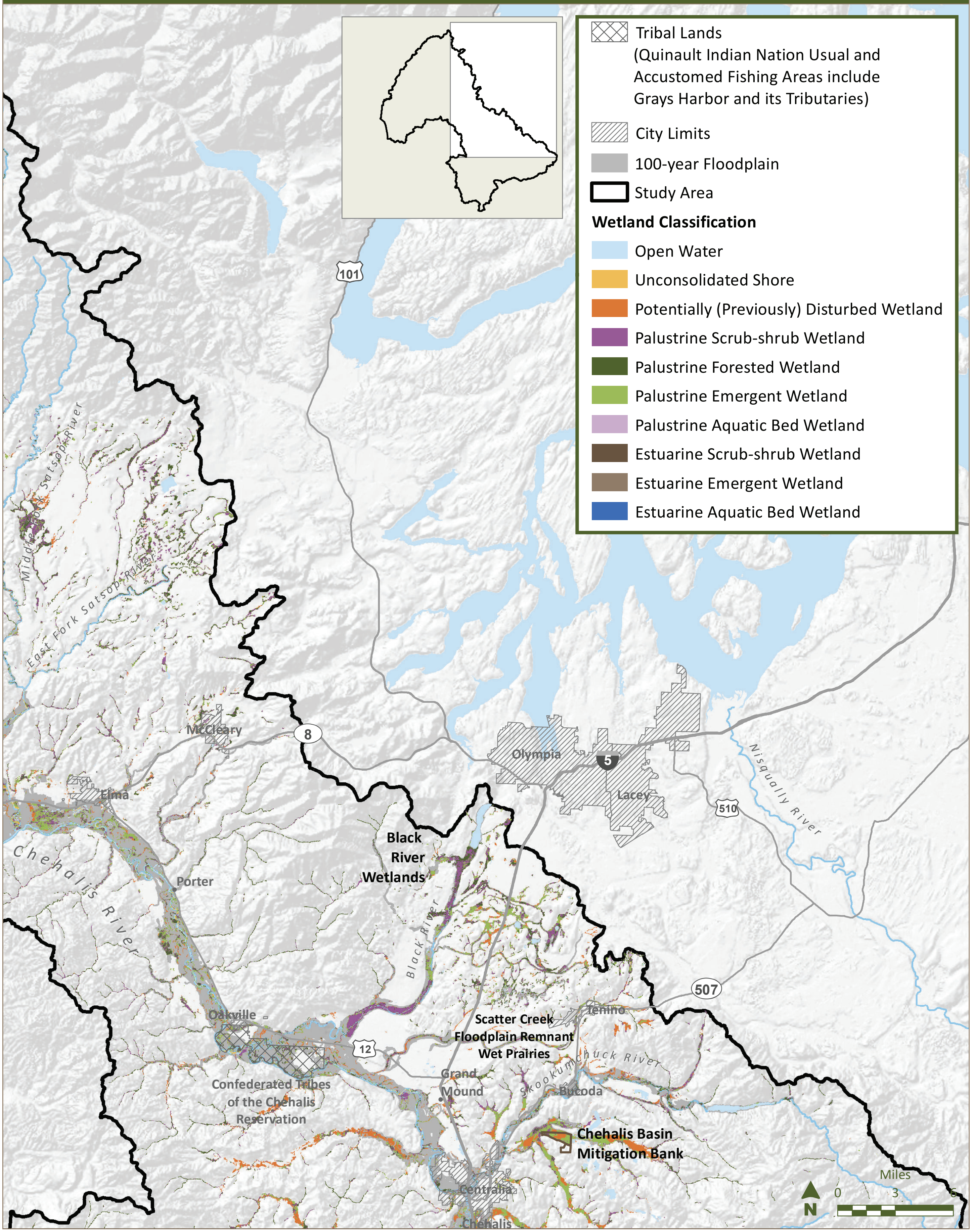
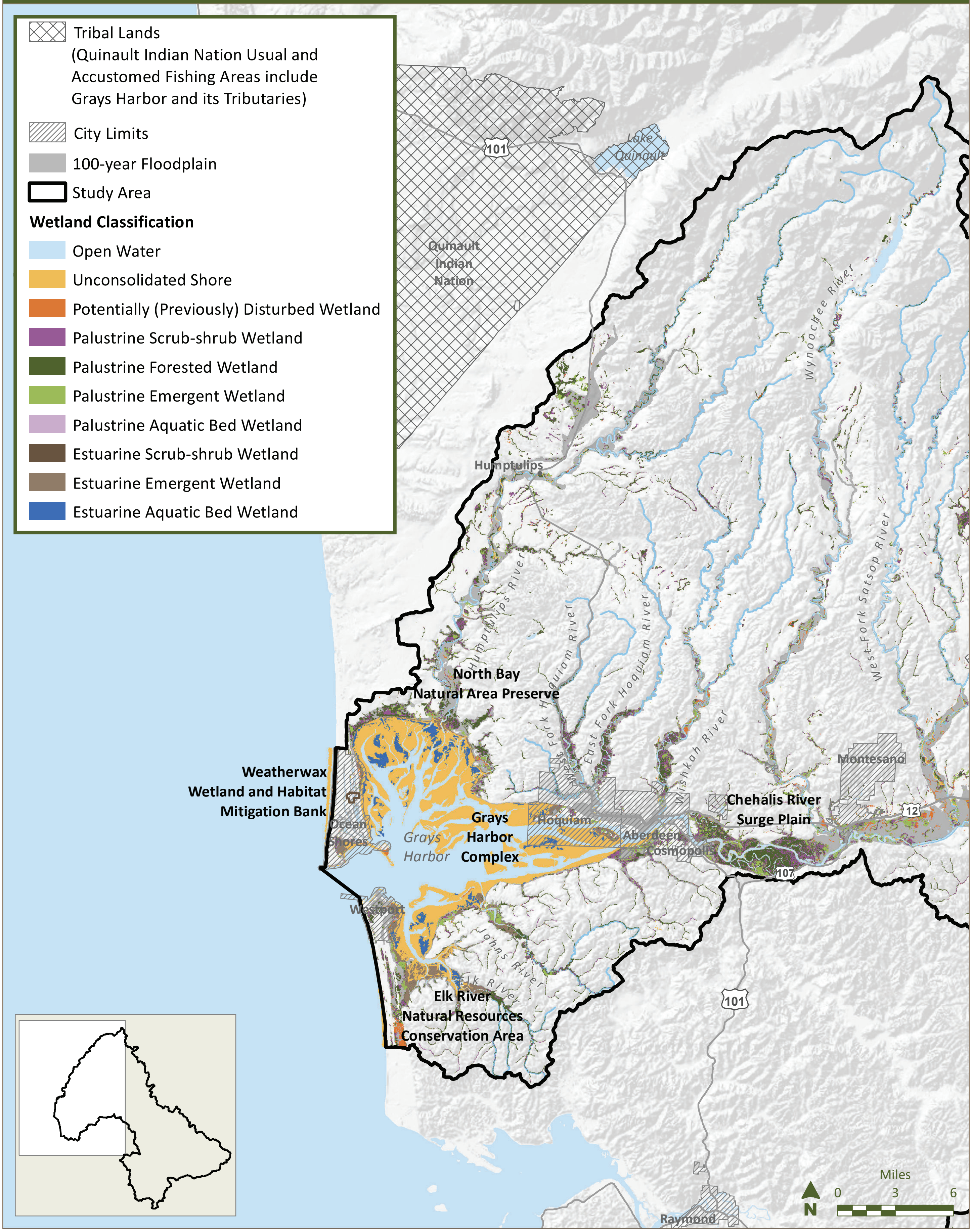


Figure 3.3-3
Wetlands - Lower Chehalis Basin



3.3.4 Vegetation

Vegetation zones are often used to differentiate habitats based on dominant tree species and/or plant associations. The map to the right shows that the Chehalis Basin lies primarily within two large-scale vegetation zones of Western Washington (the western hemlock zone and the Sitka spruce zone) and also includes areas of the Douglas fir/Oregon white oak zone—found in the prairies of the Chehalis Basin—and the Pacific silver fir zone (Van Pelt 2007).

On a finer scale, the different types of grasses, plants, trees, and land cover within the Chehalis Basin have been grouped into 11 different categories for this EIS. The vegetation and land cover categories were developed based on information from three sources: USGS National Land Cover Database, WDFW habitat surveys within the Chehalis River system, and Chehalis Basin Strategy's *Habitat Mapping and Wildlife Studies Technical Memorandum* (HMWSTS 2014).

Figure 3.3-4 shows the location of the vegetation and land cover categories within the Chehalis Basin and also depicts their general geographic extent. A detailed list of plant species commonly found within the Chehalis Basin is provided in Appendix G, Table G-1. The 11 vegetation and land cover categories are described after Figure 3.3-4. Cross-references to the vegetation and land cover terminology used by USGS, WDFW, and the Chehalis technical study are provided in Appendix G, Table G-2.

Large-scale Vegetation Zones of Western Washington

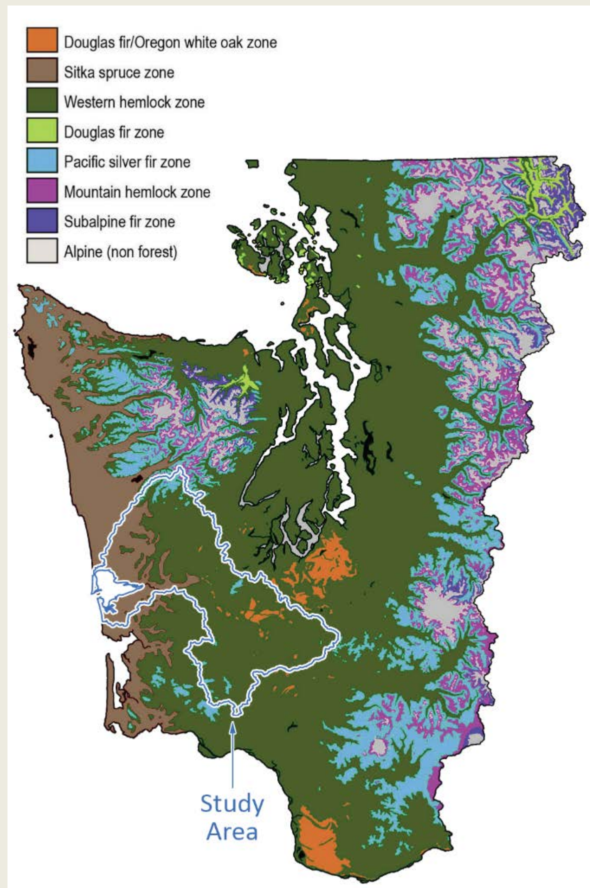
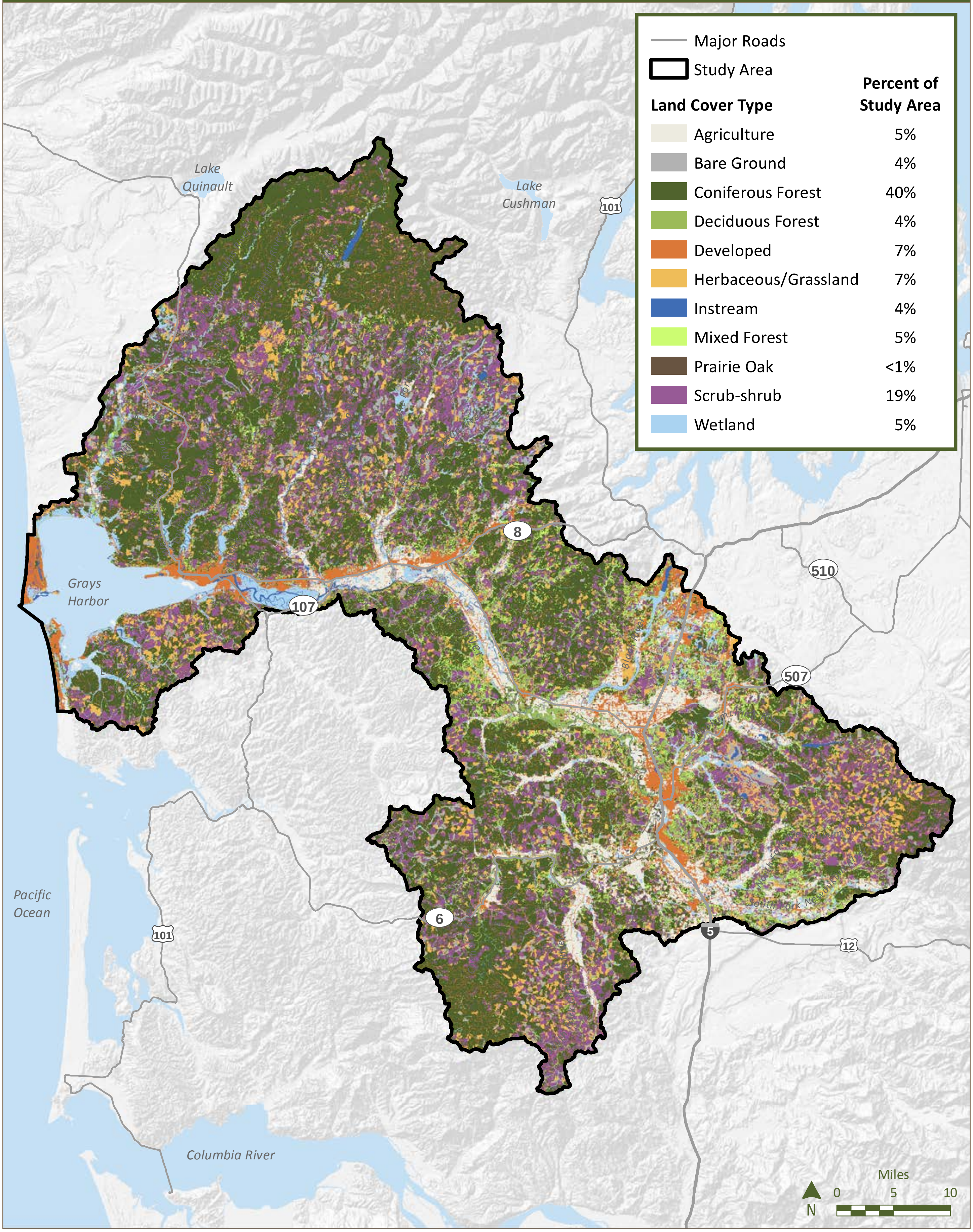


Figure 3.3-4

Vegetation and Land Cover



Agriculture

This category is represented by areas that cultivate annual and perennial crops, areas of grasses and legumes planted for livestock grazing or the production of seed or hay crops, and uncultivated areas of grass or herbaceous (non-woody) vegetation used for grazing. This category also includes land being actively tilled.

Bare Ground

This category includes land without vegetative cover such as cliffs, bedrock, riparian (within rivers or streams) gravel bars, landslide areas, gravel pits, and other undeveloped areas lacking vegetation.

Coniferous Forest

These forested areas are dominated by evergreen trees in various stages of growth and density. The majority of the coniferous forestlands have been managed for several decades to provide wood products and, therefore, the forests are typically even-aged stands of trees, ranging from less than 10 years old to more than 60 years old. The dominant, coniferous tree species include western hemlock, western red cedar, western white pine, Douglas fir, and Sitka spruce. Other plant species found in the understory of these forests include salal, Oregon grape, vine maple, red huckleberry, salmonberry, trailing blackberry, and sword fern.

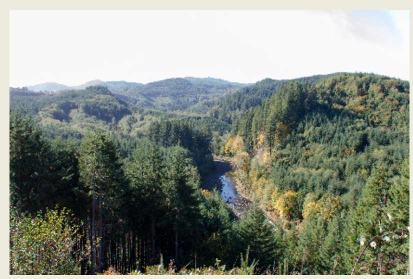
Deciduous Forest

These forested areas are dominated by deciduous trees such as cottonwood, Oregon ash, red alder, and big-leaf maple. The deciduous forestlands are commonly found alongside wetlands and riparian corridors (rivers and streams). Plant species found in the understory of these areas include salmonberry, vine maple, western azalea, Indian plum, red elderberry, snowberry, and beaked hazelnut.

Developed

This category includes areas with impervious paved or gravel surfaces and structures associated with commercial, residential, or industrial land use. Vegetation in these areas is absent or limited to lawn grasses or landscaped vegetation consisting of a variety of tree and shrub plant species.

Vegetation Zones



The majority of the coniferous forestlands have been managed for several decades to provide lumber and other wood products.

Instream areas are often bordered by deciduous forest vegetation

Herbaceous/Grassland

This category consists of uncultivated areas of grass or herbaceous (non-woody) vegetation not used for grazing.

Instream

This category is made up of open water areas that are not wetlands (i.e., no rooted vegetation), including rivers, streams, and unvegetated areas of lakes.

Mixed Forest

This category includes forested areas with a combination of coniferous and deciduous tree species. Mixed forests are found in more fragmented patches than the coniferous and deciduous forestlands, and are typically adjacent to roadways and developed areas. They also contain understory species that are typically similar to those described for coniferous and deciduous forestlands.

Prairie Oak

These areas include prairies, Oregon white oak stands, or a combination of both types of vegetation. The vegetation and habitat found in these areas is important to many wildlife species—several of which are considered threatened or endangered.

Shrub-scrub

This category comprises areas dominated by shrubs or young trees. It also includes areas dominated by species that are non-native to the region, such as Scotch broom and Himalayan blackberry. These areas are often found along roadways, within power line transmission corridors, and within recently harvested timber areas.

Wetland

Wetland areas are found in marine and estuarine (mix of fresh and saltwater) systems associated with the Pacific Ocean and Grays Harbor; riverine systems associated with the Chehalis River and many of the other rivers and larger streams in the Chehalis Basin; lacustrine systems associated with large bodies of open water (e.g., lakes); and palustrine systems that support smaller areas of open water (e.g., ponds) and emergent, scrub-shrub, and forested vegetation. A more detailed discussion of wetlands within the Chehalis Basin is presented in Sections 3.3.1 and 3.3.2.

3.3.4.1 WDFW Priority Habitats

Vegetation plays a key role in the habitat for fish and wildlife species, including priority habitats established by WDFW. This state-wide Priority Habitats and Species (PHS) List includes priority terrestrial and aquatic habitats, as well as priority habitat features (WDFW 2008). These priority habitats and features were identified because of their unique characteristics and/or because they support a diverse mix of fish and wildlife species. Of the 20 priority habitats recognized in Washington by WDFW, 16 occur in the Chehalis Basin. There are not enough data available to identify the exact priority habitat locations, or the extent of these habitats, throughout the Chehalis Basin; however, known habitats that occur within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties are presented in Table 3.3-2.

Table 3.3-2
WDFW Priority Habitats that Occur in Lewis, Thurston, Grays Harbor, Mason, and Pacific Counties

PRIORITY HABITATS	OCCURRENCE IN CHEHALIS BASIN COUNTIES[1]				
	LEWIS	THURSTON	GRAYS HARBOR	MASON	PACIFIC
TERRESTRIAL HABITATS[2]					
Aspen stands	●	●	●	●	●
Biodiversity areas	●	●	●	●	●
Herbaceous balds	●	●	●	●	●
Old-growth/mature forest	●	●	●	●	●
Oregon white oak woodlands	●	●	●	●	●
Riparian	●	●	●	●	●
Westside prairie	●	●	●	●	●
AQUATIC HABITATS[2]					
Freshwater wetlands and fresh deepwater	●	●	●	●	●
Instream	●	●	●	●	●
Coastal nearshore (estuary bay)			●		●
Open coast nearshore			●		●
Puget Sound nearshore (estuary fjord)		●			
HABITAT FEATURES[2]					
Caves	●	●	●	●	●
Cliffs	●	●	●	●	●
Snags and logs	●	●	●	●	●
Talus	●	●	●	●	●

Notes:
1. WDFW 2008
2. NatureServe 2015

3.3.4.2 Special Status Plant Species

3.3.4.2.1 Federal and State Threatened and Endangered Plant Species

The Chehalis Basin includes known occurrences of ESA-listed threatened and endangered plant species, and state-protected threatened and endangered plant species. ESA-listed species and critical habitats are identified by USFWS by county. DNR's Natural Heritage Program (DNR 2015c) also identifies specific counties in Washington where rare plant species have been documented. Although there are not enough data to quantify the extent of these plant species or their critical habitats through the Chehalis Basin, these agencies have documented their presence in some locations. The status of federally listed plant species protected under the ESA (as identified by USFWS) and state plant species with threatened and endangered status (as identified by DNR) within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties are presented in Appendix G, Table G-3. Federally listed plant species critical habitats protected under ESA within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties, as identified by USFWS, are presented in Appendix G, Table G-4.

3.3.4.2.2 State Rare Plant Species

Several rare plant species that could occur within the Chehalis Basin have been identified, based on information from the DNR Natural Heritage Program (DNR 2015c). In addition, the DNR Natural Heritage Program identifies specific counties in Washington where rare plant species have been documented. Information from the DNR Natural Heritage Program was used to identify rare plant species documented within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties. A list of all rare plant species with state status within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties is presented in Appendix G, Table G-5.

3.4 Fish and Wildlife

The Chehalis Basin provides habitat for a large variety of fish and wildlife along the Chehalis River and its tributaries, the floodplain, and throughout the forestlands of the Chehalis Basin. Some of these fish and wildlife species are abundant, while others are threatened or endangered. Many species are important to tribes, which is discussed further in Section 3.5. Several technical studies are ongoing, and annual summaries of studies on the presence and status of fish and wildlife within the Chehalis Basin have been prepared. This section provides information based on the results of those studies, as well as information from resource agencies and tribes, peer-reviewed literature, resource maps, and aerial photographs.

3.4.1 Fish

Three groupings of fish resources are presented in this section: salmonids, other fish species, and shellfish. For each grouping, their use of freshwater habitat, estuarine habitat (i.e., Grays Harbor and tidally influenced portions of tributaries feeding Grays Harbor), or both habitat types is noted.

The Chehalis River estuary is the one of the largest in Washington, providing diverse habitats for fish and shellfish production and rearing, including extensive side-channels, eelgrass beds, mud and sand flats, and wetlands (Sandell et al. 2011). As described in Section 3.1, the Chehalis River is large with many tributary sub-basins. Variation in the physical features across these basins drives the creation of a variety of fish habitats that support a diversity of fish species across WRIAs 22 and 23. Generally, headwater reaches of the Chehalis River and its tributaries have higher gradients than their lower mainstem reaches. Also, in general, tributary headwaters start in bedrock with boulder cascades and canyons, and stream channels are confined or restricted from migrating. Lower reaches are slow moving, with unconfined migrating channels that create an extensive off-channel network in the floodplains characterized by oxbows, sloughs, beaver ponds, and side channels. These habitats are highly productive sites for some fish species like Olympic mudminnow, and serve as refugia from the main channel and high-quality rearing habitat for other species like juvenile coho salmon.

High summer water temperature is the major limiting factor with regard to water quality, because it limits the amount of habitat available for cool-water species like salmon in the summer within the mainstem Chehalis River and some tributaries (see Section 3.1.2). While the upper mainstem Chehalis River has been shown to have high densities of rearing juvenile salmon, it is also warmer compared to the headwaters of the Satsop and North Fork Newaukum rivers at the same altitudes, with maximum temperatures exceeding 20°C from mid-July through August (Zimmerman and Winkowski 2016). Conversely, these conditions are conducive to warm-water species (and many non-native warm-water species). Water quality is further degraded in

Refugia

The term refugia refers to a place or places where an organism can find protection from a stressor. Cold water provides a thermal refugia for fish that cannot tolerate warmer river or stream temperatures.

summer due to interactions between high water temperature and low DO levels. The combination of high water temperatures and low DO is suspected to block the movement of cool-water fishes through the mainstem Chehalis River in summer, and in some years, cool-water fish kills have occurred in isolated pockets of low DO. Other water quality concerns affect the mainstem Chehalis River, certain tributaries, and Grays Harbor estuary, including contamination from industrial sites and elevated nutrient and fecal coliform bacteria inputs from agricultural lands.

The Chehalis Basin is a rainfall-dominated system and, as such, streamflow varies considerably across seasons with very high fall and winter flows, and relatively low summer baseflows (see Section 3.1). During summer low-flow periods, the Chehalis River is recharged by groundwater from aquifers. Groundwater levels are deep with less groundwater and surface water exchange in the lower Chehalis Basin. More interaction between surface water and groundwater occurs in the middle and upper Chehalis Basin, upstream of Grand Mound (RM 58.8; Ely et al. 2008). For some fish, river reaches which gain groundwater from aquifers are likely to provide important summer refugia that are stable in water level and cool in temperature relative to other river reaches with less groundwater input, especially for salmon and other cool-water species.

Fish Habitat

The fish species found within the Chehalis Basin rely on one or more aquatic habitats during their life:

- **Marine** habitats are saltwater environments, like Grays Harbor and the Pacific Ocean.
- **Estuarine** habitat is a mixture of freshwater from rivers and streams with saltwater from the ocean. Estuarine waters, and the lands surrounding them, are places of transition from land to sea and freshwater to saltwater.
- **Freshwater** is defined as having a low salt concentration, usually less than 1%. Freshwater habitat is the most abundant type of fish habitat in the Chehalis Basin.

3.4.1.1 Salmonids

The rivers and waterbodies in the Chehalis Basin provide habitat for salmonids (salmon and trout) that could be affected by the EIS alternatives, particularly the Chehalis River and its major tributaries (see Table 3.4-1).

3.4.1.1.1 Distribution

Chinook salmon, chum salmon, coho salmon, steelhead, and coastal cutthroat trout are widespread in the Chehalis Basin (WRIAs 22 and 23). For salmon and steelhead populations, the distribution and spawning habitat of adults has been documented by fisheries managers (see Table 3.4-1 showing observed spawning sites in specific sub-basins; WDFW 2015a), but the distribution and habitat of juvenile salmon and steelhead is not as well understood, and was recognized as a Basin-wide data gap (ASEPTC 2014a). To address this data gap, juvenile salmon and other fishes were surveyed in the upper mainstem Chehalis River, North Fork Newaukum River, West Fork Satsop River, and East Fork Satsop River.

Preliminary findings from the summers of 2013 through 2015 show that juvenile Chinook salmon and steelhead are abundant in the headwaters of the upper Chehalis River, North Fork Newaukum River, and West Fork Satsop River (Zimmerman and Winkowski 2016). In these three areas, the proportion of the fish community made up of salmonids declined from upstream to downstream, with a transition to more warm-water species in association with more moderate gradients and warmer water temperatures. Salmonids were more widely distributed throughout the entire East Fork Satsop River than the other areas surveyed, likely because the East Fork Satsop River is a relatively low-gradient river with a cool, spring-fed source. Nevertheless, it is likely that the headwaters of any tributary sub-basins to the Chehalis River that begin at higher altitudes are of primary importance to juvenile salmon during summer months versus lower reaches. Among the rivers surveyed, juvenile salmon densities were highest in the upper Chehalis River (Zimmerman and Winkowski 2016).

In the summer of 2014, juvenile salmon distributions were surveyed intensively within a 9-river-mile stretch of the mainstem Chehalis River (Winkowski and Zimmerman, in prep.). Densities of steelhead and Chinook salmon were greater at sites within approximately 1 river mile of the proposed dam site than other sites farther away. In the summer of 2015, juvenile salmon distributions were surveyed more extensively around and within the inundation area of the proposed reservoir, in the upper mainstem Chehalis River near the dam site at RM 116, and extending approximately 10 river miles upstream. Juvenile coho salmon and trout (cutthroat and rainbow/steelhead) were found throughout the proposed reservoir inundation area, which includes stretches of the upper mainstem Chehalis River and lower reaches of several small tributary creeks (WDFW 2015b). Juvenile coho salmon and trout were also observed in reaches above the proposed reservoir inundation area (WDFW 2015b). Juvenile Chinook salmon were observed only within approximately 1 river mile of the proposed dam site.

Table 3.4-1
Occurrence of Adult Salmon Spawning in Major Sub-basins of the Chehalis River Watershed

SUB-BASIN	SPRING-RUN CHINOOK SALMON	SUMMER-RUN CHINOOK SALMON	FALL-RUN CHINOOK SALMON	COHO SALMON	CHUM SALMON	STEELHEAD
South Bay Rivers			●	●	●	●
Humptulips River			●	●	●	●
Hoquiam River			●	●	●	●
Wishkah River			●	●	●	●
Wynoochee River			●	●	●	●
Satsop River		●	●	●	●	●
Lower Chehalis River tributaries			●	●	●	●
Lower mainstem Chehalis River	●		●		●	●
Black River	●		●	●	●	
Scatter Creek	●			●		
Middle mainstem Chehalis River	●		●	●		●
Middle Chehalis River tributaries	●		●	●		●
Skookumchuck River	●		●	●		●
Newaukum River	●		●	●		●
South Fork Chehalis River	●		●	●		●
Upper mainstem Chehalis River and tributaries	●		●	●		●

Juvenile salmon and steelhead can be highly mobile during the summer low-flow period in the upper mainstem Chehalis River. Up to 39% of the juvenile steelhead and coho salmon of a tagged population were observed actively moving upstream and downstream through areas in the upper Chehalis River that would be disconnected or inundated by the proposed Flood Retention Facility (Winkowski and Zimmerman, in prep.). Juvenile steelhead were observed moving over 4 miles in both the upstream and downstream directions.

The number of salmon observed spawning above the potential dam site in recent years are summarized in Table 3.4-2.

Table 3.4-2
Observed Redds and Spawner Abundance Estimates Above Proposed Flood Retention Facility

SPECIES	TOTAL NUMBER OF REDDS	SPAWNER ABUNDANCE
Spring-run Chinook salmon	13 – 46	33 – 115
Fall-run Chinook salmon	117 – 125	234 – 313
Coho salmon	87 – 776	174 – 1,552
Steelhead	610 – 1,008	1,220 – 2,016

Note: Surveys were conducted from 2013 to 2015 for salmonid species. Steelhead were surveyed in 2014 and 2015 only.

Off-channel habitat in the floodplain of the lower Chehalis River has also been identified as important overwintering habitat (Henning et al. 2007). For coastal cutthroat trout, detailed life history, distribution, and abundance information is very limited (ASEPTC 2014a). Bull trout are discussed in Section 3.4.3.

Chinook Salmon

There are nine populations of Chinook salmon recognized by WDFW, including spring-run, summer-run, and fall-run life history types within the Chehalis Basin. These population designations are generally based on the names of the rivers where the majority of adults from each respective population spawn. Within the Chehalis River, there is some uncertainty about the Chinook salmon population structure; additional genetic work is being conducted to determine if the current population designations are accurate (WDFW 2015a).

Within the Chehalis Basin, spring-run Chinook salmon are found throughout the Chehalis River and its tributaries. Spring-run Chinook salmon enter the Chehalis River in late winter and early spring, but do not spawn until fall. During summer months, spring-run Chinook salmon were observed holding in cool-water refugia, including tributaries and areas where tributaries converge with the mainstem Chehalis River. Spring-run Chinook salmon typically spawn in medium-sized tributaries, such as the Skookumchuck, Newaukum, and South Fork Chehalis rivers, with some spawning in Stillman Creek (a tributary that joins the South Fork Chehalis River at Boistfort). Spawning also occurs in the mainstem Chehalis River from near Porter (RM 33.3) to near the confluence with the Skookumchuck River (RM 67.0), and near Adna


Chinook salmon

(RM 81.3) to the upper Chehalis River (RM 113.4), with some spawning in Elk Creek (a tributary that joins the upper Chehalis mainstem at Doty). Some spawning also occurs in the Black River (WDFW 2015a).

Small numbers of summer-run Chinook salmon are observed in the Satsop River only. They enter the river beginning in late August, and spawn primarily in the East Fork Satsop River in the fall.

Fall-run Chinook salmon enter the river immediately prior to spawning and spawn throughout WRIAs 22 and 23. Spawning habitats include the mainstem Chehalis River (upstream of the confluence with the Satsop River near Elma [RM 28] to near the confluence with the Skookumchuck River [RM 67], and at the confluence with the South Fork Chehalis River [RM 88] to upstream of Pe Ell [RM 108]), as well as medium-sized tributaries up to the South Fork Chehalis River. Fall-run Chinook salmon also spawn in the Humptulips River, Hoquiam River, Wishkah River, Wynoochee River, Satsop River, and other medium tributaries feeding these rivers. Among the South Bay rivers of Grays Harbor, most spawning takes place in the lower Johns River (WDFW 2015a).

Chum Salmon

There is one recognized population of chum salmon found in the Chehalis Basin: Grays Harbor fall-run chum salmon (WDFW 2015a). Chum salmon distribution is poorly understood and is identified as a data gap for additional study (ASEPTC 2014b). Chum salmon primarily spawn in the East Fork Humptulips River, West Fork Humptulips River, mainstem Hoquiam River, mainstem Wishkah River, and the lower tributaries to the Chehalis River such as the Wynoochee, Satsop, and Black rivers. Spawning has also been observed in the lower mainstem Chehalis River and in Cloquallum Creek, a lower Chehalis River tributary (WDFW 2015a).

Chum salmon
Photo credit: USFWS

Coho Salmon

There are seven populations of coho salmon recognized by WDFW within the Chehalis Basin. In WRIA 23, coho salmon spawn in the upper reaches of the mainstem Chehalis River and in the mainstems and upper reaches of several major tributaries, including the Black River, Scatter Creek, Skookumchuck River, and upper forks of the Newaukum River. In the mainstem Chehalis River, coho salmon only spawn in the most upper reaches of the sub-basin (upstream of Pe Ell) and the East Fork Chehalis River sub-basins (in Stillman Creek and upstream of Boistfort

Coho salmon
Photo credit: Oregon Department of Fish and Wildlife

Prairie). Coho salmon spawning also occurs in Elk Creek, a tributary to the Upper Chehalis that joins the River at Doty, where adult coho salmon are trapped and transported above a natural barrier.

In WRIA 22, most coho salmon spawning occurs in the tributaries, rather than in the lower mainstem Chehalis River. In the Humptulips watershed, spawning takes place in more than 60 tributaries, with some spawning in the lower mainstem, East Fork, and West Fork of the Humptulips River. In the Wishkah and Hoquiam rivers, most spawning takes place in the mainstems, and east and west forks of the rivers. Spawning also occurs in the accessible tributaries of the Hoquiam River. In the South Bay rivers of Grays Harbor, spawning occurs in several rivers, mostly in the upper Johns River (WDFW 2015a).

Coastal Cutthroat Trout

Two populations of coastal cutthroat trout are recognized by WDFW within the Chehalis Basin: Chehalis coastal cutthroat trout and Humptulips River coastal cutthroat trout. These populations include multiple life history types, including anadromous, freshwater migrant, and freshwater resident forms. Among freshwater migrants, there are also forms that migrate within rivers (fluvial), and those that spawn and rear in streams, then later reside in lakes (adfluvial). The two populations are delineated by the locations of their respective spawning areas. The Chehalis population comprises spawning grounds in the South Bay rivers (Johns River), Hoquiam, Wishkah, Wynoochee, Satsop, Black, Skookumchuck, and Newaukum rivers, as well as in smaller tributaries and the headwaters of the Chehalis River. The Humptulips population includes spawning grounds in the Humptulips River (WDFW 2015a).

Steelhead

There are ten populations of steelhead recognized within the Chehalis Basin, including winter-run and summer-run life histories. In the Chehalis River, most spawning takes place in the mainstem Chehalis, East Fork Chehalis, and West Fork Chehalis rivers, as well as in in mainstems of medium and small tributaries. Distinct spawning populations are also distributed in the major tributaries to the Chehalis River, primarily the Wynoochee, Satsop, Skookumchuck, and Newaukum rivers. In the Humptulips, Hoquiam, and Wishkah rivers, most spawning takes place in the west and east forks of the rivers and their tributaries. Spawning also occurs in mainstems of the Wishkah and Humptulips rivers, as well as in South Bay rivers (WDFW 2015a).

Coastal cutthroat trout

Steelhead

3.4.1.1.2 Habitat Conditions

The habitat requirements for salmonids vary by species, but all share some common attributes. Throughout all adult and juvenile life history phases, salmonids require cool, clean water. Adults migrating to spawning habitats also need barrier-free passage corridors with water of sufficient depth and flow to provide unimpeded access to spawning areas. Spawning adults require specific flow conditions, cover, and access to spawning gravels to deposit eggs. Once deposited, fertilized eggs need to incubate in stable substrates that are porous enough to allow oxygenated water to flow past the developing embryos (e.g., free of excessive sediment).

When incubation is complete and juveniles emerge from spawning gravels, they need access to food, cover, and space to rear. After rearing for a period of several days to several years, depending on the species, juvenile salmon need adequate flows and barrier-free conditions to migrate downstream to marine habitats. Some juveniles migrate to the ocean in their first spring or summer, while others overwinter in freshwater. While residing in freshwater, juvenile salmonids may actively migrate upstream and downstream relatively short distances, usually less than 1 mile, but in some cases several miles—as observed in the upper Chehalis River by Winkowski and Zimmerman (in prep.). Access to upstream and downstream habitats provides foraging opportunities, as well as refuge from predators and other environmental stressors, such as refuge provided by off-channel habitat during high winter flows, or sources of cool groundwater during low summer flows (Bjornn and Reiser 1991).

The habitat available to salmonids in the Chehalis Basin is a mixture of properly functioning habitat and degraded, poorly functioning habitat (GHLE 2011). Human-caused habitat alterations have played a major role in reducing habitat function and, in turn, reducing the productivity and abundance of salmonids (Smith and Wenger 2001; GHLE 2011; ASEPTC 2014a). Some of the most important alterations to freshwater habitat have resulted from past

Habitat Diversity

Habitat diversity, which plays a key role in the health of many fish and wildlife species in the Chehalis Basin, is generally made up of the following three components:

- **Vegetative diversity** – the number of different species of vegetation present within a single habitat type
- **Habitat type** – the vegetative characteristics of an area as influenced by soil, other environmental factors, and land use (e.g., riparian areas, wetlands, instream habitats)
- **Diversity of habitat types** – the number of different habitat types present within a specified area

Within the Chehalis Basin, the lack of habitat diversity for salmonids and other fish species is largely driven by a lack of LWM in rivers and streams. Large wood is also the key driver in the creation and maintenance of side-channel habitat associated with river or stream channels and off-channel habitat associated with floodplains (ASEPTC 2014a).

Scientists recognize the connection between habitat diversity and the health of fish and species. Complexity and diversity are the keys to resilience and adaptation to long-term change (WCSSP 2013).

timber harvest practices, urbanization, agricultural land use practices, population growth, gravel mining, and dam construction.

Large trees and other vegetation that provided shade have been removed from riparian zones in historically logged areas for harvest and in agricultural areas to expand farmlands. The historical practice of using splash dams to convey logs downstream from harvest sites to mills created barriers for fish, and when large volumes of water and logs were washed downstream, direct injury or death to fish occurred, riparian zones were damaged, and sediments were mobilized and redeposited in the stream channel. Pieces of large wood in streams that would normally provide structure for fish habitat would have been actively removed for timber transport, and continue to be actively removed to prevent migration of the channel in agricultural areas in the floodplain. Agriculture and ranching promoted the removal and disconnection of off-channel habitat and straightening of small streams in the floodplain.

Where urbanization has occurred, fish habitat complexity and access is reduced compared to historical levels, which is attributed to roads, buildings, levees, culverts, water withdrawals, and waste discharges. Until the 1950s, unregulated instream gravel mining to support road building directly damaged fish habitat in tributaries of the Chehalis River. Two dams on the Skookumchuck and Wynoochee rivers directly block fish migration, and their reservoirs inundate former salmon spawning habitat. Only the Wynoochee Dam provides artificial fish passage. Smaller water diversions throughout the lower Chehalis Basin feed local municipalities, agricultural users, and hatcheries.

The estuarine habitat within Grays Harbor has been altered by timber harvesting, polluted by pulp mill operations, and reshaped by dredging to support log exports and filling of tidal zones to develop the cities of Hoquiam and Aberdeen (Smith and Wenger 2001; GHLE 2011). Hiss and Knudsen (1993) and Smith and Wenger (2001) provide comprehensive descriptions of historical human activities within WRIAs 22 and 23.

The most common freshwater habitat impairments include a lack of channel complexity (e.g., lack of large wood, channelization of the river bed, loss of floodplain connectivity), poor water quality (e.g., elevated temperature and low DO), lack of wood (i.e., currently in stream, as well as natural recruitment of wood via riparian input), sedimentation, and barriers to passage (ASEPTC 2014a). Within the estuarine portion of WRIA 22, habitat alterations have reduced habitat complexity (e.g., lack of wood), degraded water quality (see Section 3.1), eliminated access to off-channel habitats, and reduced overall quantity of estuarine habitat by 30% (Smith and Wenger 2001; GHLE 2011).

Within the Chehalis Basin specifically, the impacts of habitat alteration have been estimated for several salmon and steelhead species using the Ecosystem Diagnosis & Treatment (EDT) model (ICF 2016). The results of this analysis indicate that each species is influenced by a different set of habitat alterations and factors that limit the suitability and availability of habitat (limiting factors). For coho salmon, spring-run Chinook salmon, and winter-run steelhead, the dominant limiting factor is lack of habitat diversity and quantity, as controlled by flow. Low flow is a limiting factor for coho salmon and steelhead, with lower production following drier summers and higher production following wetter summers (Seiler et al. 2002). The lack of habitat diversity reflects historical and current land use practices that have limited the quantity and recruitment of instream LWM that would otherwise provide rearing habitat for salmon and steelhead. For fall-run Chinook salmon, channel stability and lack of habitat diversity are the top-ranked limiting factors at a Basin-wide scale. These reflect the artificial confinement of the river channel and widespread lack of floodplain access, as well as limited LWM. As a result of these and other limiting factors (see ASEPTC 2014a for a comprehensive review), the existing habitat within the Chehalis Basin supports substantially fewer adult salmon and steelhead annually (ASEPTC 2014a) than would be expected under pre-European settlement conditions (see Table 3.4-3).

Within the upper Chehalis River, fish communities tend to be dominated by salmonids in upper reaches, then increasingly dominated by dace, redside shiner, and pikeminnow in association with the transition downstream toward widening stream channels, less complex channel morphology, finer substrates, fewer pools, and higher minimum temperatures with longer periods and temperatures greater than 18°C (Zimmerman and Winkowski 2016). The distributions of juvenile coho salmon, subyearling trout, redside shiner, and dace were also influenced by habitat characteristics, such as substrate size, pool frequency, and wetted width measured on a smaller spatial scale, within 1 km reaches. These data suggest that the influence of local-scale habitat diversity on species diversity should be considered in planned actions within, and adjacent to, the Chehalis River.

Table 3.4-3
Estimated Current and Intrinsic Habitat Potential of the Chehalis Basin

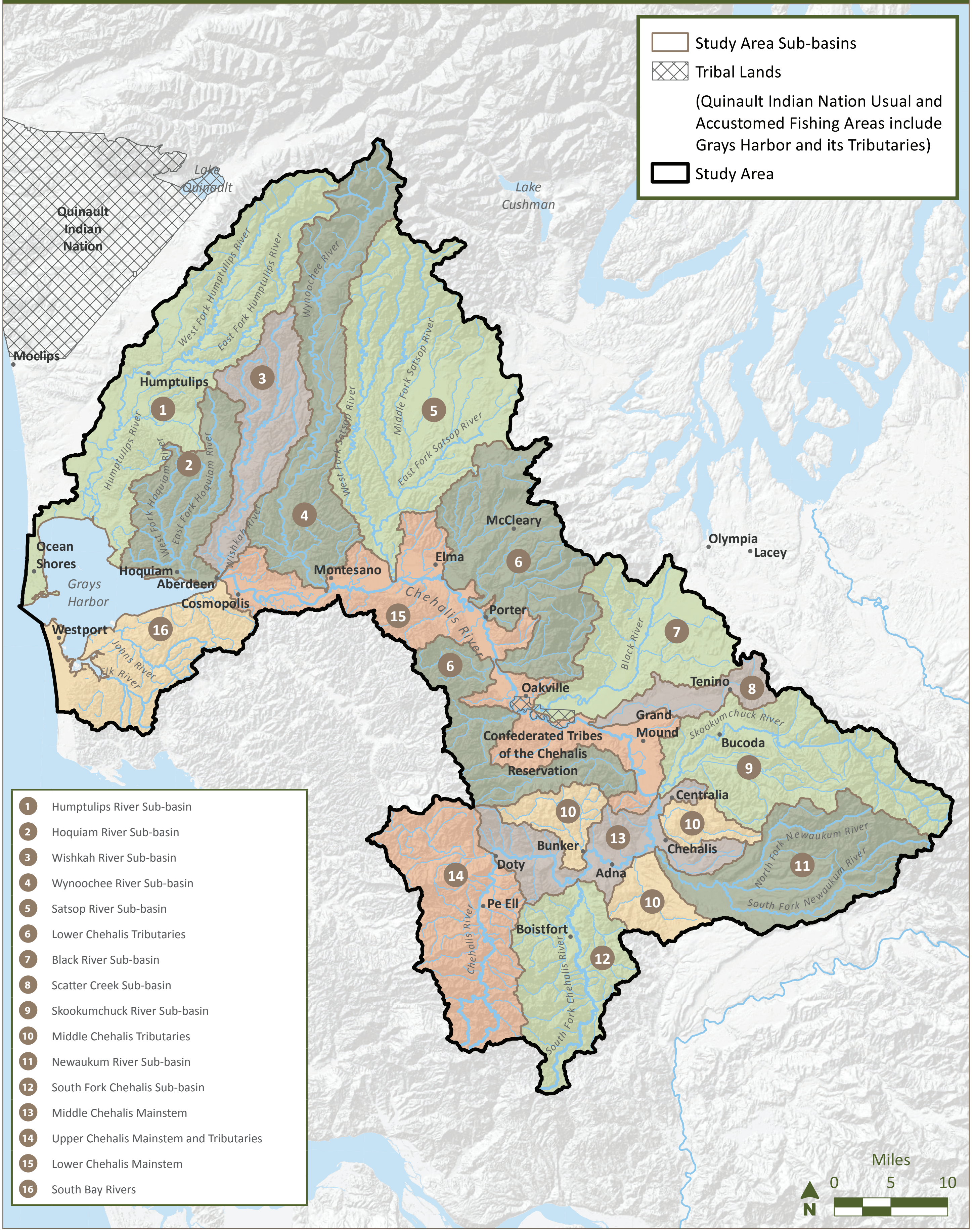
SPECIES	POTENTIAL		AREA OF HABITAT IMPAIRMENT	DOMINANT LIMITING FACTOR
	CURRENT	PRE-SETTLEMENT		
Coho salmon	40,642	96,768	70%	Habitat diversity
Fall-run Chinook salmon	25,844	45,662	47%	Habitat diversity, channel stability
Winter/fall-run chum salmon	190,550	Not estimated	Not estimated	Not estimated
Spring-run Chinook salmon	2,146	16,153	84%	Habitat diversity
Winter-run steelhead	6,800	8,616	52%	Habitat diversity

Note: Potential represented in adult fish per year
Sources: EDT model, ASEPTC 2014a, ICF 2016

The habitat issues that affect salmonids in the Chehalis Basin vary considerably by sub-basin (GHLE 2011). The *Chehalis Basin Salmon Habitat Restoration and Preservation Work Plan for WRIAs 22 and 23* (GHLE 2011) provides a detailed synthesis of habitat conditions, and identifies the most pressing habitat concerns (i.e., Tier 1 concerns) within each sub-basin. Some of these most pressing habitat concerns are lack of LWM, passage barriers from culvert and road crossings, poor riparian conditions/riparian degradation, sedimentation, poor connection with the floodplain, high (summer) water temperatures, and poor estuarine habitat. Figure 3.4-1 depicts the sub-basins. The Tier 1 concerns, and affected salmonid species within each sub-basin, are summarized in Appendix G, Table G-6.

Figure 3.4-1

Chehalis Basin Study Area Sub-basins



3.4.1.1.3 *Status and Species Abundance*

Within the Chehalis Basin, the abundance of salmonids vary by species; however, none are ESA-listed except bull trout (see Section 3.4.3). Several species of salmonids are identified as priority species or as candidates for state listing (see Appendix G, Table G-7). For Chinook salmon, chum salmon, coho salmon, and steelhead, management data are available to characterize trends in abundance. The population total run sizes are summarized in Table 3.4-4 and species life history information is contained in Appendix G.

Table 3.4-4
Salmon and Steelhead Species Run Sizes

SPECIES	YEARS DATA AVAILABLE	RUN SIZE		
		AVERAGE	HIGH	LOW
Coho salmon	1987 to 2014	60,096	130,997 (in 2014)	11,665 (in 1994)
Fall-run Chinook salmon	1987 to 2013	25,500	53,600 (in 1989)	11,900 (in 1999)
Fall/winter-run chum salmon	1987 to 2015	36,300	137,000 (in 1988)	8,900 (in 2008)
Spring-run Chinook salmon	1987 to 2015	2,300	5,200 (in 2004)	700 (in 2007)
Winter-run steelhead	1987 to 2015	12,800	23,300 (in 2004)	7,700 (in 1998)

3.4.1.2 *Other Fish Species*

There are more than 50 non-salmonid fish species found in the freshwater and estuarine habitats of the Chehalis Basin (Wydoski and Whitney 2003; Hughes and Herlihy 2012; Sandell et al. 2015). The affected environment for these species is the same as described in Section 3.4.1.1 for salmonids. State- and federally listed species, including green sturgeon and Olympic mudminnow, are discussed in Section 3.4.3. Other species that are not state-listed, but are either candidate or priority species, are described in Appendix G, Table G-7. Each species has specific habitat requirements and variable distributions throughout the Chehalis Basin. Native non-salmonid and trout species that dominate freshwater habitat in the Chehalis watershed include northern pikeminnow, largescale sucker, redside shiner, mountain whitefish (a member of the salmonid family), six species of sculpin, three species of lamprey, speckled dace, and longnose dace (see Appendix G, Table G-8; Wydoski and Whitney 2003). The distribution and habitat use by native, freshwater, non-salmonid species are also described in detail by Wydoski and Whitney (2003), Hughes and Herlihy (2012), and NatureServe (2015).

In the upper Chehalis River, North Fork Newaukum River, and West Fork Satsop River, colder headwater reaches are dominated by salmonids, which reflects the importance of these cooler reaches for summer rearing. As the river transitions to downstream areas that are warmer and slower moving, redside shiner, dace, and pikeminnow dominate the reaches (Zimmerman and Winkowski 2016). In the East Fork Satsop River, salmonids were observed to be abundant throughout the reaches. In the same surveys, mountain whitefish and largescale sucker did not follow an upstream-to-downstream trend, but were found in approximately half of the reaches surveyed, and were often found together. Few largescale suckers were observed in the East Fork Satsop River. Three-spined sticklebacks were observed in the West Fork Satsop and East Fork Satsop rivers, but were rare in the Newaukum River, and not present in the upper Chehalis River. The upper Chehalis River had the highest fish counts per mile among the sub-basins surveyed.

The inundation footprint of the reservoir occurs in a transitional zone between the warmer mainstem and cooler headwaters of the upper Chehalis River. In the summer of 2015, 12 of the non-salmonid fish species previously located in the area by Wydoski and Whitney (2003) were identified in the reservoir inundation footprint; the most widely distributed non-salmonid species were torrent sculpin, speckled and longnose dace, Pacific lamprey ammocoetes (larvae), and other unidentifiable lamprey ammocoetes (Winkowski 2015). Reticulate sculpin, redside shiner, riffle sculpin, and prickly sculpin were also observed and were less widely distributed in the Chehalis Basin. Lamprey ammocoetes require fine substrate for burrowing, and were not detected in tributary reaches, which tended to be higher gradient with fewer deposits of fine sediment. Largescale sucker, redside shiner, western brook lamprey ammocoetes, and mountain whitefish were only detected in mainstem reaches within 2.5 river miles upstream of the proposed dam site. Northern pikeminnow were only observed in supplemental reaches surveyed downstream of the proposed dam site. While mountain whitefish would be expected in cooler upstream reaches of the survey area, their presence was relatively rare overall, occurring in only 4 of the 59 reaches surveyed. The occupancy (proportion of reaches in which a species is present) and density (median count per mile) of other fish during summer low-flow conditions is shown in Table 3.4-5 (Zimmerman and Winkowski 2016). Though the river was surveyed in summer, it is likely that these species reside in the Chehalis Basin throughout the year.

Table 3.4-5
Occupancy and Density of Fish Species in the Upper Chehalis River

SPECIES (LIFE STAGE)	OCCUPANCY	DENSITY
Mountain whitefish (adult)	.51	14
Largescale sucker (adult)	.51	64
Largescale sucker (juvenile)	.51	1,643
Dace (adult)	.83	402
Dace (fry)	.54	1,304
Redside shiner (adult)	.51	283
Redside shiner (fry)	.37	1,867
Northern pikeminnow (adult)	.40	27

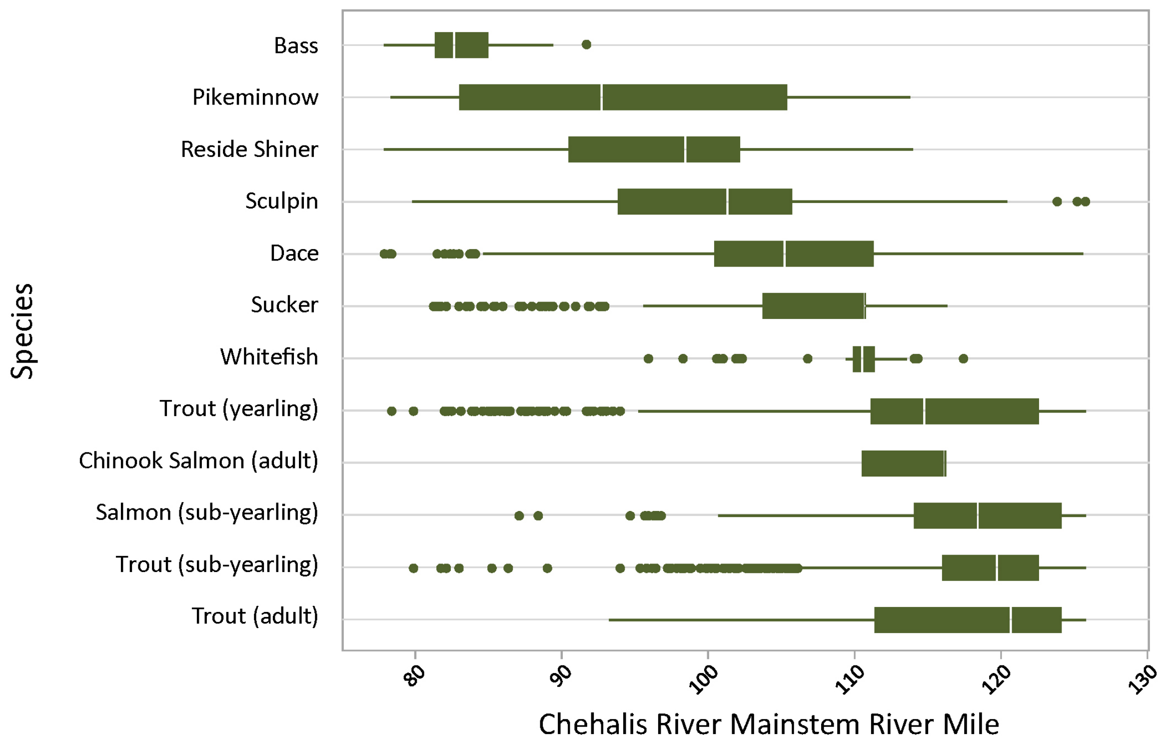
Notes:
Occupancy = proportion of reaches where species was present
Density = median count per mile in reaches where the species was present

In the Grays Harbor estuary, the fish assemblage is more diverse than in the freshwater environment. Many of the species found in freshwater may also occur in estuarine habitats, including three-spined stickleback, sturgeon, three of the sculpin species, Pacific lamprey, river lamprey, and speckled dace (Sandell et al. 2015). However, numerous marine species occur in Grays Harbor that do not occur in freshwater habitats, such as rockfish (see Appendix G, Table G-8). Some of the most commonly encountered fish species in Grays Harbor include English sole, northern anchovy, Pacific staghorn sculpin, three-spined stickleback, surf smelt, and shiner perch (Sandell et al. 2015). The distribution and habitat use by estuarine non-salmonid species in Grays Harbor were described in more detail by Monaco et al. (1990) and Sandell et al. (2014).

Non-native fish species have also been introduced to the Chehalis River and other habitats within the Chehalis Basin (see Appendix G, Table G-8). Bass are known to predate heavily on juvenile salmon anywhere their distributions overlap, and the presence of invasive bass can be a limiting factor to the sustainability of some salmon populations. Non-native predators such as largemouth bass, smallmouth bass, and yellow perch are found in at least 40% of the mainstem Chehalis River (Hughes and Herlihy 2012). Invasive bass thrive in the warmer reaches and slow-moving off-channel habitat of the lower and middle Chehalis River. Largemouth bass distribution in off-channel habitat of the Chehalis River extends at least as far upriver as the confluence with Scatter Creek (near Rochester; Hayes et al. 2015a). Among headwater reaches that include the upper Chehalis River, North Fork Newaukum River, West Fork Satsop River, and East Fork Satsop River, the only non-native predators observed were smallmouth bass. Smallmouth bass were only found in the lowest reach of the North Fork Newaukum River—a relatively low-gradient reach of river.

Figure 3.4-2 provides information on where the more common salmonid and non-salmonid fish species occur along the mainstem Chehalis River.

Figure 3.4-2
Distribution of Fish Species in the Mainstem Chehalis River



Notes:
Fish distributions determined by snorkel surveys conducted in 2013 during summer low-flow conditions. Benthic-oriented fishes such as sculpin are underrepresented by this collection method (Zimmerman and Winkowski 2016).
Box plots include first, second (median), and third quartiles, the range (lines), and outliers (dots).

3.4.1.3 Shellfish

Shellfish occur in both the freshwater and estuarine portions of the Chehalis Basin (Monaco et al. 1990; Waterstrat 2013). The species listed here do not represent the full species assemblage present within WRIAs 22 and 23, but instead represent a cross section of species that are commonly found, economically or culturally important, or are a native species that represent a conservation interest due to the impacts created by invasion or cultivation of non-native species. Additional information on fish and shellfish abundance in Grays Harbor is described in a report prepared by the National Oceanic and Atmospheric Association (Monaco et al. 1990).

Within the estuarine habitat of Grays Harbor, native Dungeness crab are common (Monaco et al. 1990; TWC et al. 2014). They may occur as juveniles or adults, and are widely distributed on the floor of the estuary (Parrish and Litle 2002). Native mollusks including butter clam, razor clam, blue mussel, and

Olympia oyster are also widely distributed across Grays Harbor (Herrmann 1972; Antrim et al. 1994). Clam species live deeper within the floor and intertidal zone sediments of Grays Harbor, while oysters live on top of the sediments. Pacific oyster and Manila clam are non-native species that are present and abundant due to aquaculture of these commercially valuable species (Monaco et al. 1990). Out of conservation concerns, WDFW has identified the Olympia oyster—the only native oyster—as a state candidate species (see Appendix G, Table G-9; WDFW 2013). Dungeness crabs, razor clams, geoduck, Pacific oysters, and Manila clams contribute to culturally and economically important recreational and commercial harvest (see Section 3.4.1.4 for more detail on commercial harvest and aquaculture of mollusks; Dethier 2006).

Freshwater mussel species have a parasitic larval stage that may require a specific fish species as a host; their distribution reflects movement and colonization of their host species (Jepsen 2009; Nedeau et al. 2009). Adult mussels live within, or on the bottom of, river or stream habitats and tend to concentrate in areas with consistent flows and substrate conditions (Nedeau et al. 2009). Freshwater mussel species are vulnerable to declines because they typically require good water quality, cannot rapidly evade changing environmental conditions, and have specific parasite-host relationships that can be disrupted if the host fish is no longer present (Nedeau et al. 2009).

Among the freshwater habitats in the Chehalis Basin, three species of freshwater mussels have been documented: western floaters, western pearlshell, and western ridged mussel (see Appendix G, Table G-10; Waterstrat 2013). These species are uncommon, and little is known about their distribution and habitat use within WRIAs 22 and 23. Nedeau et al. (2009) provide basic host life history and habitat information for these species. Western floaters are known to parasitize prickly sculpin, three-spine stickleback, and trout. Western pearlshell tend to prefer cold, clean rivers and creeks up to mountain headwaters like their host fish, salmon, and trout. Western ridged mussels co-occur with the western pearlshell, but tend to occur more frequently in depositional reaches with finer sediments.

In a WDFW survey, freshwater mussels were numerous in the mainstem Chehalis River from Elk Creek (at Doty) to the Newaukum River confluence, and mussel densities in some reaches were so high that they were the major substrate. These surveys likely covered only a fraction of the mussel distribution in the Chehalis Basin, and species composition was not determined.

3.4.1.4 Commercial Fisheries

The Chehalis Basin historically supported large commercial fisheries. Prior to colonization by European settlers in the 1850s, tribal fishers collected salmon and steelhead, as well as other species, in the Chehalis River and its tributaries (GHRPC 1992). In the 1850s and thereafter, settlers began harvesting salmon and steelhead. The first commercial cannery in Grays Harbor was established in Aberdeen in 1883; by 1934, harvests were declining. The estimated numbers of fish harvested in Grays Harbor fisheries between 1891 and 1928 (based on cannery records [Cobb 1930]) peaked in 1911 at approximately 275,000 coho salmon and 63,000 Chinook salmon. The number of canneries operating in

Grays Harbor increased from one in 1883 to six in 1919, and declined thereafter. The commercial fleet continued to grow, peaking in the mid-1970s. Also in the mid-1970s, a number of court cases and regulatory actions reshaped harvest in the Chehalis Basin and elsewhere.

In 1974, the decision in *United States vs. Washington* reallocated sport and commercial harvest to allow tribal treaty fishing rights to be exercised at usual and accustomed locations and allowed tribal and non-tribal fishers to each harvest up to 50% of the harvestable salmon and steelhead (see Section 3.5.2 for a discussion of tribal fishing resources). In 1976, the Magnuson-Stevens Fishery Conservation and Management Act created the Pacific Fishery Management Council to set harvest limits and seasons for marine waters representing the exclusive economic zone off of the Washington, Oregon, and California coasts (i.e., between 3 and 200 miles off of the coasts). Due to overfishing and habitat degradation, the abundance of wild coho and chum salmon fell well below historical numbers (Hiss and Knudsen 1993). Between 1976 and the early 1990s, commercial and charter catches declined significantly and the Grays Harbor fishing fleet declined by more than 50%.

Currently, commercial fishing takes place at a smaller scale within Grays Harbor. Most commercial fishers based in Grays Harbor fish outside the harbor for Chinook salmon, coho salmon, crab, and groundfish (including high-value species like halibut, rockfish, and sturgeon). Marinas within Grays Harbor, including Westport, Ocean Shores, Aberdeen, and Hoquiam, serve as major ports for the commercial marine fishery and are host to related businesses, including processing plants.

The value to the ports can be described in terms of the magnitude of commercial landings, or the amount of fish caught and brought to land. Grays Harbor is Washington's largest commercial port area with $19.5 million worth of commercial landings caught in Washington waters in 2006 (TRG 2008), accounting for 30% of the state's total commercial landings (TCW Economics 2008). In addition, other prominent coastal fisheries that operate outside of Washington waters deliver their products to Grays Harbor processing plants, including Pacific whiting, albacore tuna, sablefish, pink shrimp, and Alaskan halibut. Landings of catches from outside of Washington waters were valued at $7.8 million in 2006 (TRG 2008). In the same year, 3,524 jobs were provided state-wide by commercial harvest and processing, of which the Grays Harbor infrastructure was a large contributor (TCW Economics 2008).

Shellfish aquaculture of clams, geoduck, mussels, oysters, and scallops is also a major source of revenue in Grays Harbor. In 2010, shellfish aquaculture revenues were more than 90 million for the entire state of Washington. The industry provided 210 jobs and $5.9 million in labor income—specifically in Grays Harbor, which represented 7.7% of the total acreage in shellfish aquaculture in Washington (Northern Economics 2013). In 2013, 1.2 million pounds of aquacultured shellfish is estimated to have been produced in Grays Harbor—5% of the production of the entire state—worth nearly $4 million (Washington Sea Grant 2015). From 1986 to 2013, shellfish harvests have ranged from a low of 700,000 pounds in 1997 to 1.6 million pounds in 2011. Aquaculture in Grays Harbor relies almost exclusively on Pacific oyster, which has maintained a stable price over the same time span. Clam and oyster aquaculture has been negatively affected in recent years in Willapa Bay and Grays Harbor by increases in the densities of burrowing shrimp, which loosen substrates and suffocate shellfish. And in the summer of 2015, closures on the harvest of crabs and mollusks were implemented for unprecedented lengths of time by WDFW and Washington State Department of Health due to widespread toxic algal blooms occurring at unprecedented levels.

3.4.2 Wildlife

The diversity of vegetation, geology, variation in topography, and climatic gradients within the Chehalis Basin provides habitat for a variety of terrestrial and aquatic wildlife to breed, forage, rest, and overwinter. In general, wildlife habitats in the Chehalis Basin range in quality from low in developed areas to high in the forested and wetland habitats.

In general, wildlife diversity is related to the diversity of ecosystems, natural communities, and habitats (Brown 1985; Johnson and O'Neil 2001; WDFW 2008, 2015b; Hayes et al. 2016a). Elements associated with wildlife diversity include, but are not limited to, the structure and composition of vegetation communities and variations in topography, substrate, aquatic systems, and weather conditions. Wetlands and forestlands with well-developed tree and shrub layers are likely to support a greater number of species and populations of wildlife than areas with limited vegetation variation, non-native species presence, and close proximity to disturbed areas and human activities. Aquatic habitats with a variety of widths, depths, sinuosity, and riparian communities provide habitat features that can support a wider variety of aquatic associated wildlife than an aquatic system with more homogenous characteristics.

A summary of wildlife species that occur within the Chehalis Basin is provided in Appendix G, Table G-11. The list of wildlife species is not intended to be a comprehensive list of all wildlife species that could be found within the Chehalis Basin, but is based on typical wildlife species known and expected to occur in similar habitats in Lewis, Thurston, Grays Harbor, Mason, and Pacific counties, and Western Washington.

3.4.2.1 Amphibians and Reptiles

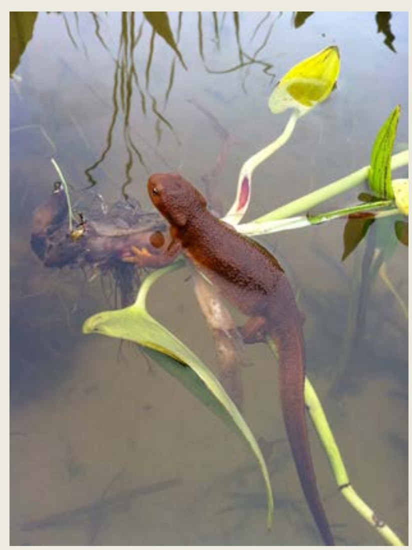
The Chehalis Basin has the highest species richness of amphibians in Washington (Cassidy et al. 1997). Wetlands and riparian areas associated with rivers and streams in the Chehalis Basin provide habitat for a variety of stillwater amphibians such as the northern red-legged frog, Pacific treefrog, and rough-skinned newt, stream-breeding amphibians such as giant salamanders, coastal tailed frog, and Columbia torrent salamander, and terrestrial amphibians found in riparian areas (i.e., stream-associated amphibians) such as western red-backed salamander, Van Dyke's salamander, and ensatina. Off-channel habitats in the Chehalis River floodplain are the dominant habitat for stillwater-breeding amphibians in the Chehalis Basin.

WDFW is currently in the process of performing multi-year wildlife surveys as part of their development of the ASRP. WDFW has released preliminary distribution data from four amphibian surveys. Egg mass and extensive surveys focused on off-channel habitats (Hayes et al. 2015b, 2015a), stream-associated amphibian surveys (Hayes et al. 2015c), and instream amphibian surveys (Hayes et al. 2015d). These preliminary technical memoranda only include survey data through the 2015 summer season and have not been statistically analyzed. Three additional WDFW reports provided data and observations for field surveys performed in early 2016 (Hayes et al. 2016a, 2016b, 2016c). These reports included surveys focused on the distribution of Dunn's and Van Dyke's salamanders in the upper Chehalis River and its tributaries (Hayes et al. 2016a), and on instream western toad surveys (Hayes et al. 2016b). The following is a summary of amphibian information from these preliminary data.

The egg mass and extensive surveys document occupancy of stillwater-breeding amphibians in off-channel habitats in the floodplain of the mainstem Chehalis River. For these surveys, the floodplain is defined as the FEMA 100-year flood line plus an additional 100 m perpendicular to the line that extends from the location of the proposed dam to the US 101 bridge in Aberdeen. The preliminary data technical memorandum survey area is within this area.

Amphibian Diversity in the Chehalis Basin

Pacific treefrog
Photo credit: Oregon Department of Fish and Wildlife



Rough-skinned newt
Photo credit: Oregon Department of Fish and Wildlife

Six native amphibian species were observed during the egg mass and extensive surveys, northern red-legged frog, northwestern salamander, long-toed salamander, Pacific treefrog, rough-skinned newt, and western toad. One non-native species, American bullfrog, was also documented (Hayes et al. 2015b, 2016a). Except for western toad, which was found at only three sites, all native amphibian species and bullfrogs were at least moderately widespread.

Western toad

Van Dyke's salamander
Photo credit: Caitlin McIntyre, Lacey, Washington

Long-toed salamander
Photo credit: Oregon Department of Fish and Wildlife

The stream-associated amphibian surveys document occupancy of terrestrial stream-associated amphibians in the headwaters of the mainstem Chehalis River. The survey data from the preliminary technical reports include the headwaters of the Chehalis River, including the vicinity of the proposed Flood Retention Facility.

A total of 12 amphibian species were observed during the 2014, 2015, and 2016 stream-associated amphibian surveys: four terrestrial amphibians and eight semi-aquatic amphibians (Hayes et al. 2015c, 2016c). Terrestrial amphibian species included western red-backed salamander, Dunn's salamander, Van Dyke's salamander, and ensatina. Semi-aquatic amphibian species included five stillwater-breeding amphibians (Pacific treefrog, northern red-legged frog, northwestern salamander, rough-skinned newt, and western toad) and the three stream-breeding amphibians (coastal giant salamander, coastal tailed frog, and Columbia torrent salamander).

Instream amphibian surveys document the occupancy of amphibians breeding in the mainstem Chehalis River and adjacent areas, including the vicinity of the proposed dam and its reservoir. Five amphibian species were observed during instream amphibian surveys: Columbia torrent salamander, northern red-legged frog, Pacific treefrog, rough-skinned newt, and western toad (Hayes et al. 2015d, 2016b). Western toad breeding was observed to be limited to the upper portions of the Chehalis Basin watershed and was more widespread in the footprint of the proposed dam and its reservoir than either up- or downstream of these areas (Hayes et al. 2016b).

Amphibian and reptile species with federal- and state-protected status, Oregon spotted frog and western pond turtle, are discussed in Section 3.4.3.1.2. In addition to these species, Dunn's salamander, Van Dyke's salamander, and western toad are WDFW state priority species, as discussed in Section 3.4.3.3.

Reptiles such as the common garter snake and western terrestrial garter snake are likely to occur in the wetland-adjacent to upland habitats of the Chehalis Basin. Wetlands riparian areas and aquatic habitats of the Chehalis Basin may support painted turtle and the non-native pond slider turtle, and could provide habitat for western pond turtle. Upland habitats with rocks and wood debris support species such as northern alligator lizard and northwestern garter snake.

3.4.2.2 Mammals

Small mammal species associated with forested habitats include shrew mole, Townsend's vole, masked shrew, and striped skunk. Larger mammals such as elk, black-tailed deer, black bear, and coyote also occur in the larger forestlands.

Elk are among the more visible and culturally important wildlife in Washington. They are enjoyed by the public through wildlife viewing, prized by hunters, and valued by Native American tribes for subsistence and ceremonial uses. In the Chehalis Basin, elk can occur in a wide range of elevations, from forested habitat to low-lying valleys, particularly during winter. They typically avoid dense, unbroken forests, largely due to a lack of adequate forage. Elk need large areas to meet migratory needs, and often move long distances on a seasonal basis (WHCWG 2010). They tend to migrate north-south between the Olympic Peninsula and Willapa Hills, and east-west between the Olympic coast and Cascade Range. Elk are characterized as having a high sensitivity to development, roads and traffic, and the presence of people and domestic animals. Elk habitat concentration areas (HCAs) are located within the Chehalis Basin and in the surrounding geographic area to the north and south. Likewise, linkage networks for elk connect HCAs north and south of the Chehalis Basin. The Chehalis River also functions as a resistance to connectivity, similar to highway or interstate development (WHCWG 2010).

Habitat Concentration Areas

Important habitat patches for elk, identified as habitat concentration areas, have been mapped within Washington. As part of the analysis to map HCAs, broad-scale patterns of wildlife habitat and landscape connectivity have also been mapped to identify linkage networks that connect HCAs for elk and other migratory species. These linkage networks can also be used to estimate how likely they are to serve a broader suite of species.

Photo credit: Jeffry Seldomridge, Curtis, Washington

Wetlands and riparian areas associated with rivers and streams in the Chehalis Basin provide habitat for North American beaver, water shrew, and raccoon. The non-native species opossum also occurs in these habitat types. These, and similar species, depend on water for foraging, breeding, and, sometimes, overwintering habitats. Streams also provide a source of drinking water for larger mammals, such as black-tailed deer and coyote.

Beaver dams create habitat for many other animals and plants of Washington. In winter, deer and elk frequent beaver ponds to forage on plants that grow. Weasels, raccoons, and herons hunt frogs and other prey along the marshy edges of beaver ponds. Migratory waterflowl and waterbirds use beaver ponds as nesting areas and resting stops during migration. Ducks and geese often nest on top of beaver lodges because they offer warmth and protection, especially when lodges are formed in the middle of a pond. The trees that die as a result of rising water levels attract insects, which in turn feed woodpeckers, whose holes later provide homes for other wildlife (Link 2004).

Developed habitats in the Chehalis Basin reduce available wildlife habitat for mammals and limit its value to larger mammals that require greater areas of unbroken habitat to forage and reproduce. These areas are likely populated by common, urban-adapted species, including raccoon and a variety of small mammals, including deer mice and voles. Developed habitats also typically are associated with non-native species such as opossum, eastern gray squirrel, and old world rodents (such as the Norway rat).

3.4.2.3 Birds

The Chehalis Basin provides a range of habitat features that can provide breeding, foraging, resting, and overwintering habitat to support a wide range of bird species (Johnson and O'Neil 2001; Evenson et al. 2016). Terrestrial bird surveys performed in 2014 during preliminary Chehalis Basin Strategy studies for the proposed Flood Retention Facility identified an extensive list of bird species within the reservoir area of the Chehalis Basin (HMWSTS 2014). Additional information on the usage of aquatic, off-channel habitats in the Chehalis River floodplain by waterfowl (e.g., ducks, geese) and waterbirds (e.g., heron, grebes, cormorants) was obtained by WDFW during ground and air surveys conducted in 2015 and 2016 (Evenson et al. 2016). This section provides a brief summary of bird species and associated habitats documented within the Chehalis Basin, or known to occur in western Puget Sound.

Forested habitats provide foraging and nesting habitat for a wide variety of songbird species such as song sparrow, bushtit, Bewick's wren, Steller's jay, spotted towhee, Swainson's thrush, winter wren, varied thrush, black-capped chickadee, dark-eyed junco, chestnut-backed chickadee, golden-crowned kinglet, and red-breasted nuthatch. Disturbance-sensitive migratory bird species such as black-throated gray warbler, solitary vireo, yellow-rumped warbler, and yellow warbler likely use forested habitats for foraging during spring and fall migrations.

Upland herbaceous and grassland habitats are used by species such as barn swallow, tree swallow, and white-crowned sparrow. Predatory birds, such as red-tailed hawks, commonly hunt in these habitat types. Other raptors such as northern harrier and bald eagle occur in forested areas near bodies of water. Snags and downed trees in logged habitat, and along the forest edges, also provide perch sites for these species. Snags in forested habitats also provide potential nest sites for cavity-nesting birds such as great horned owl, and species of woodpeckers including downy woodpecker, northern flicker, and pileated woodpecker.

Great blue heron
Photo credit: Emma Sample, Chehalis, Washington

Off-channel aquatic habitats, including open water, emergent, scrub-shrub, and forested wetland types; small isolated depressional wetland pockets; and frequently flooded agricultural fields provide a variety of habitat for terrestrial birds, waterbirds, and waterfowl. Open water sections of wetlands and ponds can be expected to provide habitat for belted kingfisher and wintering and migratory waterfowl, including gadwall, American wigeon, mallard, ring-necked ducks, scaup, American coot, green-winged teal, and cinnamon teal. Emergent and scrub-shrub wetland areas provide habitat for red-winged blackbird, song sparrow, and marsh wren, among other species including waterfowl such as mallard, green-winged teal, and American widgeon. Forested and scrub-shrub wetlands are commonly used by similar species as well as wood duck and ring-necked duck. Non-waterflow waterbird species such as great blue heron, pied-billed grebe, and double breasted cormorant also use many of these habitats. Agricultural fields that are frequently flooded during high-water events are often used by a variety of waterfowl including Canada goose, trumpeter swan, cackling goose, mallard, green-winged teal, ring-necked ducks, and American widgeon. Survey data for waterfowl and waterbirds collected by WDFW suggest that wetlands and off-channel aquatic sites that are close enough to the Chehalis River mainstem to have water flowing through them during high-water events, tend to have lower species diversity, and use than other types of off-channel aquatic habitats (Evenson et al. 2016).

The marine environment of Grays Harbor also provides habitat for waterfowl species such as heron, in addition to seabird and shorebird species, such as killdeer. A 1,500-acre section of the northeastern shoreline of Grays Harbor that includes Bowerman Basin is designated as the Grays Harbor National Wildlife Refuge. This area, which is managed by USFWS, provides crucial habitat for more than a dozen species of migrating shorebirds (USFWS 2015b). Several other wetland and non-wetland, DNR-managed natural areas occur in and adjacent to Grays Harbor.

Developed habitats in the Chehalis Basin provide habitat for disturbance-tolerant bird species such as American crow and American robin, and non-native species such as European starling and house sparrow.

3.4.3 Special Status Species

Several species that occur in WRIAs 22 and 23, and their habitats, are protected by federal and state law due to declines compared to historical numbers because their populations are unique and limited, or the Chehalis Basin has been identified as important habitat for maintaining the species.

3.4.3.1 State- and Federally Listed Threatened and Endangered Species

ESA-listed species that may occur within the Chehalis Basin were identified based on information from the endangered species websites of USFWS and NMFS (USFWS 2015c; NOAA 2015). ESA-listed species under USFWS or NMFS jurisdictions were identified based on the geographic boundaries of Distinct Population Segments (DPSs) and Evolutionary Significant Units (ESUs). ESA-listed species under USFWS jurisdiction in Washington are referenced on the USFWS website to include all ESA-listed species that occur, or may occur, within the entire county where a project is proposed. The WDFW PHS database provided information on state-protected species known to occur within the Chehalis Basin (WDFW 2015b).

For marine fish species managed in Fishery Management Plans under the Magnuson-Stevens Fishery Conservation and Management Act, EFH occurs throughout WRIAs 22 and 23, and is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." All freshwaters in all sub-basins of WRIAs 22 and 23 are considered EFH for Chinook salmon, coho salmon, chum salmon, and steelhead as freshwater that is currently viable, and has been historically accessible to these salmonid species (PFMC 1999). Grays Harbor is included as EFH for Pacific salmon, as are all nearshore marine and estuarine waters within state territorial waters (PFMC 1999). Grays Harbor is also EFH for marine fish species of commercial interest. As an estuary and seagrass area, Grays Harbor is designated as a Habitat Area of Particular Concern and is included as EFH for Pacific Coast groundfish (PFMC 2005). Grays Harbor is also included as EFH for coastal pelagic fishes including Northern anchovy, Pacific sardine, Pacific (chub) mackerel, jack mackerel, and market squid; however, these species do not depend on shallow or brackish environments to a large degree (PFMC 1998).

3.4.3.1.1 Fish

Four state- and federally listed fish species occur in freshwater and estuarine (or both) habitats in the Chehalis Basin, which are summarized in Table 3.4-6. All of the listed species are anadromous except the Olympic mudminnow.

Table 3.4-6
Status of State-listed (Sensitive, Threatened, or Endangered) and ESA-listed (Threatened or Endangered) Fish Species Potentially Occurring in the Chehalis Basin

SPECIES	*SCIENTIFIC NAME*	STATE STATUS	FEDERAL STATUS	FEDERAL AGENCY JURISDICTION	CHEHALIS BASIN CRITICAL HABITAT	HABITAT	
						FRESH-WATER	ESTUARINE
Coastal/ Puget Sound bull trout	*Salvelinus confluentus*	Candidate	Threatened	USFWS	Yes	●	●
Eulachon	*Thaleichthys pacificus*	Candidate	Threatened	NMFS	No	●	●
Olympic mudminnow	*Novumbra hubbsi*	Sensitive	N/A	N/A	N/A	●	
Southern green sturgeon	*Acipenser medirostris*	N/A	Threatened	NMFS	Yes	●	●

Note: N/A = not applicable
Source: WDFW 2013

The distribution, habitat use, and status of each listed fish species are described here. In general, the habitat alterations that have affected salmonid habitat throughout WRIAs 22 and 23 have also affected the habitats occupied by the listed species (see Section 3.4.1.1.).

Southern Green Sturgeon

On April 7, 2006, NMFS published a Final Rule that listed the southern DPSs of green sturgeon as threatened (71 Federal Register 17757). Green sturgeon is an anadromous species that spawn in freshwater, and migrate to estuarine and marine environments to feed and develop from juveniles to adults (NMFS 2015). Green sturgeon also undergo seasonal migrations and appear to be most common in Grays Harbor during late summer and early fall (Lindley et al. 2011). Little is known about the population trends of this species in Grays Harbor or elsewhere (NMFS 2015). There is uncertainty about the spawning areas used by green sturgeon, but their current documented spawning habitat does not include the Chehalis River, although suitable spawning habitat may exist there (NMFS 2005, 2015). Throughout their range, a number of factors have been identified that threaten this species including: reduction of the spawning areas, insufficient freshwater flow rates in spawning areas, contaminants, bycatch of green sturgeon in fisheries, poaching, entrainment by water projects, interactions with non-native species, small population size, impassable barriers, and elevated water temperatures (NMFS 2015). The status and life history of green sturgeon is summarized in more detail in an NMFS status review update (NMFS 2005) and online (NMFS 2015).

Olympic Mudminnow

Olympic mudminnow was state-listed as sensitive in 1999; they are unique to Western Washington and only a small proportion of the population occurs outside of the Chehalis Basin (Kuehne and Olden 2014). Olympic mudminnow only occur in habitats where there is little or no flow such as streams, wetlands, and ponds. They require habitats with a muddy bottom, and typically occur in areas with aquatic vegetation and where large predatory fish, such as bass, are absent. The historical range of Olympic mudminnow in the Chehalis Basin may have been reduced significantly as key wetland habitats have been reduced through human development (WDFW 2013). The life history and status of this species is described in more detail by WDFW (2013) in *Threatened and Endangered Wildlife in Washington: 2012 Annual Report*.

Coastal/Puget Sound Bull Trout

Bull trout was listed as threatened under the ESA by USFWS on June 10, 1998. Portions of the lower Chehalis Basin were designated as critical bull trout habitat by USFWS on September 30, 2010 (75 Federal Rule 63898). Bull trout have been documented in Grays Harbor and in the lower portions of the Chehalis River (Jeanes et al. 2003), but they do not appear to spawn in the Chehalis Basin (75 Federal Rule 63898). While bull trout have been captured in a number of different studies in the Chehalis Basin, their detailed life history, distribution, and abundance within WRIAs 22 and 23 is poorly understood (Sandell et al. 2015).

Pacific Eulachon

Pacific eulachon was listed as threatened on March 18, 2010 (75 Federal Register 13012). Pacific eulachon are an anadromous species that usually spend 3 to 5 years in marine habitat before returning to spawn in freshwater. Eulachon have been observed in Grays Harbor and spawning in the lower reaches of the Chehalis River, as well as the Wynoochee and Humptulips rivers. Pacific eulachon do not show evidence of homing to natal rivers. They typically spawn on sandy substrates, and larvae are swept downstream soon after hatching (Gustafson et al. 2010). In the winters of 2012, 2014/2015, and 2015/2016, eulachon eggs and larvae were observed in plankton tows undertaken at one site in the lower Chehalis River by WDFW, just downstream of the confluence with the Wynoochee River. This site was chosen because it is downstream of major tributary confluences in which eulachon are likely to spawn; however, it is likely that spawning occurs much farther upstream in the mainstem Chehalis River and its tributaries (Cloen 2016). A comprehensive summary of eulachon habitat preferences and life history is available in a recent status review of eulachon (Gustafson et al. 2010).

3.4.3.1.2 Wildlife

ESA-listed wildlife species and critical habitats under USFWS jurisdiction in Washington are identified by USFWS (2015c) to include all ESA-listed species that occur or may occur within the entire county where a project is proposed. The WDFW PHS (WDFW 2008, 2015a) also identifies specific counties in Washington where state-protected threatened and endangered species have been documented.

The status and preferred habitats of federally listed species protected under the ESA (as identified by USFWS) and state species with threatened and endangered status (as identified by WDFW) within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties are presented in Appendix G, Table G-12. State species with threatened and endangered status are also discussed in the following sections. Federally listed critical habitats protected under the ESA within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties, as identified by USFWS, are presented in Table 3.4-7.

Table 3.4-7

Federally Listed and Proposed Species Critical Habitat Status That Occur in Lewis, Thurston, Grays Harbor, Mason, and Pacific Counties

COMMON NAME (*SCIENTIFIC NAME*)	AGENCY	CRITICAL HABITAT STATUS[1]	LEWIS COUNTY[2]	THURSTON COUNTY[2]	GRAYS HARBOR COUNTY[2]	MASON COUNTY[2]	PACIFIC COUNTY[2]
AMPHIBIANS							
Oregon spotted frog (*Rana pretiosa*)	USFWS	Proposed		●			
BIRDS							
Marbled murrelet (*Brachyramphus marmoratus*)	USFWS	Designated	●	●	●	●	●
Northern spotted owl (*Strix occidentalis caurina*)	USFWS	Designated	●	●	●	●	
Streaked horned lark (*Eremophila alprestris strigata*)	USFWS	Designated			●		●
Western snowy plover (*Charadrius alexandrinus nivosus*)	USFWS	Designated			●		●
INSECTS							
Taylor's checkerspot (*Euphydryas editha taylori*)	USFWS	Designated		●			
TERRESTRIAL MAMMALS							
Olympia pocket gopher (*Thomomys mazama pugetensis*)	USFWS	Designated		●			
Tenino pocket gopher (*Thomomys mazama tumuli*)	USFWS	Designated		●			
Yelm pocket gopher (*Thomomys mazama yelmensis*)	USFWS	Designated		●			

Notes:
1. USFWS 2015c
2. USFWS 2015d

Oregon Spotted Frog

Oregon spotted frogs are highly aquatic, inhabiting wetland edges of ponds, streams, and lakes. They are most often associated with non-woody wetland plant communities, such as sedges, rushes, and grasses (Nussbaum et al. 1983). These aquatic environments must include a shallow emergent wetland component large enough to be capable of supporting an Oregon spotted frog population (Pearl and Hayes 2004). Oregon spotted frogs are preyed upon during all life stages by a wide variety of predators, ranging from invertebrates that prey on eggs to garter snakes and herons that feed on adults. Among the most significant of predators are the various introduced species of fish and bullfrog (McAllister and Leonard 1997).

The historical range of the spotted frog includes portions of Western Washington; although, over the past 50 years, this species has been dramatically reduced. Before 1940, Oregon spotted frog was found in portions of the Puget Sound Lowlands and the Willamette Valley. They now appear to be virtually eliminated from this area (Leonard et al. 1993). The most significant factor contributing to the decline of Oregon spotted frogs is the loss and alteration of wetland habitat. Oregon spotted frogs have life history traits, habitat requirements, and population characteristics that make them vulnerable to such loss and limit their distribution. According to WDFW, the species persists in only six Washington locations. Five of these locations are located within Klickitat County and Whatcom County. One of the six locations is located within the Chehalis Basin in Thurston County, in the Black River. WDFW has been involved in a cooperative Oregon spotted frog captive rearing project at Dailman Lake on the Joint Base Lewis-McChord in Pierce County since 2008 (WDFW 2012).

Western Pond Turtle

Western pond turtles inhabit marshes, sloughs, moderately deep ponds, and slow-moving sections of creeks and rivers (Holland 1994). They require waters with abundant aquatic vegetation and protected shallow areas where juveniles may rest and feed under cover. In Washington, the species overwinters in upland habitats adjacent to waterbodies or in mud bottoms of lakes or ponds. Basking sites such as partially submerged logs, vegetation mats, rocks, or mud banks are a critical habitat requirement for this species. This species was once widely distributed throughout Western Washington, but is now severely restricted in range. Viable populations remain only in a few restricted areas in the Columbia Gorge (WDW 1993; Holland 1994). WDFW has been involved in several cooperative western pond turtle captive rearing and re-introduction projects in a variety of locations in Washington since 1992 (WDFW 2013).

Birds and Mammals

Several bird and mammal species with state threatened or endangered status are documented within the Chehalis Basin. Bird species with state endangered status include northern spotted owl, streaked horn lark, western snowy plover, and brown pelican. Marbled murrelet is a state-threatened species. The mammal species fisher is a state endangered species and western gray squirrel is a state-threatened species. There are five gopher species with state-threatened status. Marine mammal species, whales, and seals with state-threatened and endangered status would be associated with the marine environment of the Pacific Ocean. Preferred habitats of these state species with threatened and endangered status within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties are presented in Appendix G, Table G-12.

3.4.3.2 U.S. Forest Service Special Status Species

The Pacific Northwest Regional Office of USFS and the Oregon/Washington State Office of the Bureau of Land Management established an interagency program for the conservation and management of rare species. This interagency collaboration, identified as the Interagency Special Status Sensitive Species Program (ISSSSP), focuses on a regional-level approaches for species that meet agency criteria for inclusion on sensitive- and special-status lists. This includes those species that are not federally listed as threatened or endangered, or proposed for federal listing. ISSSSP identifies high-priority species and habitats, data gaps and information needs; and develops conservation assessments and strategies (USFS 2016). USFS special-status species with state- or federal-threatened or endangered status located within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties are identified in Appendix G, Table G-12. USFS special-status species that are also WDFW priority species documented within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties are identified in Appendix G, Table G-9.

3.4.3.3 WDFW Priority Species

Information from the WDFW PHS database (WDFW 2015b) was referenced to identify state priority species that could occur within the Chehalis Basin. In addition, the *WDFW Priority Habitat and Species List* (2008) identifies specific counties in Washington where priority species have been documented. Information from the *WDFW Priority Habitat and Species List* was used to identify priority species documented within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties. The state status and habitat descriptions of WDFW priority species within Lewis, Thurston, Grays Harbor, Mason, and Pacific counties are presented in Appendix G, Table G-9. State species with threatened and endangered status are discussed in Section 3.4.3.1.

3.5 Tribal Resources

This section describes the past and present uses of the land within the Chehalis Basin by Native Americans, as well as tribal fishing and treaty resources. For the purposes of this EIS, the term "tribal resources" refers 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. Information on these resources was largely based on historical accounts and reports.

3.5.1 Native American History in the Chehalis Basin

Early Native Americans who lived within the Chehalis Basin relied on fisheries for a large portion of their diet. Salmon fishing occurred along the Chehalis River and Grays Harbor, and their tributaries. These "precontact" peoples of the Grays Harbor Basin also caught eulachon, flounder, herring, lamprey, smelt, sole, and sturgeon (James and Martino 1986; Miller 2009). Upland resources, such as bear, beaver, deer, elk, berries, roots, and bulbs were collected, and were of particular importance to inland groups (Hajda 1990). Plants used for food and textiles were also collected along streambanks and tide prairies, including sweetgrass, cattail, swampgrass, and stinging nettle (James and Martino 1986; Hajda 1990; Miller 2010).

Culturally significant properties are sites or locations considered culturally important to the history of a group or people, or where culturally important events or practices are known to have occurred. No ethnographically named places or traditional cultural properties are known within the Chehalis Basin.

Studies of the archaeology and prehistory of the Pacific Northwest divide the prehistory of the region into multiple phases or periods from about 12,500 to 225 years before present (BP). These phases are academic concepts and do not necessarily reflect Native American viewpoints. Although the earliest evidence of human occupation in the Pacific Northwest dates to nearly 12,500 years ago (Carlson 1990; Matson and Coupland 1995; Ames and Maschner 1999), the precontact archaeological record for the Washington coast and southwestern inlands primarily consists of sites with contents that are consistent with collections from, or have been dated to, the Middle (3,800 to 1,500 years BP) and Late Pacific (1,800 to 1,500 to about 225 years BP) periods. Older, unidentified sites are also likely to exist locally because they are found elsewhere on the Pacific Northwest coast and especially on the eastern Olympic Peninsula (Wessen 1984, 1990). At least one notable exception, however, is located within the Chehalis Basin along the Chehalis River. The Mellon site contains artifacts that appear to date to the Archaic (12,500 to 6,400 years BP) and early Pacific (6,400 to 3,800 years BP) periods (Kennedy 1978).

The Chehalis Basin was traditionally inhabited by the Upper and Lower Chehalis, Cowlitz, and Suwal peoples. The waters of Grays Harbor were also seasonally used for fishing by the Quinault people (Gibbs 1877; Hajda 1990; Krauss 1990; Spier 1936). The Upper and Lower Chehalis and Quinault peoples spoke dialects of the Salish language, while the Cowlitz peoples spoke dialects of both the Chinook and Salish languages. The Suwal peoples spoke a dialect of the Athapaskan language (Miller 2012). Descendants of these groups are now members of the Chehalis Tribe, Cowlitz Indian Tribe, Quinault Indian Nation, and Shoalwater Bay Indian Tribe of the Shoalwater Bay Indian Reservation. The waters of the Chehalis River, its tributaries, and Grays Harbor were, and continue to be, important fishing areas for Native American tribes in the region, while the banks of these bodies of water served as productive hunting and plant gathering areas. The Chehalis Basin was an important hub for habitation, resource collection, and travel for coastal Native American groups (James and Martino 1986). The rivers and streams of the Chehalis Basin served as a passage for coastal tribes to the Puget Sound region by way of the Chehalis River, and to the Columbia River by way of the Chehalis River and then the Cowlitz River. As evidenced by the number of groups that inhabited or seasonally fished in the region, the Chehalis Basin was a highly productive fishing area (Hajda 1990; Miller 2009, 2010).

3.5.1.1 Upper and Lower Chehalis

Like most Coast Salish groups, the Chehalis peoples relied on fisheries, particularly salmonids. Salmon was harvested along the Chehalis River, its tributaries, and Grays Harbor. Lamprey was also collected along the Chehalis River and its tributaries (Miller 2010). Grays Harbor and its tributaries provided access to other fish (including echelon, herring, and sturgeon), aquatic mammals (including fur seals, porpoises, sea lions, and sea otters), and waterfowl (James and Martino 1986; Hajda 1990). On occasions when whales would beach along the Grays Harbor shoreline and flats, the Lower Chehalis would salvage meat and blubber (James and Martino 1986; Miller 2010). The Chehalis peoples also relied on upland plants and animals including, but not limited to, roots, fibrous plants, berries, deer, and elk. Upland plant and animal resources were an important supplement to fisheries for the Upper Chehalis peoples (Tolmie 1963; Hajda 1990).

Established in 1864 by secretarial order, the 4,849-acre Chehalis Tribe reservation is located on the Chehalis River at the mouth of the Black River near Oakville in WRIA 23. The reservation is rural agricultural with low-density residential, farms, open prairies, forestland, and wetlands. In 2014, the enrolled population of the Chehalis Tribe was 894. The U.S. Bureau of Indian Affairs (BIA) Labor Force Report for 2010 (BIA 2010) shows a service population (enrolled and non-enrolled Indians living on and near the reservation) of 3,625 individuals. The reservation provides the living space, sacred and cultural sites, and natural resources that sustain the Chehalis people and culture. It provides spiritual and physical sustenance, and the means for economic self-sufficiency. Many tribal members hunt and fish to supplement their incomes (commercial harvest), to provide sustenance for their families, and for cultural reasons (subsistence and ceremonial harvest).

3.5.1.2 Quinault

In addition to salmonids, which were of particular importance to nearly all coastal groups in the Pacific Northwest, the Quinault peoples fished for eulachon and white sturgeon in the Grays Harbor estuary and along tributary streams. The Quinault people also dug for clams along the shore, hunted for marine mammals (including fur seals, porpoises, sea lions and sea otters), and caught waterfowl (Hajda 1990). Whales were hunted along the outer coast, but documentation related to the salvaging of whales in Grays Harbor by the Quinault peoples is limited (James and Martino 1986; Hajda 1990). Quinault weavers have gathered materials from the Grays Harbor area for many generations. Sweetgrass, cattail, and other grasses and willow were gathered from the shores of Grays Harbor to weave baskets and mats (James and Martino 1986).

The Quinault Indian Nation is a federally recognized Indian tribe that consists of the Quinault and Queets tribes and descendants of five other coastal tribes: Quileute, Hoh, Chehalis, Chinook, and Cowlitz (Quinault Indian Nation 2015a). The Quinault Indian Reservation was stablished in 1856 by the Treaty of Olympia and is located on the southwestern corner of the Olympic Peninsula. The Quinault Indian Nation maintains a treaty-reserved right to take fish from its “usual and accustomed fishing grounds and stations” and the privilege of gathering, among other rights, in exchange for ceding lands the tribe historically roamed freely (Northwest Indian Fisheries Commission 2015). Grays Harbor, located in WRIA 22, is within the Quinault Indian Nation’s usual and accustomed fishing and gathering areas. Sweetgrass, cattail, and other grasses that grow in either freshwater or brackish marshes on the flats of the intertidal zone, such as those areas along the shoreline of Bowerman Basin and adjacent saltmarshes in the Grays Harbor National Wildlife Refuge, have been gathered by Quinault weavers for many generations (James and Martino 1986).

3.5.1.3 Cowlitz

The Cowlitz people in the Chehalis Basin vicinity harvested salmon, trout, and lamprey in the upper reaches of the Chehalis River and its tributaries. Like the Upper Chehalis, the Cowlitz people also relied on upland plant and animal resources as an important supplement to fisheries animals (Tolmie 1963; Hajda 1990; Miller 2010). The Cowlitz Indian Tribe does not have a reservation in the Chehalis Basin.

3.5.1.4 Suwal

The Suwal people primarily relied on hunting and gathering in the forests and prairies of the upper reaches of the western tributaries of the Chehalis River. Common meat sources included deer and elk, and may have included seasonal salmon fishing. These resources were supplemented by the collection of roots and berries, although information relating to the specific plant resources that were collected is minimal (Krauss 1990).

3.5.2 Tribal Fishing

3.5.2.1 Quinault Indian Nation

As a signatory of the Treaty of Olympia (1856), the Quinault Indian Nation has treaty-reserved commercial, subsistence, and ceremonial fisheries in the Chehalis Basin; however, the Quinault Indian Reservation is located outside of the Chehalis Basin. In the 1905 *United States vs. Winans* case, the

U.S. Supreme Court held that the Treaty with the Yakima of 1855 (and similar treaties) protects tribal access rights to fishing, hunting, and other privileges on off-reservation lands. The 1974 "Boldt Decision" (*United States vs. Washington*) interpreted the rights of treaty tribes to fish in their "usual and accustomed places in common with all citizens" to mean that treaty tribes have a right to harvest 50% of the harvestable portion of fish. In 2014, harvestable portions of fish in Grays Harbor and the Chehalis River amounted to 72,600 coho salmon, 5,100 Chinook salmon, 12,900 chum salmon, and 4,800 steelhead (WDFW 2015c).

As a treaty tribe, the Quinault Indian Nation manages its fisheries and is responsible for regulating its fishers both on and off the reservation. The Quinault Indian Nation is a co-manager with WDFW for steelhead, white sturgeon, Dungeness crab, and Chinook, chum, and coho salmon (Grays Harbor and ocean fishing; Sharp 2016a). The Quinault fishers harvest salmon, steelhead, and white sturgeon in the lower Chehalis River from the mouth to approximately the confluence with the Wynoochee River, in Grays Harbor, and in the lower portions of all other rivers flowing into Grays Harbor. The species and runs harvested in Grays Harbor are the same as those harvested in the lower Chehalis River (Chinook salmon, coho salmon, chum salmon, steelhead, and white sturgeon). The Quinault Indian Nation also manages a Dungeness crab commercial and subsistence fishery in Grays Harbor.

Each year the Quinault Indian Nation and the State of Washington meet to determine how many fish and crabs can be caught in fisheries, then negotiate fishery schedules to ensure an equitable share of the catch. The process for co-management of the ocean and freshwater salmon fisheries has evolved over the years and now incorporates preseason meetings and the use of model-based predictions of abundance, number of fish available for harvest, and catch. The preseason prediction of the number of salmon that will return to the rivers entering Grays Harbor is used to shape ocean and Grays Harbor fisheries to allow for an equitable sharing of catch, and adequate escapement of adults to spawning areas. Grays Harbor salmon and steelhead fishery openings and predicted catch by week and season are based on models that consider fish timing, level of effort (number of fishers participating in the fishery), expected catch, and previous years' fishery data. In the spring, once the tribe and state reach an agreement on fisheries, a preseason summary of planned fisheries and predicted catch (the planned fisheries includes weekly schedules of weeks and days open) is released.

All commercial catch must be reported to the Quinault Indian Nation Fisheries Division. The Quinault Indian Nation does not maintain records of subsistence or ceremonial catch of salmon, steelhead, and white sturgeon (Resource Dimensions 2015). Based on interviews with fishers, subsistence harvest ranges from 5% to 20% of reported commercial catch of salmon, steelhead, and sturgeon (Resource Dimensions 2015). The Quinault Indian Nation reported 50 authorized gillnet fishers in Grays Harbor (Sharp 2016a). The Quinault Indian Nation limit the number of fishers in the Chehalis River portion of Grays Harbor and the lower Chehalis River up to the Wynoochee River to 50. Another 10 fishers are authorized in the Humptulips River, with another 10 authorized to fish in the North Bay area off of the Humptulips River.

The Grays Harbor annual management cycle is divided into three seasons. The most intense fishery (maximum number of participants) and largest catches occur during the fall from September through mid-November (Quinault Indian Nation 2015b; Sharp 2016a). Species harvested during the fall fishery are coho salmon, chum salmon, and fall-run Chinook salmon (Sharp 2016a). Coho are the most abundant species in the fall fishery, followed by chum salmon (see Table 3.5-1). The winter fishery begins in late November and extends to mid-April. This fishery is directed at winter steelhead; fishers participate early in the season to target the more abundant hatchery steelhead (Sharp 2016a). The spring and summer management period is from April through July, and is directed at sturgeon foraging in Grays Harbor (Quinault Indian Nation 2015b; Sharp 2016a). The spring and summer fishery could include catch of spring-run or summer-run Chinook salmon returning to the Chehalis River. However, the abundance of this run of Chinook salmon has been low. Generally, not enough fish are returning to the river to provide for a directed fishery. Most of the reported Chinook salmon catch shown in Table 3.5-1 is fall-run Chinook salmon.

Table 3.5-1
Quinault Indian Nation Grays Harbor Salmon, Steelhead, and White Sturgeon Commercial Fisheries Annual Catch (2004 to 2013)

YEAR	CHINOOK SALMON	COHO SALMON	CHUM SALMON	WINTER STEELHEAD	WHITE STURGEON
2004	3,546	18,093	9,600	6,742	1,544
2005	2,297	23,428	5,804	4,992	3,374
2006	3,758	8,746	4,070	3,404	2,918
2007	2,483	8,927	598	3,975	1,766
2008	1,880	10,208	2,070	1,467	3,206
2009	2,512	28,487	4,397	697	1,373
2010	3,403	25,347	8,938	1,837	1,125
2011	6,417	27,982	17,207	3,341	947
2012	3,994	30,693	11,670	2,880	598
2013	2,909	21,692	11,976	1,955	726
Average	**3,320**	**20,387**	**7,633**	**3,129**	**1,758**

Note: Amounts indicate number of fish caught
Source: Resource Dimensions 2015

3.5.2.2 Chehalis Tribe

The Chehalis Tribe is the other federally recognized Native American tribe that harvests salmon and steelhead in the Chehalis Basin. The location of the reservation at the confluence of the Chehalis and Black rivers provides a prime fishing area for the salmon and steelhead returning to the Chehalis River. Primary commercial and subsistence fisheries occur in the fall for Chinook salmon and coho salmon, and in the winter for steelhead; a spring harvest depends on the abundance of spring-run Chinook salmon that return to the river. Because the Chehalis Tribe is a non-treaty tribe, their fisheries are limited to the portion of the rivers on the reservation, and their harvest is a portion of the non-treaty allowable harvest. The Chehalis Tribe's portion of the non-treaty harvest is based on a sharing formula between the state and the tribe. The state and tribe have an agreement to share equally in the non-treaty harvestable portion of fish returning to spawning areas upstream of the Chehalis Tribe reservation boundary (Hughes 2014). The number of fish available for harvest is developed from the preseason run forecast. Annual records of number of fish harvested are not available for the Chehalis Tribe fisheries. Recreational fishing on reservation lands is permitted with a tribal fishing license. Tribal members who fish off reservation must have a valid Washington State fishing license and follow state regulations.

The Skokomish Indian Tribe recently made a claim stating the Chehalis River is part of the tribe's usual and accustomed fishing grounds. If this claim is successful, additional information on tribal resources and harvest would be evaluated.

3.6 Air Quality

This section describes the existing air quality in the Chehalis Basin based on federal, state agency, and local agency data. Because air quality is described in relation to the standards in the Clean Air Act (CAA), a brief description of CAA is also included. Additionally, this section describes air pollutant sources and existing concentrations in the Chehalis Basin, and provides a general description of greenhouse gas (GHG) emissions (a component of air quality).

3.6.1 Clean Air Act and Greenhouse Gas Emission Requirements

USEPA is the federal agency responsible for implementing the CAA, which establishes National Ambient Air Quality Standards (NAAQS). The NAAQS define levels of air quality necessary to protect the public health (primary standards) and the public welfare (secondary standards). The CAA requires states to classify air basins as either attainment or nonattainment with respect to air pollutants. Counties or regions designated as nonattainment areas for one or more pollutants must prepare a State Implementation Plan (SIP) that demonstrates how the area will achieve attainment by federally mandated deadlines. In Washington, Ecology administers the CAA and has identified State Ambient Air Quality Standards for total suspended particulates, lead, particulate matter, sulfur dioxide, carbon monoxide, ozone, and nitrogen dioxide.

Historically, Thurston County (specifically the Olympia, Tumwater, and Lacey areas) has experienced exceedances of the NAAQS for particulate matter (Ecology 2013). Through actions taken in the SIP, ambient air concentrations of these pollutants were brought into line with the NAAQS (Ecology 2015h). Today, portions of Thurston County are designated as maintenance areas for particulate matter. All other areas within the Chehalis Basin are currently in attainment for regulated pollutants (Ecology 2015i).

Ecology also inventories GHG emissions (through WAC 173-441) as part of GHG reduction efforts to minimize climate change. This rule mandates GHG reporting for the following:

- Facilities that emit at least 10,000 metric tons (MT) of GHGs per year in Washington
- Suppliers of liquid motor vehicle fuel, special fuel, or aircraft fuel that supply products equivalent to at least 10,000 MT of carbon dioxide (CO_2) per year in Washington

Currently, there are several facilities within the Chehalis Basin that fall under one of these two categories and are required to report their GHG emissions, including the TransAlta Centralia Generation Facility, a coal burning plant near Bucoda.

3.6.2 Current Air Quality Environment

Several agencies, including Ecology, the Olympic Regional Clear Air Agency, and the Southwest Clean Air Agency, collect ambient air quality data in the Chehalis Basin (Ecology 2015h, 2015i; ORCAA 2015; Southwest Clean Air Agency 2015).

Air quality in the Chehalis Basin is well within most of the standards for pollutants. Sources of regulated air pollutants and GHG emissions in the Chehalis Basin include transportation sources (such as cars, buses, trucks, trains, boats, and aircraft), urban sources (including wood smoke, emissions from commercial and industrial operations, and gas-powered residential equipment), agricultural practices (including field burning, re-entrainment of dust from practices such as plowing, and emissions from farm equipment), and wildfires. These types of sources occur, to varying degrees, throughout the Chehalis Basin. However, the largest source of GHG emissions in the Chehalis Basin is the TransAlta Centralia Generation Facility (USEPA 2013). In 2013, TransAlta reported emitting more than 7.5 million MT of CO_2 and other GHG emissions—a 30% increase from the previous year (USEPA 2013). This is the largest source (about 70%) of carbon pollution in Washington. The plant is planning to phase out coal production by 2025, according to the TransAlta Energy Transition Bill that was signed into law in 2011. One of the two units at the plant will shut down in 2020, and the second unit will shut down in 2025.

3.7 Climate Change

This section describes climate change and its influence on the environment within the Chehalis Basin. Patterns of temperature, precipitation, wind, humidity, and seasons have become less predictable throughout the world. The Earth's climate is changing—often with disruptive consequences—and that change is progressing faster than any seen in the last 2,000 years (Ecology 2015j). According to the report *Preparing for a Changing Climate*, rising levels of CO_2 and other heat-trapping gases in the atmosphere have warmed the Earth and are causing wide-ranging impacts, including rising sea levels; melting snow and ice; more extreme heat events, fires and drought; and more extreme storms, rainfall, and floods (Ecology 2012). Scientists project that these trends will continue and, in some cases, accelerate, posing significant risks to human health, forests, agriculture, freshwater supplies, coastlines, and other natural resources that are vital to Washington's economy, environment, and our quality of life (Ecology 2015j).

Because so many systems are tied to climate, a change in climate can affect many aspects related to where and how people, plants, and animals live (e.g., food production, availability and use of water, health risks). For example, a change in the usual timing of rains or temperatures can affect when plants bloom and set fruit, when insects hatch, or when streams are their fullest. This can affect the historically synchronized pollination of crops, food for migrating birds, spawning of fish, water supplies for drinking and irrigation, forest health, and more (Ecology 2015j).

In the Pacific Northwest, climate is influenced by the El Niño/Southern Oscillation and Pacific Decadal Oscillation. These oscillations have a greater impact on snow-dominated watersheds. In warm phases of both oscillations, drier winters and warmer springs cause lower snowpack and streamflow in the spring and summer (CIG 2015). Floods are triggered primarily by atmospheric weather systems, which tap moisture from the tropics and funnel it to locations in Western Washington, resulting in heavy precipitation.

The Chehalis Basin is mostly rain-dominated with little snowpack-related runoff. Precipitation typically falls as rain and causes peak flows from November to February. Runoff significantly varies, due to the precipitation variability within the Chehalis Basin, and ranges from an annual

Tracking the Change

Temperatures, rainfall, droughts, high-intensity hurricanes, and severe flooding events all are increasing and are projected to continue as the world's climate warms, according to the National Climate Assessment for 2014 (Mote et al. 2014).

Even seemingly less dramatic local changes in temperature, precipitation, and soil moisture could severely affect many things important to human life and life around us, including:

- Agriculture and food supplies
- Human health
- Natural ecosystems
- Forestry
- Water resources and availability
- Energy use
- Infrastructure and transportation

Source: Ecology 2015j

average of 43 inches along the low-lying valley areas to more than 250 inches in the Olympic Mountain watersheds (Gendaszek 2011).

Climate change has the potential to affect important variables throughout the Chehalis Basin. In general, changes in sea level would affect the low elevation wetlands and influence tidal exchange. Also, temperature and precipitation changes can shift the composition of plant communities, which could cause changes in animal communities (DNR 2009).

Climate change predictions suggest changes in quantity, timing, and intensity of precipitation that will translate into changes in streamflow magnitude, and perhaps changes in the frequency of floods. Projections for the Chehalis Basin anticipate less change in streamflow than in snow-dominated systems. However, by mid-century, rainfall events are projected to become more severe, summer streamflows are projected to decrease, and annual variability will continue to cause some periods that are abnormally wet, and others that are abnormally dry.

Climate change projections for the region are available from the CIG at the University of Washington. CIG uses multiple models to downscale global projections from the Intergovernmental Panel on Climate Change to smaller geographic areas such as the Pacific Northwest, Washington, and specific watersheds. Climate change has been modeled for several categories (e.g., temperature, precipitation, and sea level) over 100 years (for the periods of 1970 to 1999 and 2070 to 2099).

A report issued by CIG in November 2015 (Mauger et al. 2015) identifies risks to infrastructure and human health in the Puget Sound region, including the Chehalis Basin, from climate change. More intense heat waves and higher flood risks are predicted, along with the indirect effects of increased wildfire frequency, shortage of summer water supply, shifting infectious disease dynamics, and decreased air quality. Infrastructure (including airports, roads, WWTPs, and energy facilities) would also be affected, particularly for facilities in coastal and low-lying areas and floodplains.

3.7.1 Air Temperature

From 1895 to 2011, the Pacific Northwest experienced a total average annual warming of about 1.3 F, or 0.11°F per decade. Regionally downscaled climate models project increases in annual temperature of 3.3 to 9.7°F by 2070 to 2099 (compared to the period 1970 to 1999), depending on total global emissions of heat-trapping gases. These increases are projected to be the largest in the summer (Mote et al. 2014).

3.7.2 Precipitation

Annual average precipitation in the Pacific Northwest is projected to increase in the winter in both frequency and intensity as the climate warms (Mauger et al. 2016). During the summer months, models consistently predict that summer precipitation would decrease by as much as 30% in the Pacific Northwest (Mote et al. 2014).

Regional models predict increases in extreme daily precipitation events of up to 20%. These models show a general increase in extreme rainfall magnitudes; however, the large variability in model results makes the increases difficult to isolate from natural variability (Rosenberg et al. 2010).

3.7.3 Wind Velocity

Globally, winds are maintained by the temperature gradient from the equator to the poles. Global climate change models show that temperature warms poles and higher latitudes more than the equator and lower latitudes, which causes a lower temperature gradient and would likely result in weaker winds (Ren 2010). Regionally, coastal wind velocities could increase due to a faster temperature increase on land compared to water, which would increase the coastal thermal gradients that drive winds (Stephens 2008).

3.7.4 Sea Levels

Global sea levels have risen about 7 inches from 1900 to 2000, and are projected to rise another 2 feet (on average) for the Pacific Northwest by 2100 (Mauger et al. 2016). Much of the coastline of the Pacific Northwest is rising due to tectonic uplift (which raises the land surface), so sea level rise in this area could be less than the global average. However, a major earthquake could reverse centuries of tectonic uplift and increase sea level by 40 inches or more. Sea level rise could result in the decline (in quality and extent) of coastal wetlands, tidal flats, and beaches (Mote et al. 2014). By 2025, sea level rise is predicted to result in transitions from forested tidal swamp to irregularly flooded marsh in lower river surge plain areas, where rising water levels and increased saltwater intrusion would cause trees to die. In the inner estuary and greater Grays Harbor areas, there would be a loss of low elevation tidal mud and sand flats (ASEPTC 2014a).

3.7.5 Streamflow

As noted previously, the Chehalis Basin is mostly rain-dominated, thus impacts from climate change are not expected to be as dramatic as in other basins in the state. However, mean monthly runoff could increase slightly (up to 7%) from October to March and decrease very slightly (3%) during the summer months. Maximum annual daily flows could increase by up to 20% or more at the 100-year flood level (depending on the climate change model and emissions scenario; WSE 2014b). A study prepared by CIG for the Chehalis Basin Strategy prepared estimates of peak flow increases under climate change conditions (CIG 2016). CIG used 12 different Global Climate Models, several different future timeframes, three different GHG emission scenarios, and several hydrologic models to estimate a range of potential hydrologic responses to climate change. Discussions were held with CIG, Washington State, and others to develop a recommendation to use a single set of peak flow changes for purposes of this EIS. The increase in peak flows under climate change conditions is estimated to be 66% for a 100-year flood (Karpack 2016a).

3.7.6 Water Temperature

Water temperatures in streams are expected to increase due to climate change because of increases in air temperatures and lower streamflows. The increase in stream water temperatures would reduce the quality and quantity of freshwater habitat, especially for salmonid species that become stressed from high water temperatures (Mantua et al. 2010). Increasing temperatures during heat waves, during summer afternoons, and in the mid-channels of rivers and streams would increase the importance of protecting thermal refugia for aquatic life, such as cool tributaries and shaded off-channel areas with cool groundwater inflows.

3.7.7 Forests

Climate change would alter forests in the Pacific Northwest by increasing wildfire risk, increasing insect and tree disease outbreaks, and by forcing longer-term shifts in forest types and species. Warmer and drier conditions have contributed to an increase in the number and extent of wildfires since the 1970s, and the trend is expected to continue under future climate change conditions. Throughout the Northwest, the median annual area burned is projected to quadruple to 2 million acres by the 2080s (relative to the 1916 to 2007 period). This value varies within the region and is dependent on forest type, effectiveness of fire suppression, and land use (Mote et al. 2014).

3.8 Visual Quality

This section describes the visual setting of the areas where visual quality could be affected by the alternatives, and generally describes the policies and regulations that pertain to visual quality in the Study Area. The visual attributes of the proposed locations for Large-scale Flood Damage Reduction elements are given additional consideration in this section, including the upper Chehalis River near Pe Ell, the Chehalis-Centralia airport levee, and portions of I-5 within the floodplain. The visual settings for proposed areas of Restorative Flood Protection actions are also provided. The visual settings of the mainstem Chehalis River, principal rivers within the Chehalis Basin, floodplain, and shoreland areas within 200 feet of those waterbodies are described as they relate to the potential implementation of the ASRP, potential land acquisition, and conservation easement elements of the Chehalis Basin Strategy. Areas within the Chehalis Basin that are outside of the mainstem Chehalis River, principal rivers, floodplain, and shorelands contain a wide variety of visual resources; however, it is assumed that these areas would not be affected by the alternatives and are not described in this section. The information provided in this section is based on photographs, a site visit, state regulations, WSDOT's scenic and recreational highways plans, and Chehalis Basin Strategy reports.

3.8.1 Policies and Regulations Related to Aesthetics and Visual Quality

This section describes the policies and regulations concerning visual quality in the Chehalis Basin.

3.8.1.1 Shoreline Management Act

Several waterbodies in the Chehalis Basin, including the Chehalis River, are regulated under the Shoreline Management Act (see Section 2.4.3). The local SMPs regulate the use and development of shorelines, and include policies and regulations to protect aesthetic resources. Examples of local policies and regulations protecting these resources include height standards, setbacks, preservation of natural character, and protection of views.

3.8.1.2 State Scenic and Recreational Highways

Portions of SR 6, US 12, and SR 105 are designated Scenic and Recreational Highways, as described in RCW 47.39.020(11) and (26). These routes offer exceptional views of the Chehalis River valley and Grays Harbor, as well as rural, forested land and parks. The *Washington State Scenic and Recreational Highways Strategic Plan* (WSDOT 2010) establishes goals and performance measures consistent with the state's transportation policy goals; however, corridor management plans that identify specific sites for protection of views have not been developed for the management of the highway segments within the Chehalis Basin (WSDOT 2015).

3.8.2 Visual Setting

This section describes the visual setting of the pertinent areas in the Chehalis Basin that could be affected by the action elements and combined alternatives.

3.8.2.1 Mainstem Chehalis River and Tributaries, Principal Rivers, Floodplain, and Shorelands

The visual setting along the mainstem Chehalis River and other principal rivers is diverse because of the large area encompassed by these waterbodies. The mainstem flows approximately 125 miles, beginning in the relatively low-lying, unglaciated foothills and low mountains of the Willapa Hills. It initially follows a relatively low gradient, but undulates as it draws water from tributaries originating in three additional mountain ranges: the Black Hills, the Cascade Range foothills, and the southern Olympic Mountains (Ruckelshaus Center 2012) where elevations top 3,000 feet (Ruckelshaus Center 2014).

Views from highways, rail lines, and trails are predominately rural and forested, with the population distributed throughout the rural areas, but concentrated in small towns largely located in or near the floodplain (Ruckelshaus Center 2014). The visual experience south of Centralia is characterized by a wide river valley in a sparsely populated, largely agricultural area. The middle portion of the mainstem is characterized by development and major infrastructure including I-5 and the main rail lines, which cut through the middle of the river's floodplain. The upper portion is characterized by a narrow river valley and a modified floodplain area. Within and near the urban areas, commercial and industrial land uses are visible.

Many transportation corridors, including I-5, state highways, and local roadways run along or intersect the mainstem, principal rivers, floodplains, and shorelands. They intermittently offer views of the adjacent waterbodies and land uses. When flooding occurs, water can be seen on some roadways, and during a major flood, portions of the roadway can become completely submerged. Structures that are elevated above the floodplain are visible above the floodwater.

Table 3.8-1 describes the visual attributes of the principal rivers, shorelines, and floodplains that largely characterize the Chehalis Basin. To facilitate understanding of the geographic location that is being described, the Chehalis Basin is broken down into sub-basins (listed in the first column). Representative photographs of visual features in the Chehalis Basin are shown in Figures 3.8-1 and 3.8-2.

Table 3.8-1
Visual Characteristics of the Tributaries, Associated Floodplains, and Shorelines

TRIBUTARY BASIN	PRINCIPAL TRIBUTARIES	TRIBUTARY FEATURES	FLOODPLAIN FEATURES	SHORELAND FEATURES
Mainstem Chehalis River	• Black River[1] • Boistfort River • Cloquallum River[1] • Hoquiam River[1] • Humptulips River[1] • Lincoln Creek[1] • Newaukum River • Satsop River[1] • Skookumchuck River[1] • Wishkah River[1] • Wynoochee River[1]	• Diverse visual features • Views of upstream areas tend to appear undisturbed and include native vegetation • Downstream, river modifications are evident	• Riprap and other bank protection • Splash dams • High concentrations of people, development, and activities characteristic of urban development in Chehalis, Centralia, Aberdeen, and Hoquiam	• Lack of vegetation in urbanized areas • Agricultural activities predominant in less populated areas • Largely forested and natural in appearance in rural areas
Black	• Black River[1] • Porter Creek[1]	• Generally slow-moving, palustrine-type quality with shallow waters	• Agricultural uses, including dairy farms, evident • Generally low-density, rural quality	• Grazing and agricultural uses evident up to rivers' edge in many areas • Low gradients
Boistfort	• Chehalis River[1] • Lake Creek[1] • Stillman Creek[1]	• Logging road crossings and other features intersect waterways and affect flow	• Riprap evident along South Fork Chehalis River	• Conifers present along Stillman Creek • Clearing, including logging, up to rivers' edge • Agricultural, residential, and urban uses, and roads present
Cloquallum	• Mox-Chehalis Creek[1] • Newman Creek[1] • Vance Creek[1] • Falls Creek • Workman Creek[1] • Wildcat Creek	• Headwaters in low hills of the Olympic Mountains • Flows through broad valleys • Low to moderate grade • Logjams and booms present in Mox-Chehalis	• Agricultural uses • Bank protection evident	• Forested, with evidence of logging • Livestock and residential uses • Newman Creek and Vance Creek shorelines are especially used for agricultural and residential development

TRIBUTARY BASIN	PRINCIPAL TRIBUTARIES	TRIBUTARY FEATURES	FLOODPLAIN FEATURES	SHORELAND FEATURES
Hoquiam-Wishkah	• Hoquiam River[1] • Wishkah River[1] • Polson Creek • Hoover Creek • Barnard Creek	• Low gradient • Hoquiam straddles lower Hoquiam mainstem • Diversion dams on Little North Fork Hoquiam River and West Fork Hoquiam River • Barrier culverts evident	• Commercial and residential development • SR 101 and local roads present	• Flat, brushy valleys surrounded by low hills • Second-growth timber and agriculture lands • Logging and development evident
Humptulips	• Humptulips River[1] • Big Creek[1] • Stevens Creek • Deep Creek[1]	• Narrow corridors with fast flows, slides present	• Agricultural and forest uses present • Roads throughout	• Heavily forested and vegetated, with clear cutting evident
Lincoln	• Lincoln Creek[1] • Independence Creek[1] • Garrard Creek[1] • Gaddis Creek • Rock/Williams Creek[1]	• Scouring evident along streambeds, bank erosion evident	• Riprap and roads present	• Agriculture and residential uses present
Newaukum	• Newaukum River • Salzer Creek[1] • Coal Creek[1] • Dillenbaugh Creek[1] • Berwick Creek • China Creek	• I-5, US 12, and other road crossings present • Moderate flows • Dam at North Fork Newaukum River	• Agricultural and urban uses with road crossings throughout, particularly in the Centralia area	• Lacks vegetation and has an openness quality in many areas
Satsop	• Satsop River[1] • Cook Creek • Decker Creek[1] • Baker Creek • Rabbit Creek • Smith Creek[1] • Black Creek[1] • Still Creek	• Many road crossings, many areas with low water levels and relatively slow flows	• Many riprapped areas	• Largely lacking vegetation with many hardwoods present, visual evidence of logging

TRIBUTARY BASIN	PRINCIPAL TRIBUTARIES	TRIBUTARY FEATURES	FLOODPLAIN FEATURES	SHORELAND FEATURES
Skookumchuck	• Skookumchuck River[1] • Scatter Creek[1]	• TransAlta dam, I-5, Highway 99, local roads, and railroad crossings	• Hard armoring and riprapping present	• Agriculture, urban/suburban development, logging present
South Harbor	• Elk River[1] • Johns River[1] • Alder Creek • Charley Creek • Newskah Creek[1]	• Many crossings, narrow at source becoming increasingly broad near harbor	• Urban development (visible) in many areas of the floodplain	• Relatively well maintained and vegetated, particularly in the Elk River Natural Resources Conservation Area and around the Elk and Johns rivers
Wynoochee	• Schaeffer Creek • Black Creek[1]	• Wynoochee Dam and many crossings present	• Armoring and diking protecting farmlands and residential development	• Timber harvests and agricultural practices evident

Note:
1. Waterways either partially or wholly designated as Shorelines of the State
Source: Adapted from information contained in the *Chehalis Basin Watershed Management Plan* (CBP 2004)

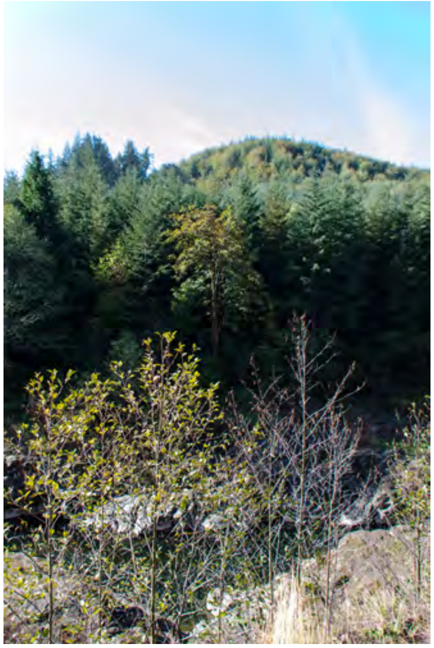
Figure 3.8-1
Visual Features

Riparian area in upper Chehalis River

Views of forested area in upper Chehalis Basin with evidence of clear cutting

Logging road on Weyerhaeuser property in upper Chehalis Basin

View looking east, within the outer footprint of potential flood retention facility



View looking west, within the outer footprint of potential flood retention facility

Figure 3.8-2
Visual Features

Chehalis River in Pe Ell

Salmon spawning habitat at the SR 6 overpass of the Chehalis River in Pe Ell

View looking south from atop the Chehalis-Centralia Airport Levee

View looking north from atop the Chehalis-Centralia Airport Levee

View of I-5 from the Mellen Street Overpass in Chehalis

Location of potential fish passage improvements and restoration

3.8.2.2 Upper Chehalis River, Near Pe Ell

The visual setting of the area where the Flood Retention Facility is proposed provides relatively natural views, with a dominant characteristic of openness. The upper Chehalis River bends and braids in a general northeasterly direction. Within the upper Chehalis River, sand and gravel bars are present, as well as woody and rock debris. The banks of the upper Chehalis River are in a natural state, and the river cuts through gentle rolling hills on either side. The shoreland areas are heavily vegetated, and upland areas are forested predominantly with conifers. Logging roads with river crossings and recent clear cuts on either side of the upper Chehalis River are visible.

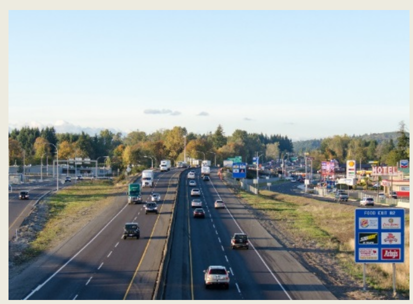
Upper Chehalis River

3.8.2.3 Chehalis-Centralia Airport Levee

The airport levee is elevated from ground level and circumnavigates a portion of the airport perimeter. It begins at the parking lot near the south side of the airport and continues for 2 miles along Airport Road. It is topped with crushed gravel and, because it doubles as a recreational trail, provides an elevated view of the airport, including the parking lot, hangars, and other airport infrastructure. From atop the levee, views of retail businesses to the east and the golf course to the west are also present.

Chehalis-Centralia Airport Levee

3.8.2.4 Interstate 5



I-5 in Centralia

The visual setting for I-5 is typical of interstate highways of its type in the region. Traffic can generally be seen moving through the area at typical highway speeds. Structures viewed from the highway are predominately commercial and industrial, with some residential and agricultural uses present. Buildings that have been elevated above the floodplain are evident on both sides of the interstate. The right-of-way is relatively level with, or slightly elevated above, adjacent uses in most areas. During floods, the inundation of portions of I-5 and adjacent structures is evident.

3.8.2.5 Aberdeen/Hoquiam North Shore Levee

The visual setting for the Aberdeen/Hoquiam area is primarily urban with densely developed industrial, commercial, and residential areas. The area is generally flat, with a gentle slope from the north down to the waterfront. Buildings are generally one or two stories. The Chehalis River and Grays Harbor shorelines are developed for industry, including docks and tank farms. The shorelines of the Hoquiam and Wishkah rivers are densely developed with pockets of trees. An area on the east bank of the Wishkah River is less densely developed and has areas of riparian vegetation.

3.8.2.6 Restorative Flood Protection

The Restorative Flood Protection actions would be located in the upper Chehalis Basin upstream of the confluence with the Newaukum River, along the mainstem Chehalis River and its tributaries (see Figure 2.3-5 in Section 2.3.3.1). The visual setting of the mainstem is characterized by a narrow riparian corridor, surrounded by agricultural land with forestland in the uplands. The small towns and communities of Doty, Dryad, Meskill, Millburn, Adna, Littell, Claquato, and Fords Prairie are located along the river. Buildings in these communities are not densely spaced, and are primarily one or two stories. Rainbow Falls State Park is located on the mainstem Chehalis River, east of Dryad. The park is located on both banks of the Chehalis River and is primarily forested. Its namesake waterfall is located on the Chehalis River. The tributaries of the mainstem Chehalis River, including Elk, Bunker, Deep and Stearns Creeks, have narrower riparian corridors with surrounding agricultural land and forestlands.

The South Fork Chehalis River is bordered by a broad agricultural valley in the north, with scattered communities including Boistfort, Klaber, and Curtis. These communities are similar to those along the mainstem. To the south, the agricultural valley narrows. South of the community of Wildwood, the area is primarily used for active logging with patches of forest and cleared areas. Stillman Creek is a tributary on the west side, with a narrow riparian corridor surrounded by a broad agricultural valley to the north and forestland upstream. The visual setting along the North Fork and South Fork of the Newaukum River are similar, with broad valleys used for agricultural and surrounded by forestland. The mainstem Newaukum River flows through a broad valley that is predominantly used for agricultural with a narrow riparian corridor. The Newaukum River flows under I-5 and through an increasingly urban area before it joins the mainstem Chehalis River near Chehalis.

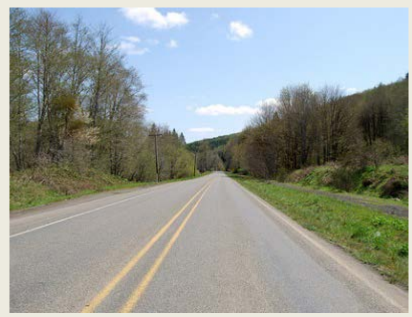
3.9 Noise

This section generally describes noise, as well as the regulatory and environmental settings for the Chehalis Basin.

Noise is generally measured in terms of the sound pressure level expressed in decibels (dB). The number of fluctuation cycles or pressure waves per second of a particular sound is the frequency of the sound. The human ear is less sensitive to higher and lower frequencies than to mid-range frequencies. Therefore, sound level meters used to measure environmental noise generally incorporate a filtering system that discriminates against higher and lower frequencies, in a manner similar to the human ear, to produce noise measurements that approximate the normal human perception of noise. Measurements made using this filtering system are termed A-weighted decibels (dBA). The noise levels referred to in this EIS are stated as hourly equivalent sound levels (L_{eq}) in terms of dBA.

Noise levels decrease with distance from a noise source. The L_{eq} noise level from a line source, such as a road, would decrease by 3 to 4.5 dBA for every doubling of distance between the source and the receiver. The L_{eq} noise level from a point source, such as a generator, would decrease by approximately 6 dBA for every doubling of distance between the source and the receiver. Subjectively, a 10 dBA change in noise levels is perceived by most people to be approximately a twofold change in loudness (e.g., an increase from 50 to 60 dBA causes the perceived loudness to double). Generally, 3 dBA is the minimum change in outdoor sound levels that can be perceived by a person with normal hearing.

General ambient environmental noise is often described using the day-night average sound level (L_{dn}). The L_{dn} is a community noise metric which describes a receiver's cumulative noise exposure from all of the events that occur over a full 24-hour period, with an increase of 10 dB for events that occur between 10:00 p.m. and 7:00 a.m. to account for greater nighttime sensitivity to noise.



Existing Noise Levels

Existing noise sources in the Chehalis Basin include agricultural activities, commercial and industrial facilities, trains, small airports, and highways.

Many parts of the Chehalis Basin, like this section of SR 6 just east of Pe Ell, have very low noise levels.

State and local regulations identify the allowable noise levels for construction and operation of facilities and businesses. These regulations would apply when implementing the EIS alternatives.

Photo credit: WDFW

3.9.1 Applicable Noise Regulations

WAC imposes limits on the allowable environmental noise levels from a variety of sources in any 1-hour period (WAC 173-60, *Maximum Environmental Noise Levels*). The maximum allowable levels depend on the classification of the property receiving the noise and the noise source. The classification system is called the Environmental Designation for Noise Abatement (EDNA), and is generally based on a property's use.

WAC 173-60-040 establishes maximum permissible environmental noise levels. There are three EDNA designations (WAC 173-60-030), which generally correspond to residential, commercial and recreational, and industrial and agricultural uses. These are listed as follows:

- Class A: Lands where people reside and sleep (such as residential/recreational)
- Class B: Lands requiring protection against noise interference with speech (such as commercial)
- Class C: Lands where economic activities are of such a nature that higher noise levels are anticipated (such as industrial/agricultural)

Table 3.9-1 summarizes the maximum permissible levels applicable to noise received at the three EDNAs.

Table 3.9-1
Maximum Allowable Noise Levels

EDNA OF NOISE SOURCE	EDNA OF RECEIVING PROPERTY		
	CLASS A (dBA L_{EQ})	CLASS B (dBA L_{EQ})	CLASS C (dBA L_{EQ})
Class A (residential/recreational)	55	57	60
Class B (commercial)	57	60	65
Class C (industrial/agricultural)	60	65	70

Source: WAC 173-60-040

The following noise sources or activities are exempt from the noise limits listed in Table 3.9-1 (WAC 173-60-050):

- Sounds created by traffic on public roads
- Sounds created by warning devices (e.g., back-up alarms)
- Sounds from blasting and from construction equipment are exempt from the standards during the day (7:00 a.m. to 10:00 p.m. on weekdays, and from 9:00 a.m. to 10:00 p.m. on weekends) in rural and residential districts

In general, counties and cities in the Chehalis Basin have adopted state regulations, which would apply to implementing elements of the EIS alternatives.

3.9.2 Current Noise Environment

The Chehalis Basin is primarily rural with towns and small cities (including Centralia, Chehalis, and Aberdeen) located along the Chehalis River. Existing noise sources in the Chehalis Basin include agricultural activities, commercial and industrial facilities, trains, small airports, and highways. Many parts of the Chehalis Basin are sparsely populated and have very low noise levels. Several of the elements of the proposed alternatives would primarily be located in rural areas with low existing noise levels (EDNA Class A). Other proposed elements of the alternatives would be located in or near cities and towns with somewhat higher noise levels (EDNA Classes A, B, and C).

3.10 Land Use

The Chehalis Basin comprises a diverse variety of land uses. This section describes current land use, including a brief overview of the governing policies that regulate these uses and ownership within the Chehalis Basin. The information in this section is based on data from federal and state agencies, as well as reports prepared by tribes and reports prepared as part of the Chehalis Basin Strategy.

3.10.1 Regulatory Overview

Many regulations are in place to regulate the types of land use within the Chehalis Basin. The following provides a brief overview of the primary policies governing land use in the Chehalis Basin.

The Growth Management Act (GMA) requires certain counties and cities to create comprehensive plans. These plans contain policies consistent with GMA goals such as encouraging urban growth; reducing sprawl; encouraging multimodal transportation systems, affordable housing, economic development, environmental protections; and many more (RCW 63.70A.020). Additionally, the GMA requires jurisdictions to protect critical areas including wetlands, aquifer recharge areas, fish and wildlife HCAs, frequently flooded areas, and geologically hazardous areas (WAC 36.70A.030[5]).

SMPs regulate development within 200 feet of jurisdictional waterbodies to be consistent with the Shoreline Management Act goals stated in RCW 90.58.020. These regulations emphasize appropriate shoreline land use, protection of shoreline environmental resources, and protection of the public's right to access and use state shorelines. The regulations also provide higher standards for Shorelines of Statewide Significance, such as the Chehalis River. Jurisdictions within the Chehalis Basin are currently comprehensively updating their SMPs to be consistent with new Shoreline Management Act Guidelines (WAC 173-26), which were revised in 2003 with additional amendments made in 2011.

In Washington, Ecology is the lead agency responsible for overseeing floodplain management. Current floodplain management regulations were created in 1989 with interim modifications, including Washington adopting portions of the NFIP requirements as minimum floodplain management requirements. NFIP is a federal program administered by FEMA to provide a means for property owners to purchase insurance to financially protect themselves from flood damages. NFIP sets minimum standards that communities must comply with to participate in the program. Washington has adopted higher standards than those used nationally by FEMA—most notably prohibition of new residential development in a floodway. Ecology actively encourages local governments to adopt higher-than-minimum FEMA standards in their flood ordinances, and makes recommendations on local Critical Area Ordinances to better align with flood management regulations.

Ecology, either independently or in collaboration with FEMA, provides technical assistance and grants to local communities for the purpose of reducing flood damages and protecting environmental functions of the floodplain (Ecology 2015k). Ecology is also engaged with FEMA and local agencies in upgrading the accuracy of GIS tools (e.g., RISK Map) used for regulating floodplain areas.

As an incentive for implementing floodplain management activities that result in flood damage reduction, a Community Rating System (CRS) was developed under FEMA's NFIP (FEMA 2014). This is a voluntary program in which communities complete activities related to public information, mapping and regulations, flood damage reduction, and warning and response. These projects will gain communities points, which determine their class. Class ratings range from Class 1 communities that have completed the most activities and receive the highest flood insurance premium reductions, to Class 10 communities that do not participate in CRS (NFIP 2015b).

Currently, 11 communities within the Chehalis Basin participate in NFIP; however, only Centralia, and Chehalis, Lewis County, and Thurston County participate in CRS (FEMA 2014).

All non-federal/non-tribal commercial forestland in Washington is governed by the FPA (see Chapter 2). The forest practices regulatory program prescribes management practices to protect public resources and public safety while maintaining a viable timber industry. The regulatory program includes an adaptive management component, providing flexibility to respond to new information and adapt protective measures as scientific knowledge evolves. The current Forest Practice rules protect unstable slopes, riparian forests, and wetlands; address forest roads; and include a compliance monitoring program. In 2006, USFWS and NMFS approved the *Forest Practices Habitat Conservation Plan,* which covers state and private forestland in Washington, to ensure compliance with the federal ESA. The purpose of the 50-year *Forest Practices Habitat Conservation Plan* is to protect habitat, support healthy and economically viable forests, and create regulatory stability for landowners.

The *Forest Practices Habitat Conservation Plan* includes regulations related to forest roads and culverts, buffer zones, and unstable slope mitigation measures.

3.10.2 Land Ownership

Most of the land within the Chehalis Basin is privately owned, followed by publically owned and tribal owned lands (see Table 3.10-1). Much of the public land is located within parks or preservation areas, including WDFW wildlife areas such as the Chehalis Wildlife Area, Scatter Creek Wildlife Area, Olympic Wildlife Area, and portions of the Johns River Wildlife Area. The federal government manages areas within the Olympic National Forest and Gifford-Pinchot National Forest. In addition, much of the Chehalis Basin is managed by DNR, which oversees uses such as timber production and recreation and preservation areas, including the Capital State Forest and the Chehalis River Surge Plain Natural Area Preserve. The Chehalis Tribe reservation is approximately 4,849 acres and is located along the Chehalis River, northwest of Chehalis, Centralia, and Grand Mound, and south of US 12 (Chehalis Tribe 2014).

The majority (approximately 80%) of the land within the Chehalis Basin is forestland (deciduous, coniferous, and mixed forest), with 54% classified as managed forests. "Managed forests" are defined as lands outside of federal management that are more than 80 contiguous forested acres.

Table 3.10-1
Land Ownership in the Chehalis Basin

OWNERSHIP		PERCENTAGE
Public	State government	13%
	Federal government	7%
	Local government	2%
Tribal		<1%
Private		77%

Source: DNR (https://fortress.wa.gov/dnr/adminsa/gisdata/metadata/cadastre_parcel.htm)

3.10.3 Distribution of Land Uses in the Chehalis Basin

Land use is varied in composition and distribution throughout the Chehalis Basin. Forestlands are the most prominent cover type and are mainly concentrated outside of the floodplain (see Table 3.10-2).

The use of forestland in the Chehalis Basin is primarily for recreation and timber production. It is estimated that 54% of the Chehalis Basin is managed for timber production using common forest practices, which include clear-cutting, seed-tree operations, rotational harvest, and selective cutting (USGS 2011).

Table 3.10-2
Land Cover Types in the Chehalis Basin and the Chehalis River Floodplain

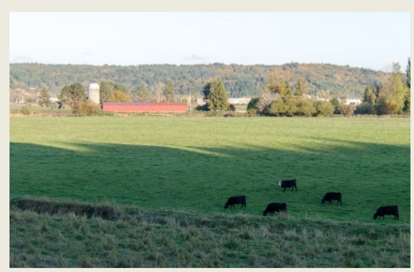
LAND COVER TYPES	CHEHALIS BASIN	CHEHALIS RIVER FLOODPLAIN	TYPES OF LAND USES
Agriculture	5%	41%	Livestock grazing, crop farming, and commercial dairy operations
Forestlands, Grasslands, Wetlands	80%[1]	39%	Timber production, recreation
Developed	7%	11.5%	Residential homes, shopping centers, industrial facilities
Bare Ground	8%	8.5%	Gravel or sand bars (Grays Harbor), water, landslide areas, gravel pits

Note:
1. In the 2014 *Draft Chehalis River Basin Report*, DNR reported that forestland comprised 84% of the Chehalis Basin (Rogers and Walters 2014). However, because other land cover types were not addressed in the 2014 DNR report, the table represents land cover data from 2011.
Source: USGS 2011

Agriculture is generally concentrated in low-lying river valleys, especially along the mainstem and tributaries in the southern portion of the Chehalis Basin, and along the Chehalis River between Grand Mound and Montesano. Agriculture within the Chehalis Basin consists mainly of livestock grazing, crop farming, and commercial dairy operations (CBP 2004).

In addition to areas currently used for farming, prime farmland is also located in the Chehalis Basin. Prime farmland is a federal classification characterized as land that contains the best conditions for producing food, feed, forage, fiber, and oilseed crops (NRCS 2015). Within the Chehalis Basin, this land is found mainly within the river valleys of the Chehalis, Newaukum, and Humptulips rivers, and near the mouth of Grays Harbor. Prime farmland covers approximately 13% of the Chehalis Basin, and areas that would be prime farmland if managed (e.g., through irrigation) make up an additional 14% (USDA 2014). In total, 27% of the Chehalis Basin has the characteristics of prime farmland.

Most developed areas in the Chehalis Basin occur near the Chehalis River—particularly around Chehalis, Centralia, Aberdeen, Hoquiam, and Ocean Shores, and along US 12 and I-5 (see Table 3.10-2). Currently, there are approximately 1,943 residential buildings and 1,071 non-residential buildings located within the Chehalis River floodplain (WSE 2014d). Non-residential buildings include agricultural, commercial, industrial, and government buildings, as well



Agriculture

Common agricultural practices in the Chehalis Basin include livestock grazing; however, there are no Bureau of Land Management-regulated rangelands within the Chehalis Basin.

as schools. Much of the commercial and industrial development within the floodplain consists of shopping centers, warehouses, pulp and paper mills, commercial off-loading from marine vessels, and others.

Land use in the Chehalis Tribe reservation, located at the confluence of the Chehalis and Black rivers, is predominantly forestland (60%) and agricultural (29%), with development occurring across 7% of the reservation (USGS 2011). Land use and natural resource protection within the reservation are governed by the laws enacted by the Chehalis Tribe. For example, recreational fishing on reservation lands is permitted with a tribal fishing license.

3.11 Recreation

This section describes the variety of recreational opportunities within the Chehalis Basin relating to the Chehalis River and its tributaries, Grays Harbor, the Pacific Coast, forestlands, large national and state forests, state parks, and a broad range of local parks and activities. Many features of the Chehalis Basin are used by residents and visitors for fishing, boating (including kayaking and whitewater boating), hiking, hunting, bird watching, camping, and other recreational activities. The Chehalis Basin includes the Capitol State Forest, the Lower Chehalis State Forest, several publicly owned wildlife areas, and portions of the Mount Baker-Snoqualmie National Forest and Olympic National Forest.

The description of recreational facilities within the Chehalis Basin is limited to recreational sites and activities that are affected by, or are likely to be affected by, flooding or EIS alternatives. This includes in-water recreation (such as fishing, boating, and whitewater rafting) in the Chehalis River, its tributaries, or Grays Harbor; state and local parks located adjacent to rivers; and recreational sites adjacent to elements of the EIS alternatives. This section also considers county and city plans and policies relating to recreation in, or adjacent to, waterbodies. The content of this section is based on information from federal, state, and agencies and several organizations. Recreational features in the Chehalis Basin are summarized in Figures 3.11-1 through 3.11-3.

Scout Island Bridge, Stan Hedwell Park

Lintott/Alexander Park

Photo credits: Larry Gessele, Onalaska, Washington

Figure 3.11-1

Recreational Features - Upper Chehalis Basin

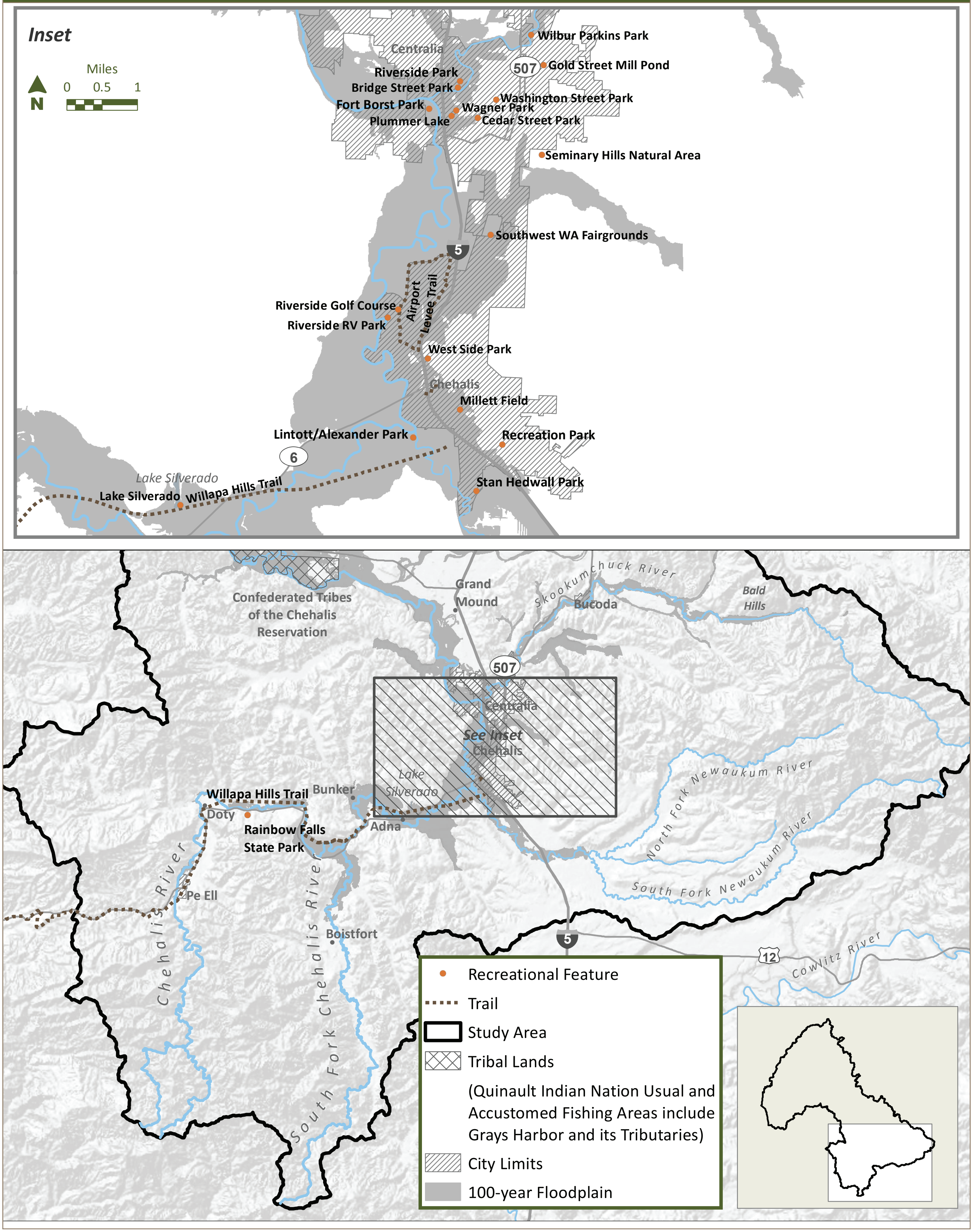


Figure 3.11-2

Recreational Features - Middle Chehalis Basin

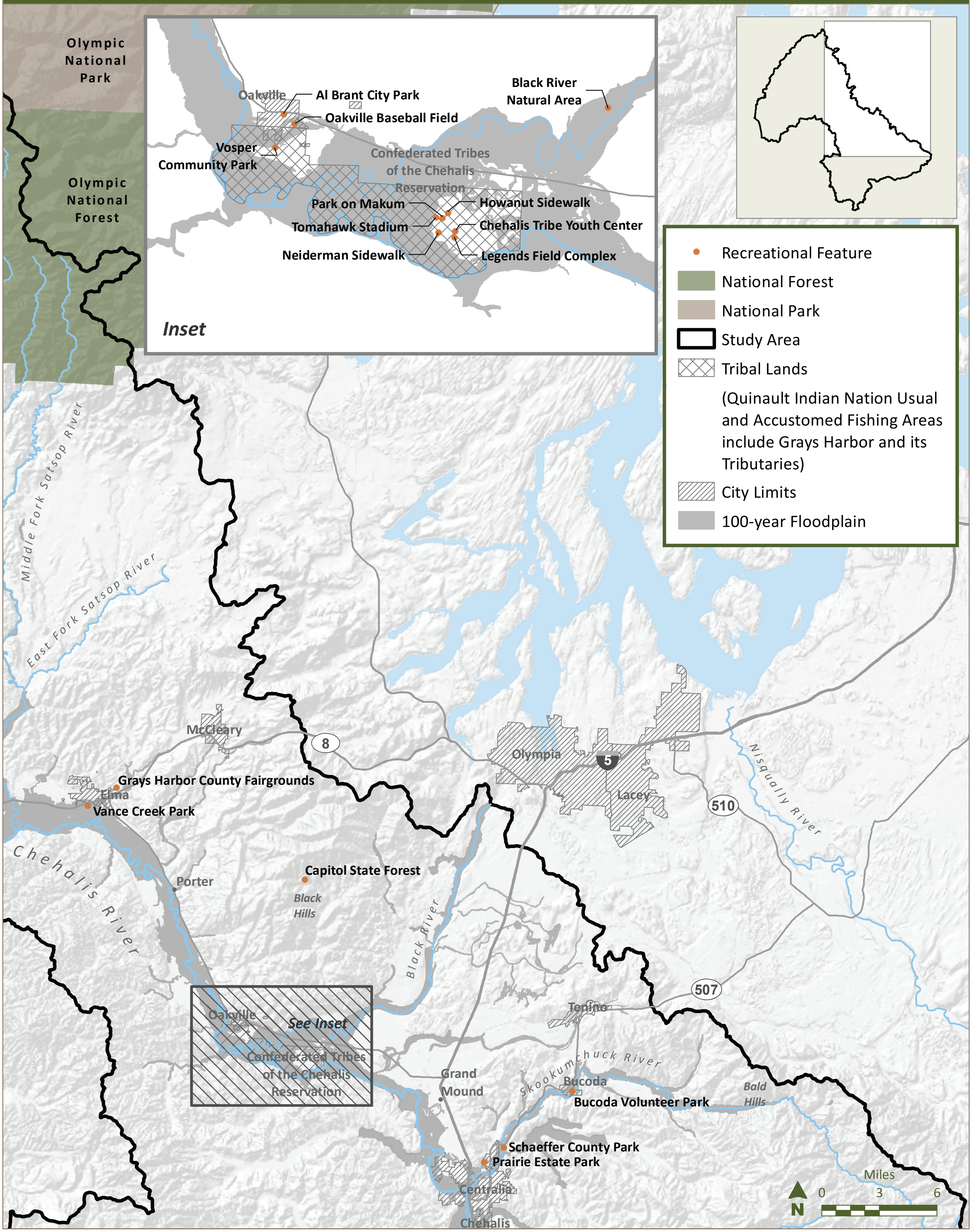
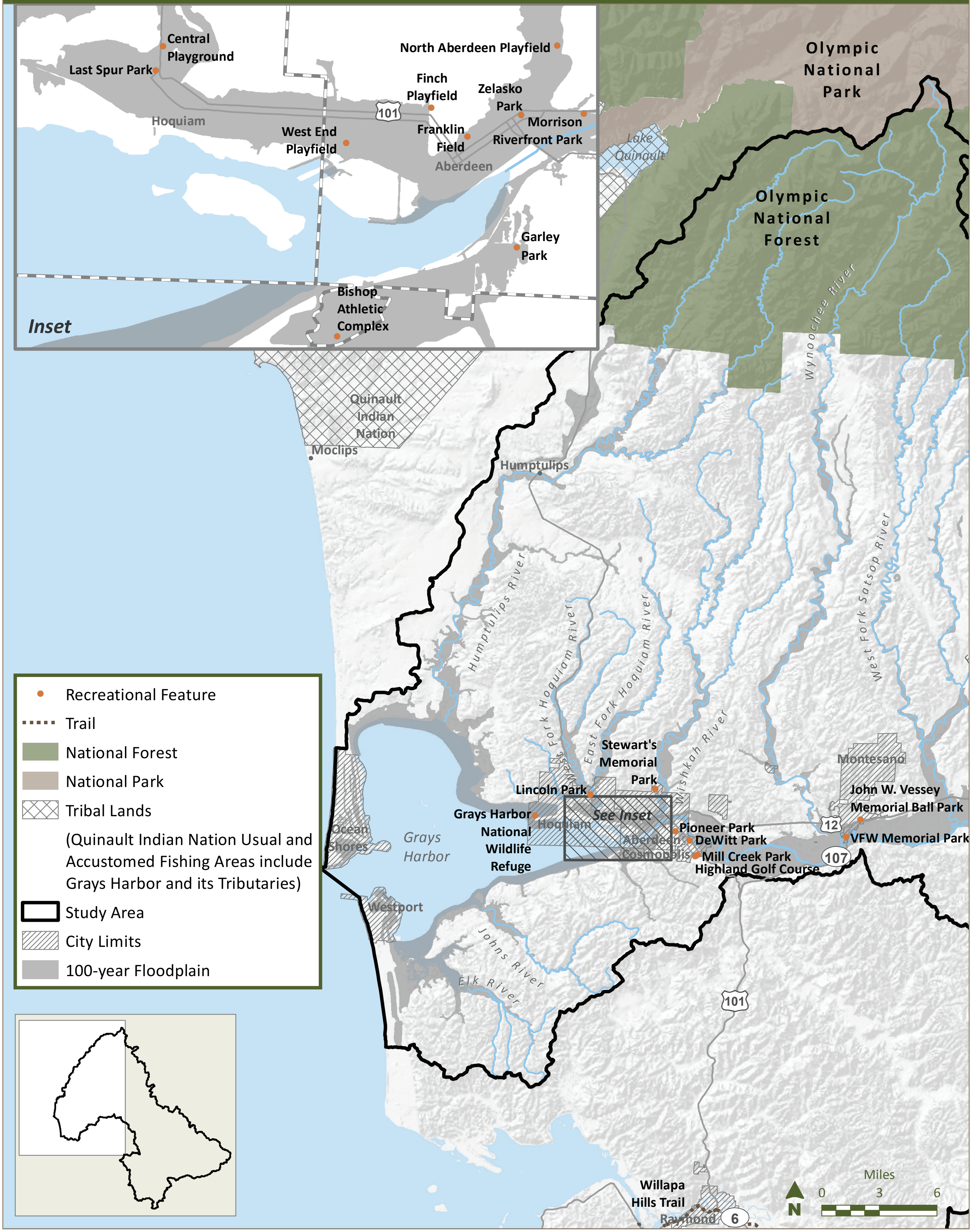


Figure 3.11-3

Recreational Features - Lower Chehalis Basin



3.11.1 Recreational Fishing and Boating

Fishing is a major recreational use in the Chehalis River and its tributaries. WDFW monitors the freshwater salmon sport catch for rivers in the Chehalis River system. The most recent data are from April 2011 through March 2012. Table 3.11-1 shows the numbers and types of salmon caught in rivers in the Chehalis River system during that time period.

Table 3.11-1
Salmon Catch in Grays Harbor, the Chehalis River, and Their Tributaries

RIVER	TOTAL CATCH	SPECIES	MONTHS
Chehalis River	7,363	Chinook salmon (168) Chum salmon (1) Coho salmon (5,380) Jack Chinook salmon (80) Jack coho salmon (1,734)	September to January
Satsop River	2,947	Coho salmon (2,610) Jack Chinook salmon (2) Jack coho salmon (335)	October to January
Skookumchuck River	306	Coho salmon (277) Jack coho salmon (29)	October to January
Grays Harbor	3,327	Chinook salmon (194) Coho salmon (2,862) Jack coho salmon (271)	August to November
Elk River	7	Coho salmon	October
Hoquiam River	71	Coho salmon (64) Jack coho salmon (7)	October to December
Humptulips River	6,263	Chinook salmon (3,086) Chum salmon (1) Coho salmon (2,988) Jack Chinook salmon (65) Jack coho salmon (123)	September to January
Johns River	101	Coho salmon	September to November
Wishkah River	166	Coho salmon	October to December

Source: Kraig 2014

WDFW also reports on salmon fishing by county of residence. In 2011, the percentage of residents who filled out catch record cards was 14% in Lewis County, 16% in Grays Harbor County, and nearly 10% in Thurston County. This includes both freshwater and marine salmon (Kraig 2014). Salmon caught by residents of each county were not necessarily caught within that county or within the Chehalis River or its tributaries.

WDFW also reported 70 sport sturgeon caught in the Chehalis River below the Black River. All 70 were white sturgeon. Fifty white sturgeon were caught in June and July of 2011, and 20 were caught in

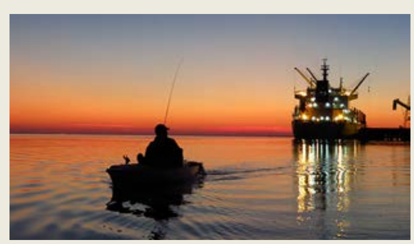
December 2011 and January 2012 (Kraig 2014). The steelhead catch for the Chehalis River and its tributaries from April 2011 to March 2012 is displayed in Table 3.11-2.

Table 3.11-2
Steelhead Sport Catch in Grays Harbor, the Chehalis River, and Their Tributaries

WATER	RACE	TOTAL CATCH	MONTHS
Chehalis River above Black River	Winter	318	December to April
Chehalis River below Black River	Summer	48	August to October
	Winter	517	November to March
South Fork Chehalis River	Winter	12	December to March
Newaukum River	Winter	11	January to March
Satsop River	Summer	30	September to October
	Winter	575	November to March
West Fork Satsop River	Summer	3	October
	Winter	48	January to February
Skookumchuck River	Summer	9	July to October
	Winter	3,145	November to April
Van Winkle Creek	Summer	19	June to July
Wishkah River	Winter	11	November to December and March
Wynoochee River	Summer	2,161	June to October
	Winter	2,623	November to April
Hoquiam River	Winter	2	December
Humptulips River	Summer	167	June to October
	Winter	901	November to March
East Fork Humptulips River	Summer	2	September
West Fork Humptulips River	Summer	1	October
	Winter	41	February to March
Stevens Creek	Winter	84	December to February
Grays Harbor	Summer	12	July to October

Source: Kraig 2014

In addition to fishing, boaters use the Chehalis River and its tributaries for kayaking, canoeing, whitewater boating, and rafting. Boat access points and boat launches are available throughout the Chehalis Basin. Many are owned and operated by WDFW, while others are in local parks, such as Fort Borst Park in Centralia.



Fishing on the Hoquiam River
Photo credit: Colleen Kulp, Aberdeen, Washington

The American Whitewater Association rates whitewater rapids from Class I to Class VI based on difficulty. Class I rapids are the easiest to navigate, Class V rapids are for experts, and Class VI rapids are classified as extreme or exploratory rapids. Table 3.11-3 lists the river reaches in the Chehalis Basin and their whitewater class.

Table 3.11-3
Whitewater Classes of Chehalis Basin Rivers

RIVER	REACH	CLASS
East Fork Chehalis River	Mile 3 to Chehalis River	III
West Fork Chehalis River	Mile 3 to Chehalis River	III-IV
Chehalis River	West Fork to Pe Ell	III-IV
	Pe Ell to Doty	II
	Rainbow Falls to Meeskill	II
East Fork Humptulips River	FR 2206 access to FR 22 Bridge	III
	FR 22 Bridge to Gorge	III
	Gorge Run downstream to Boise Bridge	III
West Fork Humptulips River	FR 2203 access to Donkey Creek Road	II
	FR 2204 bridge to FR 2203 access	IV+
East Fork Satsop River	Simpson Hatchery to Cook Creek	II
Middle Fork Satsop River	Walter Creek to Baker Creek	III+ (IV)
	Baker Creek to road off Kelly Hall Road (Fools Canyon)	IV-V
	Access off Kelly Hall Road to Tornow Road	II
West Fork Satsop River	FR 23 to FR 2260 Bridge	IV+
	FR 2260 Bridge to West Satsop Road	II
Wynoochee River	Wynoochee Reservoir to Save Creek	II-III (V)

Notes:
FR = Forest Road
( ) = One or two rapids in the reach meet the class in parentheses. For example, the Wynoochee Reservoir to Save Creek reach generally ranges from Class II (Novice) to Class III (Intermediate), but one to two rapids are Class V (Expert). The Class V rapids can be portaged for those who are at a novice to intermediate skill level.
Source: American Whitewater 2015

3.11.2 Parks on the Chehalis River and Its Tributaries

Many state, county, and city parks are located directly adjacent to the Chehalis River and its tributaries. Rivers are commonly considered a recreational feature. County and city parks located adjacent to the Chehalis River and its tributaries range from small neighborhood parks to large recreation areas. For example, Fort Borst Park is the largest park in Centralia at 101 acres. It features trails, fields, gardens, rentable kitchens and shelters, bathrooms, a public boat ramp on the Chehalis River, and several historic buildings. The park is located at the confluence of the Chehalis and Skookumchuck rivers in the floodplain, and has been known to flood during large storm events.

While open space can be considered a compatible floodplain land use, parks with structures and improvements can be damaged by floods. Two major state recreation facilities that suffered damages in the 2007 flood are Rainbow Falls State Park and the Willapa Hills Trail.

3.11.2.1 Rainbow Falls State Park

Rainbow Falls State Park is owned and operated by Washington State Parks and is located on the Chehalis River near Dryad. The park, built in 1935 by the Civilian Conservation Corps, is 139 acres with 3,400 feet of shoreline on the Chehalis River. The park features 10 miles of hiking trails through old-growth forest, 7 miles of bike trails, an access trail to the Willapa Hills Trail, horseshoe pits, interpretive signage, a softball field, 53 campsites (including partial utility RV campsites, horse campsites, and hiker- and biker-only sites), a kitchen shelter with water and electricity (which can be reserved), 26 picnic tables, a group campsite (which can also be reserved), a metal-detecting area, a dump station, and restrooms featuring two showers (WSP 2014). The park is also used for fishing, swimming, bird watching, and wildlife viewing.

From the 1960s until 2007, the Rainbow Falls State Park entrance could be accessed via a bridge across the Chehalis River from SR 6. In the 2007 flood, the bridge collapsed into the Chehalis River. A replacement bridge is currently under construction. Without the bridge, the northern portion of the park (featuring campsites, restrooms, the softball trail, and access to the Willapa Hills Trail) has been disconnected from the southern portion (featuring hiking trails; WSP 2014). Since 2007, the original park entrance from Leudinghaus Road (a gravel road used as a service entrance since the 1960s; AECOM 2012) has been used to access the park. The southern portion of the park is accessible from SR 6. The Chandler Road Bridge, approximately 1 mile west of the park, is the nearest crossing. The Chandler Road Bridge was also destroyed in the 2007 flood, though it has since been replaced.

Rainbow Falls State Park
Photo credit: www.scenicwa.com

The 2007 flood also damaged the park office located near the former park entrance bridge and destroyed the 3-inch water line attached to the underside of the bridge, which connected water to the south side of the park (AECOM 2012).

3.11.2.2 Willapa Hills Trail

The Willapa Hills Trail is a 56-mile-long multiuse trail, with segments that are accessible to bicycle riders and horseback riders. The trail runs from Chehalis to South Bend, and passes Rainbow Falls State Park and Pe Ell. Several bridges on the trail were washed out in the December 2007 flood and have not been replaced, making some portions of the trail inaccessible.

Willapa Hills Trail
Photo credit: Larry Gessele, Onalaska, Washington

According to the Lewis County Community Trails organization, the Spooner and Dryad trestle bridges were replaced in late 2015, and the Bridge 5 trestle near Adna is scheduled to be redecked, with new side rails added, by the end of May 2016 (Lewis County Community Trails 2016).

3.11.2.3 Southwest Washington Fairgrounds

The Southwest Washington Fairgrounds are located in unincorporated Lewis County between Centralia and Chehalis. The Southwest Washington Fair is held annually for 6 days in August, but the fairgrounds are used throughout the year for events, including auctions, car shows, and gun shows. Facilities on the fairground site are rentable, including pavilions, stages, an expo hall, and a barn. Portions of the fairgrounds are used for RV storage from October through March. Camping sites are also available during the fair and year-round.

The fairgrounds are in the floodplain and have a history of flooding. In January 1990, the levee around the fairgrounds was overtopped. In November 1986, flood levels at the fairgrounds reached 9 feet (CRBFA 2010). There is no outlet for draining floodwaters from the fairgrounds (Brown and Caldwell 2008). The fairgrounds were flooded in the 2007 flood, during which many buildings on the grounds were damaged, and again during the 2009 flood.

View from the Willapa Hills Trail
Photo credit: Larry Gessele, Onalaska, Washington

Southwest Washington Fairgrounds
Photo credit: Danielle Belongia, Colorado Springs, Colorado

3.11.2.4 Local Parks

Table 3.11-4 identifies the four local parks located in Chehalis and Centralia adjacent to the Chehalis River and its tributaries.

Table 3.11-4
Local Parks Located Adjacent to the Chehalis River and Its Tributaries

PARK NAME (LOCATION)	RIVER/CREEK	FEATURES	IN FLOODPLAIN?
Fort Borst Park (Centralia)	Chehalis and Skookumchuck rivers	101 acres with fields, playground, wading pool, lake, courts, arboretum, rentable kitchens and outdoor shelters, public boat ramp, trails, dog park, restrooms, historic buildings	Yes
Rotary Riverside Park (Centralia)	Skookumchuck River	14.05 acres with parking, restrooms, rentable shelters, picnic shelters, paved trail, fishing and water access, playground, skateboard park, sport fields, natural areas	Yes
Lintott/ Alexander Park (Chehalis)	Chehalis River	Approximately 6 acres with rentable picnic areas, playground, horseshoe pits	Yes, in floodway
Stan Hedwall Park (Chehalis)	Newaukum River and Dillenbaugh Creek	Approximately 200 acres with baseball fields, little leagues, youth soccer, wooded areas, trails, fishing, pavilion, playground, volleyball courts, RV area, restrooms with showers, covered shelter	Yes, portions in floodway

3.11.3 Agritourism

Farming is an important land use in the Chehalis Basin, as discussed in Section 3.10. Farmers in the Chehalis Basin encourage agritourism as a recreational use, drawing tourists to the Chehalis Basin from other areas of Western Washington. The Greater Lewis County Community Farmers Market is held on Tuesdays in downtown Chehalis. In addition, several farms in the Chehalis Basin host farm visits. A September 2015 article in *Edible Seattle* magazine featured farms hosting farm visits, including two creameries on SR 6, a farm stand in Rochester, a ranch in the Black Hills area, and a farm and winery near the Black River. The Newaukum Valley Farm, located adjacent to the Chehalis River upstream of Adna, hosts monthly "Chefs in Our Field" farm dinners, bringing chefs from Seattle to cook meals on site using produce from the farm. Lewis County actively encourages the development of agritourism in the Chehalis Basin (Crain 2015).

Farmers market in Chehalis

3.11.4 Recreation at Specific Locations

The EIS alternatives include specific elements that could be located in the vicinity of the following recreational sites.

3.11.4.1 Upper Chehalis River (Weyerhaeuser Property)

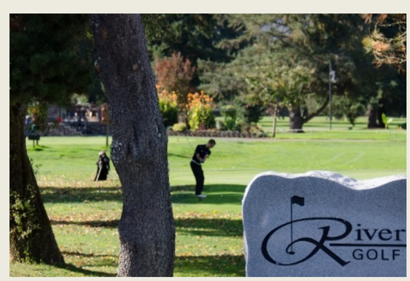
A Flood Retention Facility on Weyerhaeuser land is proposed in one of the EIS alternatives. Weyerhaeuser sells recreational access permits for hunting and camping on their lands. The proposed facility site is in the Pe Ell South Permit Area within the Pe Ell Operating Area. Weyerhaeuser sold all of the 550 permits available for the Pe Ell South Permit Area for the recreation year of August 2015 through July 2016. Weyerhaeuser also sells six leases each year for semi-private blocks of forestland in the Pe Ell Operating Area, which consists of the Pe Ell South Permit Area and Pe Ell North Permit Area. Leases are put up for bid each spring (Weyerhaeuser 2015).

Most permits are issued for hunting; however, permits are also provided for fishing, mushroom gathering, berry picking, and camping. The recreational access permit allows both non-motorized and vehicular access (no all-terrain vehicles or motorcycles) to the Weyerhaeuser road system. Weyerhaeuser also allows each permittee to collect a few cords of firewood (Schuh 2016).

In addition to the limited and fee-based private recreation on Weyerhaeuser land, the reach of the Chehalis River that includes the proposed facility site is listed as a Class III-IV whitewater area by the American Whitewater Association, as described in Section 3.11.1. This reach of the river is generally not used for kayaking because of access limitations (O'Keefe 2016).

3.11.4.2 Chehalis-Centralia Airport Area

The Chehalis-Centralia Airport is located adjacent to the privately owned Riverside Golf Course, which is open to the public. The golf course is located between the airport and the Chehalis River. The golf course features a clubhouse with a restaurant and an outdoor covered pavilion that is available for private party rental. There is also an RV park on the golf course property. The existing airport levee is located across a local road from the Riverside Golf Course. The top of the existing airport levee is approximately 15 feet wide and has a gravel surface. The levee is used as an informal walking trail and is accessible from several points, including a staircase across the street from the entrance to the Riverside Golf Course. The trail along the top of the levee is approximately 1.75 miles long.



Riverside Golf Course

3.11.4.3 I-5 Projects Area

The City of Chehalis's Stan Hedwall Park (see Table 3.11-4) is located in the vicinity of the I-5 Projects action element of the alternatives. Recreation Park, likewise owned and operated by the City of Chehalis, is also near the I-5 Projects area. Recreation Park features an outdoor community pool, a spray park, covered picnic areas, a rentable community building and kitchen, and Penny Playground, which was built with community-raised funds.

3.11.4.4 Chehalis-Centralia Railroad

The Chehalis-Centralia Railroad operates a steam train along the former Milwaukee Road Track. Scenic tours start at the Chehalis Centralia Museum and travel along the upper Chehalis River to stops at Milburn and Ruth. The railroad offers regularly scheduled runs through the summer along with dinner trains approximately once a month from Mother's Day to October. Special train events include Easter Trains, Pumpkin Trains, Santa Steam Trains, and Murder Mystery Trains.

3.12 Historic and Cultural Preservation

Historic and cultural preservation refers to the idea that a place's value is in part derived from its heritage, and that this heritage is worth preserving. In this section, the term "cultural resources" is used to refer to the broad range of resources that represent or convey this heritage, or help tell the story of a region's past. A cultural resource can be considered any building, structure, object, site, landscape, or district associated with human manipulation of the environment. These resources are often valued by a particular group of people (monetarily, aesthetically, culturally, or religiously), and can be historic in character or date to the prehistoric past (i.e., prior to written records). Cultural resources also include tribal cultural resources or graves, Indian human remains, and traditional cultural properties.

Two categories of cultural resources are discussed in this section—archaeological resources and historical resources throughout the Chehalis Basin. Archaeological resources encompass features and deposits located on or below the ground surface that are evidence of prior human occupation or use in a particular area. Historical resources include elements of the built environment, such as buildings, structures, or human-made objects or landscapes. Culturally significant properties are described herein.

A literature review and records search was conducted to identify cultural resources present in the Chehalis Basin, focusing on the Chehalis River floodplain and urban areas. The following sources of information were used:

- The DAHP's *Washington Information System for Architectural and Archaeological Records Data* for previously completed cultural resources studies and previously documented archaeological, ethnographic, and historic resources located in the Chehalis Basin
- Seattle Public Library
- University of Washington library
- ICF International's corporate library

This review revealed that multiple cultural resource studies have been completed within the Chehalis Basin, and that these studies have identified many historic properties, including archaeological sites, historic buildings, and cemeteries. The majority of cultural resource studies have taken place in Chehalis, north of NW Folsom Street, while much of the Chehalis Basin remains unstudied for cultural resources.

These studies describe the European American settlement of the Chehalis Basin, which first occurred in the late 1840s. Growth progressed slowly due to the difficulty of transportation to the area. However, following the completion of the Northern Pacific Railroad and the establishment of a depot in Chehalis in 1873, the town grew rapidly. The region's economy has primarily focused on timber and agriculture in the years since, and has experienced several growth cycles as demand for, and access to, these products has increased or decreased (Ott 2008; Ruby and Brown 1992). During the late twentieth century and into the twenty-first century, new industry and the establishment of a commuter population has prompted slow, but continued growth in the Chehalis Basin.

In addition to the known historic properties, there is also the potential for previously unidentified cultural resource sites within the Chehalis Basin. Given the relative frequency of culturally significant properties in the Chehalis Basin, it is highly probable that additional resources are present. Existing cultural resources conditions described further in this section are focused on the Large-scale Flood Damage Reduction Actions, since the area of these proposed actions are more defined than other action elements evaluated in this EIS.

Ongoing coordination with the State Historic Preservation Officer, DAHP, and local tribes has been conducted over the past several years as part of the Chehalis Work Group research and activities. This coordination and consultation will continue during evaluation of the EIS alternatives.

3.12.1 Existing Cultural Resource Conditions (Flood Retention Facility)

No previous archeological studies or cultural resources evaluations have been completed in the area of the proposed Flood Retention Facility. The Washington Statewide Archaeological Predictive Model (WSAPM) was used to identify the potential for archaeological deposits and the need for archaeological surveying at the facility location, which is included in the summary information in Table 3.12-1.

Table 3.12-1
FRO and FRFA Summary

CATEGORY	FRO FACILITY	FRFA FACILITY
Approximate area of potential ground disturbance	881 acres	1,344 acres
Previous cultural resource studies	0	0
Cultural resources eligible for National Register of Historic Places	0	0
Potential for archaeological deposits	• High to moderate (42% of site) • Low to very low (58% of site)	• High to moderate (35% of site) • Low to very low (65% of site)

Although no cultural resources have been documented within the boundary of the Flood Retention Facility, it is likely that as-yet undocumented cultural resources would be identified once project-specific cultural resources studies are performed.

3.12.2 Existing Cultural Resource Conditions (Airport Levee Improvements)

More than 80% of the Airport Levee Improvements area has been previously studied for cultural resources, with 16 archaeological resources identified (9 evaluated), and two built environment properties identified (one evaluated). Information on the past studies and potential for cultural resources (based on WSAPM) for the Airport Levee Improvements is included in Table 3.12-2.

Table 3.12-2
Airport Levee Improvements Summary

CATEGORY	AIRPORT LEVEE IMPROVEMENTS
Approximate area of potential ground disturbance	40 acres
Previous cultural resource studies	9
Cultural resources eligible for National Register of Historic Places	6
Potential for archaeological deposits	Very high (100% of site)

Based on the results of previous cultural resource studies and WSAPM, it is highly likely that as-yet undocumented cultural resources would be identified once project-specific cultural resources studies are performed for the Airport Levee Improvements.

3.12.3 Existing Cultural Resource Conditions (I-5 Projects)

Over 20% of the I-5 Projects area has been previously studied for cultural resources, with nine archaeological resources identified (four evaluated), and one built environment property identified (not evaluated). Information on the past studies and potential for cultural resources (based on WSAPM) for the I-5 Projects is included in Table 3.12-3.

Table 3.12-3
I-5 Projects Summary

CATEGORY	I-5 PROJECTS
Approximate area of potential ground disturbance	94 acres
Previous cultural resource studies	9
Cultural resources eligible for National Register of Historic Places	2
Potential for archaeological deposits	Very high (100% of site)

Based on the results of previous cultural resource studies and WSAPM, it is highly likely that as-yet undocumented cultural resources would be identified once project-specific cultural resources studies are performed for the I-5 Projects.

3.12.4 Existing Cultural Resource Conditions (Aberdeen/Hoquiam North Shore Levee)

Over 20% of the Aberdeen/Hoquiam North Shore Levee area has been previously studied for cultural resources, with no archaeological resources identified and 41 built environment properties identified (2 evaluated). Information on the past studies and potential for cultural resources (based on WSAPM) for the Aberdeen/Hoquiam North Shore Levee is included in Table 3.12-4.

Table 3.12-4
Aberdeen/Hoquiam North Shore Levee Summary

CATEGORY	ABERDEEN/HOQUIAM NORTH SHORE LEVEE
Approximate area of potential ground disturbance	98 acres
Previous cultural resource studies	5
Cultural resources eligible for National Register of Historic Places	0
Potential for archaeological deposits	• Very high to moderate (97% of site) • Low to very low (3% of site)

Based on the results of previous cultural resource studies and WSAPM, it is possible that as-yet undocumented cultural resources would be identified once project-specific cultural resources studies are performed for the Aberdeen/Hoquiam North Shore Levee.

3.12.5 Existing Cultural Resource Conditions (Restorative Flood Protection)

For Restorative Flood Protection, the amount of previous research and the number of identified cultural resources depends on the exact boundaries of ground disturbance. As an estimate, this analysis uses the valley bottom areas within the Restorative Flood Protection treatment areas as a potential area of ground disturbance. Approximately 9% of this area has been previously studied for cultural resources. Information on the past studies and potential for cultural resources (based on WSAPM) for the Restorative Flood Protection alternative is included in Table 3.12-5.

Table 3.12-5
Restorative Flood Protection Summary

CATEGORY	ABERDEEN/HOQUIAM NORTH SHORE LEVEE
Approximate area of potential ground disturbance	21,000 acres
Previous cultural resource studies	70+
Cultural resources eligible for National Register of Historic Places	6+
Potential for archaeological deposits	Very high (100% of site)

As-yet undocumented cultural resources would be identified once project-specific cultural resources studies are performed.

3.13 Transportation

This section generally describes the major components of the transportation network in the Chehalis Basin that are either currently affected by flooding or would be affected by the EIS alternatives. The history of transportation system flooding is described here, based on available information. A number of information sources were used to identify resources within the Chehalis Basin, including local and regional planning documents and transportation inventories, Chehalis Basin flood plans, and online mapping.

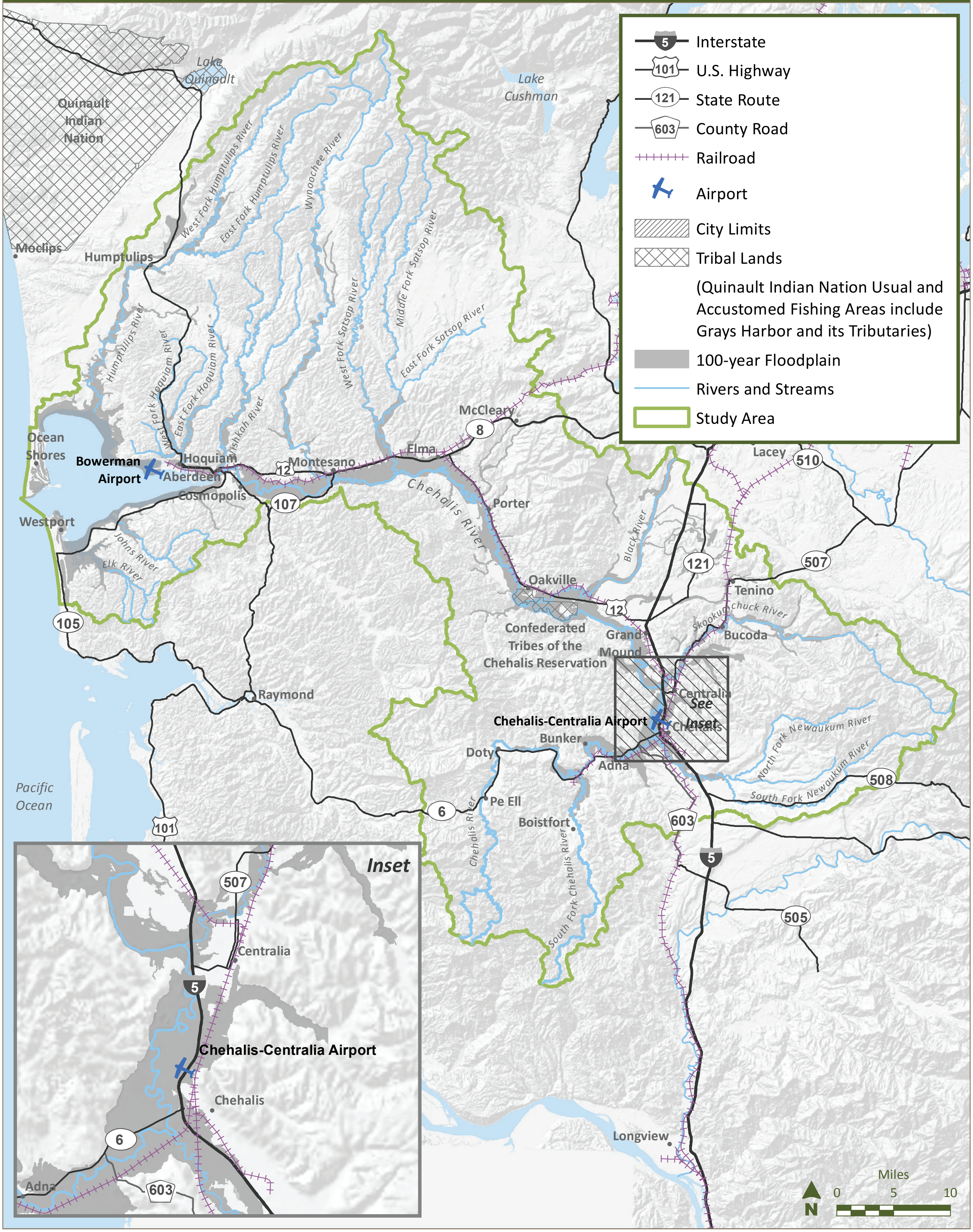
A range of types of transportation facilities are located throughout the Chehalis Basin, many of which have been affected by flooding, including I-5, two U.S. highways, 23 airports (21 private and 2 public), two rail lines and one rail spur, bridges and culverts, and a number of state highways, arterials, and local access roads. The 1996, 2007, and 2009 floods are known to have caused extensive damage to roads and bridges in the Chehalis Basin (Ruckelshaus Center 2012). Table 3.13-1 describes the 11 major roadways within the Chehalis Basin. Figure 3.13-1 shows the major roadways and transportation features in the Chehalis Basin.

Table 3.13-1
Major Roadways Within the Chehalis Basin

ROADWAY	DESCRIPTION
I-5	This roadway is the main interstate highway on the West Coast; it extends through Washington, Oregon, and California to the U.S. border.
US 12	This highway is the primary route for east and west travel from I-5 to the Cascade Range; it heads east from I-5, south of Chehalis, through White Pass to I-82 at Yakima. By way of I-5, it connects north and west to Grays Harbor County. This two-lane road provides the primary access to the eastern half of Lewis County. From west to east, this highway serves Centralia, Chehalis, Napavine, Mossyrock, Morton, Randle, and Packwood.
US 101	This highway heads northwest from I-5 in Thurston County and onward to the Olympic Peninsula.
SR 6	This highway provides an important east and west connection between I-5 and the Pacific Coast, through Western Lewis County to Pacific County. It serves Pe Ell and Chehalis.
SR 8	The road runs generally east-west from US 12 at Elma, through McCleary to US 101.
SR 107	The roadway extends from US 12 at Montesano, through Melbourne, to US 101.
SR 121	The highway is a loop road in Thurston County off of I-5, and heads east from I-5 through a sparsely populated rural area to Millersylvania State Park and back to the freeway.
SR 505	This road runs east and west in Lewis County, serves Winlock and Toledo, and connects to I-5 and SR 504.
SR 507	This highway runs north and south in Lewis County. It serves Centralia and Chehalis, north to the county line, and into Thurston County, where it serves Bucoda, Tenino, Yelm, and Rainier, ending in McKenna.
SR 508	This highway runs east and west through Lewis County, serving Onalaska and Morton, and connects to I-5 and SR 7.
CR 603	This highway runs north and south from SR 6 near Chehalis to SR 505 at Winlock.

Notes: CR = County Road, I = Interstate, SR = State Route, and US = U.S. Route

Figure 3.13-1
Major Roadways and Transportation Features



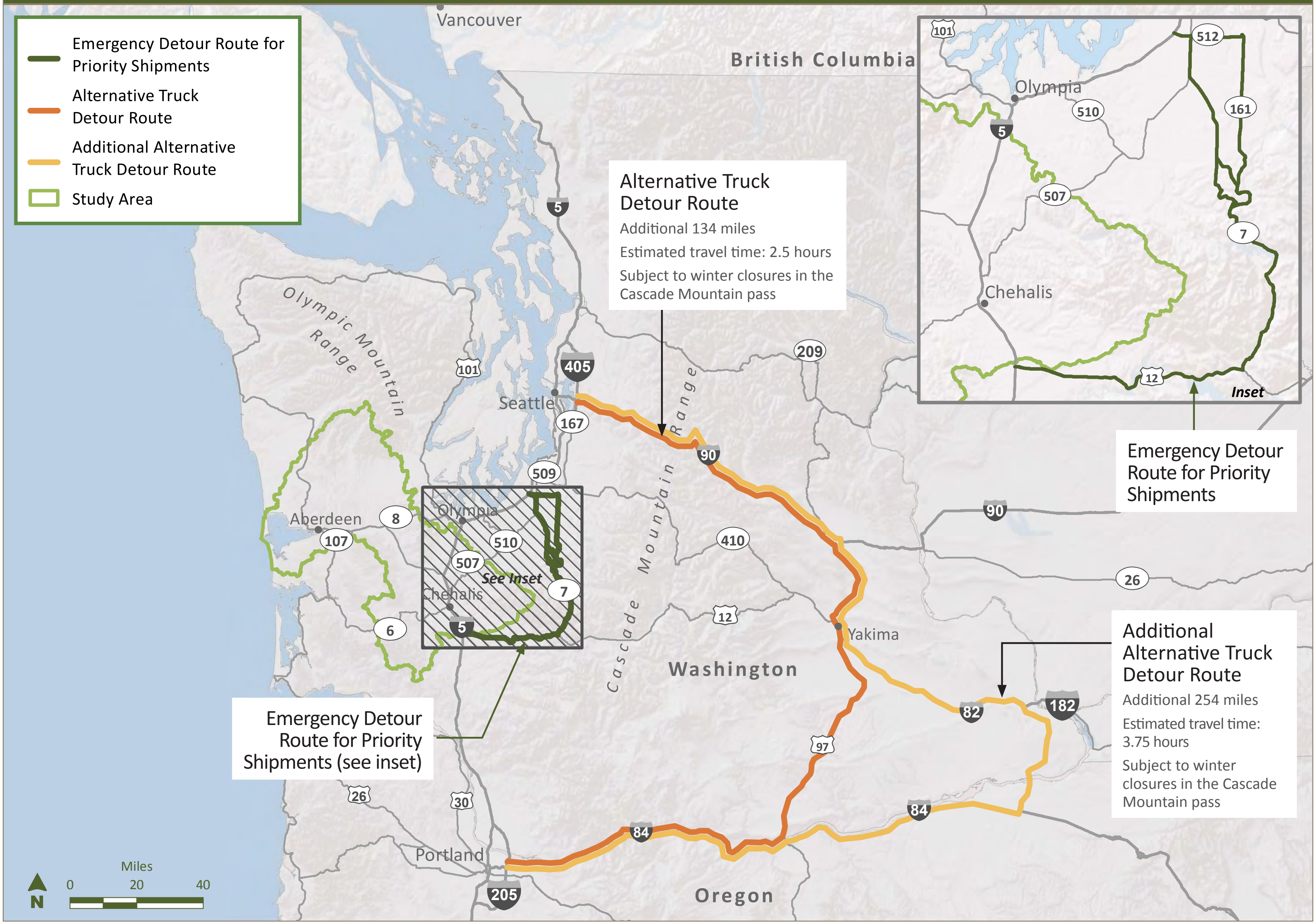
3.13.1 I-5

The flooding of I-5 is a national, regional, and local issue because the roadway is a major corridor for the movement of people and goods, as well as a primary route for local trips. Flooding in the Chehalis Basin has affected access to I-5, closing it for 4 days in 1996 and 2007, and 2 days in 2009 (WSDOT 2014). WSDOT estimated the total cost of freight delays along I-5 in 2007 in the tens of millions of dollars (Ruckelshaus Center 2012). This amount includes estimates for freight-related business losses and associated reductions in economic output, as well as an estimate of state-wide economic impact, such as employment, personal income, and sales tax receipts. It does not include local economic impacts, impacts due to passenger vehicle delay, BNSF rail closures, or roadway maintenance and repair. WSDOT also modeled the costs of I-5 closure that would occur with a modeled 100-year flood (WSDOT 2014). The predicted costs for a 5-day closure of I-5 are more than $11 million, including costs of additional time and mileage for those who travel on detour routes.

WSDOT has developed an emergency detour route, using SR 7 and US 12 when I-5 is closed (see Figure 3.13-2). Northbound trucks will be detoured off I-5 at Exit 68 onto US 12 eastbound, then northbound on SR 7 through Morton and Elbe. At milepost 12.69 on SR 7, trucks will be detoured onto Alder Cutoff Road, to SR 161 in Eatonville. From that point, drivers could continue northbound on SR 161 and connect to SR 512, or connect to SR 7 using 304th Street East. Drivers would then find their own routes back to I-5. For southbound trucks, there is no defined route to reach the southbound detour because many options are available. Drivers would be expected to find their way to the intersection of SR 7 and SR 702. From there, drivers will be routed on SR 7 through La Grande, Elbe, and Morton to US 12. At US 12, drivers will continue westbound to I-5.

Passenger cars will be able to use the detour with no restrictions. To control the volume of traffic on the detour and maintain access for emergency responders, WSDOT has developed a pass system for trucks. Trucking companies must apply for permits through the Commercial Vehicle Information Systems and Networks (CVISN) program to access the detour route. CVISN will control the types of goods that can be transported through the area and will limit the number of trucks that can travel along the route to 50 per hour per direction. Criteria for activating the detour route are that I-5 has been closed for 24 hours, is predicted to be closed for at least 3 days, and that the National Guard has been activated. Checkpoints manned by the National Guard will be set up at SR 7 in Morton and at the intersection of SR 7 and SR 702 in Pierce County. The National Guard will check passes and divert trucks that are not permitted. Trucks with a valid permit will have a 3-hour window to enter the detour route. If permitted trucks miss their assigned window, they must reapply for a new permit.

Figure 3.13-2
Flood Detour Routes



When the emergency detour route is not activated, or for trucks without a pass, there are two detour options available. An available detour route uses I-84 in Oregon, US 97 in Eastern Washington, and I-90 over Snoqualmie Pass. This route adds 134 miles to the trip between Seattle and Portland, with an estimated travel time of 2.5 hours. A secondary detour route uses I-84, I-82 through the Tri-cities in Eastern Washington, and I-90 over Snoqualmie Pass. The secondary detour adds 254 miles to the trip between Portland and Seattle, with an estimated travel time of 3.75 hours. Although longer, the secondary route could be preferable to trucks in bad winter weather. Since both routes use I-90, the detours are subject to winter closures of that highway in the Cascade Range pass due to snow and avalanches. At such times, no detour would be available.

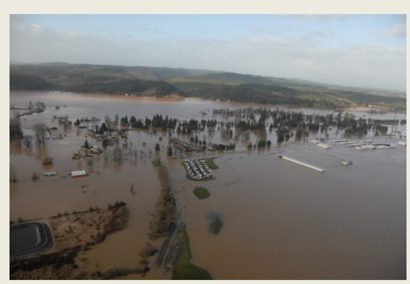
3.13.2 Local Roadways Affected by Flooding

This section generally describes the historic flooding of roadways and bridges in the Chehalis Basin, as well as an indication of the types of problems that have occurred for local roadways during floods. Flooded roadways have affected the ability of people to evacuate and emergency service providers to reach some areas. Flooding has damaged some area roads and bridges, causing long-term access issues during repair or replacement.

3.13.2.1 Lewis County

Routes into, and out of, local communities in Lewis County have been generally blocked during floods (Ruckelshaus Center 2012). The area of Lewis County around the upper mainstem of the Chehalis River, which is highly vulnerable to flooding, includes the Boistfort Valley, Pe Ell, Curtis, Adna, Dryad, and Doty. In this area, local roads, including access roads to area farms and dairies, have regularly flooded. SR 6 closes in multiple places during floods because the elevation of the roadway is below flood elevations in several locations. In the 2007 flood, damage to Lewis County roads amounted to approximately $1.5 million. The flood also damaged many logging roads, rail and air infrastructure, the Curtis Industrial Park rail line, railroad bridges, and culverts throughout the flood inundation area.

Roads in the cities of Centralia and Chehalis (Twin Cities) have experienced some of the most substantial flooding and flood damage in the Chehalis Basin. The Chehalis-Centralia Twin City Town Center has been inundated by floodwaters. At the height of the December 2007 storm, 20 square blocks near downtown Centralia were flooded, with resulting access limitations. The Centralia Business District is vulnerable to flooding from the Skookumchuck River and China Creek. Flooded roadways resulted in access issues to critical facilities such as the hospital on Cooks Hill Road in Centralia. The area surrounding the small community of Galvin has been inundated during minor flooding.



2007 flood in Lewis County

Photo credit: WSDOT

3.13.2.2 Thurston County

In rural portions of southern Thurston County, roads in the Skookumchuck River valley upstream of Chehalis have been affected by flooding, with floodwater covering farmland and closing roads. Bucoda is periodically inundated during floods and, when the one roadway into town (SR 507) flooded, the town was effectively isolated. Grand Mound, Oakville, and Porter-Malone are located along the lower mainstem Chehalis River, and flooding in this area has regularly affected property, including roads (Ruckelshaus Center 2012). Old Highway 99 SW, Old Highway 99 SE, and Little Rock Road SW pass through the floodplain and have been exposed to flooding. In a major flood, these roads have been blocked or damaged, preventing access to some areas. There are 45 bridges in, or that cross over, the floodplain in the Chehalis Basin. Some of these bridges provide the only ingress and egress to some neighborhoods (Thurston County 2013).

Key Access Points

This bridge over the Chehalis River in Montesano is one of 45 bridges in, or that cross over, the Chehalis River floodplain. Some of these bridges provide the only ingress and egress to particular neighborhoods.

Photo credit: WDFW

3.13.2.3 Grays Harbor County

Most of the developed communities and towns in Grays Harbor County are located along the lower mainstem Chehalis River. Montesano experiences flooding from the Wynoochee River; many local streets in these communities have experienced flooding. Floods have inundated, and virtually isolated, Aberdeen, with US 101 under 2 feet of water (CH2M HILL 2001). In the 1997 flood, the Wynoochee valley, Satsop River valley, Brady Loop Road area, Johns River area, and Humptulips River Basin received major damage (CH2M HILL 2001) and area roads were flooded. Segments of US 12 east of the Black River Bridge were inundated with almost 2 feet of water in the 2007 and 2009 floods (WSDOT 2014).

3.13.2.4 Chehalis Tribe Reservation

In the 1996 flood, 75% of the Chehalis Tribe reservation was covered in water, with measured flood depths of up to 10 feet. Vital access routes, including Howanut Road, Anderson Road, and Moon Road, were under 1 to 4 feet of fast-moving water, and portions of US 12 through the reservation were flooded.

3.13.3 Airports

In the Chehalis Basin, there are two public airports and 21 private airfields/heliports, two of which (in McCleary and Aberdeen) are operated by local hospitals (Washington Public and Private Airports by County 2015). The Elma Municipal Airport is in a mapped floodplain, but is not known to have flooded. The Chehalis-Centralia Airport (located in the Twin Cities area) is a general aviation facility with one 5,000-foot runway that serves non-scheduled private and commercial flights. Although the

Chehalis-Centralia Airport is protected by a dike system, those dikes were overtopped during a January 1990 flood, closing the airport. During the 2007 flood, the airport levee was overtopped and water covered most of the airport for approximately 4 days, damaging airport facilities. The 2007 flood caused the airport's automatic weather observation system to be down for 46 days, and closed the active day runway for 3 days. Runway closure halted Pacific Cataract and Laser Institute flights. Initially emergency evacuations were conducted at the Chehalis-Centralia Airport, but when the airport was flooded, emergency evacuations were moved to W.F. West High School in Chehalis.

A levee-based improvement project was completed at the airport in July 2014, which involved expanding the width of the existing levee on the inside (airport side) by an additional 32 acre-feet of fill without increasing the levee elevation.

3.13.4 Rail Lines

There are two major railroad lines in the Chehalis Basin, and past floods have necessitated the closures of both. The BNSF Railway operates its mainline through Thurston and Lewis counties, crossing the Chehalis River floodplain from east to west near Chehalis. Amtrak provides passenger railway service along this line with a stop in Centralia. The Union Pacific Railroad operates a north-south route through a portion of the Chehalis Basin, from Chehalis, north through Thurston County, to Tacoma. In addition, the Puget Sound and Pacific Railroad (PSAP) extends from Centralia to Aberdeen and Hoquiam through Elma. It also has branches that extend from Chehalis to Centralia to Curtis, and from Elma to Shelton. PSAP provides switching and haulage for Union Pacific at Aberdeen, Hoquiam, Grays Harbor, Shelton, and McCleary (Union Pacific 2016). There is also a spur line, the Curtis Industrial Park rail line, which connects the Port of Chehalis to the Curtis Industrial Park near Pe Ell. This facility was damaged as a result of flooding in 2007.

Centralia Train Depot
Photo credit: Jason Baker, Centralia, Washington

3.14 Public Services and Utilities

This section focuses on federal, state, county, municipal, tribal, or private facilities that provide basic services to the public, support development, and protect public health and safety. These include, but are not limited to, educational facilities, health care facilities, police and fire protection, solid waste disposal and treatment, water supply and wastewater disposal, electricity and natural gas provisions, and telephone and cable services. Many of these are considered by the Chehalis Basin communities to be critical facilities. The *Lewis County Comprehensive Flood Hazard Management Plan* (Brown and Caldwell 2008) defines a critical facility as follows:

> *A facility for which even a slight chance of flooding would be too great. Critical facilities include but are not limited to schools, hospitals, police, fire and emergency response installations, nursing homes, and installations that produce, use, or store hazardous materials or hazardous waste.*

For the purposes of this EIS, public services and utilities include all public service districts, facilities, and utilities located within WRIAs 22 and 23, with a focus on those areas subject to flooding from the Chehalis River and its tributaries. This includes Grays Harbor County, Lewis County, and a small portion of Thurston County, as well as Aberdeen, Centralia, Chehalis, Cosmopolis, Elma, Hoquiam, McCleary, Montesano, Napvine, and Oakville. The information in this section was largely extracted from area maps, county and city plans and websites, and Geographic Information Systems data.

3.14.1 Public Services

Public services in the region are provided by tribal, federal, state, county, and local governments, as well as by volunteer fire departments and other volunteer groups. This EIS focuses on fire and emergency management services (EMS), education, and public health services provided within the Chehalis Basin, because these are the services with the greatest potential to be affected by flooding. The locations of public services in the Chehalis Basin are identified in Figures 3.14-1 through 3.14-3. Sections 3.15.2 and 3.15.3 describe the flood warning system and flood emergency response in the Chehalis Basin.

3.14.1.1 Fire and Emergency Management Services

Fire control organizations located within the Chehalis Basin are associated with Chehalis Basin cities, Grays Harbor County, Lewis County, Thurston County, DNR, USFS, and the Chehalis Tribe. Although each jurisdiction maintains the primary responsibility for providing services within their boundaries, mutual agreements often exist between different fire districts through which they consent to assist each other in the event that one district is unable to contain an emergency situation using existing resources and personnel (Washington State Fire Marshal’s Office 2009).

There are 34 fire departments and districts, in addition to one regional fire authority (West Thurston Regional Fire Authority), that are located within the Chehalis Basin portions of Grays Harbor, Lewis, and Thurston counties. The West Thurston Regional Fire Authority is a partnership between Thurston

County Fire District 1 and Thurston County Fire District 11, which was formed to maximize efficiencies and improve service delivery (West Thurston Regional Fire Authority 2015). Most of the local fire control organizations consist of professional and volunteer firefighters that are trained to provide the following services:

- Emergency medical response (basic life support and advanced life support)
- Fire suppression
- Emergency ambulance transport
- Hazardous materials initial response
- Fire prevention and code enforcement
- Non-emergency ambulance transport
- Inter-facility ambulance transport
- Community service programs and public education

BIA is responsible for protecting Indian reservation lands, such as the lands occupied by the Chehalis Tribe. BIA either provides fire protection with its own personnel and equipment or through various cooperative agreements with local fire jurisdictions (Washington State Fire Marshal's Office 2009).

Fire and EMS facilities known to be located within the Chehalis River floodplain are described in Table 3.14-1. Some of these facilities have been damaged during a major flood, including the four fire districts in the upper Chehalis Basin that were damaged in the 2007 flood.

Table 3.14-1
Fire and Emergency Management Service Facilities Known To Be Located Within the Chehalis River Floodplain

JURISDICTION	FIRE AND EMS FACILITIES	SERVICE AREA
Grays Harbor County	Aberdeen Fire Department	Aberdeen
	Artic Fire Department 15	Cosmopolis
	Grays Harbor Fire Protection District 1	Oakville
	Hoquiam Fire Department	Hoquiam
	Montesano Fire Department	Montesano
	Ocean Shores Fire Department	Ocean Shores
Lewis County	None	None
Thurston County	None	None

Sources: FEMA 2008a, 2008b, 2009; Kliem and Holden 2011

3.14.1.2 Police

In addition to the Washington State Patrol, the Chehalis Reservation Police Department, and the sheriff's departments of Grays Harbor, Lewis, and Thurston counties, there are 13 police departments located within the Chehalis Basin—8 in Grays Harbor County, 4 in Lewis County, and 1 in Thurston County (see Table 3.14-2). Five police departments (Chehalis Reservation, Aberdeen, Hoquiam, Westport, and Oakville) and the Washington State Patrol office in Aberdeen (33% of the facilities within the Chehalis Basin) are located within the Chehalis River floodplain.

Table 3.14-2
Chehalis Basin State Patrol, County Sheriff, and Police Facilities

JURISDICTION	POLICE DEPARTMENT
Washington State	Washington State Patrol
Chehalis Tribe reservation	Chehalis Reservation Police
Grays Harbor County	Grays Harbor County Sheriff
	Aberdeen Police
	Elma Police
	Montesano Police
	Hoquiam Police
	Westport Police
	Oakville Police
	Ocean Shores Police
Lewis County	Lewis County Sheriff
	Chehalis Police
	Centralia Police
	Tenino Police
	Napavine City Police
Thurston County	Tumwater Police
	Thurston County Sheriff

Sources: FEMA 2008a, 2008b, 2009; Kliem and Holden 2011

The Washington State Patrol has jurisdiction over state roadways within the Chehalis Basin (I-5, US 12, US 101, SR 6, SR 8, SR 105, SR 109, SR 507, SR 508, and SR 603). County sheriffs are responsible for maintaining the peace within their respective counties (RCW 36.28.010) and filing complaints for all violations of criminal law within their jurisdictions (RCW 36.28.011).

3.14.1.3 Public Education

There are 20 school districts and a total of 58 primary and secondary schools located within the Chehalis Basin. The school districts range in size from small rural school districts that consist of one school (e.g., Boistfort, Cosmopolis, McCleary, Evaline, and Pe Ell) to larger school districts, such as Chehalis and Centralia, which have seven schools. Two colleges, three vocational/technical schools, ten public libraries, and nine museums are located within the Chehalis Basin, in addition to educational facilities provided by the Chehalis Tribe. During past flooding events in the Chehalis Basin, schools have been used as local shelters. Therefore, it is important that access to schools during floods is maintained (Ruckelshaus Center 2012). Public education facilities known to be located within the Chehalis River floodplain are listed in Table 3.14-3.

Table 3.14-3
Chehalis Basin Public Education Facilities Located in the Chehalis River Floodplain

JURISDICTION	NAME OF FACILITY	TYPE OF FACILITY
Washington State	None	None
Chehalis Tribe reservation	Chehalis Tribe Youth Center	Youth center
Grays Harbor County	A.J. West Elementary School	School
	Alexander Young Elementary School	School
	Harbor High School	School
	Miller Junior High School	School
	Elma Elementary School	School
	Central Elementary School	School
	Emerson Elementary School	School
	Hoquiam Middle School	School
	Lincoln Elementary School	School
	Oakville Elementary School	School
	Oakville Middle School and High School	School
	Grays Harbor College	College/university
	Grays Harbor Beauty College	Vocational/technical schools
	Techline the Technology People Computer Training School	Vocational/technical schools
	Aberdeen Park Timberland Library	Library
	Hoquiam Timberland Library	Library
	Polson Museum	Museum
Lewis County	Green Hill School	School
	Washington Elementary School	School
	Centralia College	College/university
	Lewis County Special Education	Vocational/technical schools
	Veterans Memorial Museum	Museum
Thurston County	Chehalis-Centralia Railroad and Museum	Museum

Sources: FEMA 2008a, 2008b, 2009; Kliem and Holden 2011

3.14.1.4 Public Health

During natural hazard events, hospitals are critical infrastructure. Regardless of the nature and severity of damage, flooded hospitals are typically not functional while cleanup and repairs are undertaken (FEMA 2007). In addition, access roads that extend across flood-prone areas could be damaged by erosion, washout of drainage culverts, failure of fill and bedding materials, and loss of road surface (FEMA 2007). This could prevent uninterrupted access to a facility, and thus impair the functionality of the hospital. There are two community hospitals (Grays Harbor Community Hospital and Providence Centralia Hospital) and two medical centers (Seamar Community Health Center and Valley View Health Center) located within the Chehalis Basin. The Valley View Health Center has locations in Chehalis, Centralia, Onalaska, and Pe Ell. The Valley View Health Center in Chehalis is the only facility located within the floodplain (FEMA 2008a, 2008b, 2009). However, during past flooding events in the Chehalis Basin, access to the Providence Centralia Hospital has been restricted for days at a time (Ruckelshaus Center 2012).

Figure 3.14-1
Public Services – Upper Chehalis Basin

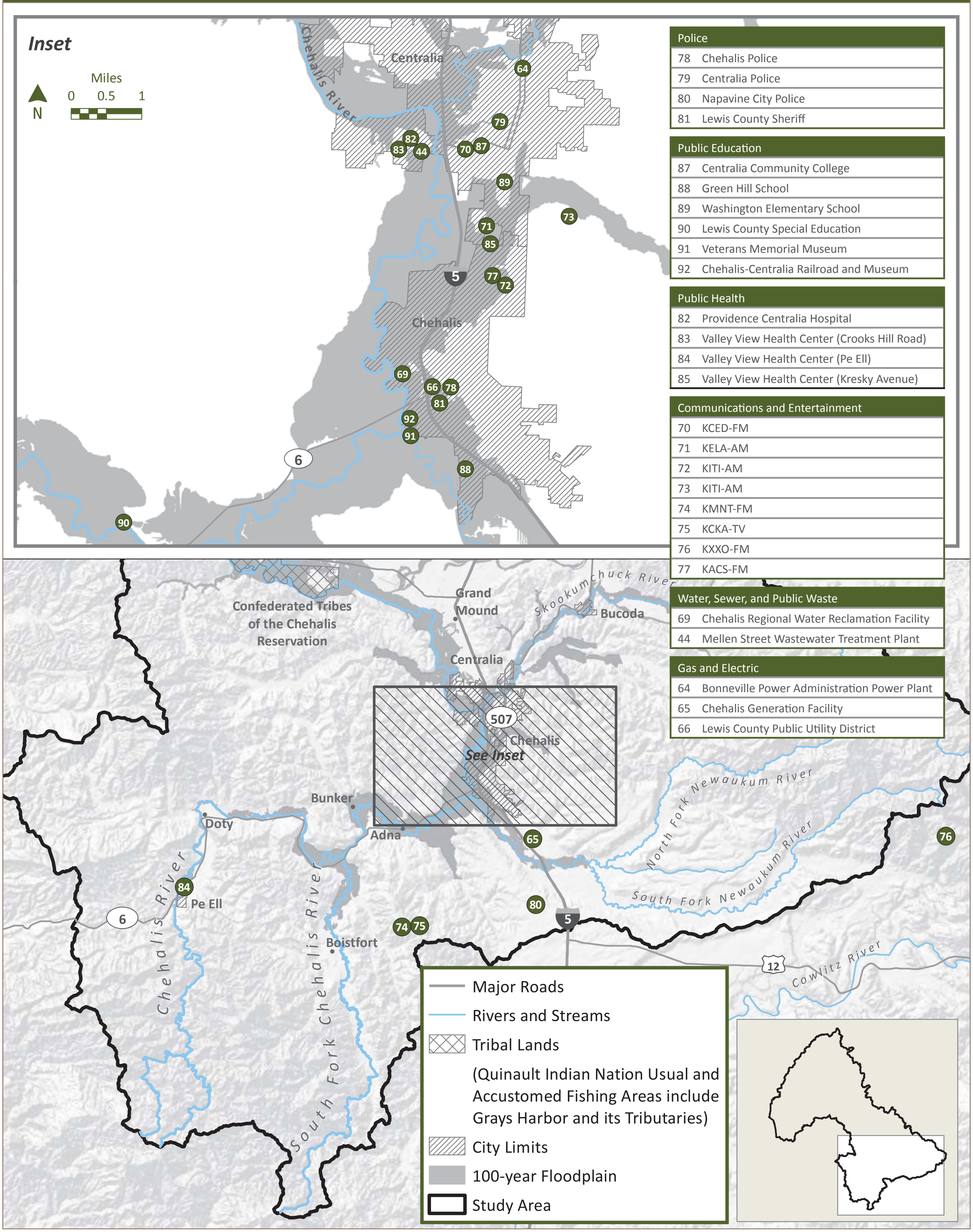


Figure 3.14-2

Public Services – Middle Chehalis Basin

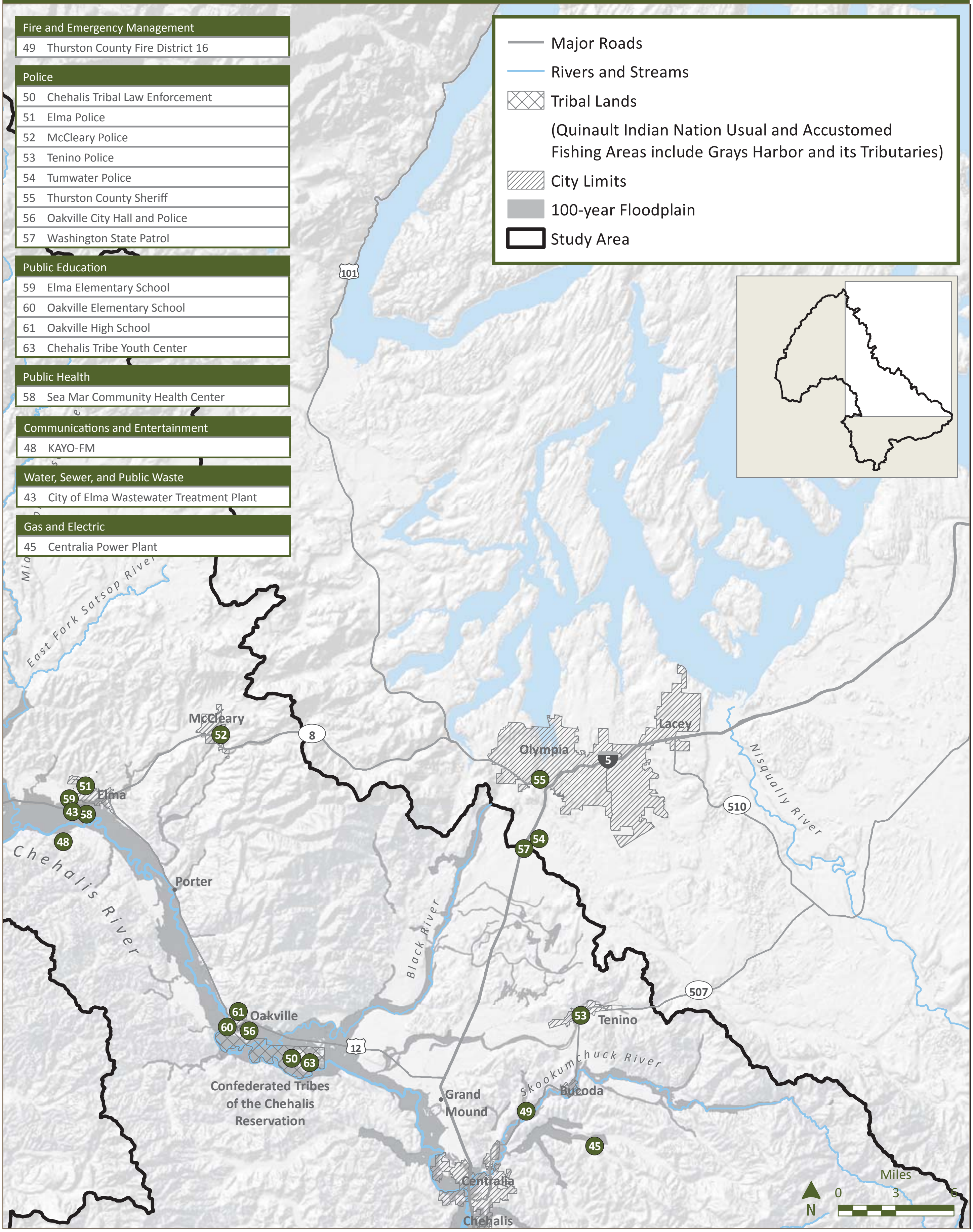
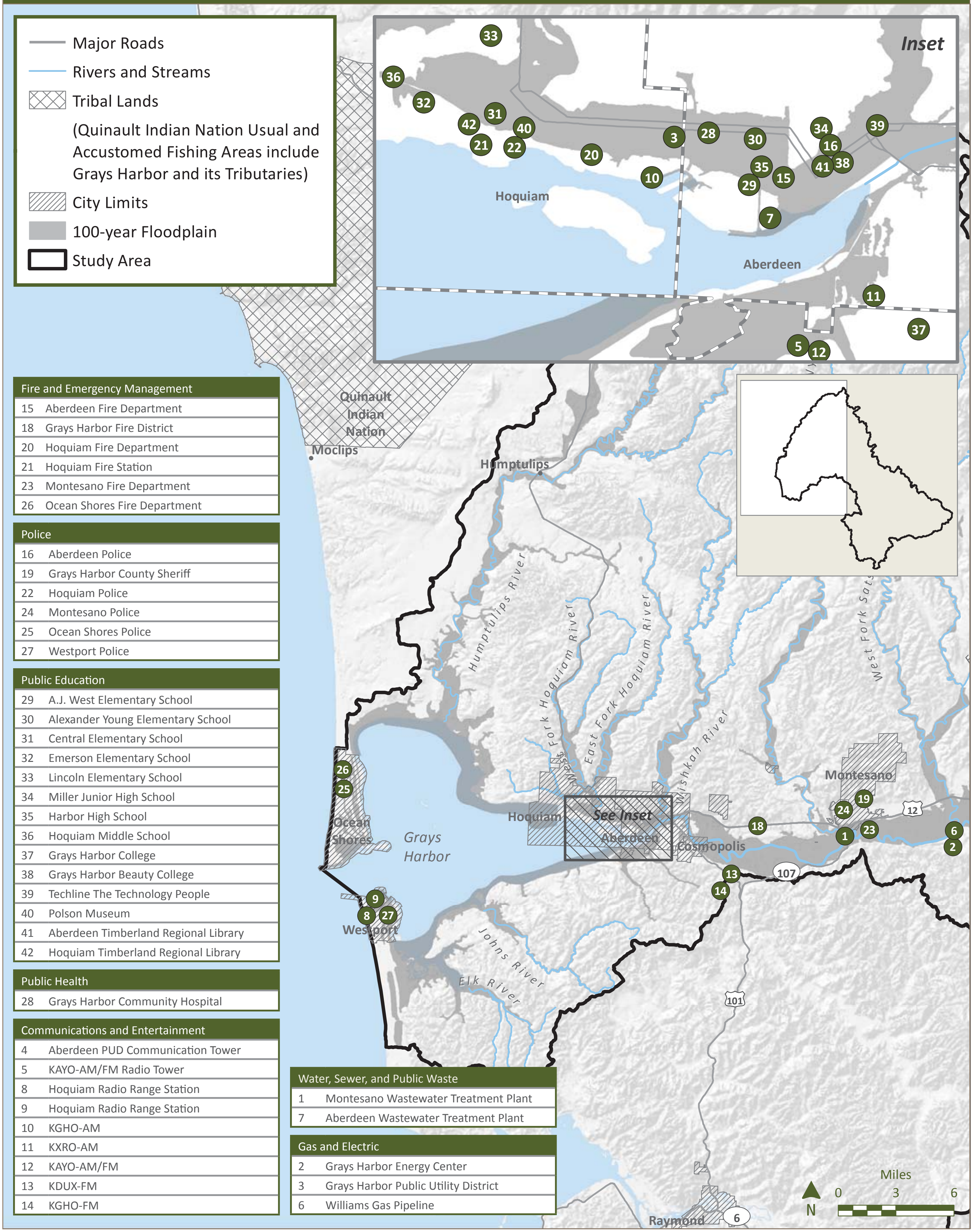


Figure 3.14-3

Public Services – Lower Chehalis Basin



3.14.2 Utilities

Utilities are vital components to the emergency response effort after a flood. Having adequate provisions of drinkable water, heat, and electricity is essential during a flood, particularly at critical facilities such as hospitals, but having workable means of communication is also critical. Public utilities in the Chehalis Basin are provided by tribal, county, city, and private suppliers. There are three public utility districts (PUDs) located within the Chehalis Basin: Grays Harbor PUD, Lewis County PUD, and Thurston County PUD. These PUDs predominately provide electricity and, in some cases, communication service. In general, the provision of utility infrastructure is directly correlated to the size of the population it serves. As a result, population levels, coupled with any topographic or other constraints to where utilities can be provided, often dictate how well a community is served.

3.14.2.1 Communications and Entertainment

Often public announcements and natural hazard warnings are distributed via local radio stations, cell phones, and email notifications. Internet and phone services within the Chehalis Basin are typically provided by private companies; however, Grays Harbor PUD offers wholesale telecommunication facilities and services to qualifying, state-certified, third-party service providers to provide connectivity to a customer.

Cell phone and internet service is not provided in all areas throughout the Chehalis Basin, particularly not in unpopulated areas or areas where provision of such utilities is unsupportable or geographically prohibited. As a result, radio transmissions tend to be a more viable option for informing the community during natural hazard events. However, numerous radio towers in the Chehalis Basin are located within the floodplain, some of which have been flooded in the past. The following facilities in Grays Harbor County are currently located within the floodplain (Kliem and Holden 2011):

- Aberdeen PUD Communication Tower
- Chehalis Tribe Communication Tower
- Hoquiam Radio Range Station
- KAYO-AM/FM Radio Tower
- KGHO-AM Radio Tower
- KXRO-AM Radio Tower

Most of the radio stations in Lewis County are located in the greater Chehalis-Centralia area, including KACS-FM,

Communications and Entertainment Private Service Providers

- Alltel
- CenturyLink
- Cingular
- Clearwire
- Coast Communications Co.
- Comcast
- Exede Satellite Internet
- HughsNet Satellite
- Qwest
- ReachONE
- Scatter Creek InfoNet
- Sprint/Nextel
- Tenino Telephone Company
- T-Mobile
- TSS
- US Cellular
- Verizon
- Wave Broadband

KITI-AM, KELA-AM, KSWS-FM, KYNW-FM, KCED-FM, and KMNT-FM (Radio-Locater 2015). Many of the towers associated with these stations are located along the I-5 corridor, making them more prone to flood risk.

3.14.2.2 Water, Sewer, and Public Waste

The larger municipalities of Lewis County, such as Centralia and Chehalis, have city-provided water systems. The main sources of drinking water for the Chehalis-Centralia area are the Chehalis and Newaukum rivers. Domestic water supply for Chehalis comes from the North Fork Newaukum River and the Chehalis River. Centralia also draws from several groundwater wells. In Lewis County, water services are provided by three public systems: Lewis County Water Districts, Boistfort Water (a community, non-profit water distribution system) that uses Stillman Creek as its source, and Thurston County PUD (a private owner and manager of 33 small water systems in the county; Brown and Caldwell 2008). The water supply for Pe Ell comes from Lester Creek, a tributary of the upper Chehalis River upstream of the proposed dam location. Domestic water supply in rural areas is primarily from individual wells. The Boistfort Valley Water Corporation provides drinking water to unincorporated areas of Boistfort, Curtis, Adna, and Claquato. Their primary surface water source is from Stillman Creek, a tributary to South Fork Chehalis River. The 2007 floods destroyed the intake in the creek.

Wastewater and solid waste utilities are typically provided by counties and cities; however, in rural communities, wastewater treatment is primarily through private septic systems. There are several WWTPs located within the Chehalis Basin, five of which are located within the floodplain: the Mellen Street WWTP (Centralia), the City of Aberdeen WWTP, the Chehalis Regional Water Reclamation Facility (City of Chehalis, City of Napavine, and Lewis County Water and Sewer District No. 4), the City of Elma WWTP, and the City of Montesano WWTP (FEMA 2008a, 2008b, 2009). The Mellen Street WWTP has mostly been replaced by the new Goodrich Road WWTP (Centralia WWTP), but the Mellen Street WWTP still provides pumping and transfer functions to support the Goodrich Road WWTP. Grays Harbor County manages its sewer plant and solid waste, and plans and operates its domestic and industrial water system (Grays Harbor County 2015). Lewis County provides its water and sewer services through a district system, of which three are located within the Chehalis Basin: Water/Sewer Districts 2 (Onalaska), 4 (Chehalis), and 5 (North Onalaska; Lewis County 2015a).

According to the *Lewis County Comprehensive Flood Hazard Management Plan*, the Mellen Street WWTP is subject to risk during flooding and could become inoperable. However, Centralia's new WWTP on Goodrich Road is out of the floodplain and should remain operable through any floods up to and including the 100-year event (Brown and Caldwell 2008). The Montesano WWTP is located on the bank of the Wynoochee River and is subject to bank erosion.

3.14.2.3 Gas and Electric

Electrical power is created by the Bonneville Power Association (BPA), the Cowlitz Falls Hydroelectric Project, the Wynoochee River Project, and the Yelm Project. Power is then transmitted and distributed by one of Chehalis Basin PUDs (Grays Harbor County or Lewis County), local municipalities (City of McCleary or Centralia City Light), or Puget Sound Energy (PSE; Thurston County). As a result, overhead and underground transmission and distribution lines, as well as substations, are located throughout the Chehalis Basin, some within the floodplain.

Gas and electric facilities located within the Chehalis Basin include the BPA power plant in Centralia, the Coastal Energy wind farm, the Grays Harbor Energy Center, the Centralia Power Plant (a coal power plant operated by TransAlta Corporation), and the Chehalis Generation Facility (a natural gas power plant operated by PacifiCorp; EFSEC 2013). TransAlta also owns and operates the Centralia Steam Electric Plant (Brown and Caldwell 2008). Of these facilities, only the Centralia Power Plant is located within the floodplain. In addition, multiple substations throughout the Chehalis Basin are located within the floodplain. While it does not provide local service, the Chehalis Power Plant in the Port of Chehalis Industrial Park is located in the Chehalis Basin; however, it is not within the floodplain (Brown and Caldwell 2008).

The region is served by major natural gas pipelines operated by PSE and Cascade Natural Gas that traverse the Chehalis Basin, crossing the Chehalis River floodplain at multiple locations (Thurston County 2011). PSE is the natural gas provider for Thurston County, Centralia, and Chehalis, while Cascade Natural Gas Corporation distributes natural gas in most of Grays Harbor County (Greater Grays Harbor Inc. 2015). The Williams Gas Pipeline also traverses the Chehalis Basin, providing petroleum to Thurston County. Utility providers and their service areas are listed in Table 3.14-4.

Table 3.14-4
Chehalis Basin Utilities and Providers

JURISDICTION	ELECTRICITY	NATURAL GAS	PETROLEUM
Grays Harbor County	Grays Harbor County Public Utility District	Cascade Natural Gas Corporation	Individual independent vendors
	City of McCleary	Williams Gas Pipeline	
Lewis County	Centralia City Light	Puget Sound Energy	Olympic Pipeline Company
	City of McCleary		
	Grays Harbor County Public Utility District		
	Lewis County Public Utility District		
Thurston County	Puget Sound Energy	Puget Sound Energy	Individual independent vendors

Sources: PSE 2015; Grays Harbor County 2007

3.15 Environmental Health and Safety

This section describes the two major environmental health and safety matters associated with flooding in the Chehalis Basin: contaminated floodwaters and flood warning systems. Critical emergency facilities, such as hospitals and police and fire stations, are described in Section 3.14. Relative to environmental health and safety, this section focuses on the areas within the Chehalis Basin that are subject to flooding from a 100-year flood based on available information from federal, state, and local agencies.

3.15.1 Contaminated Floodwater

Floodwater can become contaminated in a variety of ways. Water can come in contact with agricultural chemicals or hazardous materials at contaminated sites, or it can dislodge chemicals stored above ground. Floods can also inundate livestock areas and septic and wastewater treatment systems, and can be contaminated with untreated sewage and the decomposing bodies of drowned livestock. WWTPs could become flooded, or malfunction, and release untreated sewage to adjacent waterbodies, or can cause backflow of sewage into homes. Drinking water can be contaminated when wells or water treatment systems are flooded. Contaminated floodwater could also seep into groundwater.

These contaminated waters become health hazards if the public comes in contact with them through direct physical contact, ingestion, or open wounds (OSHA 2015). Household items that have been flooded pose a health concern if they come into close contact with people. Floodwater often contains infectious organisms such as *E. coli* and *Salmonella,* which can cause intestinal illnesses. Agricultural or industrial chemicals can cause chemical poisoning. Many materials used in home construction, including wood, fiberglass, and insulation, can absorb floodwater and the contaminants it carries, leaving flooded homes contaminated even after they dry out.

Ecology lists multiple hazardous sites in the Chehalis Basin. The majority of these sites are associated with gas stations or other vehicle facilities, and most of the contaminants are petroleum or related products. The sites are generally clustered around cities and towns in the Chehalis Basin. Ecology ranks six sites in the floodplain as hazard ranking 1 or 2 with a higher priority for cleanup (Ecology 2015l). Four of these sites are in Grays Harbor County and two are in Thurston County. USEPA lists three National Priority List sites in the floodplain: Hamilton-Labree Roads Groundwater Contamination, American Crossarm and Conduit, and the Centralia Municipal Landfill (USEPA 2015). Both the Hamilton-Labree Roads and American Crossarm and Conduit sites are near Chehalis. All three sites have undergone some level of cleanup and are still being

2007 flood

monitored by Ecology or USEPA. The American Crossarm and Conduit site is near Dillenbaugh Creek and the Centralia Municipal Landfill is near Salzer Creek.

The Centralia, Montesano, Mellen Street, and Goodrich Road WWTPs are all located within the floodplain (see Section 3.14.2.2). The Mellen Street WWTP in Centralia has flooded and become inoperable in the past. The Montesano WWTP has been flooded by the Wynoochee River, but the City installed a sheetpile wall to stabilize the lagoon dike and ensure it did not fail and release its contents into the river; further protection through local projects is still being considered. Septic tanks are located throughout the rural areas of the Chehalis Basin and have contaminated floodwater in the past. The 2007 flood caused the death of thousands of livestock and flooded livestock areas, contaminating floodwater.

The 2007 flood required a 10-month cleanup, which was conducted by Ecology's Southwest Regional Office Spill Response Unit. The cleanup area for the 2007 flood included Pe Ell, Doty, Adna, Littell, and the area between Chehalis and Centralia. A temporary hazardous waste storage site was located at the Meskill Solid Waste Transfer Station (Holcomb 2008).

Overall, spill responders collected and disposed of 4,000 gallons of oil, gasoline, paint, pesticides, anti-freeze, flammable liquids, and corrosive substances, as well as 17,500 pounds of hazardous solid substances, oil-contaminated debris, and empty drums and containers. Flooding of the Chehalis-Centralia Airport contaminated floodwater with jet fuel and other fuel. Household propane tanks were also flooded, and were retrieved and disposed of by Ecology in coordination with Lewis County officials and commercial propane companies. Overall, spill responders and crew members disposed of 4,000 gallons of oil, gasoline, paint pesticides, anti-freeze, flammable liquids, and corrosive substances, as well as 17,500 pounds of hazardous solid substances, oil-contaminated debris, and empty drums and containers.

3.15.2 Flood Warning Systems

Many areas of the Chehalis Basin are rural and remote. As described in Section 3.14.2.1, cell phone and internet services are not available throughout all areas in the Chehalis Basin.

Three counties in the Chehalis Basin manage flood warning systems through their emergency management departments. The county emergency management departments provide flood warning services for all jurisdictions in the counties, except Centralia. Centralia does not contract with Lewis County for emergency management and has its own department. In emergencies, each emergency management department activates its emergency operations center.

All emergency management departments have a notification system that allows residents to sign up for automated notifications of emergencies (e.g., floods) through emails or phone calls. The emergency management departments have websites with links to river gages and weather reports. During flood emergencies, these websites provide specific warning information about floods, including road closures. The counties also provide emergency preparedness education, including for storms and floods, as well as brochures with information on what to do before, during, and after a flood.

Following the 2007 flood, many Chehalis Basin residents complained that the flood forecasting and warning system was inadequate for predicting flooding on their property. In response, the Chehalis River Basin Flood Authority funded a study of the existing system and implemented a plan to improve it. New rainfall, temperature, and river monitoring stations were installed. The Flood Authority also established a web-based early warning system that includes links to weather and river forecasts. During floods, the site would include emergency alerts and additional information on the flood. This system also allows residents to sign up for automated notifications of emergencies. Improvements to the flood warning system are ongoing.

3.15.3 Emergency Response

During floods, local fire departments typically assist with rescue operations, emergency medical service, the warning process, and sandbagging operations (Brown and Caldwell 2008). Sheriffs for Grays Harbor County and Lewis County direct the emergency management programs for their jurisdictions. The Grays Harbor County Sheriff also acts as the director of emergency management, and the Lewis County Sheriff's Office sends out warnings to the community in the event of a disaster or critical emergency via a mass notification system called Code Red (Lewis County 2015b).

Grays Harbor County's Division of Emergency Management is responsible for emergency preparedness; disaster, emergency response/recovery, and hazardous materials response planning; running the Emergency Operations Center; conducting responder training; providing public education, outreach, and exercises for disaster and emergency response; and operating the StormReady and TsunamiReady programs (Grays Harbor County 2015).

Thurston County also has an emergency management department, which provides flood information and assistance, public education and outreach, and natural hazard planning documents; however, it is not associated with the Thurston County Sheriff's Office. See Section 3.15.2 for additional information about flood warning systems.