Chehalis Basin Strategy

Draft Wetland Mitigation Plan

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ACRONYMS AND ABBREVIATIONS

Applicant	Chehalis River Basin Flood Control Zone District
BA	biological assessment
BMP	best management practice
BO	biological opinion
CB	Chehalis Basin
CBS	Chehalis Basin Strategy
cfs	cubic feet per second
CHTR	collection, handling, transfer, and release
Corps	United States Army Corps of Engineers
CWA	CWA
CWMP	conceptual wetland mitigation plan
DAHP	Department of Archaeology and Historical Preservation
DEIS	Draft environmental impact statement
Ecology	Washington State Department of Ecology
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FR	forest road
FRE	Flood Retention Expandable
gpm	gallons per minute
HGM	hydrogeomorphic
HPA	Hydraulic Project Approval
MOAR	Mitigation Opportunities Assessment Report
MSA	Magnuson-Stevens Act
MSL	mean sea level
NEPA	National Environmental Policy Act

NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
OHWM	ordinary high-water mark
PAB	palustrine aquatic bed
PEM	palustrine emergent
PFO	palustrine forested
PMF	probable maximum flood
PSS	palustrine scrub shrub
PUB	palustrine unconsolidated bottom
QIN	Quinault Indian Nation
RCC	roller compacted concrete
RM	river mile
SEPA	State Environmental Policy Act
TTT	Temporary trap and transport
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VMP	Vegetation Management Plan
WDFW	Washington State Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation
WSEL	Water Surface Elevation

EXECUTIVE SUMMARY

ES.1 Introduction and Purpose

This conceptual wetland mitigation plan (CWMP) prepared by the Applicant (Chehalis River Basin Flood Control Zone District) proposes mitigation to address the wetland and wetland buffer impacts reported in the State Environmental Policy Act (SEPA) Draft Environmental Impact Statement (DEIS) (Washington State Department of Ecology [Ecology] 2020) for construction and operation of the Proposed Action. The purpose of this CWMP is to provide the Applicant's mitigation proposal to support the Lead Agency's determination of whether mitigation of unavoidable impacts to wetlands and wetland buffers is technically feasible. The Applicant holds the position that it would be feasible to appropriately mitigate the wetland and buffer impacts that would result from the construction and operation of the Proposed Action.

The Chehalis River Basin Flood Control Zone District (Applicant) is proposing construction of the Flood Retention Expandable (FRE) facility on the upper Chehalis River (River Mile [RM] 108.5), near the city of Pe Ell, Washington, and levees located in the downstream developed areas between the cities of Centralia and Chehalis, Washington. The Proposed Action would be a component of the Chehalis Basin Strategy, which is "a collaborative, science-based process that was created to address the dual challenges of extreme flooding and degraded aquatic species habitat" (Chehalis Basin Strategy 2022). An analysis of Proposed Action impacts was presented in the Washington State Environmental Policy Act (SEPA) Draft Environmental Impact Statement (DEIS) published by Ecology in February 2020 (Ecology 2020). Subsequently, The Applicant prepared a mitigation opportunities assessment report (MOAR) (Kleinschmidt 2020) to evaluate the availability of mitigation opportunities to address the impacts identified in the SEPA DEIS. The MOAR identified mitigation opportunities and estimated the required mitigation types, quantities, and locations available within the upper Chehalis River Basin to mitigate the impacts reported in the SEPA DEIS. The Applicant is also identified as the Applicant in the SEPA environmental review process.

This mitigation plan is intended to support the SEPA environmental review process. It is a precursor to future mitigation plans that will include the detail necessary to inform environmental permitting for local (e.g., shorelines, critical areas, land use), Clean Water Act (CWA) Sections 401 and 404, Endangered Species Act (ESA) Section 7 consultation, Hydraulic Project Approval, and other related permits. This mitigation plan specifically addresses impacts to wetlands and wetland buffers from the Proposed Action as identified in the SEPA DEIS. Although the Proposed Action will have unavoidable effects on aquatic habitats (including streams and stream buffers), aquatic effects and related mitigation are not included in the scope of this CWMP. The Applicant prepared a separate FRE facility Habitat Mitigation Plan that focuses on mitigating effects on aquatic and terrestrial species and habitats (Kleinschmidt 2022).

ES.2 Probable Impacts of Proposed Action on Wetlands and Buffers

Calculation of wetland and wetland buffer impacts reported in this CWMP is based on, and matches, the impact analysis for the Proposed Action in the SEPA DEIS Appendix O (Ecology 2020). Table ES.2-1 summarizes the total estimated probable direct impacts to wetlands and wetland buffers that would result from construction and operation of the Proposed Action. For the purpose of determining mitigation requirements in this CWMP, these impacts are assumed to be permanent per the impact analysis reported in the SEPA DEIS Appendix O (Ecology 2020). The impacts summarized in Table ES.2-1 are the basis for determining the amount and types of wetlands and wetland buffer mitigation to be included in the mitigation proposal presented in this CWMP.

Table ES.2-1
Summary of Total Estimated Wetland and Buffer Impacts from the Proposed Action

STUDY AREA LOCATION	DIRECT WETLAND IMPACTS (ACRES)					WETLAND BUFFER IMPACTS (ACRES)
	CATEGORY I	CATEGORY II	CATEGORY III	CATEGORY IV	TOTAL	
FRE Facility	0	0	1.08	0	1.08	30.14
Temporary Reservoir Area	0	2.82	6.95	0	6.5	303.15
Airport Levee	0	6.25	0.37	0	6.62	44.2
Total	0	9.07	8.40	0	17.47	377.51

Notes:
1. Source: Table data compiled from multiple tables in SEPA DEIS Appendix O (Ecology 2020).
2. Totals match compiled total wetland and buffer impacts stated in Section 3.2.4 of SEPA DEIS Appendix O (Ecology 2020).

ES.3 Mitigation Strategy

The mitigation objectives and strategy provide a foundation for the development of the mitigation proposal and help to ensure the proposed mitigation effectively serves its intended purpose. The high-level mitigation objectives are summarized below:

- Identify and implement all feasible and effective avoidance and minimization measures.
- Mitigate for unavoidable impacts to wetlands and wetland buffers. The Proposed Action would require mitigation for permanent direct impacts to 17.4 acres of wetland and 377 acres of wetland buffer.
- Ensure no net loss of wetland area and no net loss of wetland function.
- Adhere to the general requirements for mitigation planning consistent with all applicable current local, state, and federal guidance and regulations.

The proposed mitigation strategy comprises three primary components to mitigate impacts to wetlands and wetland buffers from the Proposed Action. The first component would be preservation of forest land adjacent to the temporary reservoir outside the maximum extent of the inundation zone, and inclusive of existing wetlands within the preserved forest area. The second component of the mitigation strategy would be enhancement of existing riparian wetlands along the margins of the Chehalis River reach that extends approximately 20 miles downstream of the FRE facility to the confluence with the South Fork Chehalis River. The third mitigation component would be restoration or creation of depressional wetland on the Chehalis River floodplain within the reach of the Chehalis River extending downstream of the FRE facility to the airport levee area.

ES.4 Compensatory Mitigation

Compensatory mitigation is required to address unavoidable impacts to wetlands and buffers that would result from the construction and operation of the Proposed Action. The proposed compensatory mitigation would have three primary components to mitigate impacts to 17.4 acres of wetlands and 377 acres of wetland buffers from the Proposed Action. The first component would be preservation of at least 500 acres of forestland adjacent to the temporary reservoir and outside the maximum extent of the inundation zone, including at least 11.4 acres of wetland area. The second would be enhancement of 22.4 acres of existing riparian wetlands along the margins of the Chehalis River reach that extends approximately 20 miles downstream of the FRE facility to the confluence with the South Fork Chehalis River. The third mitigation component would be restoration or creation of 35.6 acres of depressional wetland on the Chehalis River floodplain in the reach of the Chehalis River that extends downstream of the FRE facility to the airport levee area. All wetland mitigation would include fully vegetated buffers that would constitute a component of the mitigation for the wetland buffer impacts resulting from the Proposed Action.

Table ES.4-1 summarizes the wetland impacts and the corresponding proposed mitigation for each type of impact. Impacts to wetland buffers would be mitigated at a 1:1 replacement ratio for the 377.5 acres of buffer impacts. Actual buffer mitigation may exceed that ratio based on the total preservation area required to preserve 11.4 acres of wetlands (baseline proposal is 500 acres), and the requirement to provide full buffers for 22.4 acres of riparian wetland enhancement and 35.6 acres of wetland restoration/creation.

The Applicant has identified feasible locations to implement the quantity and types of mitigation as proposed. Preservation of forestland in the vicinity of the temporary reservoir is feasible as a component of the land purchase from Weyerhaeuser that would be necessary to secure the land for the FRE facility and temporary reservoir under the Proposed Action. Wetland enhancement within riparian buffers of the Chehalis River and its tributaries is feasible within the river corridor downstream of the FRE facility extending to the Airport Levee area. Candidate mitigation sites identified in the MOAR (Kleinschmidt 2020) were further evaluated and screened, and four potential mitigation sites were identified for wetland restoration or creation on the Chehalis River floodplain downstream of the FRE facility. Those four sites have a combined total of approximately 90 acres that would be used for mitigation.

Table ES.4-1
Summary of Proposed Mitigation by Impact Type

IMPACT TYPE	PORTION OF IMPACT (ACRES)	PROPOSED MITIGATION TYPE	MITIGATION RATIO	PROPOSED MITIGATION QUANTITY (ACRES)
Category II Wetland	0.5	Preservation	12:1	6
	1.0	Enhancement	12:1	12
	7.6	Restoration/Creation	3:1	22.8
Total	**9.1**			
Category III Wetland	0.7	Preservation	8:1	5.6
	1.3	Enhancement	8:1	10.4
	6.4	Restoration/Creation	2:1	12.8
Total	**8.4**			
Buffer	**377.5**	Establish Wetland Buffer	1:1	377.5

ES.5 Monitoring and Adaptive Management

Wetland mitigation would be required to meet specific performance standards over a performance monitoring period that would be stipulated in environmental permits. Monitoring and adaptive management provide a way to manage uncertainty by triggering evaluation and implementation of contingency corrective measures when mitigation sites fail to meet performance standards during the performance monitoring period.

A project-specific monitoring and adaptive management plan would be developed for the wetland mitigation plan as it evolves to include specific mitigation sites. Key elements of the monitoring and adaptive management plan include:

- **Performance metrics** – select metrics to measure and document the performance of wetland and buffer mitigation.
- **Monitoring schedule** –specify the timing of the monitoring events during the performance monitoring period. The schedule provides a basis for evaluating incremental progress toward ultimate target conditions for habitat and ecological function.
- **Performance standards** –identify specific success criteria for each performance metric. Failure to meet performance standards triggers the process of diagnostic analysis and, if appropriate, contingency corrective actions. Performance standards would be linked to the monitoring schedule, and some standards would increase over time based on the anticipated/desired progress towards target habitat condition and function.
- **Diagnostic analysis** – describe the evaluation process to determine the root causes when mitigation fails to achieve the performance standards.

- **Contingency corrective actions** – identify a set of contingency corrective actions that may be implemented to redirect the mitigation toward meeting the performance standards.

Each of these key elements of monitoring and adaptive management would be different for each different type of mitigation. Those differences are discussed for the three primary components of the wetland mitigation proposal: preservation of forest land inclusive of wetlands, enhancement of existing riparian wetlands along the Chehalis River, and restoration/creation of depressional wetland on the Chehalis River floodplain.

1 INTRODUCTION

The Chehalis River Basin Flood Control Zone District (Applicant) is proposing construction of the Flood Retention Expandable (FRE) facility on the upper Chehalis River (RM 108.5), near the city of Pe Ell, Washington, and levees located in the downstream developed areas between the cities of Centralia and Chehalis, Washington. An analysis of Proposed Action impacts was presented in the Washington State Environmental Policy Act (SEPA) Draft Environmental Impact Statement (DEIS) published by Washington Department of Ecology (Ecology) in February 2020 (Ecology 2020). Subsequently, The Applicant prepared a mitigation opportunities assessment report (MOAR) (Kleinschmidt 2020) to evaluate the availability of mitigation opportunities to address the impacts identified in the SEPA DEIS. The MOAR identified mitigation opportunities and estimated the required mitigation types, quantities, and locations available within the upper Chehalis River Basin to mitigate the impacts reported in the SEPA DEIS. The Applicant is also identified as the Applicant in the SEPA environmental review process.

This conceptual wetland mitigation plan (CWMP) prepared by the Applicant proposes mitigation to address the wetland and wetland buffer impacts reported in the SEPA DEIS (Ecology 2020) for construction and operation of the Proposed Action. The purpose of this CWMP is to provide the Applicant's mitigation proposal to support the Lead Agency's determination of whether mitigation of unavoidable impacts to wetlands and wetland buffers is technically feasible.

1.1 Background

The Applicant proposes a new flood hazard reduction project including construction of a new flood retention facility in the upper Chehalis Basin near the city of Pe Ell, Washington. Proposed Action elements include levee improvements near the Chehalis Airport, and the FRE facility with a temporary reservoir designed to fill episodically to mitigate flooding during peak flow events (HDR 2017, 2018a; Chehalis River Basin Flood Control Zone District 2019). The SEPA DEIS published in February 2020 described the proposed project and presented a preliminary assessment of project effects on wetlands and wetland buffers (Ecology 2020). This CWMP relies on the SEPA DEIS and its Appendix O as the primary source for the description of the project, characterization of the affected environment, and description of anticipated project impacts. In support of the SEPA DEIS, wetlands within the project area were identified and documented in a wetland delineation report (Anchor QEA 2018). Figure 1.1-1 shows the study area located within the upper Chehalis Basin. The study area was defined to include a reasonable geographic range for mitigation opportunities based on common practice for locating mitigation in accordance with published regulatory guidance (WDFW 2000).

Figure 1.1-1
Study Area

The Proposed Action is currently under environmental review. Ecology published a DEIS under SEPA in February 2020 (Ecology 2020). The U.S. Army Corps of Engineers (Corps) published a DEIS prepared in accordance with the National Environmental Policy Act (NEPA) in September 2020 (Corps 2020). Both documents reported findings that the FRE facility would have unavoidable, adverse impacts on wetlands and buffers. This CWMP was developed to mitigate those unavoidable impacts.

This CWMP describes the existing and potential future conditions of the wetlands and their buffers in the area potentially impacted by construction or operation (Impact Area) of the FRE facility as well as the area considered for mitigation (Mitigation Area).

Existing conditions in the affected environment are described relative to the wetlands that have been identified in the SEPA DEIS as likely to be affected by the Proposed Action. This document summarizes the potential Proposed Action effects on these resources, describes avoidance and minimization measures, and proposes conceptual actions to mitigate those unavoidable effects. Although wetland and buffer impact characterization would be refined and revised during future Proposed Action phases (e.g., design and permitting), this wetland mitigation plan addresses the impacts published in the SEPA DEIS for the purpose of supporting Ecology's SEPA evaluation of whether it would be technically feasible to mitigate those impacts. Refinements to impact characterization made during future environmental permitting would be incorporated into the development of future mitigation plans.

1.2 Purpose and Scope

The purpose of this CWMP is to provide a mitigation proposal to the SEPA lead agency to inform their evaluation and determination of whether adequate mitigation to offset unavoidable Proposed Action effects on wetlands and buffers is technically feasible and economically practicable. This CWMP provides a form of due diligence as the Proposed Action advances to the next phase of environmental review under SEPA. While the NEPA DEIS was published with different impact quantities, this report is aligned to address the anticipated impacts as reported in the SEPA DEIS.

The SEPA DEIS characterized anticipated unavoidable Proposed Action impacts to wetlands and buffers without developing a specific quantitative assessment of mitigation needs. The primary purpose of this CWMP is to propose mitigation for effects on wetland and wetland buffers under the Proposed Action.

This mitigation plan is intended to support the SEPA environmental review process. It is a precursor to future mitigation plans that will include the detail necessary to inform environmental permitting for local (e.g., shorelines, critical areas, land use), Clean Water Act (CWA) Sections 401 and 404, Endangered Species Act (ESA) Section 7 consultation, Hydraulic Project Approval, and other related permits. This mitigation plan specifically addresses impacts to wetlands and wetland buffers from the Proposed Action as identified in the SEPA DEIS.

Although the Proposed Action will have unavoidable effects on aquatic habitats (including streams and stream buffers), aquatic effects and related mitigation are not included in the scope of this document and are addressed in a separate FRE facility Habitat Mitigation Plan that is focused on mitigating effects on aquatic and terrestrial species and habitats (Kleinschmidt 2022).

2 PROJECT DESCRIPTION

2.1 Project Objective and Siting/Location

During periodic floods, the Chehalis River overtops its banks and enters the floodplain resulting in extensive bank erosion and water damage that has devastated homes, farms, businesses, churches, and schools. Many of these floods have caused the closure of Interstate-5 and State highways 6 and 12, disrupting the flow of traffic and transport of commercial goods between Seattle, Washington, and California. Flooding of this type has occurred as recently as 2022.

The proposed FRE facility and associated temporary reservoir, located at river mile (RM) 108.5 about two miles south of the community of Pe Ell, are intended to reduce flood damage and transportation disruption during major floods (Figure 2.1-1). The Proposed Action would not protect communities from all flooding, nor would it be designed to stop regular annual flooding of the Chehalis River. The proposed FRE facility would reduce flooding originating in the Willapa Hills.

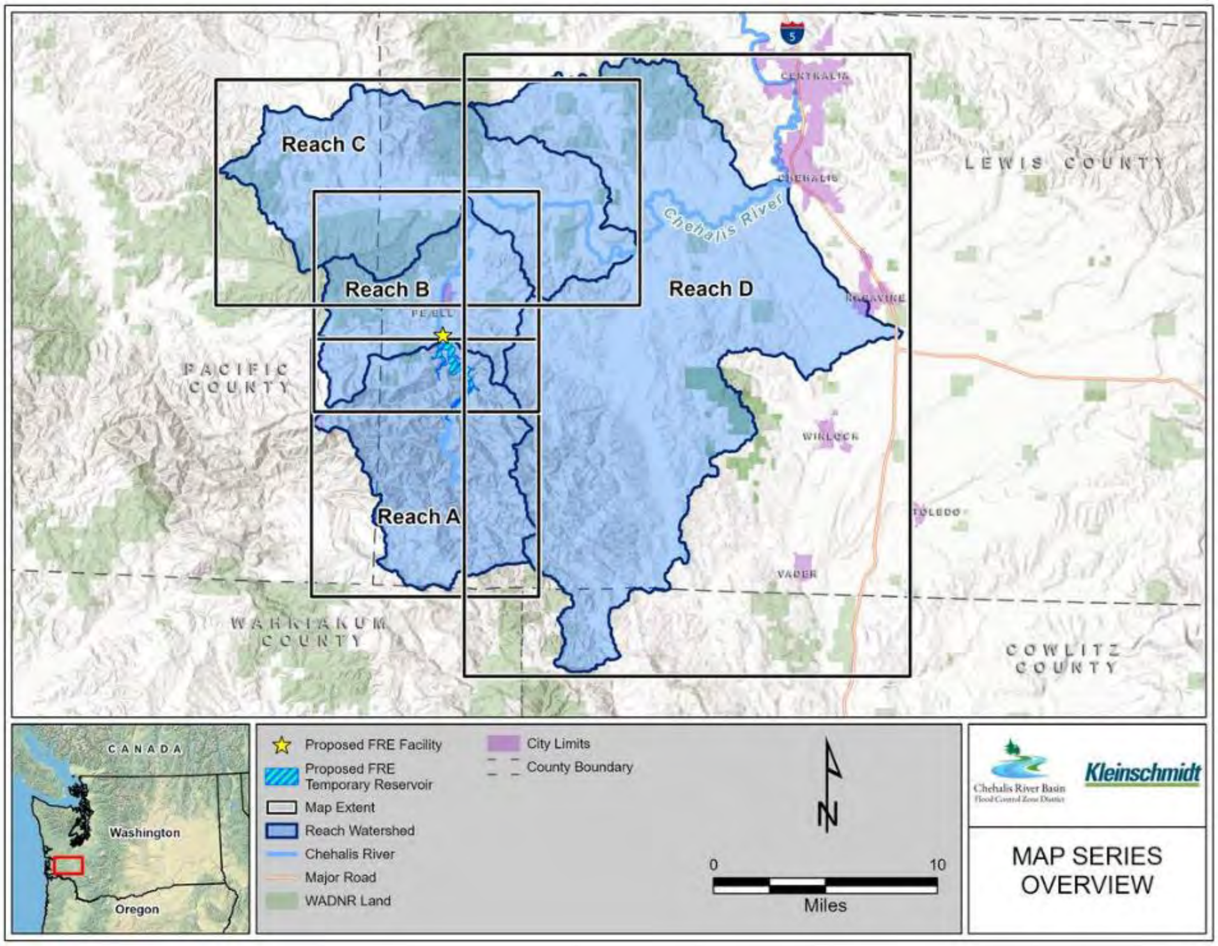
The proposed FRE facility would only operate during major floods, when river flows are forecasted to reach 38,800 cubic feet per second (cfs) or more as measured at the Chehalis River Grand Mound gage located in Thurston County. Floods of this magnitude are projected to have a 15% probability of occurrence in any one year, or a 7-year recurrence interval. Major floods also include those with a lower frequency of occurrence, such as 10-year and 100-year flood.

The facility would be operated to temporarily store floodwater and then slowly release it following the flood peak. Specific flow release operations would depend on inflows and the need to hold water to relieve downstream flooding

When the FRE facility is not operating, the Chehalis River would flow freely through the structure's low-level outlets at its normal rate of flow and volume, and no water would be stored or backed up upstream of the facility. Thus, when the FRE facility is not operating, sediment transport and fish passage would occur as they do under current conditions.

The preliminary design of the proposed FRE facilities, construction and operations were presented in the engineering design report and supplement (HDR 2017, 2018b) and are summarized below. Once permitted, the FRE facility construction would be anticipated to begin in 2025 and operations in 2030.

Figure 2.1-1
Study Area for the Chehalis Basin Including Position of the Proposed FRE Facility, and Planned Mitigation Areas



2.2 FRE Facility Features

The FRE facility would be constructed along the mainstem Chehalis River at RM 108.5, just downstream from the Crim Creek confluence. The FRE facility and its facilities would be located in uplands (landward of the ordinary high-water mark [OHWM]), in-water (waterward of the OHWM), or both and would include a combination of permanent and temporary (i.e., removed after construction) features. The design, construction methods, and operations plans summarized below are subject to updates during future design phases.

2.2.1 Permanent Features

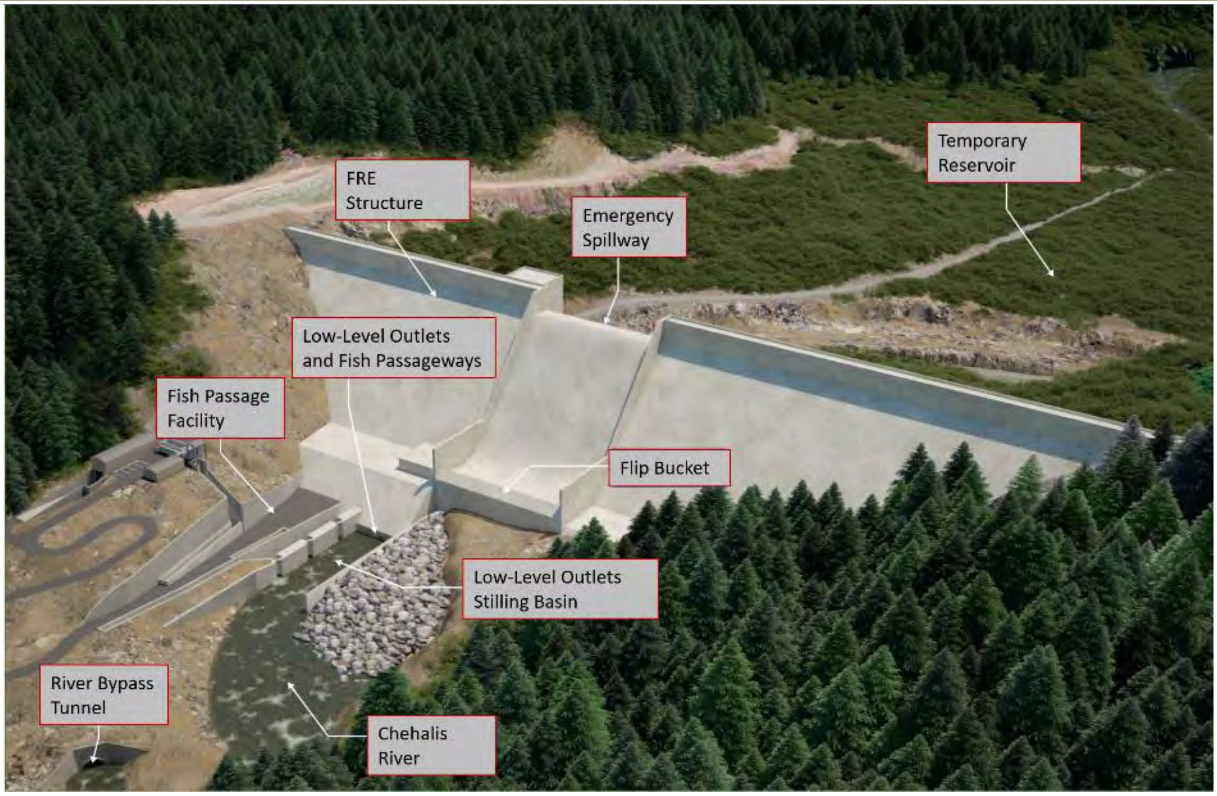
Permanent features of the Proposed Action include the FRE Facility; Fish Collection, Handling, Transfer, and Release (CHTR) Facility, Aggregate source quarries and access roads, and improvements to the Town of Pe Ell Water System. These proposed permanent features are described below.

2.2.1.1 FRE Facility

The FRE facility (Figure 2.2-1) would be designed to retain water temporarily during major floods. The primary components would include the following:

- A roller compacted concrete (RCC) flood retention structure sized for 65,000 acre-feet of flood retention (equivalent flood volume of the December 2007 flood of record) with an estimated maximum structural height of 254 to 270 feet, crest elevation of 651 feet mean sea level (MSL) and a spillway crest elevation of 628 feet. The foundation excavation and treatment would support potential future expansion and preclude the need for significant in-water work related to future foundation treatments.
- An overflow spillway, designed to pass flood flow up to and including the Probable Maximum Flood (PMF), estimated to be 69,800 cfs at the Grand Mound gage (Watershed Sciences and Engineering 2019), without structure overtopping, as required under the Washington State Dam Safety Office guidelines. The spillway includes an uncontrolled crest structure, a spillway chute, flip bucket, and plunge pool. The location and configuration of the lower portion of the spillway chute and flip bucket would be the same as required for potential future expansion of the FRE facility to eliminate the need for demolition and reconstruction of these features.
- Five 270-foot long, unlit conduits through the bottom of the structure to convey normal river flow and gates for flood regulation, provide for upstream and downstream fish passage and allow downstream movement of sediments, and large woody material (LWM).
- Fish passage facilities designed for volitional passage upstream and downstream when the FRE facility is not operating, and assisted passage during flood regulation periods.
- A concrete apron for fuel tank unloading and fuel storage containment areas.

Figure 2.2-1
Proposed FRE Facility Roller-Compacted Concrete Gravity Structure, Measuring 1,550 Feet Long, 270 Feet High. Proposed In-situ Location at Chehalis RM 108.5



Source: Ecology 2021.

2.2.1.2 Fish Collection, Handling, Transfer, and Release Facility

The FRE facility would be designed to allow for upstream and downstream fish passage when the FRE facility is not operating. The FRE facility is anticipated to operate for retention of major flood waters approximately every 7 years under current conditions and every 4-5 years under future modeled mid- and late-century conditions (Ecology 2021). During flood retention operation of the FRE facility and subsequent debris removal, all but the flow outlets would be closed. One outlet would remain partially open to convey river flow to downstream reaches. At these times, fish passage would be restricted. To prevent upstream passage delays, a fish trap and transport facility (CHTR) would be constructed along the right-bank (looking downstream) adjacent to the conduit stilling basin (HDR 2018b). The facility would collect fish and transport them to release sites upstream of the FRE facility.

Concepts for the CHTR were developed from 2013 through 2017 in collaboration with multi-agency resource specialists from the CBS Fish Passage Technical Subcommittee. The CHTR is designed to pass all life stages of all resident, anadromous, and lamprey species that currently occupy the affected reach of the Chehalis River.

A half-Ice Harbor-type adult fish ladder was selected for the CHTR, in part because of its ability to accommodate passage of aquatic species with a wide range of swimming and jumping capabilities. The current design features meet National Marine Fisheries Service (NMFS) passage criteria for adult salmonids. The juvenile fish ladder would be nearly identical to the adult fish ladder except for minor differences (e.g., no turning pools, only one entrance resting pool, additional pool in the ladder) and overall fish ladder slope and floor slope across each pool that meets NMFS passage criteria for juvenile salmonids. A Bonneville-style steel flume lamprey ramp with resting boxes would be located adjacent to the west wall of the juvenile fish ladder. A gravel area adjacent to lamprey fish ladder ramp would provide an access path for its full length.

A fish lift would be located at the upstream end of the ladder and would consist of a trap, hopper, and lift. A vee-trap would be built into the hopper to allow fish to volitionally enter but not exit. The lift system would vertically transport fish approximately 80 feet to a sorting and handling area. The fish lift would carry fish to respective holding tanks, with separate water supplies and drainage systems. Each gallery would be equipped with sprinkler systems and a false weir at the upstream side of the structure. Netting would be provided over galleries that hold juvenile fish. Both adult and juvenile galleries would meet NMFS criteria for holding. Fish would be hand-sorted by operators and sent through automatic diverter gates to the appropriate holding tanks, and eventually on to haul trucks for upstream release.

The CHTR fish passage facility would require water for operations. Water for some CHTR elements would be supplied via gravity flow while others would require pumping. The CHTR intake would draw water from the conduit stilling basin through a set of fish screens that would be designed to NMFS juvenile screening criteria. A prefabricated or concrete masonry unit building would be constructed adjacent to the sorting building to house mechanical and electrical equipment and to provide storage for equipment and materials associated with the CHTR.

2.2.1.3 Aggregate Source Quarry and Access Road Improvements

Construction of the FRE facility would require the development of a quarry site to source aggregate materials for concrete production and road base. Although only one quarry would be developed to support FRE facility construction, two potential quarry sites (North and South) have been identified. Although the size of the quarry has not yet been defined, for the purposes of this assessment it was assumed that the selected site would be cleared of vegetation to support up to a 10-acre quarry for aggregate production. In addition, each quarry would require upgrades and widening of existing access roads including Forest Road (FR) 1000 and FR 1020 (Pacific Forest Resources, Inc. 2019), resulting in additional clearing of six acres of vegetation.

2.2.1.4 Improved Construction Access Roads – FRE Facility Site

To the extent possible, the Applicant would minimize disturbance and new impervious surfaces by using existing roads to provide access to and around the construction site. Permanent road improvements would be necessary to provide sufficient load bearing for construction equipment. Improvements would likely include amendment with quarry spalls and subsequent maintenance activities. Designed improvements would require the implementation of applicable measures to minimize erosion and sediment inputs to the river.

2.2.1.5 Long-Term Vehicle Access around Inundation Area

To the extent possible, the Applicant proposes to use existing roads to provide permanent access around the temporary reservoir. However, a bypass may be required for FR 1000, which is a main access road for Weyerhaeuser forestry operations in the upper basin. Up to six miles of FR 1000 would be inundated during peak flood retention, at which time a detour could be used consisting of FR A-line, FR F- line, and FR 2000 to rejoin FR 1000 upstream of the temporary reservoir footprint. Future designs will inform the nature of proposed upgrades and long-term vehicular access.

2.2.1.6 Power/Data Lines

The FRE facility and CHTR facilities would require an electrical supply during construction and operation for pumps, conduit gates, fish holding tanks, and other equipment. The permanent electrical service would be provided by installation of an overhead or buried distribution power line connected to the electrical grid. The location of the interconnection and route of the interconnecting distribution line would be determined in coordination with the local power supply utility. At this time, the Applicant anticipates that overhead or buried lines would be installed along existing roads within the first 6 months of year-1 of the construction schedule.

2.2.1.7 Debris Management Staging and Storage Areas

Following flood retention, the flood pool would be drawn down, and accumulated debris would be removed. A debris management sorting yard would be constructed with an appropriate surface (e.g., rock or gravel) to allow vehicular access and use following drawdown. Debris management storage and staging areas would support the deployment of boats and barges from existing access roads. Debris would be stockpiled in a log sorting yard located between RM 109.6 and 109.9.

2.2.1.8 Town of Pe Ell Water System Improvements

The primary water source for the Town of Pe Ell is Lester Creek, which flows into Crim Creek just upstream of its confluence with the Chehalis River. The water source is upstream of the proposed FRE facility (Figure 3-8, Ecology 2020). This primary water supply system includes the water intake and reservoir system on Lester Creek, more than 10,000 linear feet of 8-inch water line, a pump station, a treatment facility, and a distribution system. The water line spans the Chehalis River on an existing bridge. During low-flow periods, Pe Ell uses the Chehalis River as a secondary (backup) water intake, but its use is limited. The Chehalis River intake is approximately 2,500 feet south of, and approximately 180 feet lower in elevation, than the water treatment facility.

Based on their location relative to anticipated construction areas, Pe Ell’s water treatment facility and the Lester Creek intake would not be affected by FRE facility construction; however, the water supply pipeline may be affected by construction and operation of the FRE facility, and approximately 8,000 feet of the pipeline is located within the temporary reservoir. Therefore, portions of the pipeline may require improvement or relocation. In addition, improved access to the Lester Creek intake is likely necessary to allow for long-term inspections and maintenance during FRE facility operations, which may inundate the lower portion of Lester Creek and associated access areas. At approximately 640 feet in elevation, the Lester Creek withdrawal point is located upstream of and outside of the maximum pool elevation of the temporary reservoir, which is 620 feet (based on the 2007 flood). The water treatment facility and pump station are outside of the area of modeled inundation and are therefore not anticipated to be affected by the Proposed Action.

Although the Applicant acknowledges that improvements to Pe Ell's surface water system (e.g., intake on Lester Creek and the water transmission line) may be necessary to construct and operate the FRE facility, specific improvements have not yet been defined. The Applicant would coordinate with the Town in future design phases to determine what is required. For the purposes of this assessment, however, the Applicant assumes that improvements to or relocation of the existing water line would be part of the Proposed Action.

In addition, for the purposes of this assessment, the Proposed Action includes improvements to, or replacement of, the Lester Creek intake, improved access to the Lester Creek intake, and possible upgrades at the Chehalis River intake. Designs for any renovation or replacement of existing intake structures would meet current NMFS and Washington Department of Fish and Wildlife (WDFW) screening criteria for the protection of fish.

2.2.2 Temporary Features

2.2.2.1 Concrete Batch Plant

To produce concrete for construction, a concrete batch plant would be constructed along the right-bank (looking downstream) of the Chehalis River. It would produce both RCC and conventional concrete and include the following:

- RCC batch plant,
- Conventional concrete batch plant,
- Aggregate crushing and screening,
- Aggregate storage,
- Fly ash storage,
- Cement storage.

2.2.2.2 Dewatering and Water Management Facilities and Materials

A series of cofferdams would be temporarily installed in the river to divert flow around construction areas and facilitate construction of in-water elements "in the dry." Other dewatering elements include:

- Super Sack®, Ecology block, Aqua bag, or other with Visqueen,
- Temporary dewatering pumps, screens, settling basins or structures (e.g., Baker tanks).

2.2.2.3 Temporary Trap and Transport for Upstream Adult Salmonid Passage

During construction, a tunnel would be constructed to bypass the river around the FRE facility and CHTR in-water work areas that would provide downstream fish passage during the 32-month FRE facility/CHTR construction period; however, due to high velocities in the tunnel it would not meet standards for upstream fish passage. Therefore, a temporary trap and transport (TTT) facility (HDR 2022a) is proposed to provide upstream passage for migratory fishes during construction when the river bypass is operating.

The TTT facility would be installed and begin operation prior to any other in-water work. The TTT facility would likely consist of a channel-spanning velocity barrier (Ogee crest or similar) with a fish ladder on the right bank that leads to holding ponds/tanks that would be accessed by transport trucks. The TTT would include right- and left-bank abutments, a channel-spanning barrier, and a right-bank ladder with attraction water intake, holding tank, and haul truck approach. Depending on the type of barrier selected, power may be required to operate the facility. The upstream fish passage barrier would be located downstream of the bypass tunnel outlet to direct all the fish passing upstream into a trap. Once in the trap, fish would be transferred to transport tanks. Personnel would drive the tanks upstream to predetermined release sites selected in coordination with U.S. Fish and Wildlife Service (USFWS), NMFS, and WDFW. Individuals would be released back into the river to continue their migration upstream. Once construction is complete and the FRE facility begins normal run-of-river operation, the TTT, or portions thereof, would be removed.

The intake for the TTT facility would conform to the most current NMFS and WDFW fish passage and screening design guidelines and criteria. At this time, the Applicant proposes targeted upstream passage for anadromous and resident species known to occur within the influence of the flood retention structure, in the inundation area of the associated temporary reservoir, and upstream of the temporary reservoir. This includes adult and juvenile spring-run and fall-run Chinook salmon, coho salmon, winter steelhead, and coastal cutthroat trout as well as adult Pacific and Western brook lamprey and 14 resident fish species (HDR 2022a). Juvenile salmonids, resident fish, and lamprey that are captured and collected would be transported upstream of the construction area and released back to the Chehalis River. The TTT operation period would be the same operation period as the bypass tunnel during construction.

2.2.2.4 River Diversion Bypass Tunnel

A bypass tunnel would be excavated via blasting in uplands along the right-bank of the Chehalis River to provide a river bypass during construction of the FRE facility. Based on the estimated peak flow rates that would be likely to occur during the 32-month construction period and the height of proposed upstream cofferdams to direct water into the tunnel, the bypass tunnel is designed to accommodate approximately 7,000 cfs, which roughly corresponds to a 2.8-year recurrence flow event. The tunnel would provide downstream fish passage for all fish for the duration of the FRE facility construction period. The tunnel would be constructed to meet NMFS passage guidelines, including velocity and slope criteria.

2.2.2.5 Temporary Construction Access Roads

To the extent possible, the Applicant proposes to use existing roads to provide temporary access to and around the construction site. Approximately 9,100 linear feet of temporary gravel roads would be developed within the active construction site for access. Temporary construction roads would provide access for various planned work activities, equipment and material storage, and construction administration. Temporary roads would also provide access to and from the selected quarry site to the material processing and production areas. At this time, the Applicant proposes to decommission all temporary roads in the active construction site following construction, and to restore habitats to preconstruction condition.

2.2.2.6 Staging Areas

Six primary staging areas would be established near the construction site and would include construction offices, areas for material processing and storage, parking for construction vehicles, and fuel storage and containment. Material excavated from the FRE facility structure footprint and abutments would be permanently relocated, stabilized, and revegetated at site mobilization and staging activity areas. Staging and construction laydown areas would be prepared with appropriate site grading, surfacing, and drainage provisions that allow for construction equipment and materials to be stored, secured, and utilized.

2.3 FRE Facility Construction

Construction of all FRE facility infrastructure would be completed in approximately 4.5 years and would begin as early as spring 2025. Appendix A contains a conceptual design drawing set, including details of all proposed facilities. The FRE facility engineering design report and supplement (HDR 2018a, 2018b) contains conceptual design drawings including details of all proposed facilities.

2.3.1 Access, Mobilization, and Staging

Trips to and from the FRE facility site from regional locations where materials are sourced have not been directly evaluated. No new access roads would be required, as all construction related vehicular trips would use existing roadways where construction related vehicular use would become indistinguishable from background levels of traffic.

Access to the FRE facility construction site would be provided from Muller Road and FR 1000. The Applicant anticipates that construction workers would park off-site in existing lots and be shuttled to the construction area to limit construction-related traffic and vehicles. A rough range for two-axle truck off-site round trips would be between 100,000 and 180,000 loads, and three-axle or larger off-site truck round trips would be between 16,000 and 26,000 loads over the 4.5-year duration of construction activities. Based on this information, between 10 and 40 truck trips are expected for a typical workday.

During FRE facility construction, vehicles would access the left bank atop both the upstream and downstream RCC cofferdam structures. The existing right-bank upstream access roadway is at elevation 465 feet and would connect to the upstream RCC cofferdam at the same elevation.

2.3.2 Equipment

Construction Equipment would include the following, to be refined during final design of the FRE facility:

- Bulldozers, excavators, front-end-loaders, off-road fixed wheel and articulated haul-trucks, integrated tool carriers and rollers.
- Cranes ranging up to 250 tons or larger.
- Quarry and FRE facility project site material processing equipment including pneumatic drills, blasting product transfer and storage, concrete production equipment, generators, utility buildings, electrical control, and large vehicles.
- Support Equipment (trucks, water trucks, vacuum trucks, boom trucks, vans), shipping containers, and temporary buildings.

2.3.3 Site Clearing

Site preparation for upland construction would require establishing erosion and sedimentation control measures, and clearing and grubbing. Approximately 23 acres of mixed coniferous/deciduous upland forest vegetation of varying sizes and age classes would be cleared for construction and for staging. Approximately 6.5 acres of vegetation within this cleared area would be occupied by the FRE facilities footprint (structures, access roads, and other features required for operations), and the vegetation would be permanently lost. The Applicant would restore and revegetate all areas cleared for construction staging and access that are not part of the permanent facility footprint. Plants selected for revegetation would be flood tolerant.

2.3.4 Pre-construction Vegetation Management

The Applicant has prepared a Vegetation Management Plan (VMP) (HDR 2021, Appendix B) to guide vegetation removal and tree harvest in the temporary reservoir including pre- and post-construction. A primary objective of the VMP is to minimize the extent of tree clearing and vegetation removal in the temporary inundation area footprint, while balancing the need to reduce the amount of woody material that would be generated within the area during a flood that triggers FRE facility operation.

The temporary inundation zone was modeled to determine the water surface elevation (WSEL) of the temporary reservoir at various floods and the duration that the area would be inundated (HDR 2020). The inundation analysis described three discrete phases of temporary inundation pool drawdown, or evacuation which are currently being assessed in the VMP to define selective tree harvest and vegetation removal strategies:

- Initial Temporary Reservoir Evacuation (WSEL 528 feet to maximum pool inundation; 238-528 acres).
- Debris Management Evacuation (WSEL 500-528 feet; 122 acres).

- Final Temporary Reservoir Evacuation (WSEL 425-500 feet; 159 acres).

The Initial Reservoir Evacuation Area would not be slated for pre-construction logging. This portion of the reservoir would be inventoried and monitored following construction. Tree retention is proposed to help limit temporal impacts to shading and river temperature associated with the tree removal in the Initial Reservoir Evacuation Area. Monitoring would reveal the need for tree replacements and in-planting once the facility is operational. Flood-tolerant species, such as black cottonwood or Oregon ash, would be in-planted along the riparian fringe and in flatter areas that may experience sedimentation during flooding events that inundate lower portions of the reservoir. The need for additional planting will be determined following a disturbance event through monitoring.

Twenty percent of the proposed selective tree harvest would occur each construction year over the five-year construction period. Species harvestable for commercial timber may be removed for this objective. Selective tree harvest would be sequenced such that trees within the Riparian Management Zones of the Chehalis River and its tributaries are harvested last. Appropriate flood tolerant trees would be replanted each year during construction to replace the trees selectively harvested. Monitoring would be conducted throughout the FRE facility temporary reservoir to document pre-construction riparian functions, wetland management zone conditions, and upland habitat conditions as they pertain to vegetation community composition.

The Debris Management Evacuation Area is also expected to require logging of affected trees, but some of the existing vegetation is expected to survive and be retained. Tree species that are expected to be intolerant of flooding, such as Douglas fir, would be removed as they perish and replaced with more flood-tolerant species. In-planting trees at the start of construction and prior to logging could assist in the establishment of flood-tolerant species and those that may require some shade during establishment, such as Western red cedar. This area would also include the establishment of a Debris Management Sorting Yard that would intercept and stockpile LWM that may be transported downstream during a flood event. The woody debris that is stockpiled may be used for habitat enhancement associated with the overall proposed project. Selective replacement of overstory near the river would help moderate the temporal impacts to stream shading and river temperature associated with tree removal in the Debris Management Evacuation Area.

The vegetation in the Final Reservoir Evacuation Area would be most affected by the operation of the proposed FRE facility. This area would be flooded most frequently and for a longer duration than the other inundation areas. The approach in this area would be to aggressively plant the riparian portions with flood-tolerant species of woody plants, mostly willow species, and monitor the area following a disturbance event, and then selectively remove larger vegetation during the dry part of the year. Some of the trees that perish could be retained as downed wood or snags to enhance wildlife habitat on-site.

Monitoring may also reveal other species of plants that could be planted in this area to bolster resiliency. One goal of the vegetation removal would be to reduce the potential for debris and vegetation to damage the FRE facility, and also to reduce the safety risk for operations personnel. Full removal of large trees near the facility or trees that have been determined to pose a threat to the safe operation of the facility would be recommended to achieve this primary goal. Once the large trees have been removed, appropriate vegetation can be re-planted. The remaining acres in the Final Reservoir Evacuation Area would be initially in-planted and converted over time to species that are more tolerant of flooding than the existing vegetation, but trees would be removed only following events that cause tree death. Shrub and organic material would be retained in this area to provide soil stabilization during the overstory conversion. Large Woody Material removed from this area would be harvested in a manner that is conducive for reuse of the material in habitat restoration or enhancement efforts associated with the overall Proposed Action.

2.3.5 Quarry Site Preparation and Blasting

Site preparation for quarry site development at either of the two sites under consideration would require site clearing, excavation, and blasting to mine aggregate rocks, and development of temporary access roads and staging areas. Quarry blasting would be expected to continue for up to 3 years of the total construction period and would occur one to four times per week, up to several times per day, during active development of the quarries.

2.3.6 Slope Stabilization

In addition to implementing the VMP and best management practices (BMPs), additional stabilization of steep slopes in the temporary inundation area may include the introduction of horizontal drainage into vulnerable slopes or the placement of berms at the toes of steep slopes.

2.3.7 Source Water for Concrete Mixing and Other Construction

During construction, water would be required for a variety of objectives, including on-site concrete mixing, dust suppression, and truck wash-downs. The quantity of required water would vary depending upon the nature of construction-related activities but could average 100 to 750 gallons per minute (gpm) for non-concrete mixing uses. During aggregate and RCC production to construct the FRE facility, a constant supply of 200 to 400 gpm (approximately 0.44 to 0.89 cfs) would be required for up to 32 months of construction. Such water may be provided from multiple sources, including water delivery trucks or a temporary well for construction. Any water withdrawn from a temporary diversion structure would be screened with screens meeting NMFS and WDFW criteria for fish protection.

2.3.8 Site Dewatering

The FRE facility in-water construction area would occupy 5.82 acres of habitat within the OHWM, including adjacent areas isolated by cofferdams (Corps 2021). Construction of all facilities in the river channel would take place in dewatered conditions. Dewatering the river channel would be accomplished by installing a series of cofferdams and the construction of a bypass tunnel.

Most of the work directly related to construction of the FRE facility and CHTR would occur over a period of approximately 32 months. During this 32-month period, the river would be diverted into a bypass tunnel and around the work site. Prior to the 32-month river bypass period, two consecutive in-water work windows would be required to construct the bypass tunnel, the TTT, and the RCC cofferdams. Preparatory phases of in-water work in Years 1 and 2 has been proposed to occur from July–September to minimize the footprint of dewatering facilities, minimize the impact to the river, and reduce the risk of flooding dewatered areas. Following this 32-month period, one additional July 1–September 30 in-water work period would be required to complete the Proposed Action and remove the RCC cofferdams. In total, FRE facility construction below the OHWM would require approximately 4.5 years based on the proposed sequencing.

The contractor would be required to submit dewatering plans to the Applicant a minimum of 60 days prior to in-water work, and to agencies for regulatory review to ensure consistency with existing environmental authorizations within 30 days.

2.3.9 Fish Salvage

Fish would be present in the Chehalis River during all phases of in-water construction. The Applicant would coordinate with WDFW during future permitting phases to develop fish salvage plans for each stage of in-water work. Salvage would be accomplished by experienced fish biologists using a combination of netting, electrofishing, and progressive pumping down of the water level. Fish salvage would be conducted in accordance with fish exclusion protocols developed by Washington State Department of Transportation (WSDOT) (WSDOT 2016). Electroshocking would occur in accordance with NMFS (2000) electrofishing guidelines.

2.3.10 Pile Driving: FRE Facility Foundation or TTT Support

Impact pile drivers may be used to provide temporary excavation support within the FRE facility construction area, including the area isolated for the TTT. At the current stage of design, the number and size of piles that may be required is unknown, and the duration of pile driving is also unknown. All impact-driven piles, if required, would be installed “in the dry” behind isolation cofferdams.

2.3.11 In-Channel and Near-Channel Blasting

In-channel or near-channel blasting would be required for preparation of the FRE facility structure foundation (waterward of OHWM) and diversion bypass tunnel excavation (adjacent to natural OHWM, in uplands). Blasting for tunnel construction would occur once or twice per day over a period of approximately 9 months with almost all blasting occurring in the interior of the tunnel. Blasting for excavation of the FRE facility structure foundation would occur as often as four times per week over approximately 12 months.

2.4 Operations and Maintenance Phase

During non-flood retention periods, the FRE facility would function as a run-of-the-river facility, where all five conduits would be held open continuously to allow unregulated flows through the facility. During these periods, most of the natural hydrologic, geomorphic, and hydraulic stream processes would be maintained. Water and sediment are expected to freely pass through the facility, upstream and downstream fish passage would be provided via the conduits, and woody material up to 3 feet in diameter and 15 feet in length would pass through the conduits to be transported downstream.

During typical seasonal flow (e.g., 2-year flood of 3,000 – 6,000 cfs) and flows up to 12,500 cfs (approximately a 10-year event) at the FRE facility site, water would pass through the low-level outlets without surcharging (i.e., backwatering/ponding upstream). The FRE facility would operate when flood forecasts predict a major or greater flood. The FRE facility conduit gates would begin to close and start holding water approximately 48 hours before flows at the Grand Mound gage (USGS Gage No. 12027500) were predicted to exceed 38,800 cfs due to heavy rainfall in the Willapa Hills. Once conduit gates begin to close, flows through the conduit gates would be reduced until reaching a flow of 300 cfs. A 300-cfs flow is a naturally occurring winter low flow on the Chehalis River. The outflow rate would be adjusted based on observed flows and revised predictions. The FRE facility would be operated to keep river outflow at a reduced rate until the peak flood passes the Grand Mound gage.

FRE facility operation would cause the temporary reservoir to fill. The size of the temporary reservoir would depend on the peak of the flood flow and its duration; the maximum extent would be 808 acres for a >100-year flood and would have a maximum depth of 212 feet (measured at conduit invert elevation 408 feet). Peak flood flows for major or greater floods are predicted to last on the order of 2 to 3 days. Once the peak flood flow passes, a three-stage reservoir evacuation operation would be implemented. The duration of temporary reservoir evacuation would depend on the magnitude of the flood and the amount of water temporarily stored. For catastrophic floods on the order of 75,100 cfs, it is estimated that inundation would last approximately 36 days total from closing of conduit gates through final reservoir drawdown.

2.4.1 Fish Passage

Across the range of normal flows and smaller flood conditions, fish would pass both upstream and downstream through the five outlets in the FRE facility concrete, each 310 feet in length and unlit. The conduits would be designed to mimic passage conditions currently available in the 450-foot-long bedrock canyon through which the Chehalis River now flows at the proposed FRE facility location. Depending on river flows, conduit gates would be closed and opened to maintain optimum fish passage conditions. Most of the time, when no impoundment is occurring, aquatic species passing upstream would be able to move from the river, into the stilling basin, through the conduits, and back into the river upstream of the structure. Fish passing downstream would follow the same path in the opposite direction. The FRE facility conduits would be designed to provide year-round, volitional upstream and downstream passage for migrating adult salmon and steelhead, resident fish, and lamprey for the full range of flows up through the high fish passage design flow, as required by NMFS criteria (NMFS 2011). During low-flow periods, the conduits would be managed to concentrate flow through one or more conduits to meet minimum design passage requirements.

2.4.1.1 CHTR Upstream Fish Passage During FRE Facility Operations

During major floods that trigger FRE facility operations, the conduits would be closed except for the largest conduit, which would remain partially open to convey minimum flows (300 cfs) downstream. During these periods, upstream fish passage would be provided by the CHTR facility. The CHTR fish passage facility would collect migrating adult salmon and steelhead, juvenile salmon and steelhead, resident fish, and lamprey moving upstream during an impoundment event, and safely transport them upstream of the FRE facility. Attraction flow would cue fish passing upstream from the river into the conduit stilling basin, and then into the fish ladders. Water supplied to the fish ladders and lamprey ramp would attract fish and lamprey to the traps. The conceptual designs for the juvenile/resident fish ladder and lamprey ramp would be based on the best available science, including studies published as recently as 2018 (HDR 2018a). Once trapped, fish would be sorted or passed into transport tanks and moved upstream of the FRE facility. The upstream release sites would be determined during future design or construction phases.

Although adult salmon and steelhead only pass upstream during certain periods of the year, the CHTR would be capable of operating at any time to accommodate resident fish, lamprey, and juvenile salmon and steelhead that currently transit this reach and move up or down stream. From 1994 through 2017, floods that would have triggered FRE facility operations occurred primarily from November through April. The months of December through February have the highest probability of FRE facility operation and subsequent CHTR operation.

The CHTR facility would begin operating as soon as the FRE facility conduit gates begin closing and would continue to operate until the flood pool is emptied and run-of-river operations resume. At the beginning of CHTR operations, river flow through the conduits would be well above the high fish passage design flow (2,200 cfs; see HDR 2018a). Although NMFS and WDFW guidelines do not require that fish passage be provided during these periods (i.e., conduit passage at flows above the high fish passage design flow), the CHTR would operate during this period to provide upstream passage. Operation of the CHTR would continue through water retention, as the temporary inundation pool is drawn down, as release from the temporary inundation area is slowed for debris management, and as the last remaining water is released. This process could take several weeks.

Once the temporary inundation pool is evacuated and the FRE facility structure would return to normal run-of-river operation through the conduits, the CHTR facility would be shut down. As part of the shutdown of the CHTR facility, any remaining fish would be safely removed and returned to the river, the fish ladder entrance gates would be closed, and the water supply turned off. The CHTR facility would be cleaned, prepared for the coming extended dormant period, and secured.

2.4.2 Downstream Fish Passage during FRE Facility Operations

Downstream passage of out-migrating fish would be delayed during FRE facility operations. During FRE facility operation and impoundment, the conduit gates would be nearly closed (allowing only 300 cfs) and water would be retained upstream of the FRE facility structure. Subsequently, any out-migrating fish entering the impoundment at this time would be temporarily detained in the inundation pool unless, in an unlikely scenario, they were able to locate the partially opened conduits gates at depth. Downstream fish passage would become available through the FRE facility conduits as flood retention operations cease and the temporary inundation pool drawdown is initiated.

2.4.3 Temporary Inundation Pool Evacuation

During FRE facility operations, flood pool release rates would be maintained at 300 cfs until unregulated flow at Grand Mound is less than 38,800 cfs. After flood flows decrease, the flood pool would be evacuated over a period of up to 34 days, depending on the volume stored. To draw down the pool, the conduit gates would be opened, and outflow increased from 300 cfs to approximately 6,000 cfs for a large flood. Flood pool drawdown rates would be limited to 10 feet per day (5 inches per hour) from the maximum pool elevation down to WSEL 528 feet.

When the flood pool is drawn down to WSEL 528 feet, the drawdown rate would decrease to 2 feet per day to accommodate debris handling. Reduction in the drawdown rate during this period would cause a corresponding reduction in outflow. Debris management operations would occur for approximately two weeks. Following debris management, and when the flood pool has reached WSEL 500 feet, drawdown rates would increase again to 10 feet per day (2-5 inches per hour) until the pool is emptied. The temporary inundation area would be empty at an elevation of 425 feet, at which time the conduit gates would be completely opened and the Chehalis River would return to a free-flowing state (Anchor QEA 2017).

2.4.4 Post-Flood Retention Sediment Transport

Following a flood-retention event, any sediment that had deposited within the conduits prior to gate closure would be swept through the conduits and deposited in the stilling basin, or downstream in the natural channel.

2.4.5 Woody Debris Management

Wood and vegetation debris from surrounding tributaries and hillslopes would be transported into the temporary reservoir during major floods with water retention. Following initial drawdown (10 feet per day), drawdown would slow to 2 feet per day when the temporary reservoir level reaches WSEL 528 feet. Boats would be used to remove floating LWM to a designated sorting yard on the west bank between RM 109.6 and 109.9 that is accessible from existing roads for reuse in downstream habitat enhancement projects or disposal.

Debris would be cut up and disposed of, and wood suitable for instream mitigation actions would be sorted and trucked out of the temporary reservoir area. The removal of stockpiled material would occur after the flood pool is drained and once the ground dries out enough to allow heavy equipment onto the sorting yard. Debris management would end when the water surface elevation of the temporary inundation area falls to WSEL 500 feet, which is the ground elevation at the log sorting yard.

2.4.6 Post-Construction Vegetation Management

Following a flood, trees in the temporary reservoir footprint would be monitored for significant stress and mortality. Flood stress in plants can cause yellowing or browning of leaves, curled leaves, leaf wilt and drop, reduced size of new leaves, early fall color, branch dieback, formation of sprouts along stems or trunk, and greater susceptibility to harmful organisms such as canker fungi and insects (Jull 2008). There would be uncertainty in predicting an elevation at which trees will likely be severely stressed or killed once the FRE facility is activated during major floods. The uncertainty is due in part to the unpredictable nature of floods and in part to the difficulty in predicting how individual trees will respond to inundation.

Trees in the FRE facility temporary reservoir would be monitored by a forester or other approved professional annually, and after periods of prolonged inundation, for signs of flood stress. Unhealthy and dead trees would be marked and removed on an as-needed basis to eliminate potential risks to FRE facility operations personnel and facility infrastructure. Trees that would need to be removed would be either cut and removed from the site, topped and retained as a snag, cut and retained on-site as downed large woody material, or removed and utilized as material for other mitigation actions for the Proposed Action. Monitoring efforts would also evaluate the establishment of tree and shrub species in areas where planting is conducted (i.e., Debris Management Evacuation and Final Reservoir Evacuation Areas).

3 REGULATORY REVIEW

Ecology prepared a DEIS issued on February 28, 2020, using the SEPA requirements in Washington Administrative Code 197-11. Ecology's DEIS evaluates the probable significant adverse impacts on the environment from the Proposed Action and alternatives and considers the future conditions when the Proposed Action is proposed to be constructed and operated.

Impacts to wetlands and associated buffers are regulated by multiple jurisdictions: federal, tribal, state, and local agencies with overlapping jurisdiction. The following summary identifies agencies and their corresponding authority to regulate unavoidable impacts to wetlands and buffers. See Appendix O of the SEPA DEIS for a thorough list of anticipated permits required for this project.

3.1 Federal Regulations

3.1.1 Section 404 Clean Water Act Permit

The Corps has jurisdiction over work in Waters of the United States through CWA Section 404. Within the upper Chehalis Basin, Waters of the United States would include the Chehalis River, its tributaries, and associated wetlands. The Corps has authority to require mitigation for unavoidable impacts to Waters of the United States. Corps jurisdiction under CWA Section 404 is triggered by construction of the proposed FRE facility within Waters of the United States. While there are multiple federal regulations that apply to the Project, the Corps will coordinate the federal review process and interact with other federal and tribal agencies.

Section 404 of the CWA requires discharges of dredged/fill material to waters of the U.S. be done only under the authorization of a permit. As part of this approval, Endangered Species Act and Section 106 of the National Historic Preservation Act consultations would also be required. The Corps will coordinate Proposed Action review between the federal agencies.

3.1.2 National Environmental Policy Act

Concurrent with the Washington SEPA review process, the Corps, as federal lead agency, is conducting a review of the Proposed Project under the NEPA. This includes consulting under Section 7 of the federal Endangered Species Act with the USFWS and National Oceanic Atmospheric Administration (NOAA) Fisheries and under Section 106 of the National Historic Preservation Act with Tribes, Department of Archaeology and Historical Preservation (DAHP), and the Applicant.

The Corps issued a NEPA DEIS on September 28, 2020, which identified potential impacts to terrestrial and aquatic resources for the proposed project. The estimated wetland and buffer impacts noted in the NEPA DEIS differ from the SEPA DEIS. Because this document is a pre-cursor for Washington State regulations, the differences in the NEPA DEIS impacts are not addressed in this document.

Further, the Corps will not continue their environmental review until NMFS and U.S. Fish and Wildlife Service (USFWS) issue the Biological Opinion (BO) for this project. The federal NEPA review process is estimated to be delayed 18 months and will follow a different schedule than the state review timelines.

3.1.3 Endangered Species Act

Section 7 of the ESA requires that the Corps ensure that any action they authorize for the Proposed Action does not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat for such species. Under Section 7, the Corps must consult with NOAA Fisheries and USFWS as part of the CWA Section 404 permitting process to evaluate the Proposed Action effects on federally listed threatened and endangered species. The Applicant would complete a Biological Assessment (BA), which NOAA Fisheries and USFWS would review and issue their findings, likely in a BO. The BO would specify nondiscretionary conditions to construct and operate the Project. While NOAA Fisheries and USFWS do not have the authority to directly require mitigation, the ESA consultation considers mitigation as part of the Proposed Action, and the mitigation can affect the outcome of the consultation's conclusions regarding the project's potential to jeopardize the continued existence of species or adversely modify critical habitat.

Further, the Magnuson-Stevens Act (MSA) requires an assessment of Project-related effects on designated Essential Fish Habitat (EFH) for Chinook and coho salmon. The Proposed Action may affect listed species or designated critical habitats. USFWS is evaluating the effects on listed and proposed species and critical habitats and required compensatory mitigation for unavoidable impacts.

3.1.4 Magnuson-Stevens Fishery Conservation and Management Act Provisions; Essential Fish Habitat

The MSA governs marine fisheries management in U.S. federal waters; federal agencies are required to consult with NOAA Fisheries on activities that may affect essential fish habitat. The Corps addresses this regulation under their federal review.

3.1.5 Section 106 of the National Historic Preservation Act

As part of the federal review, the Corps would address Section 106 of the National Historic Preservation Act to consider any potential impacts to historic properties. This includes a separate consultation with interested and affected tribes, the State Historic Preservation Officer at the Washington State DAHP.

3.1.6 National Flood Insurance Program

To comply with 44 Code of Federal Regulations 65.3, National Flood Insurance Program participating communities must provide the Federal Emergency Management Agency (FEMA) with technical information related to changes to the Special Flood Hazard Area. This would apply from the area inundated in the FRE facility temporary reservoir downstream to near Montesano. Conditional approvals by FEMA are needed prior to construction of the project.

3.2 Tribal

The Tribes would participate both through the Federal permitting process as they work with the federal agencies, government to government. The Tribes would also provide input through the State's co-management process.

The U.S. Government recognizes tribal rights to fish and wildlife within each tribe's designated "Usual and Accustomed Areas" as established by treaties between the tribes and the U.S. Government. Two tribal entities are present and have rights within the Chehalis Basin: the Quinault Indian Nation (QIN), and the Confederated Tribes of the Chehalis Reservation. The Corps engages in a government-to-government consultation with tribes when those rights are potentially affected by a proposed project seeking a CWA Section 404 permit. The consultation typically includes a focused dialog on impacts to aquatic and terrestrial species and the mitigation associated with those impacts. The tribal consultation typically has a strong influence on the nature and extent of the mitigation requirements.

Washington's salmon and steelhead fisheries are managed cooperatively in a co-management relationship. Co-management of fisheries occurs through government-to government cooperation. One government is the State of Washington, and the other is Indian tribes whose rights were preserved in treaties signed with the federal government in the 1850s. In addition to involvement through the Corps permitting process, tribes are co-managers of fisheries with WDFW, and as such tribes are actively involved in the state permitting process.

The Office of the Chehalis Basin (OCB) Board includes tribal representation. Tribal consultation is triggered by the need for a CWA Section 404 permit and state approval through the Hydraulic Permit Approval process.

3.3 State

Unlike the federal review process, Washington State agencies review and approve projects independently. There are two primary state agencies who would review the Proposed Action –WDFW and Ecology.

Washington State Hydraulics Code grants authority to WDFW to issue Hydraulic Project Approval (HPA) permits for projects that involve work in Waters of the State of Washington. WDFW has jurisdiction over in-water construction as well as Proposed Action effects on aquatic and terrestrial species and their habitats. WDFW has the authority to apply conditions when granting an HPA permit including specifying mitigation requirements. Mitigation requirements specified by WDFW are typically developed in close coordination with tribes. WDFW jurisdiction is triggered by construction work within Waters of the State of Washington.

3.3.1 State Environmental Policy Act

Ecology prepared a DEIS issued on February 28, 2020, using the SEPA requirements in Washington Administrative Code 197-11. Ecology's DEIS evaluated and developed estimated quantities of the probable significant adverse impacts on the environment from the Proposed Action and alternatives and considers the future conditions when the Proposed Action would be constructed and operated. To make a final determination and issue the Final DEIS, Ecology would determine whether the impacts as described in the SEPA DEIS can be effectively and economically mitigated. This document provides the information necessary for Ecology to issue a determination and Final DEIS to demonstrate the unavoidable impacts from the Project can be both adequately (based on ecological functions and values) and cost efficiently mitigated.

3.3.2 Section 401 Clean Water Act Water Quality Certification

In Washington State, the U.S. Environmental Protection Agency (USEPA) delegated their regulatory authority under the Clean Water Act to Ecology. While a federal (Corps Section 404) permit would be needed to implement the Proposed Action, Ecology would also review the Proposed Action as EPA's delegated authority under Section 401 of the Clean Water Act to ensure the Applicant has demonstrated that the Proposed Action would meet state water quality standards. Ecology administers CWA Section 401 Water Quality Certification permits in coordination with the Corps and linked to the CWA Section 404 permit as a concurrent requirement.

3.3.3 Washington State Shoreline Management Act

Ecology's involvement in this Project is triggered by work within Waters of the State of Washington, by the scope and scale of the project, and by the potential to have significant environmental impacts. Ecology's jurisdiction is multifaceted for this Proposed Action, with regulatory responsibilities under SEPA, the State Shoreline Management Act, and review and approval of local jurisdiction decisions. In addition to the SEPA process, Ecology manages shorelines of statewide significance and those wetlands that extend beyond the limits of federal wetland jurisdiction under the Shoreline Management Act. Ecology also oversees municipal land use jurisdictional decisions under the State Shoreline Management Act and the Growth Management Act. Ecology also has Jurisdiction under CWA Section 401 as delegated by USEPA.

3.4 Local and Regional

Municipal governments have jurisdiction over land use, shoreline zones, and critical areas under the State Growth Management Act and the State Shoreline Management Act. Jurisdiction is triggered by land use application requirements and proposed work within shoreline management zones and growth management areas.

Lewis County together with the City of Chehalis, would review the Proposed Project under their critical areas ordinances because it is within, abutting, or likely to adversely affect a critical area or buffer.

4 WETLAND IMPACT ASSESSMENT

The source and basis for this wetland impact assessment is Appendix O of the SEPA DEIS (Ecology 2020). The wetland impact assessment is organized to first describe the existing wetlands and buffers within the Proposed Action impacted area, and then present the impacts associated with the major elements of the Proposed Action (i.e., FRE facility and associated areas, temporary reservoir, and airport levees). This impact assessment replicates the wetland and buffer impacts published in the SEPA DEIS for the proposed action. Although wetland and buffer impact characterization would be refined and revised during future Proposed Action phases (e.g., design and permitting), this wetland mitigation plan addresses the impacts published in the SEPA DEIS for the purpose of supporting Ecology's SEPA evaluation of whether it would be technically feasibility to mitigate those impacts. Refinements to impact characterization made during future environmental permitting would be incorporated into the development of future mitigation plans.

4.1 Existing Wetlands within the Project Area

Existing wetlands within the project area were documented by the delineation of wetlands, waters, and OHWM conducted in 2017 (Anchor QEA 2018) for the FRE and temporary reservoir and in 2018 (Anchor QEA 2019) for the airport levee area. Existing wetlands were further described in Appendix O of the DEIS (Ecology 2020). Wetlands are identified and described in the following sections for the FRE facility and associated areas, the temporary reservoir, and the airport levees. Wetlands are described in three ways according to the Washington State Wetland Rating System (Hruby 2014):

- Wetland cover class (Cowardin class),
- Hydrogeomorphic (HGM) class,
- Washington State wetland rating (Category I, II, III, or IV).

4.1.1 FRE Facility and Associated Areas

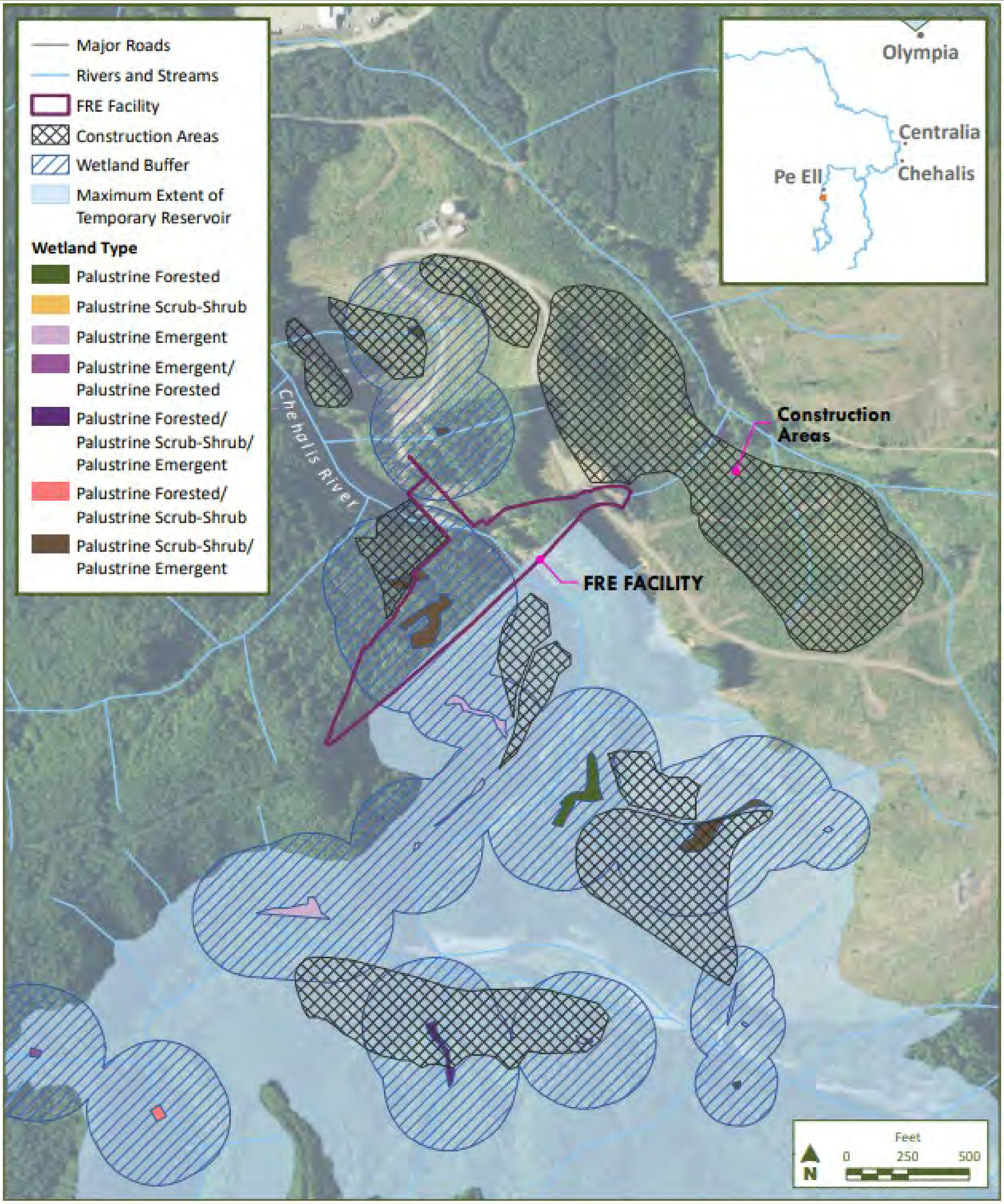
Two Category III wetlands are located within the proposed FRE facility site footprint and associated construction and operation areas (Figure 4.1-1). Those two wetlands have a total area of 0.65 acres and are classified as PSS/PEM (Palustrine Scrub Shrub/Palustrine Emergent). Wetlands exist along the north and south quarry access roads within 25 feet of the existing road edge. The wetland areas and wetland cover classes are shown in Table 4.1-1. North and south quarry access roads are shown on Figures 4.1-2, 4.1-3, and 4.1-4.

Table 4.1-1
Wetland Area Associated with the FRE Facility and Quarry Access Roads Within the Vicinity of the Temporary Reservoir by Wetland Cover Class

WETLAND COVER CLASS	FRE FACILITY (ACRES)	NORTH AND SOUTH QUARRY ACCESS ROADS[1] (ACRES)	HUCKLEBERRY RIDGE QUARRY ACCESS ROAD[2] (ACRES)	TOTAL ACRES OF WETLANDS
Palustrine Emergent	0.00	0.05	0.00	0.05
Palustrine Scrub Shrub/ Palustrine Emergent	0.65	0.01	0.00	0.66
Palustrine Forested/ Palustrine Emergent	0.00	0.02	0.00	0.02
Palustrine Forested/Palustrine Scrub Shrub/ Palustrine Emergent	0.00	0.04	0.00	0.04
Total	**0.65**	**0.12**	**0.00**	**0.77**

Notes:
1. Delineated wetlands within the FRE facility and temporary reservoir (Anchor QEA 2018).
2. Modeled Wetlands Inventory (Ecology 2011).
3. Source: SEPA DEIS, Appendix O, Table O-4 (Ecology 2020).

Figure 4.1-1
Wetlands and Waterbodies Near the FRE Facility



Source: SEPA DEIS, Appendix O, Figure O-10.

4.1.2 Temporary Reservoir

The wetland delineation completed in 2017 (Anchor QEA 2018) identified 89 wetlands within the 856-acre footprint of the temporary reservoir with a total cumulative wetland area of 10.18 acres. Delineated wetlands in the temporary reservoir are shown in Figure 4.1-2, Figure 4.1-3, and Figure 4.1-4. Wetland cover class and hydrogeomorphic (HGM) classes of delineated wetlands in the temporary reservoir area are summarized by drainage basin in Table 4.1-2. Number and area of existing wetlands by Category in the temporary reservoir and by drainage basin are shown in Table 4.1-3.

Table 4.1-2

Wetland Area Associated with the FRE Facility and Quarry Access Roads Within the Vicinity of the Temporary Reservoir by Wetland Cover Class. Cowardin Classes Includes Palustrine Emergent (PEM), Palustrine Scrub Shrub (PSS), Palustrine Forested (PFO), and Combinations

	COWARDIN CLASS							HGM CLASS			
BASIN NAME	PEM	PSS	PFO	PFO/PEM	PFO/PSS	PSS/PEM	PFO/PSS/PEM	DEPRESSIONAL WETLANDS	SLOPE WETLANDS	RIVERINE WETLANDS	TOTAL
Upper Chehalis River	18	1	1	7	6	14	6	13	40	0	**53**
Crim Creek	4	3	1	2	6	11	0	5	22	0	**27**
Lester Creek	0	0	0	0	1	1	1	0	3	0	**3**
Hull Creek	2	0	0	1	0	2	0	0	4	1	**5**
Browns Creek	0	0	0	0	0	0	0	0	0	0	**0**
Big Creek	1	0	0	0	0	0	0	1	0	0	**1**
Roger Creek	0	0	0	0	0	0	0	0	0	0	**0**
Smith Creek	0	0	0	0	0	0	0	0	0	0	**0**
Alder Creek	0	0	0	0	0	0	0	0	0	0	**0**
Total	**25**	**4**	**2**	**10**	**13**	**28**	**7**	**19**	**69**	**1**	**89**

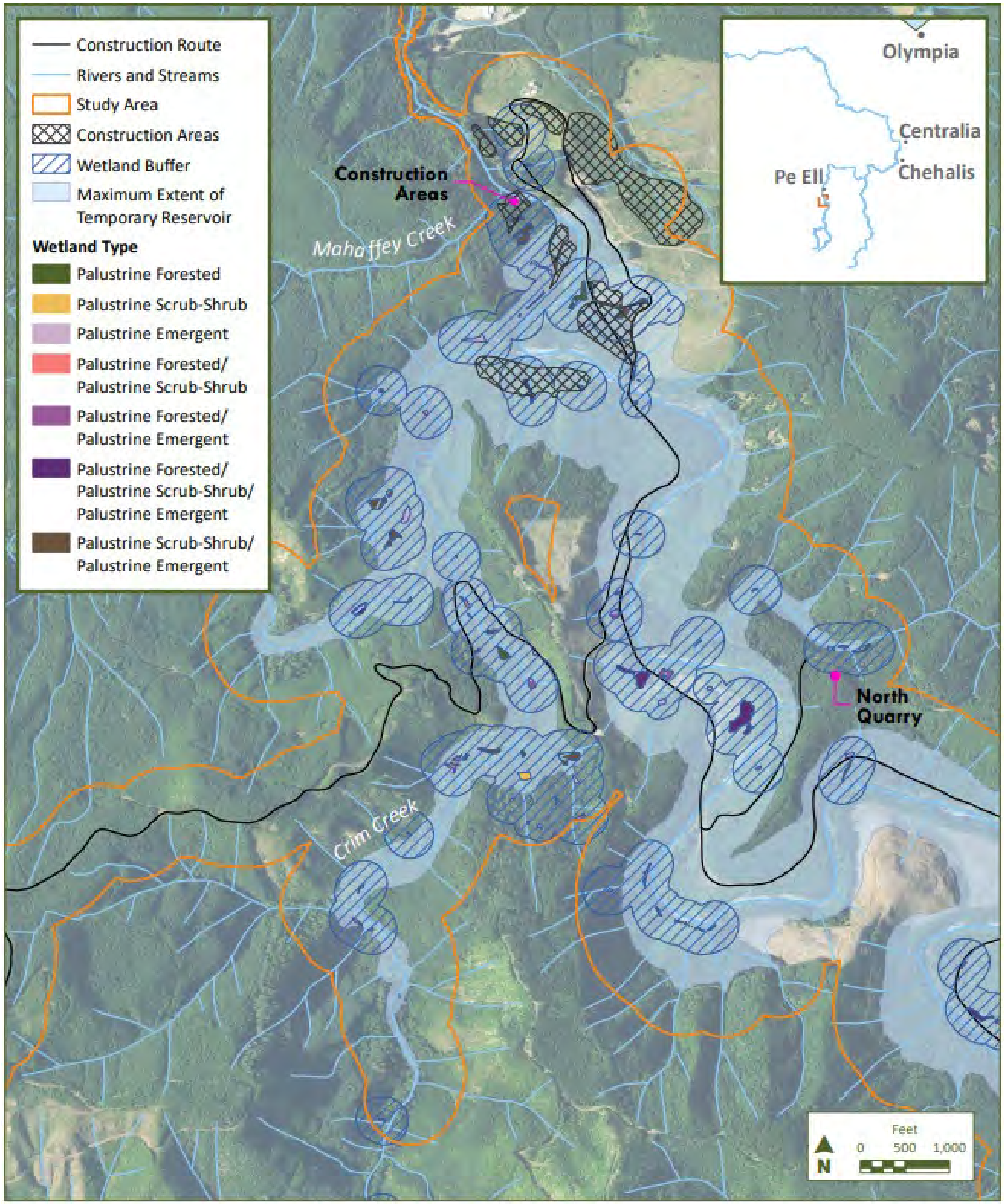
Notes:
1. Source: SEPA DEIS, Appendix O, Table O-5 (Ecology 2020)

Table 4.1-3
Number and Area of Existing Wetlands by Category in the Temporary Reservoir by Drainage Basin

DRAINAGE BASIN	CATEGORY II WETLANDS		CATEGORY III WETLANDS		TOTAL IDENTIFIED WETLANDS	
	NUMBER	ACRES	NUMBER	ACRES	NUMBER	ACRES
Upper Chehalis River	8	2.38	45	4.18	53	6.56
Crim Creek	4	0.40	23	2.44	27	2.84
Lester Creek	0	0	3	0.67	3	0.57
Hull Creek	1	0.02	4	0.13	5	0.15
Browns Creek	0	0	0	0	0	0
Big Creek	0	0	1	0.06	1	0.06
Roger Creek	0	0	0	0	0	0
Smith Creek	0	0	0	0	0	0
Alder Creek	0	0	0	0	0	0
Total	**13**	**2.80**	**76**	**7.48**	**89**	**10.18**

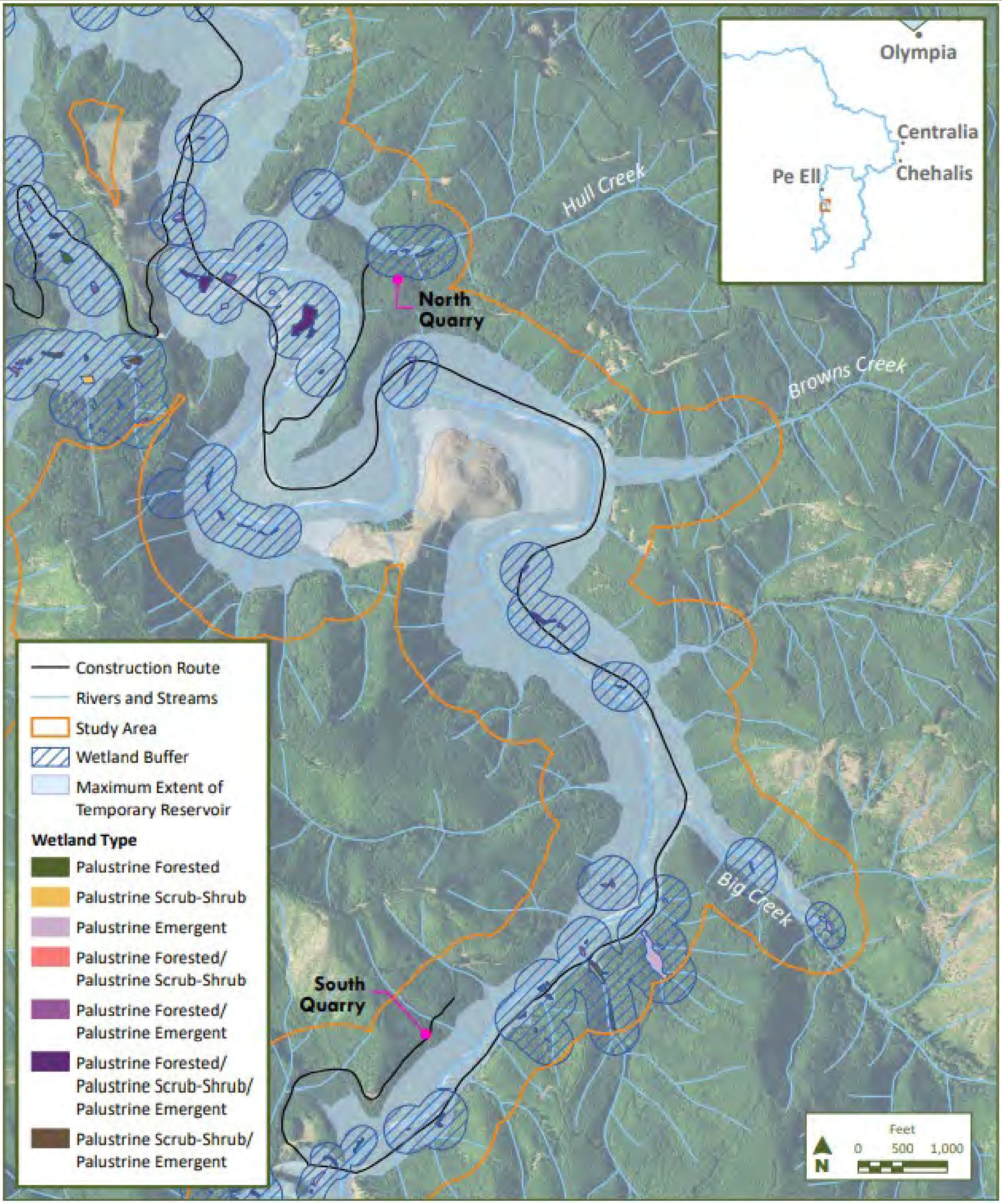
Notes:1.
Source: SEPA DEIS, Appendix O, Table O-6 (Ecology 2020)

Figure 4.1-2
Wetlands and Waterbodies in the Vicinity of the Temporary Reservoir



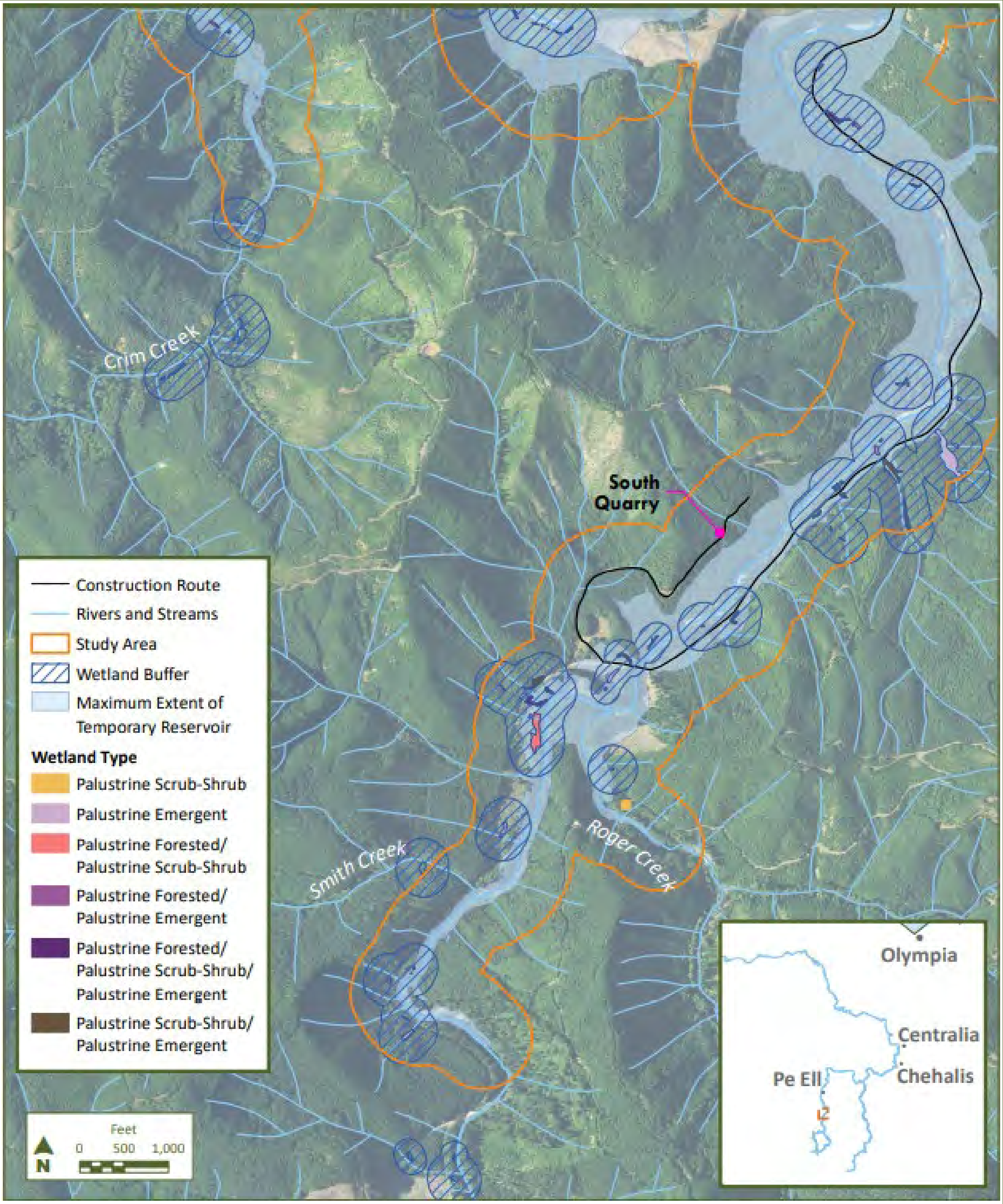
Source: SEPA DEIS, Appendix O, Figure O-11.

Figure 4.1-3
Wetlands and Waterbodies in the Vicinity of the Temporary Reservoir



Source: SEPA DEIS, Appendix O, Figure O-12.

Figure 4.1-4
Wetlands and Waterbodies in the Vicinity of the Temporary Reservoir



Source: SEPA DEIS, Appendix O, Figure O-13.

4.1.3 Airport Levees

Wetland cover (Cowardin) class and hydrogeomorphic (HGM) classes of delineated wetlands in the airport levee area are summarized in Table 4.1-4. The number and area of existing wetlands by Category in the airport levee area are shown in Table 4.1-5. Total wetland area in the vicinity of the airport levees is 6.26 acres. Wetland area extends off site at that location.

Table 4.1-4

Number of Existing Wetlands in Each Cowardin Class Within the Area of Airport Levee Changes

COWARDIN CLASS						
PEM	PSS/PEM	PSS/PEM/ PUB	PSS/PEM/ PAB/PUB	PFO/PSS/ PEM/PAB/ PUB	HGM CLASS DEPRESSIONAL WETLANDS	TOTAL
1	1	2	1	1	8	8

Source: SEPA DEIS, Appendix O, Table O-7 (Ecology 2020).

Table 4.1-5

Number and Area of Existing Wetlands by Category Within the Area of Airport Levee Changes

CATEGORY II WETLANDS		CATEGORY III WETLANDS		TOTAL IDENTIFIED WETLANDS	
NUMBER	ACRES	NUMBER	ACRES	NUMBER	ACRES
3	6.26	3	0.37	**6**	**6.63**

Source: SEPA DEIS, Appendix O, Table O-8 (Ecology 2020).

Source: SEPA DEIS, Appendix O, Figure O-14.

4.2 Impact Calculations

Calculation of wetland and wetland buffer impacts reported in this CWMP is based on, and matches, the impact analysis for the Proposed Action in the SEPA DEIS Appendix O (Ecology 2020). Table 4.2-1 summarizes the probable direct impacts from construction activities, and Table 4.2-2 summarizes the probable direct impacts from FRE facility operations. The SEPA DEIS (Ecology 2020) identified no probable indirect construction impacts on wetlands or wetland buffers. The impact analysis in SEPA DEIS Appendix O considered potential operational effects on floodplain wetlands downstream of the FRE and concluded that, "*These probable adverse impacts are considered **minor** for wetlands because the affected wetlands would not be eliminated or lose their primary hydrologic source, but would no longer be inundated by overbank flooding that occurs infrequently.*"

Table 4.2-1
Summary of Probable Wetland and Buffer Impacts from Construction Activities

STUDY AREA LOCATION	DIRECT WETLAND IMPACTS (ACRES AND NUMBERS)[1]					WETLAND BUFFER IMPACTS (ACRES)
	CATEGORY I	CATEGORY II	CATEGORY III	CATEGORY IV	TOTAL	
FRE Facility	0	0	1.08 (8)	0	1.08 (8)	30.14
Temporary Reservoir Area	0	2.76 (11)	3.74 (51)	0	6.5 (62)	213.85
Airport Levee	0	6.25 (3)	0.37 (3)	0	6.62 (6)	44.2
Total	0	9.02 (14)	5.19 (62)	0	14.21	288.19

Notes:
[1]Source: SEPA DEIS Appendix O, Table O-12 (Ecology 2020).

Table 4.2-2
Summary of Probable Wetland and Buffer Impacts from Operation Activities

STUDY AREA LOCATION	DIRECT WETLAND IMPACTS (ACRES AND NUMBERS)[1]					WETLAND BUFFER IMPACTS (ACRES)
	CATEGORY I	CATEGORY II	CATEGORY III	CATEGORY IV	TOTAL	
FRE Facility	0	0	0	0	0	
Temporary Reservoir Area Zones 1 and 2	0	2.76 (11)	3.74 (51)	0	6.5 (62)	213.85
Temporary Reservoir Area Zones 1 and 2	0	0.05 (2)	3.21 (21)	0	3.26 (23)	89.30
Airport Levee	0	0	0	0	0	0
Total	0	2.81	6.95	0	9.76	303.15

Notes:
[1]Source: SEPA DEIS Appendix O, Table O-14 (Ecology 2020).

Total estimated direct impacts to wetlands and wetland buffers are summarized in Table 4.2-3. For the purpose of determining mitigation requirements in this CWMP, these impacts are considered permanent in alignment with the impact analysis reported in the SEPA DEIS Appendix O (Ecology 2020). The impacts summarized in Table 4.2-3 are the basis for determining the amount and types of wetlands and wetland buffer mitigation to be included in the mitigation proposal presented in this CWMP.

Table 4.2-3
Summary of Total Estimated Wetland and Buffer Impacts from the Proposed Action.

STUDY AREA LOCATION	DIRECT WETLAND IMPACTS (ACRES)					WETLAND BUFFER IMPACTS (ACRES)
	CATEGORY I	CATEGORY II	CATEGORY III	CATEGORY IV	TOTAL	
FRE Facility	0	0	1.08	0	1.08	30.14
Temporary Reservoir Area	0	2.82	6.95	0	6.5	303.15
Airport Levee	0	6.25	0.37	0	6.62	44.2
Total	0	9.07	8.40	0	17.47	377.51

Notes:
1. Source: Table data compiled from multiple tables in SEPA DEIS Appendix O (Ecology 2020).
2. Totals match compiled total wetland and buffer impacts stated in Section 3.2.4 of SEPA DEIS Appendix O (Ecology 2020).

5 MITIGATION STRATEGY AND APPROACH

The SEPA DEIS reported that construction and operation of the Proposed Action would result in 17.4 acres of direct permanent impact to wetlands and 377.5 acres of impact to wetland buffers. This CWMP proposes mitigation to address those impacts in accordance with the general requirements for mitigation planning, consistent with all applicable current local, state, and federal guidance and regulations.

The proposed approach to mitigating project impacts follows conventional mitigation sequencing. The first step identifies measures to avoid and minimize impacts. Common minimization measures include management plans, design refinements, and refinements to operations. After avoidance and minimization measures are applied, the remaining unavoidable impacts to wetlands are addressed using compensatory mitigation. Section 5.1 discusses avoidance and minimization measures. Section 5.2 presents the rationale, strategy, and approach to developing the compensatory mitigation proposal.

5.1 Avoidance and Minimization

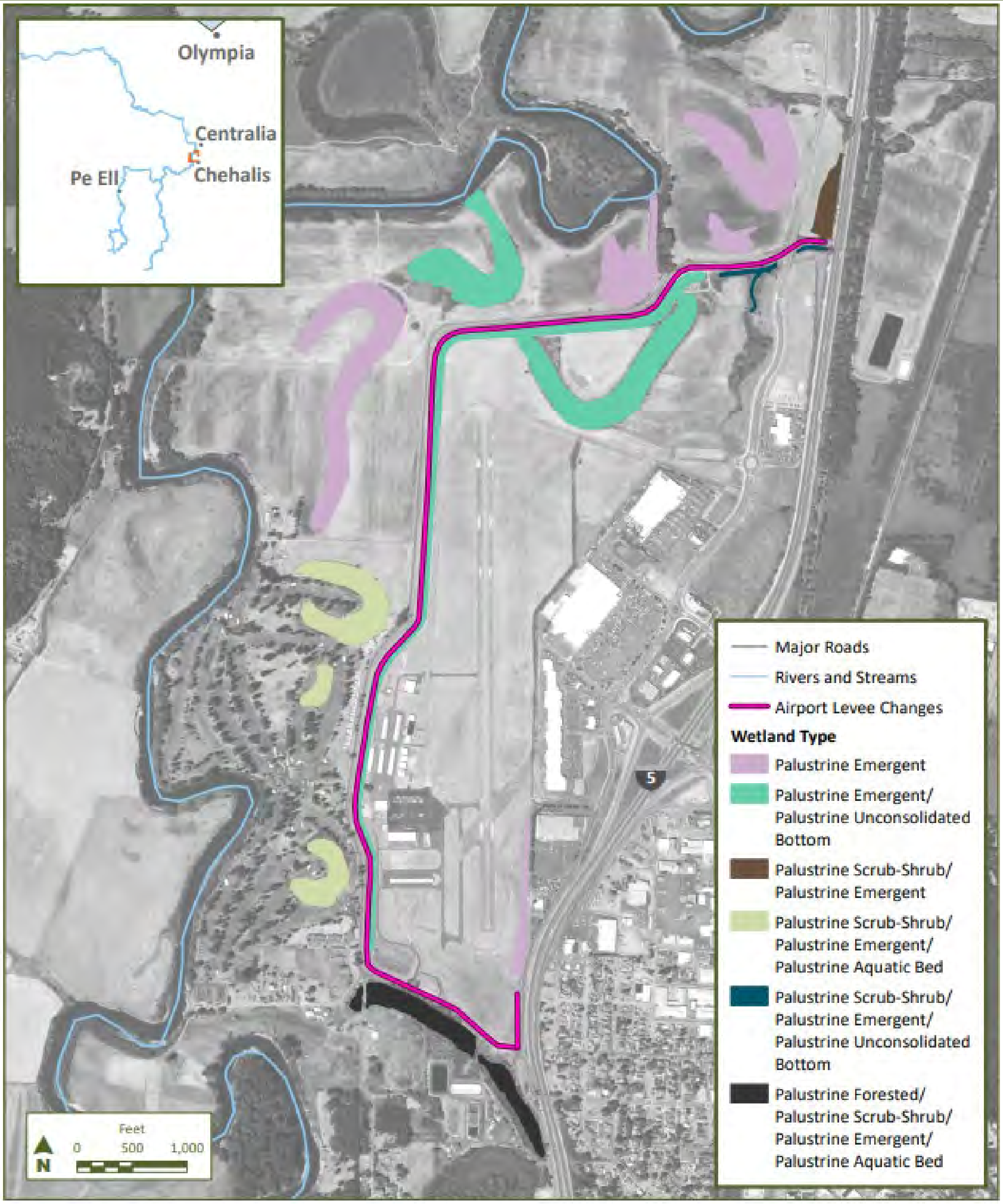
Identifying and incorporating avoidance and minimization measures is an essential first step applied during the iterative design process that occurs as part of the environmental permitting process. Design refinements to the Proposed Action have the potential to substantially reduce impacts to wetlands and buffers. Two specific minimization and avoidance measures are presented here to illustrate the potential impact reduction that could be achieved.

It should be noted that the wetland and buffer impacts used in this CWMP to determine the mitigation proposal match the impacts reported in the SEPA DEIS (Ecology 2020). The potential avoidance and minimization of impacts described below for the airport levee design and the vegetation management plan are avoidance and minimization measures that would be further developed and applied as part of mitigation sequencing during the environmental permitting phase.

5.1.1 Airport Levee Design Refinements

As described in the SEPA DEIS (Ecology 2020), the proposed improvements to the Airport Levee would result in 6.62 acres of permanent direct impact to wetlands. Figure 4.1-5 shows the relation between the proposed Airport Levee improvements and the existing adjacent wetlands. The Applicant evaluated the conceptual design for the levee improvements and documented a way of completing the proposed improvements while avoiding the direct permanent impact to wetlands. Specifically, The Applicant prepared a technical memorandum documenting the ability to use standard levee design and construction methods to avoid permanent impacts to wetlands adjacent to the proposed levee construction work (HDR 2022b). The technical memorandum prepared by HDR for the Applicant is included as Appendix C. The subject analysis documented that the proposed Airport Levee improvements can be constructed within the existing Airport Levee footprint. Limiting the construction to occur within the existing levee footprint eliminates the need to extend any construction activity or permanent facilities into the adjacent wetland.

Figure 4.1-1
Wetlands Near the Airport Levee Changes



Application of the design refinements proposed by the Applicant would result in avoidance of 6.62 acres of permanent direct impact to wetlands. The Airport Levee improvements would instead result in temporary construction impacts limited to vegetation trimming during construction at the edge of the wetland located along the existing levee embankment.

5.1.2 Vegetation Management Plan

The Applicant prepared a Vegetation Management Plan (VMP) (HDR 2021) that is included with this CWMP as Appendix B. The VMP was discussed earlier in this CWMP as part of the project description in Section 2.3.4 and Section 2.4.6. The VMP would guide vegetation removal and tree harvest in the temporary reservoir including Pre- and Post-Construction. A primary objective of the VMP would be to minimize the extent of tree clearing and vegetation removal in the temporary reservoir, while balancing the need to reduce the amount of woody material that would be generated in the area during a flood that triggers FRE facility operation.

The VMP provides opportunities to reduce the impacts to the wetlands located within the temporary reservoir. The amount of potential impact reduction is not estimated here. The Applicant would evaluate the potential wetland impact minimization in consultation with regulatory agencies during the environmental permitting phase.

5.2 Mitigation Objectives and Strategy

The mitigation objectives and strategy provide a foundation for the development of the mitigation proposal and help to ensure the proposed mitigation effectively serves its intended purpose. The high-level mitigation objectives are summarized below:

- Identify and implement all feasible and effective avoidance and minimization measures.
- Mitigate for unavoidable impacts to wetlands and wetland buffers. The Proposed Action would require mitigation for permanent direct impacts to 17.4 acres of wetland and 377 acres of wetland buffer.
- Ensure no net loss of wetland area and no net loss of wetland function.
- Adhere to the general requirements for mitigation planning consistent with all applicable current local, state, and federal guidance and regulations

The proposed mitigation strategy comprises three primary components to mitigate impacts to wetlands and wetland buffers from the Proposed Action. The first component would be preservation of forest land adjacent to the temporary reservoir outside the maximum extent of the inundation zone, and inclusive of existing wetlands within the preserved forest area. The second component of the mitigation strategy would be enhancement of existing riparian wetlands along the margins of the Chehalis River reach that extends approximately 20 miles downstream of the FRE facility to the confluence with the South Fork Chehalis River. The third mitigation component would be restoration/ creation of depressional wetland on the Chehalis River floodplain within the reach of the Chehalis River extending downstream of the FRE to the airport levee area. All wetland mitigation would include fully vegetated buffers that would constitute a component of the mitigation for the wetland buffer impacts resulting from the Proposed Action.

5.2.1 Wetland Preservation in Forest Land Near the Temporary Reservoir

The rationale for including wetland preservation in the forest near the temporary reservoir focuses on ensuring there are protected wetlands and buffers similar in category, class, and function compared to those impacted by construction and operation of the FRE facility and temporary reservoir. Including preservation of nearby similar habitats increases the potential for wildlife communities displaced by impacts to find suitable habitats nearby.

5.2.2 Wetland Enhancement in the Chehalis River Riparian Corridor

Enhancement of existing wetlands within the riparian corridor of the Chehalis River downstream of the FRE facility opportunistically dovetails with the parallel FRE facility Habitat Mitigation Plan that focuses on that reach of the river. Establishing forested conditions adjacent to the river would provide much needed shade to cool warm summer water temperatures. Existing wetlands within the riparian corridor may be enhanced by managing invasive plant species, by improving hydrologic connections to the river and tributaries, and by establishing a diverse native plant community targeting enhancement of a mixture of PFO and PEM wetland classes.

5.2.3 Restoration/Creation of Depressional Floodplain Wetlands

Restoring and/or creating depressional wetlands on the Chehalis River floodplain within the target reach would replace lost wetland functions including habitat functions, hydrologic functions, and water quality functions. Part of the rationale for selecting depressional floodplain wetlands relates to the amount and scale of wetland mitigation required and what may be more readily and reliably achieved and sustained in the floodplain setting.

5.3 Mitigation Bank Credit Purchase

A mitigation bank credit purchase is not included as part of the mitigation proposal presented in this CWMP. Purchase of mitigation bank credits is discussed here as a possible future option for wetland mitigation depending on the future availability of wetland mitigation bank credits. There is one private mitigation bank in the project area with mitigation credits available. As of January 10, 2022, The Chehalis Basin Wetland Mitigation Bank had 9.29 credits available for purchase (Anderson, personal communication, May 12, 2022). Some of those credits may be pending if the bank owners are negotiating credit sales with other potential customers. No significant credit releases are expected to occur during the SEPA environmental review process. More mitigation bank credits will be released at the time the Chehalis Basin Wetland Mitigation Bank achieves performance standards as stipulated in the credit release schedule included in the mitigation bank instrument.

Published federal and state mitigation guidance (Ecology 2021; Ecology et al. 2021) prioritizes use of mitigation bank credits to address wetland impacts. Currently there are limited credits available, and the available credits are being negotiated for other projects. Therefore, this mitigation plan does not propose a mitigation bank credit purchase as part of the wetland mitigation. The Chehalis Basin Wetland Mitigation Bank has not met key vegetation performance standards, so no large credit releases are expected within the next two years. If additional mitigation bank credits are later released during the permitting phase, a bank credit purchase may be considered as a possible contingency that may be evaluated at that time.

5.4 Mitigation Ratios and Mitigation Quantities

Published mitigation guidelines prescribe mitigation ratios to determine the amount of mitigation required for a given set of wetland impacts (Ecology et al. 2021). Table 5.4-1 presents the ratios prescribed by that current joint federal and state mitigation guidance.

The mitigation quantity calculations presented in this CWMP apply the ratios prescribed in Table 5.4-1 assuming the wetland category of the impacted wetland and the mitigation wetland are the same (i.e., Category III wetlands are mitigated by Category III wetlands, Category II wetlands are mitigated by Category II wetlands). In practice, the proposed mitigation will target establishing and maintaining Category II wetlands, which should yield additional overall ecological lift.

Table 5.4-1
Compensation Ratios for Permanent Impacts for Eastern and Western Washington

CATEGORY OF IMPACTED WETLAND	RE-ESTABLISHMENT OR CREATION	REHABILITATION	PRESERVATION	ENHANCEMENT
Category IV	1.5:1	3:1	6:1	6:1
Category III	2:1	4:1	8:1	8:1
Category II	3:1	6:1	12:1	12:1
Category I	4:1	8:1	16:1	16:1

Notes:
Source: *Wetland Mitigation in Washington State – Part 1 (Version 2),* Table 6B-1 (Ecology et al. 2021).
Ratios reflect the amount of compensation related to the amount of impact.
The category of impacted wetland is based on scores for functions. Compensation ratios in this table generally do not apply when impacts involve a wetland whose category is based on special characteristics.
All proposed preservation sites need to meet the preservation criteria listed in Chapter 5.2.3.1 (Ecology et al. 2021).

6 COMPENSATORY MITIGATION

6.1 Proposed Compensatory Mitigation

The proposed mitigation would have three primary components to mitigate impacts to 17.4 acres of wetlands and 377.5 acres of wetland buffers from the Proposed Action. The first component would be preservation of at least 500 acres of forestland adjacent to the temporary reservoir and outside the maximum extent of the inundation zone, including at least 11.4 acres of wetland area. The second would be enhancement of 22.4 acres of existing riparian wetlands along the margins of the Chehalis River reach that extends approximately 20 miles downstream of the FRE facility to the confluence with the South Fork Chehalis River. The third mitigation component would be restoration or creation of 35.6 acres of depressional wetland on the Chehalis River floodplain in the reach of the Chehalis River that extends downstream of the FRE facility to the airport levee area. All wetland mitigation would include fully vegetated buffers that would constitute a component of the mitigation for the wetland buffer impacts resulting from the Proposed Action. These three wetland and buffer mitigation components are described in more detail in the following sections.

6.2 Preservation of Forest Land

The first component of the proposed mitigation would be preservation of forestland adjacent to the temporary reservoir outside the maximum extent of inundation. The amount of preservation for mitigation would be at least 500 acres, but the actual amount would depend on the total area of existing wetland present in the proposed preservation area (or areas). The wetland delineation results reported in Appendix O of the SEPA DEIS (Ecology 2020) indicated that the study area included the area around and adjacent to the temporary reservoir extending approximately 500 ft from the maximum extent of inundation. Within that area, 27 wetlands were identified with a total area of 2.25 acres including 26 Category III wetlands (2.24 acres) and 1 Category II wetland (0.01 acre). The specific boundaries and total area of the preservation area would be determined by conducting a wetland delineation in the forest lands around the temporary reservoir and selecting an area (or areas) that contains at least 11.6 acres of existing wetland.

The rationale for proposing preservation as a component of the mitigation proposal is to preserve nearby existing wetlands that provide the same ecological functions that would be lost in the wetlands effected by the Proposed Action. Most (69 of 89) of the wetlands affected by the temporary reservoir are small slope wetlands with habitat as a primary wetland function. The proximity of the proposed preservation to the impacted wetlands increases the opportunity for those wetlands to serve ecological communities and populations displaced by the impacts. The quantities specified in this mitigation plan are minimum quantities, and this component of the mitigation proposal is scalable and may be increased as part of mitigation plan refinements expected to occur during future phases of environmental review.

6.3 Enhancement of Riparian Wetlands

The second component of the proposed mitigation would be enhancement of riparian wetlands along the margins of the Chehalis River in the approximately 20-mile river reach that extends downstream of the FRE facility to the confluence of the South Fork Chehalis River. The Stream and Terrestrial Habitat Mitigation Plan (Kleinschmidt 2022) includes a proposal to reforest the river margins to increase shade and thereby mitigate temperature impacts associated with the anticipated loss of shade in the temporary reservoir. The proposed enhancement of existing riparian wetlands would be accomplished opportunistically in the riparian reforestation areas. Approximately 820 acres of riparian areas would be reforested as part of the proposed mitigation. Most of that area is expected to be upland forest with included wetlands. The proposed wetland quantity for enhancement is a minimum of 22.4 acres. Appendix O of the SEPA DEIS (Ecology 2020) reported and mapped a modeled wetland inventory (not field delineated) downstream of the FRE facility (Appendix O, Figure O-3). The modeled wetland inventory indicates the likely existence of wetlands along the channel margins in this target reach with the incidence of wetlands increasing downstream of Doty, Washington.

Wetland enhancement actions would focus on the removal and management of invasive species, enhanced connection to the river channel and overbank flows, and establishment of diverse native wetland plant communities in wetland areas. These actions would prioritize enhancement of habitat functions to replace those lost in the impacted wetlands. Therefore, enhancement would also include introduction of habitat features within the wetlands (e.g., brush piles, snags, and downed logs).

Riparian wetlands in the proposed Mitigation Area are likely to be depressional (HGM class) wetlands. Most (69 of 89) of the impacted wetlands within the temporary reservoir are small slope wetlands, however depressional wetlands make up 19 of the impacted wetlands. While the HGM class of the proposed wetland mitigation is different than most impacted wetlands, habitat functions are the primary wetland functions provided by the impacted wetlands would be the priority functions provided by the proposed wetland enhancement. The concept for the proposed riparian wetland enhancement is illustrated in Figure 6.3-1, which was previously published in the Aquatic and Terrestrial Habitat Mitigation Opportunities Assessment Report (Kleinschmidt 2020).

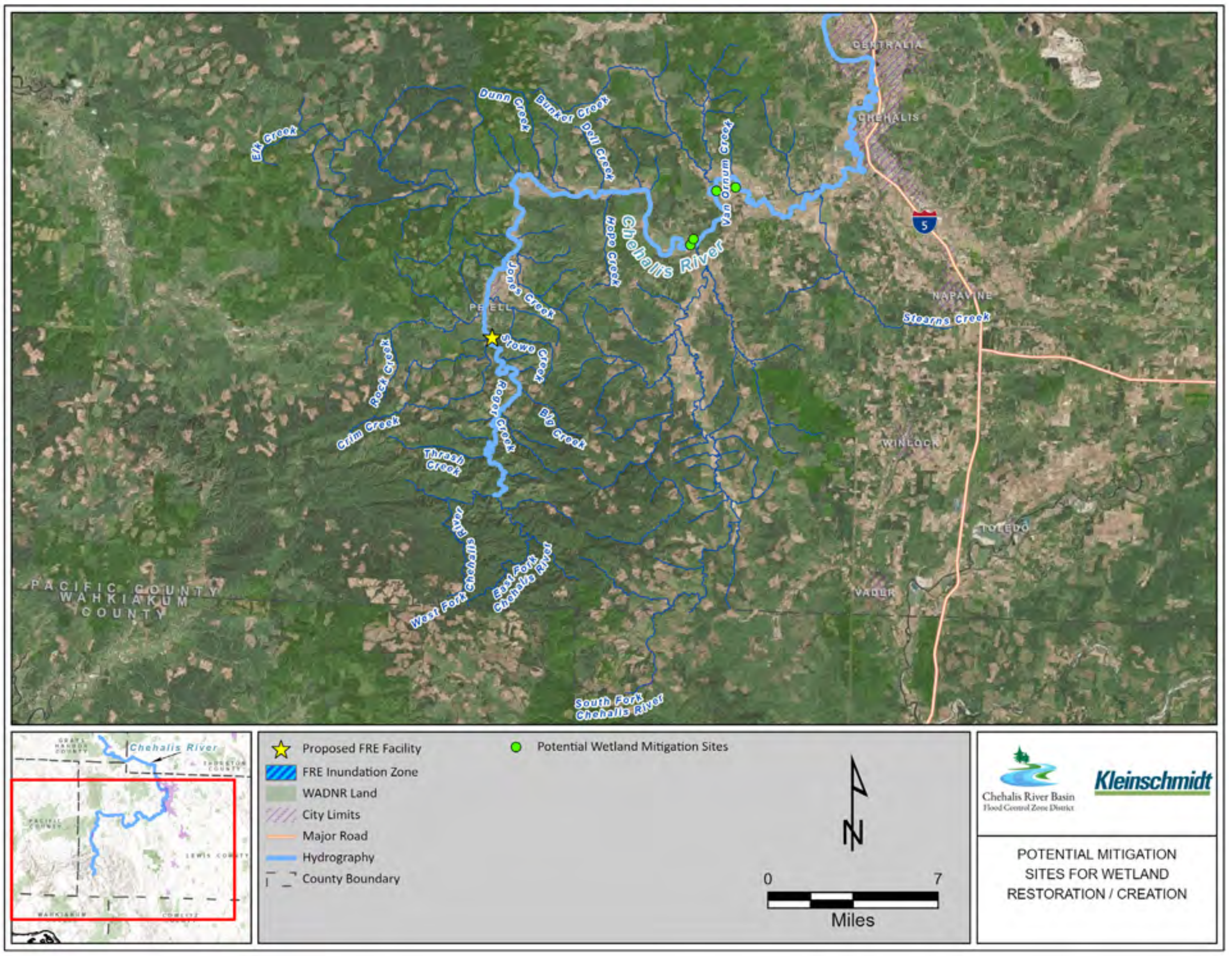
Figure 6.3-1
Example Concept for Riparian Wetland Enhancement Mitigation in Landscape Context

Source: Aquatic and Terrestrial Mitigation Opportunities Assessment Report (Kleinschmidt 2020).

6.4 Restoration or Creation of Depressional Floodplain Wetlands

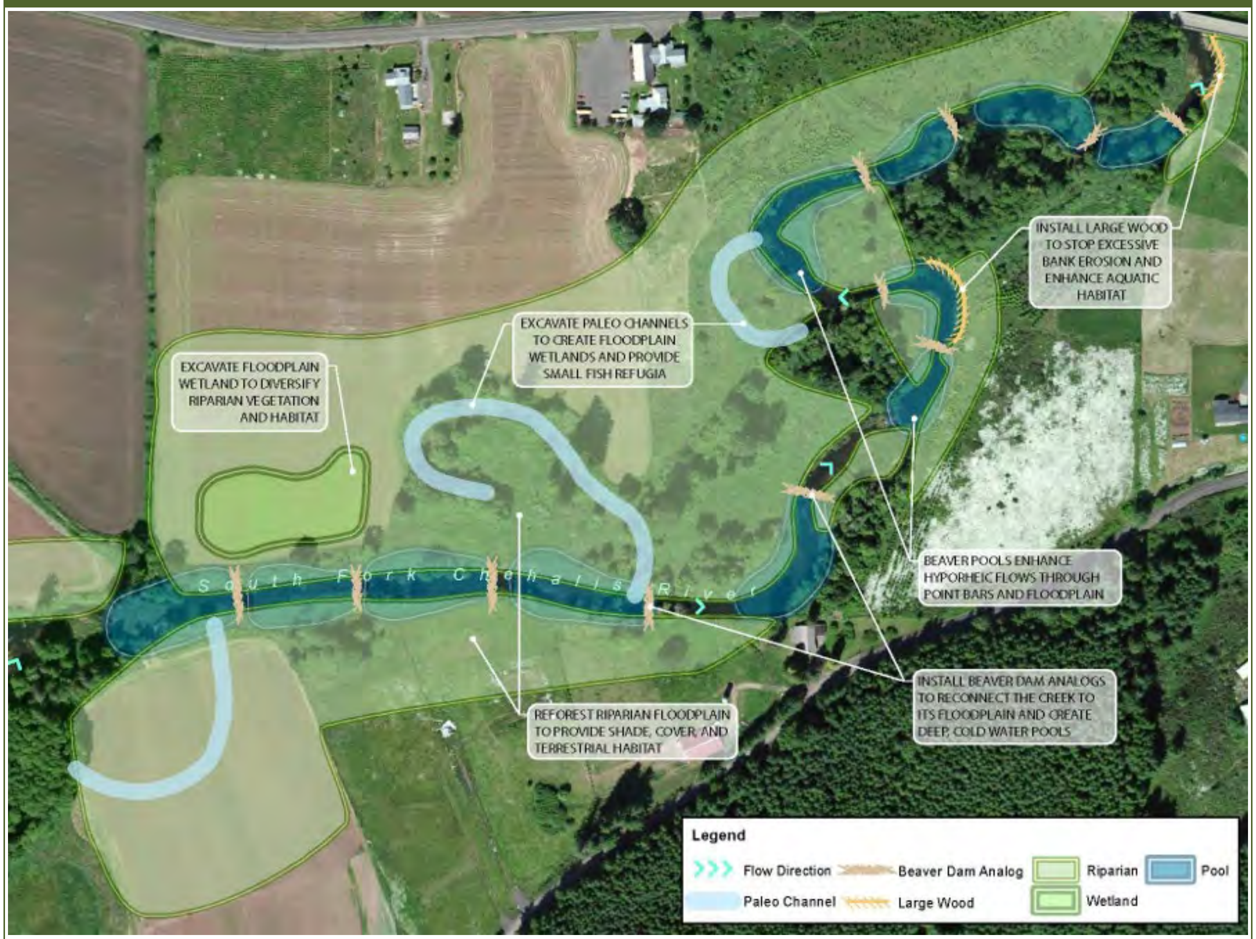
The third primary component of the proposed wetland mitigation would include restoration or creation of a combined total of 35.6 acres of depressional wetland on the floodplain at multiple locations along the Chehalis River reach extending downstream of Doty, Washington to the airport levee area. Figure 6.4-1 shows candidate locations within this reach, identified and screened by the Applicant for areas where the proposed mitigation could be implemented. The four potential wetland mitigation locations shown of Figure 6.4-1 include a total of approximately 90 acres. Those sites were screened from the larger list of candidate mitigation sites identified in the MOAR (Kleinschmidt 2020). The screening process focused on confirming that the landscape and geomorphic context would support wetland mitigation including a combination of enhancement, restoration, and creation.

Figure 6.4-1
Potential Locations for Establishing Depressional Wetland on the Chehalis River Floodplain



Wetland restoration or creation would focus on establishing, or re-establishing (depending on history of the selected site[s]), depressional wetlands on the Chehalis River floodplain. Mitigation actions would focus on excavation to support achieving wetland hydrology, removal and management of invasive species, enhanced connection to the river channel and overbank flows, and establishment of diverse native wetland plant communities in wetland areas. These wetlands would prioritize enhancement of habitat functions to replace lost habitat functions provided by the impacted wetlands. Therefore, enhancement would also include the introduction of habitat features in the wetlands (e.g., brush piles, snags, and downed logs). The concept for the proposed depressional floodplain wetland is illustrated in Figure 6.4-2, which was previously published in the Aquatic and Terrestrial Habitat Mitigation Opportunities Assessment Report (Kleinschmidt 2020).

Figure 6.4-2
Example Concept for Depressional Floodplain Wetland Mitigation in Landscape Context



Source: Aquatic and Terrestrial Mitigation Opportunities Assessment Report (Kleinschmidt 2020).

6.5 Minor Mitigation Components

In addition to the compensatory mitigation described above, any incidental temporary construction impacts to wetlands would also include post-construction restoration of those wetlands by re-establishment of a diverse native plant community and soil decompaction of areas impacted by construction activities within wetlands.

6.6 Comparison of Proposed Mitigation to Impacts

Appendix O of the SEPA DEIS reported that mitigation would be needed to address impacts to 17.4 acres of wetlands and 333 acres of wetland buffers from construction and operation of the Proposed Action. Table 6.6-1 summarizes the wetland impacts and provides a crosswalk between those impacts and the proposed mitigation. Impacts to wetland buffers would be mitigated at a 1:1 replacement ratio for the 377.5 acres of buffer impacts. Actual buffer mitigation would exceed that ratio based on the total preservation area required to preserve 11.6 acres of wetlands (baseline proposal is 500 acres), and the requirement to provide full buffers for 22.4 acres of riparian wetland enhancement and 35.6 acres of wetland restoration/creation.

Table 6.6-1
Summary of Proposed Mitigation by Impact Type

IMPACT TYPE	PORTION OF IMPACT (ACRES)	PROPOSED MITIGATION TYPE	MITIGATION RATIO	PROPOSED MITIGATION QUANTITY (ACRES)
Category II Wetland	0.5	Preservation	12:1	6
	1.0	Enhancement	12:1	12
	7.6	Restoration/Creation	3:1	22.8
Total	**9.1**			
Category III Wetland	0.7	Preservation	8:1	5.6
	1.3	Enhancement	8:1	10.4
	6.4	Restoration/Creation	2:1	12.8
Total	**8.4**			
Buffer	**377.5**	Establish Wetland Buffer	1:1	377.5

The Applicant has identified feasible locations to implement the quantity and types of mitigation as proposed. Preservation of forestland in the vicinity of the temporary reservoir is feasible as a component of the land purchase from Weyerhaeuser that would be necessary to secure the land for the FRE facility and temporary reservoir under the Proposed Action. Wetland enhancement within riparian buffers of the Chehalis River and its tributaries is feasible within the river corridor downstream of the FRE facility extending to the Airport Levee area. Candidate mitigation sites identified in the MOAR (Kleinschmidt 2020) were further evaluated and screened, and four potential mitigation sites were identified for wetland restoration or creation on the Chehalis River floodplain downstream of the FRE facility. Those four sites have a combined total of approximately 90 acres that would be used for mitigation.

7 MONITORING AND ADAPTIVE MANAGEMENT

Wetland mitigation would be required to meet specific performance standards over a performance monitoring period that would be stipulated in environmental permits. Monitoring and adaptive management provide a way to manage uncertainty by triggering evaluation and implementation of contingency corrective measures when mitigation sites fail to meet performance standards during the performance monitoring period.

A project-specific monitoring and adaptive management plan would be developed for the wetland mitigation plan as it evolves to include specific mitigation sites. The following sections provide generalized descriptions of the key elements of the monitoring and adaptive management plan, which include:

- **Performance metrics** – select metrics to measure and document the performance of wetland and buffer mitigation.
- **Monitoring schedule** – specify the timing of the monitoring events during the performance monitoring period. The schedule provides a basis for evaluating incremental progress toward ultimate target conditions for habitat and ecological function.
- **Performance standards** – identify specific success criteria for each performance metric. Failure to meet performance standards triggers the process of diagnostic analysis and, if appropriate, contingency corrective actions. Performance standards would be linked to the monitoring schedule, and some standards would increase over time based on the anticipated/desired progress towards target habitat condition and function.
- **Diagnostic analysis** – describe the evaluation process to determine the root causes when mitigation fails to achieve the performance standards.
- **Contingency corrective actions** – identify a set of contingency corrective actions that may be implemented to redirect the mitigation toward meeting the performance standards.

Each of these key elements of monitoring and adaptive management would be different for each different type of mitigation. Those differences are discussed below for the three primary components of the wetland mitigation proposal: preservation of forest land inclusive of wetlands, enhancement of existing riparian wetlands along the Chehalis River, and restoration/creation of depressional wetland on the Chehalis River floodplain.

7.1 Regulatory Requirements for Adaptive Management

7.1.1 Washington State Regulations

The Washington Administrative Code WAC 173-700-403 requires that large-scale mitigation projects have an adaptive management plan. Adaptive management plans must include the following elements at a minimum:

- Goals and objectives,
- Identification of potential causes for site failure,
- A management strategy to address unforeseen changes in site conditions or if the monitoring indicates that the site will not achieve performance standards specified in the instrument, and
- The sponsor's responsibilities and process for reporting and implementing adaptive management activities.

Mitigation site sponsors shall notify Ecology when adaptive management activities are implemented to address unforeseen problems with site conditions. If the adaptive management activities are ineffective in correcting deficiencies at the site, Ecology may require remedial actions as specified in WAC 173-700-601.

7.1.2 Federal Regulations

In addition to state regulations the Corps also has adaptive management long-term management plan reporting requirements. During the monitoring and adaptive management phase of large-scale mitigation projects, the applicant must provide the Corps with an annual report that includes an itemized account of the management tasks in accordance with the adaptive management plan and any specify any adaptive management activities conducted during the reporting period. During the long-term management phase, the responsible party responsible for long-term management of the mitigation site shall submit a biennial report that contains an itemized account of the management tasks in accordance with the long-term management plan and any remedial actions conducted during the reporting period. Each annual report must also:

- Specify the time covered by the reporting period.
- Describe the management tasks conducted including the cost and time required.
- The total cost for management tasks conducted during the reporting period.
- Describe the management and maintenance tasks anticipated A description of the management and maintenance activities proposed for the next reporting year.
- A description of the overall condition of the Bank, including photos documenting the status of the Bank Property during the Reporting Period and a map documenting the location of the photo points.

7.2 Performance Metrics

Performance metrics must align with the objectives for mitigation performance. Performance metrics are tailored for each mitigation type. The proposed performance metrics are summarized and described in the following sections for each of the three primary mitigation components. These performance metrics are preliminary and illustrative and would be refined and expanded in future iterations of this CWMP.

7.2.1 Preservation of Forest Land Wetlands and Buffers

Preservation of forestland wetlands and buffers requires administrative protection of the mitigation area through property acquisition and a deed restriction, conservation easement, or other legal document that prevents future actions from degrading the habitat. Establishing the preservation area and documenting the mitigation value of the preservation require baseline field data collection to establish the location, area, and ecological condition of the wetlands and buffers that would be preserved. The first step in establishing the preservation area necessarily requires a delineation and functional assessment of the wetlands in the area committed for preservation. Subsequent monitoring of wetlands and buffers would focus on documenting that the wetlands and their buffers are effectively preserved compared to the baseline conditions established by the initial delineation and functional assessment.

Performance metrics for preserved wetlands and buffers focus on documenting the continued presence and ecologically healthy condition of those wetlands. Therefore, it is recommended that performance of preservation mitigation be evaluated using the following measures:

- **Preservation 1**: Conduct a wetland delineation and functional assessment of the wetlands within the preservation area at baseline (Year 0) and at 5-year intervals during the monitoring period.
- **Preservation 2**: Confirm existence and persistence of legal preservation document (e.g., deed restriction, conservation easement).

7.2.2 Enhancement of Riparian Wetlands

The proposed wetland enhancement focuses on enhancing wetland habitat functions by aggressive management of invasive species and by establishing and sustaining a robust, diverse, native plant community. Performance metrics therefore focus on documenting the condition of the plant community. The proposed performance metrics address invasive species management, plant mortality, plant density, and plant diversity.

- **Enhancement 1:** Identify the invasive species present on site, and measure arial coverage of invasive species.
- **Enhancement 2**: Measure plant success and plant mortality as a ratio of dead stems to live stems within a test plat.
- **Enhancement 3**: Measure the number of stems per unit area as an indication of plant density.

- **Enhancement 4**: Identify and count the number of different plant species growing in a test plat.

7.2.3 Creation/Restoration of Depressional Floodplain Wetlands

Successful wetland creation/restoration requires restoration of wetland hydrology along with restoration of a diverse native plant community. Performance metrics therefore focus on documenting wetland hydrology in addition to the condition of the plant community. The proposed performance metrics address wetland hydrology, invasive species management, plant mortality, plant density, and plant diversity. Performance metrics for the wetland buffer are also included focused on plant establishment and maintenance.

- **Restoration 1**: Document wetland hydrology by demonstrating soil saturation within 12 inches of the ground surface for at least four consecutive weeks during the growing season in years when rainfall meets or exceeds the 30-year average.
- **Restoration 2:** Identify the invasive species present on site, and measure arial coverage of invasive species. Applies to both wetlands and buffer areas.
- **Restoration 3**: Measure plant success and plant mortality as a ratio of dead stems to live stems within a test plat. Applies to both wetlands and buffer areas.
- **Restoration 4**: Measure the number of stems per unit area as an indication of plant density. Applies to both wetlands and buffer areas.
- **Restoration 5**: Identify and count the number of different plant species growing within a test plat. Applies to both wetlands and buffer areas.
- **Restoration 6**: Provide wildlife habitat by constructing habitat features including snags, downed logs, and brush piles.

7.3 Monitoring Schedule

In current practice, performance monitoring periods for wetland mitigation are typically 10 years and may extend to 15 years for wetland mitigation that includes establishment of forest plant communities. The combination of plant establishment and effective management of invasive species are the factors that typically drive the monitoring period. For the Proposed Action, the proposed performance monitoring schedule is 20 years. More frequent monitoring events (e.g., year 1, 3, 5, 7, 10) are proposed during the first 10 years to ensure successful wetland plant establishment and achievement of wetland hydrology. After the initial 10 years, monitoring would shift to 5-year intervals (i.e., year 10, 15, 20). If monitoring results document any deficiencies with respect to performance criteria at years 15 or 20, or if adaptive management corrective measures are implemented, the monitoring period would be extended, and monitoring frequency may be increased to evaluate and document the effectiveness of the adaptive management corrective measures. The details of the monitoring extension would vary depending on the nature of the adaptive management corrective measure(s).

The monitoring schedule would be integrated into the performance standards discussion so that performance targets and requirements are linked to schedule milestones, and progress toward full performance may be documented and evaluated.

7.4 Performance Standards

Proposed Action specific performance standards would be established by the approving agencies during the permitting process to determine relative success of mitigation. The performance standards are linked to the mitigation designs and are therefore specific to each mitigation action project. The performance standards included in this section are preliminary and illustrative based on common practice for wetland restoration. Performance standards would be refined during the future environmental permitting process.

7.4.1 Preservation of Forest Land Wetlands and Buffers

Performance standards for preservation of forest land wetlands and buffers align with the performance metrics and monitoring schedule as summarized below:

Baseline, Years 5, 10, and 15

- Conduct a wetland delineation and functional assessment of the wetlands within the preservation area. Total delineated wetland area within the preservation area would be at least 11 acres.
- Confirm existence and persistence of legal preservation document (e.g., deed restriction, conservation easement).

7.4.2 Enhancement of Riparian Wetlands

Performance standards for enhancement of riparian wetlands and buffers align with the performance metrics and monitoring schedule as summarized below:

Baseline

- Conduct a wetland delineation and functional assessment of the wetlands within the riparian enhancement areas. Total delineated wetland area within the riparian enhancement areas would be at least 22 acres.

Years 1 and 3

- Native, wetland woody species (both planted and naturally propagated) will achieve an average density of at least four plants per 100 square feet.

Year 5

- Aerial cover of native woody species (both planted and naturally propagated) will be at least 30 percent in the enhanced wetland.

- Aerial cover of native woody species (both planted and naturally propagated) will be at least 30 percent in the wetland buffer.

Year 7

- Aerial cover of native woody species (both planted and naturally propagated) will be at least 40 percent in the enhanced wetland.
- Aerial cover of native woody species (both planted and naturally propagated) will be at least 40 percent in the wetland buffer.

All Years

- Washington State listed Class A Noxious Weeds identified on the site shall be eradicated.
- Washington State listed Class A and B Noxious Weeds identified on the site shall be controlled. Control requires prevention of all seed production and prevention of the dispersal of all propagative parts capable of forming new plants.
- Noxious Weeds including reed canarygrass, non-native blackberries, and Scot’s broom will not exceed 25 percent aerial cover in enhanced wetlands and buffers.

Performance Standard

Years 10, 15, and 20

- Aerial cover of native woody species (both planted and naturally propagated) will be at least 70 percent in the enhanced wetland.
- Aerial cover of native woody species (both planted and naturally propagated) will be at least 50 percent in the wetland buffer.

7.4.3 Creation/Restoration of Depressional Floodplain Wetlands

Performance standards for creation/restoration of depressional wetlands and their buffers align with the performance metrics and monitoring schedule as summarized below:

Baseline

- Wetland restoration would be verified by developing an as-built plan that documents that grading, plant installation, seeding, and installation of habitat structures were all completed per the design plans and specifications.

Years 1 and 3

- Native, wetland woody species (both planted and naturally propagated) will achieve an average density of at least four plants per 100 square feet.

Year 5

- Aerial cover of native woody species (both planted and naturally propagated) will be at least 30 percent in the wetland.

- Aerial cover of native woody species (both planted and naturally propagated) will be at least 30 percent in the wetland buffer.

Year 7

- Aerial cover of native woody species (both planted and naturally propagated) will be at least 40 percent in the wetland.
- Aerial cover of native woody species (both planted and naturally propagated) will be at least 40 percent in the wetland buffer.

All Years

- Washington State listed Class A Noxious Weeds identified on the site shall be eradicated.
- Washington State listed Class A and B Noxious Weeds identified on the site shall be controlled. Control requires prevention of all seed production and prevention of the dispersal of all propagative parts capable of forming new plants.
- Noxious Weeds including reed canarygrass, non-native blackberries, and Scot's broom will not exceed 25 percent aerial cover in wetlands and buffers.

Performance Standard

Years 10, 15, and 20

- Aerial cover of native woody species (both planted and naturally propagated) will be at least 70 percent in the wetland.
- Aerial cover of native woody species (both planted and naturally propagated) will be at least 50 percent in the wetland buffer.
- Conduct a wetland delineation and functional assessment of the wetlands within the riparian enhancement areas. Total delineated wetland area within the creation/restoration areas will be at least 35.5 acres.

7.5 Diagnostic Analysis

The monitoring plan would be designed to document progress toward achieving performance standards, and monitoring data would demonstrate whether sufficient progress is made or if corrective measures may be needed to achieve performance standards. The milestone performance goals and final performance standards each represent a trigger for diagnostic analysis and potential contingency corrective measures. When the proposed mitigation fails to meet milestone performance targets, diagnostic analysis would be triggered to identify the root causes of substandard performance and select effective corrective measures. The steps in the diagnostic analysis process are summarized below, and specific contingency/corrective actions are discussed later in Section 7.6.

- **Step 1: Review the Monitoring Data** – Monitoring data review would consider the monitoring history as well as the current monitoring result. Performance trends are relevant and can help with diagnosis of root causes. For example, if performance is trending toward the standards but progress is slower than expected, the root causes and corrective measures may be different compared to a situation where there is a negative trend.

- **Step 2: Conduct a Site Inspection** – The site inspection focuses on confirming the monitoring results and assessing whether the observed deficiency is localized or representative of the entire wetland. Localized deficiencies may be addressed with localized corrections, whereas systemic deficiencies likely require a systemic correction. The site inspection also must include an assessment of potential causes of the performance deficiency. Are any local or nearby landscape changes evident? Do plants show signs of damage due to browsing, disease, desiccation, or other forms of plant stress? Are there portions of the site that are thriving that could offer clues on potential corrections to poorly performing areas?
- **Step 3: Identify the Root Causes of the Performance Deficiency** – The nature of root causes is critical for identifying and selecting appropriate corrective measures.
- **Step 4: Select and Implement Corrective Measures** – Corrective measure must align with root causes and redirect the mitigation back on track to achieve performance standards.
- **Step 5: Adjust the Monitoring Schedule** – Substantive changes to the mitigation site arising during implementation of corrective measures may require adjustments to the monitoring schedule including extending the timeline for monitoring and adjusting the timing of achieving performance targets. The purpose of such adjustments is to allow sufficient time for the corrective measures to work and demonstrate successful plant establishment.
- **Step 6: Document the Results** – Results of the diagnostic analysis, corrective measures, and any adjustments to the monitoring schedule will be reported to the permitting agencies.

The diagnostic analysis phase must be conducted in close coordination with the permitting agencies with jurisdiction over mitigation performance. Corrective measures and adjustments to the performance monitoring schedule must be approved by those agencies.

7.6 Contingency Corrective Actions

Contingency corrective actions can vary widely depending on the specific nature of both the mitigation action and the site conditions or other factors that form the root causes of sub-standard mitigation performance. Specific corrective actions would be developed as part of the adaptive management plan prepared during permitting. The following examples illustrate the kinds of corrective actions that would be applicable to the mitigation proposed in this CWMP.

7.6.1 Scenario 1 – Failure to Meet Plant Establishment Standards

There are many possible factors that could prevent wetland or buffer mitigation from achieving performance standards for plant establishment. Root causes may include plant mortality in response to dry weather, excessive plant damage due to wildlife browsing, poor quality plant material initially installed, poor soil conditions, invasive species competition. Each of these example root causes is coupled with possible contingency corrective actions in Table 7.6-1.

Table 7.6-1
Contingency Corrective Measures for Root Causes of Failure to Meet Plant Establishment Standards

ROOT CAUSES	CONTINGENCY CORRECTIVE MEASURES
Plant mortality due to seasonal dry soil conditions	**Option 1:** For years 1-3, consider adding a temporary watering system to help young plants get established, especially in buffers and in wetlands that are prone to dry out during late summer and fall months. **Option 2**: Consider a mulch or other soil amendment that may be used to help soils retain more water.
Excessive damage to young plants from wildlife browsing	**Option 1**: Install temporary fencing around the mitigation site to discourage wildlife browsing during initial plant establishment. Remove fencing once plants are established. **Option 2**: Install temporary protective measures around individual young plants more prone to wildlife browsing. Remove protective measures once plants are established enough to support browsing. **Option 3**: Replace dead and damaged plants with alternative plant species that are less favored by browsing wildlife.
Plant mortality or poor growth due to poor soil conditions	**Option 1**: Evaluate soil amendment options and apply selected soil amendment to support more effective plant establishment. Replace dead and damaged plants.
Plant mortality or poor growth due to competition by invasive species	**Option 1**: Increase frequency and intensity of invasive species management. Accelerate plant establishment by applying soil amendments and/or seasonal supplemental watering during plant establishment.

7.6.2 Scenario 2 – Failure to Meet Standards for Wetland Hydrology

Root causes for failure to achieve wetland hydrology are primarily physical in nature and may require more aggressive corrective measures compared to plant establishment. Corrective measures are different depending on the primary source(s) of wetland hydrology. Wetland hydrology may be provided by rainfall runoff, connection or association with a surface water body, shallow groundwater, or a combination of these water sources. Example root causes are coupled with possible contingency corrective actions in Table 7.6-2.

Table 7.6-2
Contingency Corrective Measures for Root Causes of Failure to Meet Wetland Hydrology Standards

ROOT CAUSES	CONTINGENCY CORRECTIVE MEASURES
Groundwater elevation is deeper than anticipated and does not produce soil saturation long enough within 12 inches of the ground surface	**Option 1:** Determine shallow groundwater elevations by seasonal monitoring and grade the affected portion of the wetland to reliably achieve wetland hydrology. Replant affected portions of the wetland and reset/extend the monitoring timeline for that portion of the site. **Option 2**: Evaluate the site to determine if there is an alternative or supplemental natural source of water to support hydrology such as a stream or spring that may be connected to the wetland.
Depressional wetlands do not remain wet long enough during the growing season to support wetland hydrology.	**Option 1**: Evaluate the mechanisms for filling the depressional wetland and reevaluation the size of the wetland related to the size of the contributing drainage area. Reduce the target size of the individual wetland and implement new similar mitigation to replace the reduced mitigation area. **Option 2**: Evaluate the site to determine if there is an alternative or supplemental natural source of water to support hydrology such as a stream or spring that may be connected to the wetland.
Riverine wetlands do not flood sufficiently or remain wet long enough to support wetland hydrology	**Option 1**: Evaluate surface connections between the wetlands and the surface water body source. If feasible, enlarge the capacity of the connection or lower the elevation of the connection to facilitate more exchange of water between the surface water body and the wetland.

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Appendix A
Conceptual Design Drawing Set

Appendix A. Department of Army Permit Application Drawing Set

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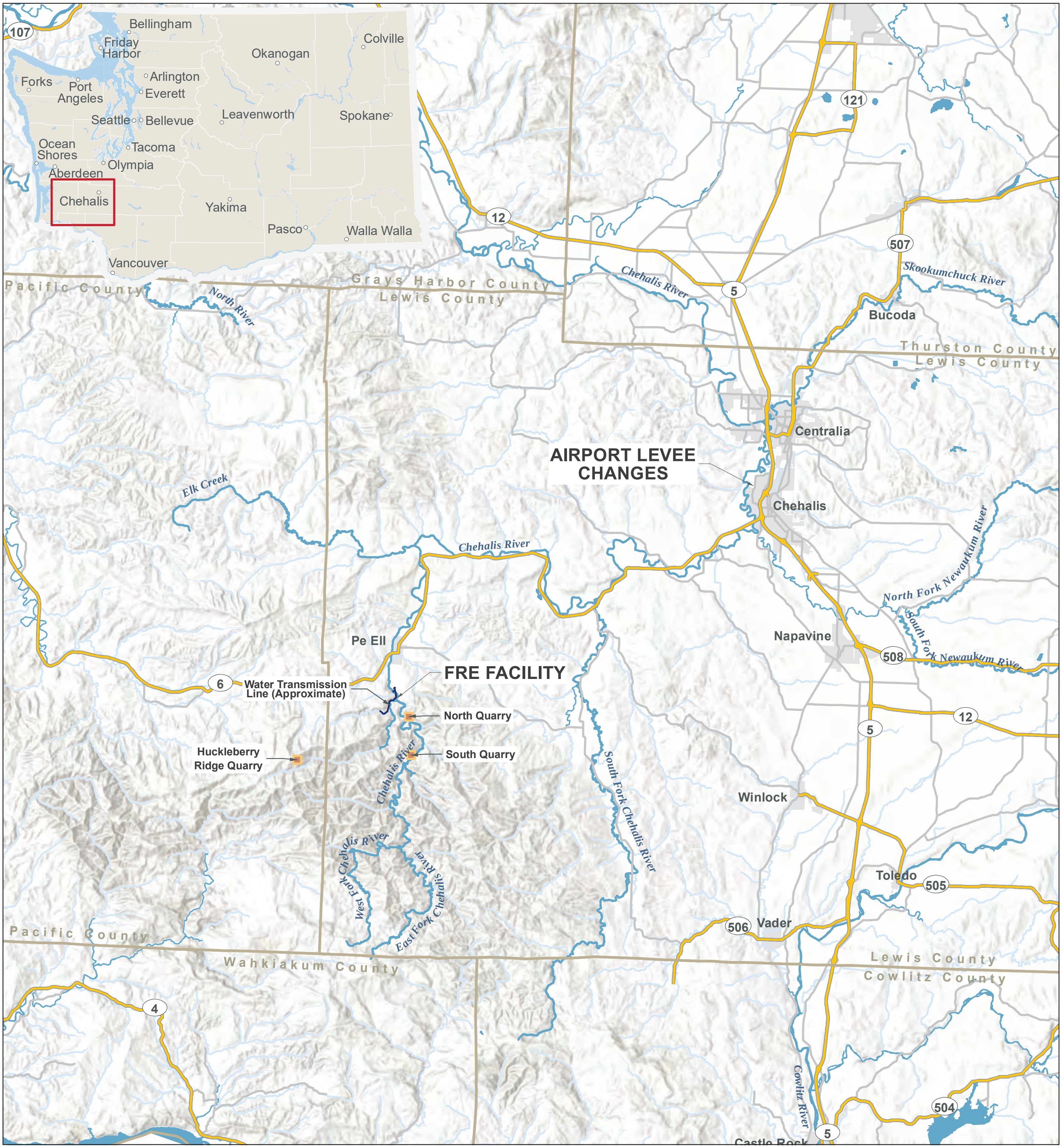

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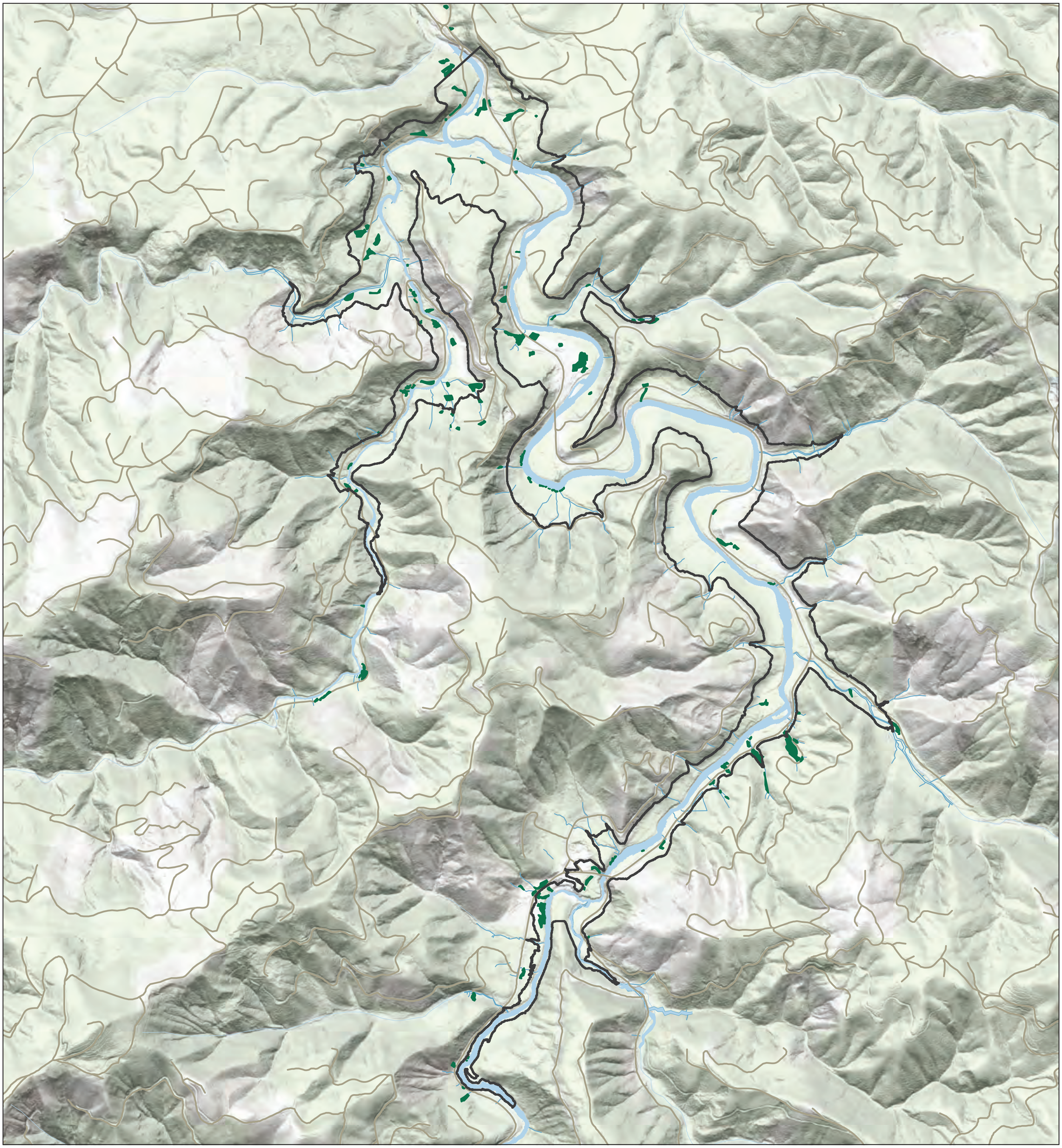
Overall Site Plan and Key Map

APPLICANT: Chehalis River Basin Flood Control Zone District DATUM: North American Datum 1983 ADJACENT PROPERTY OWNERS: See Appendix C for full list of property owners	Chehalis River Basin Flood Damage Reduction Project REFERENCE #: NWS-2014-1118 LAT/LONG: FRE Facility: 46.545080, -123.298656 Airport Levee: 46.681091, -122.985087	PROPOSED PROJECT: Construct floodwater retention facility and associated infrastructure, and raise levee at the Centralia-Chehalis Airport IN: Chehalis River, Tributaries, and Wetlands NEAR: Pe Ell, and Chehalis COUNTY: Pacific and Lewis County STATE: WA SHEET: 1 of 22 DATE: 7/29/2020



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Feet

ANCHOR QEA WETLAND AND STREAM DELINEATION STUDY AREA (WSEL 628FT) MAXIMUM EXTENT OF TEMPORARY INUNDATION POOL (MAX EXTENT OF TEMP. INUNDATION)

DELINEATED WETLAND (ANCHOR QEA 2018)

DELINEATED STREAMS (ANCHOR QEA 2018)

Existing Conditions FRE Facility

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
See Appendix C for full list of property owners

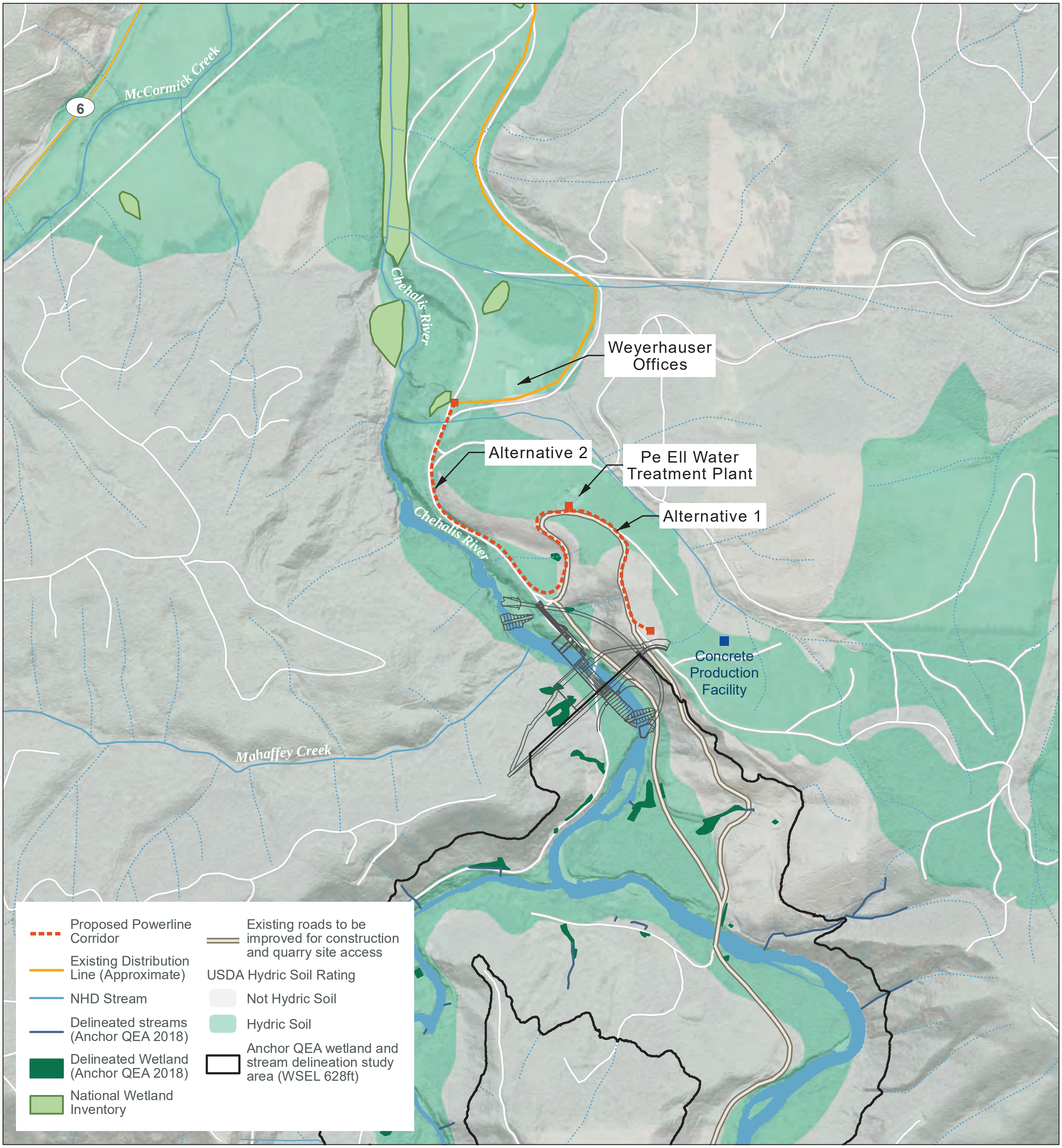
Chehalis River Basin Flood Damage Reduction Project

REFERENCE #: NWS-2014-1118

LAT/LONG:
FRE Facility: 46.545080, -123.298656
Airport Levee: 46.681091, -122.985087

PROPOSED PROJECT:
Construct floodwater retention facility and associated infrastructure, and raise levee at the Centralia-Chehalis Airport

IN: Chehalis River, Tributaries, and Wetlands
NEAR: Pe Ell, and Chehalis
COUNTY: Pacific and Lewis County STATE: WA
SHEET: 2 of 22 DATE: 7/29/2020



Existing Conditions
Powerline Corridor

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
See Appendix C for full list of property owners

Chehalis River Basin Flood Damage Reduction Project

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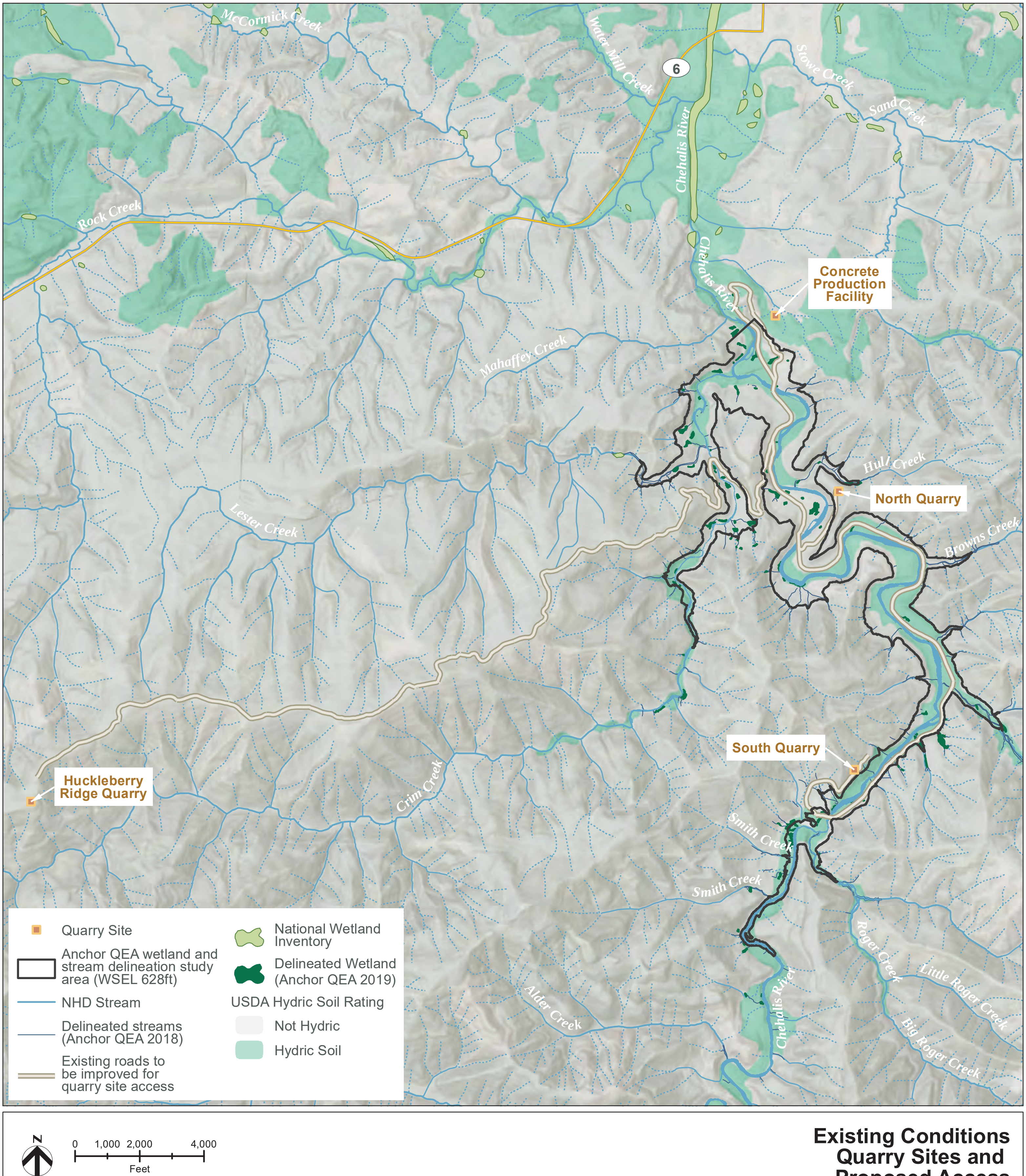
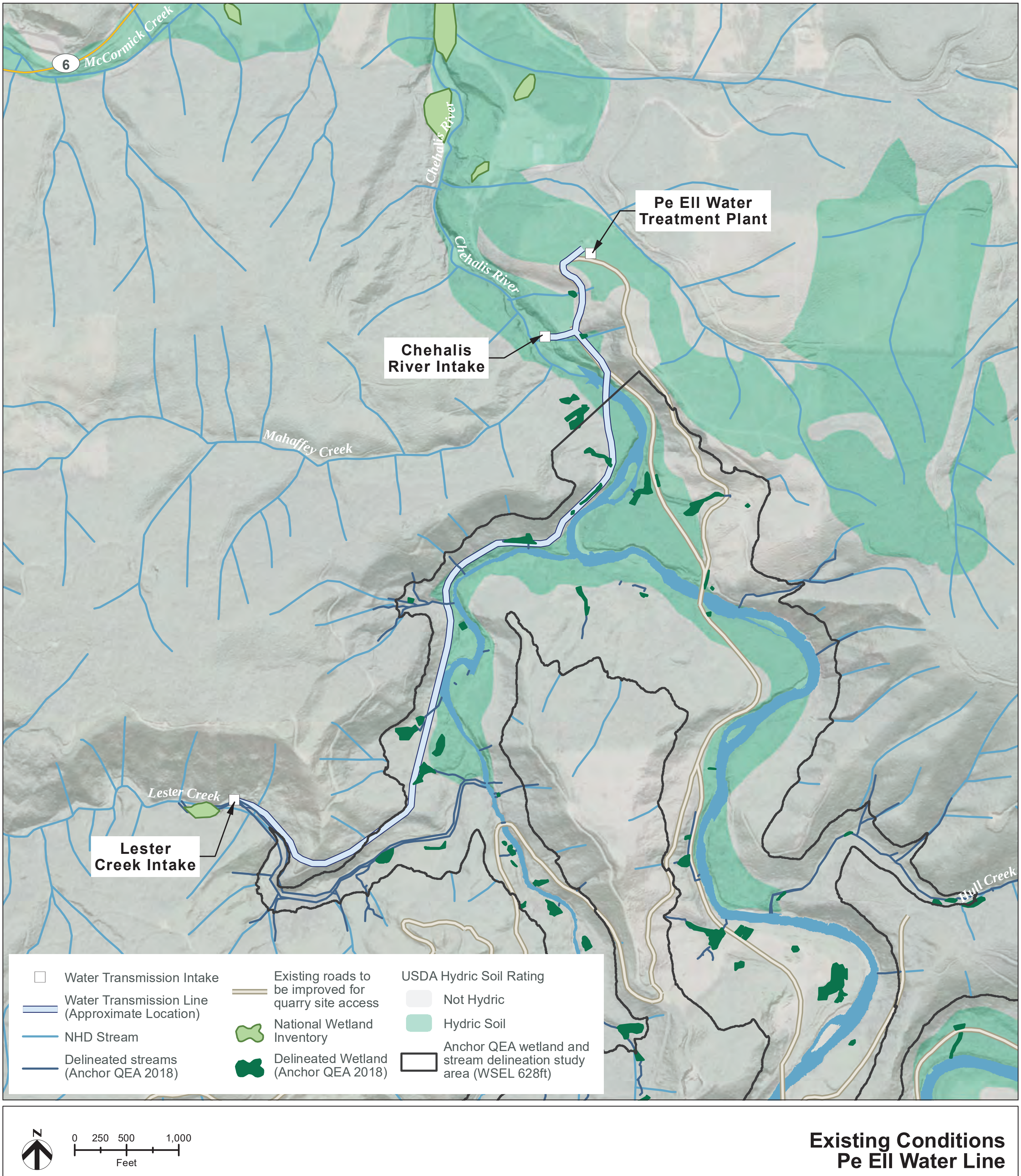
PROPOSED PROJECT:
Construct floodwater retention facility and associated infrastructure, and raise levee at the Centralia-Chehalis Airport

IN: Chehalis River, Tributaries, and Wetlands
NEAR: Pe Ell, and Chehalis
COUNTY: Pacific and Lewis County STATE: WA
SHEET: 3 of 22 DATE: 7/30/2020



Existing Conditions Quarry Sites and Proposed Access

APPLICANT: Chehalis River Basin Flood Control Zone District DATUM: North American Datum 1983 ADJACENT PROPERTY OWNERS: See Appendix C for full list of property owners	Chehalis River Basin Flood Damage Reduction Project REFERENCE #: NWS-2014-1118 LAT/LONG: FRE Facility: 46.545080, -123.298656 Airport Levee: 46.681091, -122.985087	PROPOSED PROJECT: Construct floodwater retention facility and associated infrastructure, and raise levee at the Centralia-Chehalis Airport IN: Chehalis River, Tributaries, and Wetlands NEAR: Pe Ell, and Chehalis COUNTY: Pacific and Lewis County STATE: WA SHEET: 4 of 22 DATE: 7/29/2020



Existing Conditions
Pe Ell Water Line

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
See Appendix C for full list of property owners

Chehalis River Basin Flood Damage Reduction Project

REFERENCE #: NWS-2014-1118

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IN: Chehalis River, Tributaries, and Wetlands
NEAR: Pe Ell, and Chehalis
COUNTY: Pacific and Lewis County STATE: WA
SHEET: 5 of 22 DATE: 7/29/2020

N

0 250 500 1,000

Feet

Culverts

Airport

Levee

Levee Study Area

Delineated Wetland (Anchor QEA 2019)

Estimated Wetland

Existing Conditions Chehalis-Centralia Airport Levee

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
See Appendix C for full list of property owners

Chehalis River Basin Flood Damage Reduction Project

REFERENCE #: NWS-2014-1118

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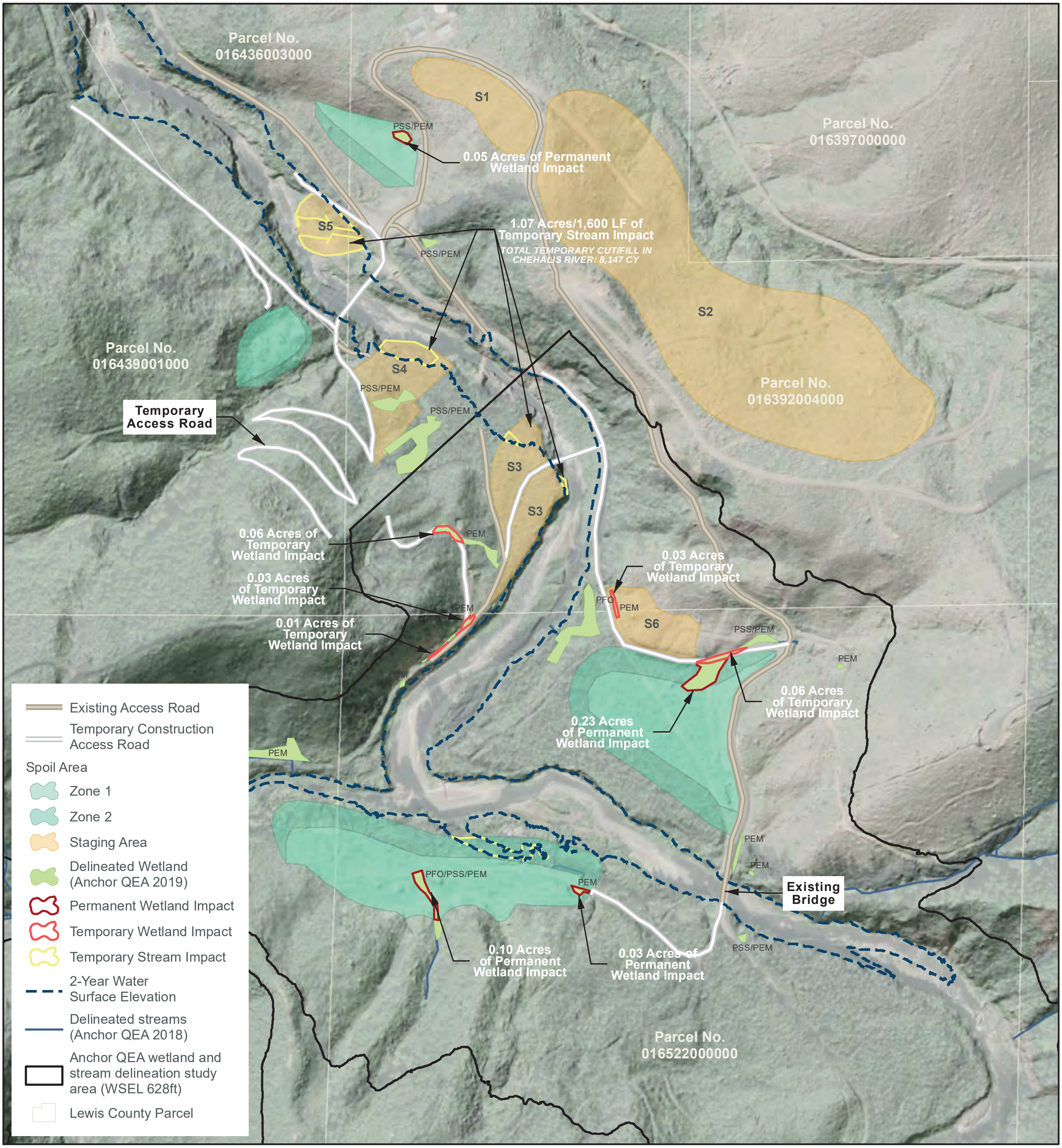
NEAR: Pe Ell, and Chehalis
COUNTY: Pacific and Lewis County STATE: WA
SHEET: 6 of 22 DATE: 7/29/2020



N

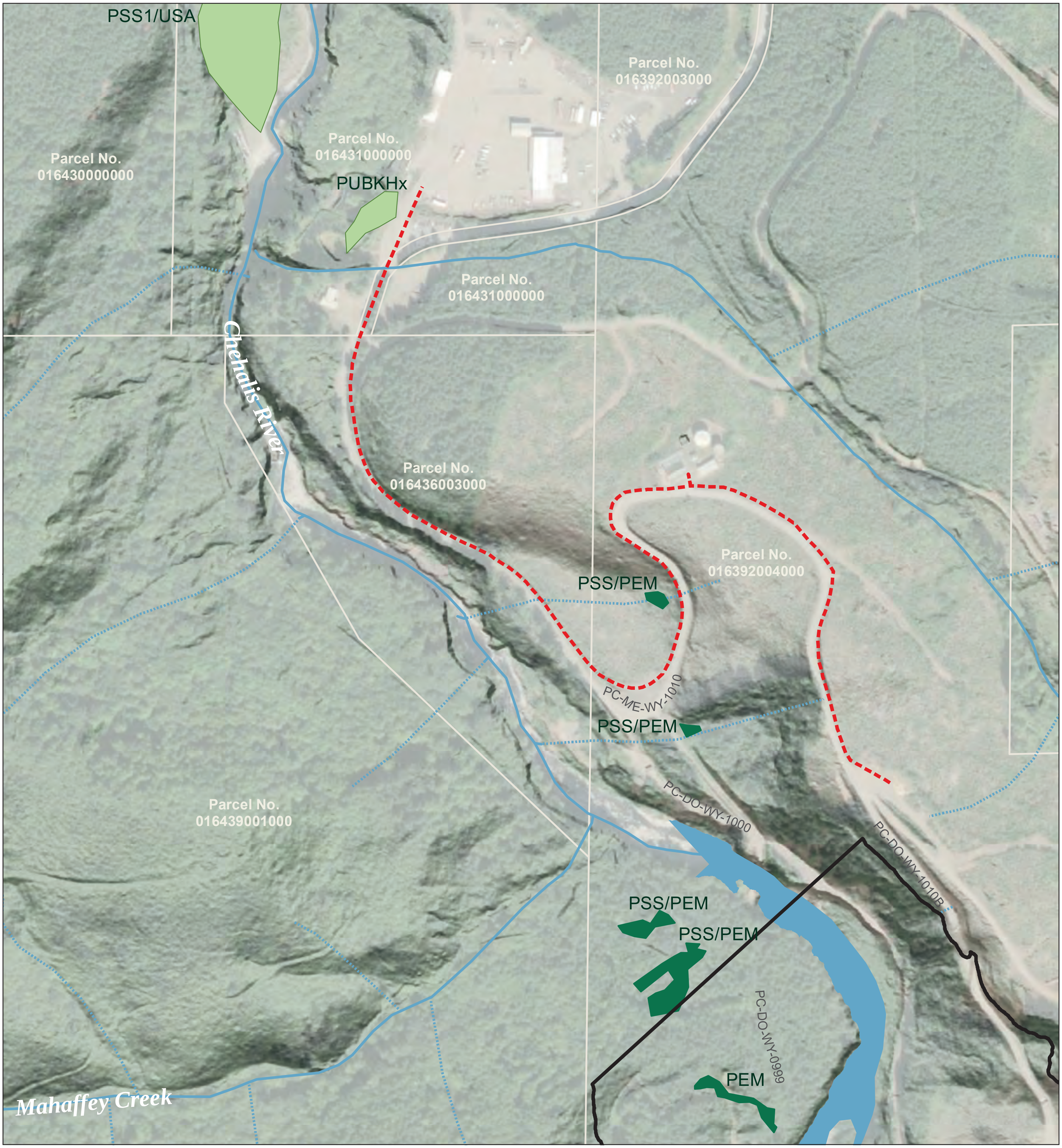
0 100 200 400
Feet

Total Wetland Cut/Fill:
Temporary: 762 CY
Permanent: 3,273 CY

Total Temporary Cut/Fill In Chehalis River: 8,147 CY

FRE Facility Construction Access and Staging

APPLICANT: Chehalis River Basin Flood Control Zone District DATUM: North American Datum 1983 ADJACENT PROPERTY OWNERS: See Appendix C for full list of property owners	Chehalis River Basin Flood Damage Reduction Project REFERENCE #: NWS-2014-1118 LAT/LONG: FRE Facility: 46.545080, -123.298656 Airport Levee: 46.681091, -122.985087	PROPOSED PROJECT: Construct floodwater retention facility and associated infrastructure, and raise levee at the Centralia-Chehalis Airport IN: Chehalis River, Tributaries, and Wetlands NEAR: Pe Ell, and Chehalis COUNTY: Pacific and Lewis County STATE: WA SHEET: 7 of 22 DATE: 7/29/2020



N
0 125 250 500
Feet

Proposed Powerline Corridor
National Wetland Inventory
Delineated Wetland (Anchor QEA 2019)
Delineated stream (Anchor QEA 2018)
Anchor QEA wetland and stream delineation study area (WSEL 628ft)
Lewis County Parcel

Powerline Corridor Plan View

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
See Appendix C for full list of property owners

Chehalis River Basin Flood Damage Reduction Project

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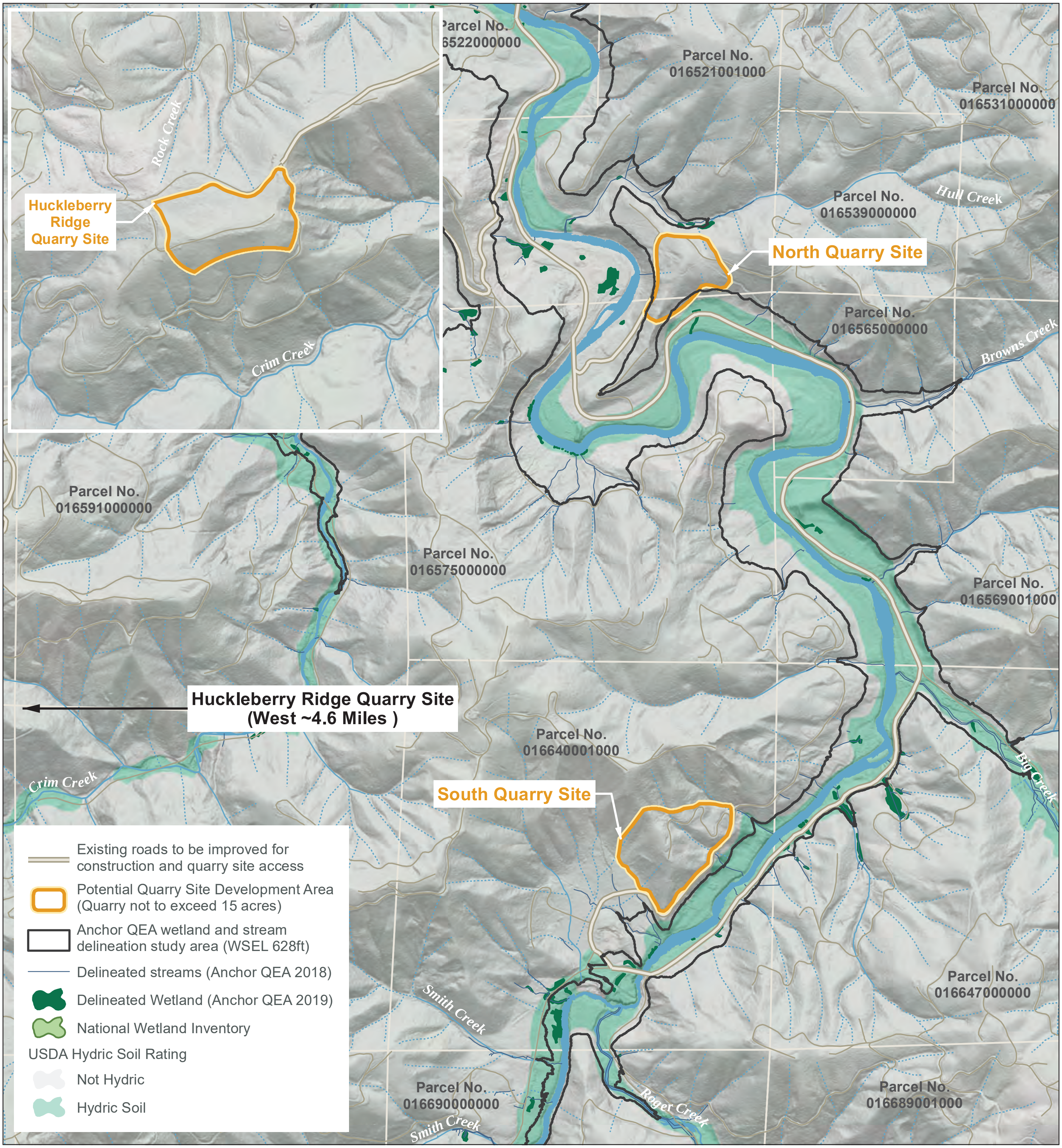
SHEET: 8 of 22 DATE: 7/29/2020



Potential Quarry Sites – Plan View

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
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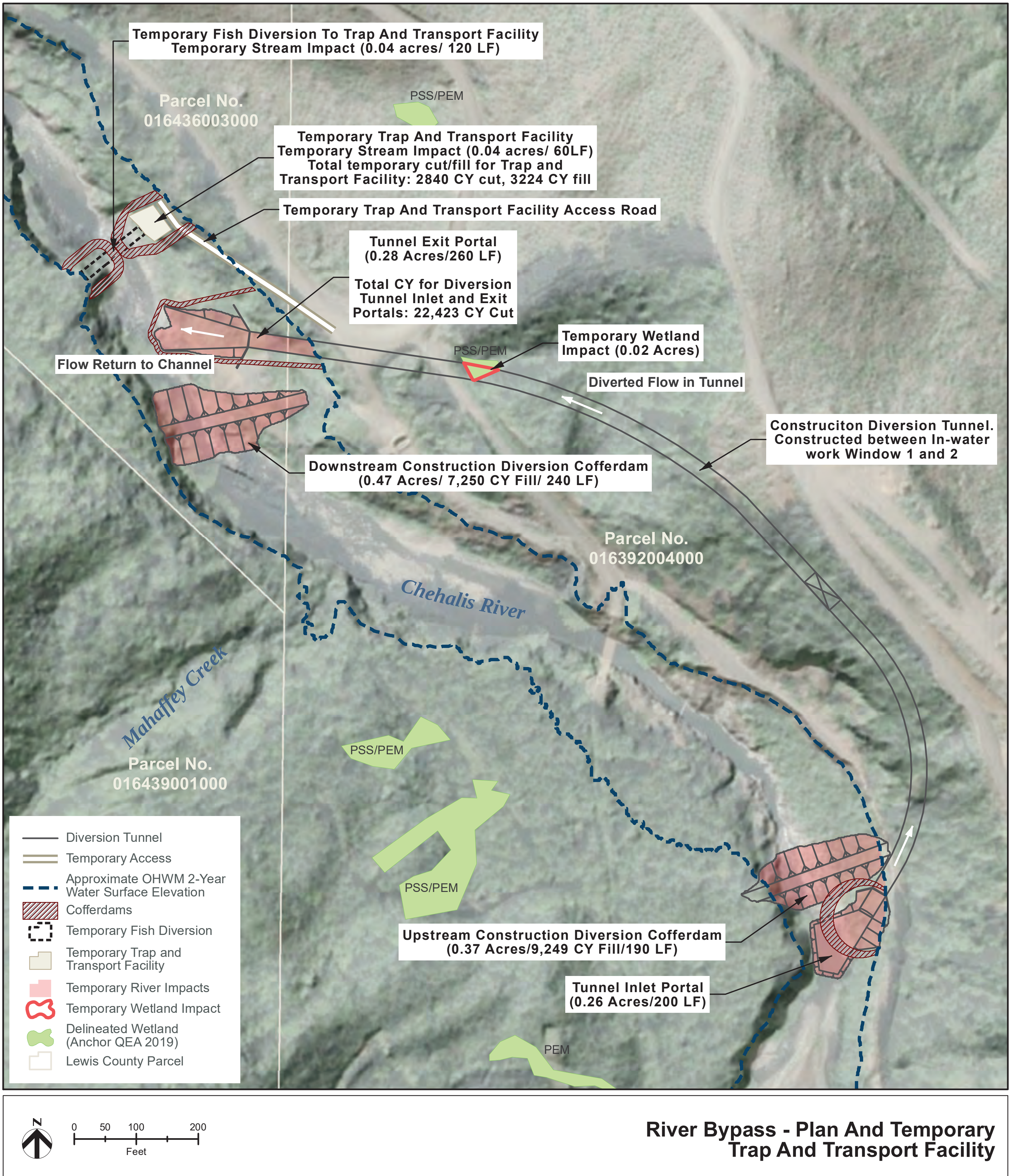
SHEET: 9 of 22 DATE: 7/29/2020



River Bypass - Plan And Temporary Trap And Transport Facility

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
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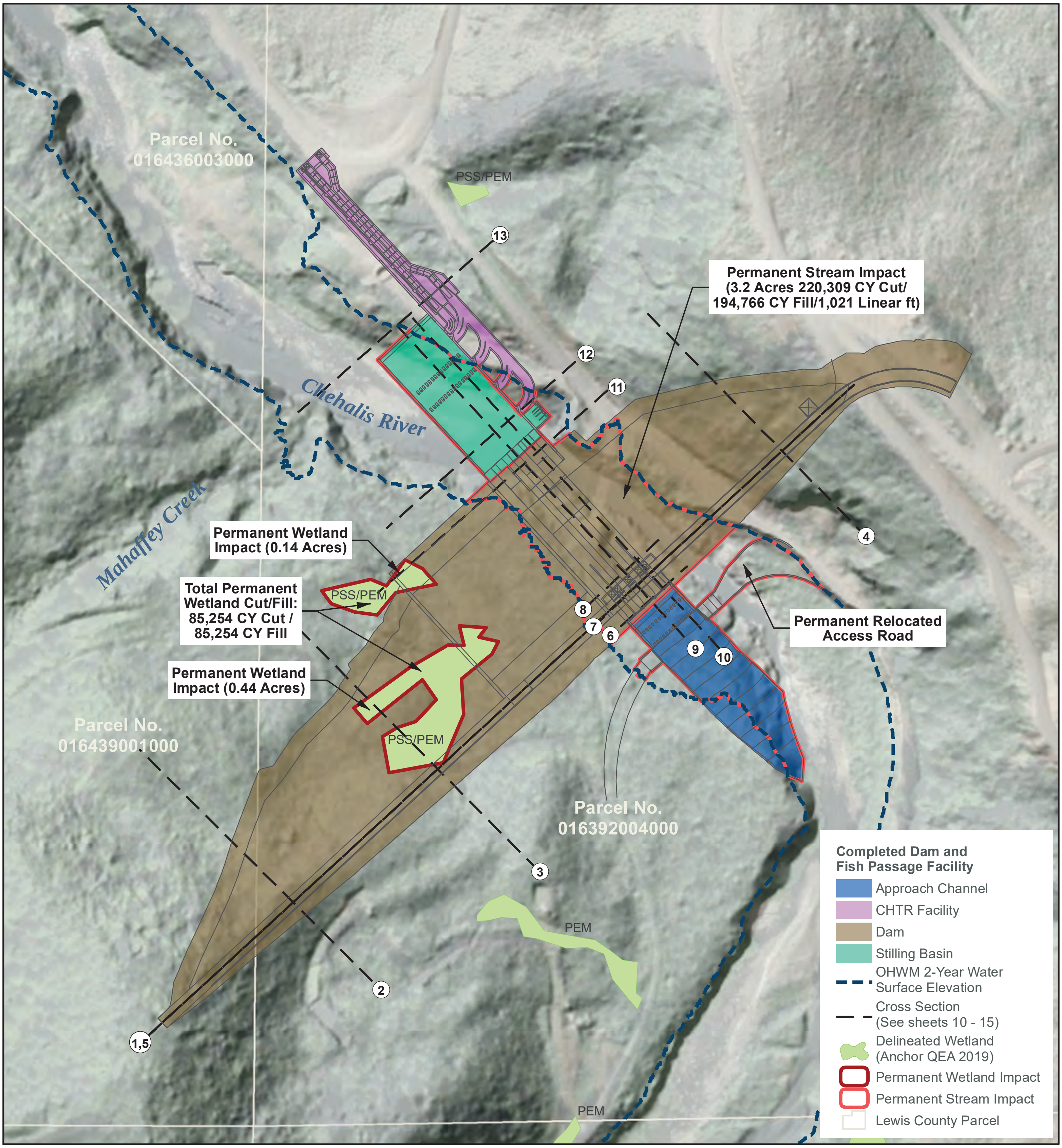

N

0 50 100 200

Feet

FRE and CHTR Proposed Conditions – Plan View

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
See Appendix C for full list of property owners

Chehalis River Basin Flood Damage Reduction Project

REFERENCE #: NWS-2014-1118

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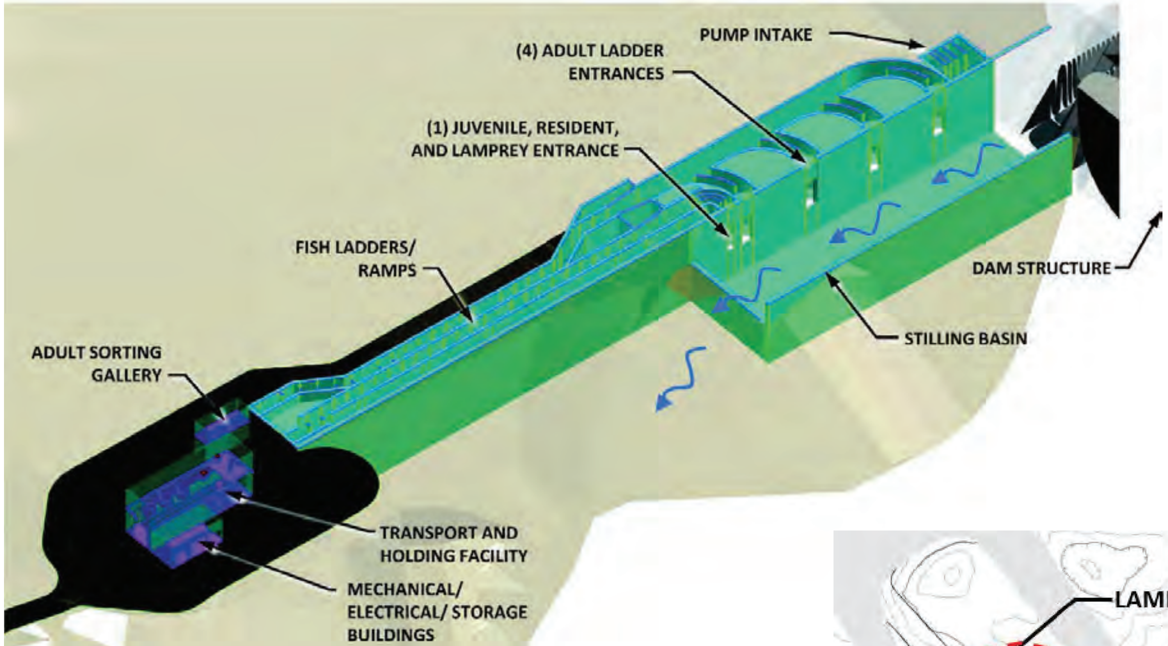
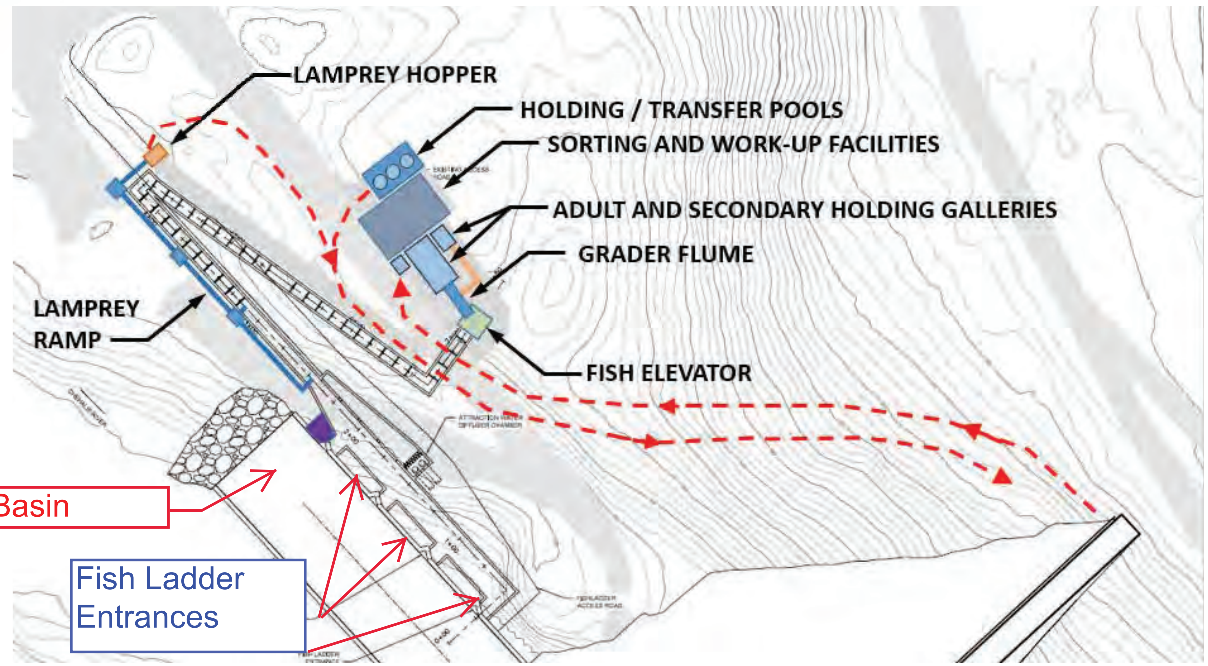
COUNTY: Pacific and Lewis County STATE: WA
SHEET: 11 of 22 DATE: 7/30/2020



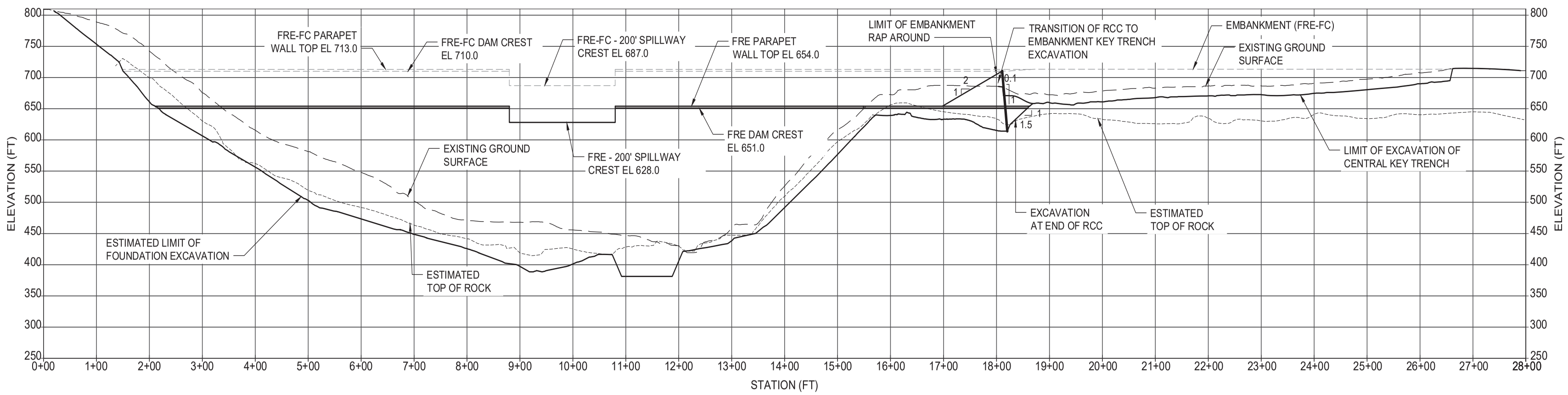
Isometric View of CHTR Fish Passage Facility

CHTR Plan View



Proposed CHTR Fish Passage Facility

APPLICANT: Chehalis River Basin Flood Control Zone District DATUM: North American Datum 1983 ADJACENT PROPERTY OWNERS: See Appendix C for full list of property owners	Chehalis River Basin Flood Damage Reduction Project REFERENCE #: NWS-2014-1118 LAT/LONG: FRE Facility: 46.545080, -123.298656 Airport Levee: 46.681091, -122.985087	PROPOSED PROJECT: Construct floodwater retention facility and associated infrastructure, and raise levee at the Centralia-Chehalis Airport IN: Chehalis River, Tributaries, and Wetlands NEAR: Pe Ell, and Chehalis COUNTY: Pacific and Lewis County STATE: WA SHEET: 12 of 22 DATE: 7/30/2020



DAM EXCAVATION PROFILE (1)

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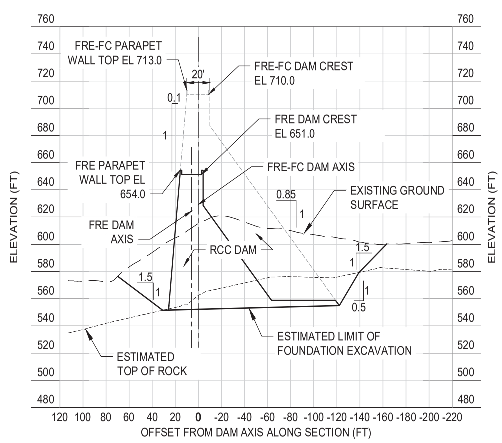
SCALE IN FEET



DAM EXCAVATION TYPICAL SECTION (2)

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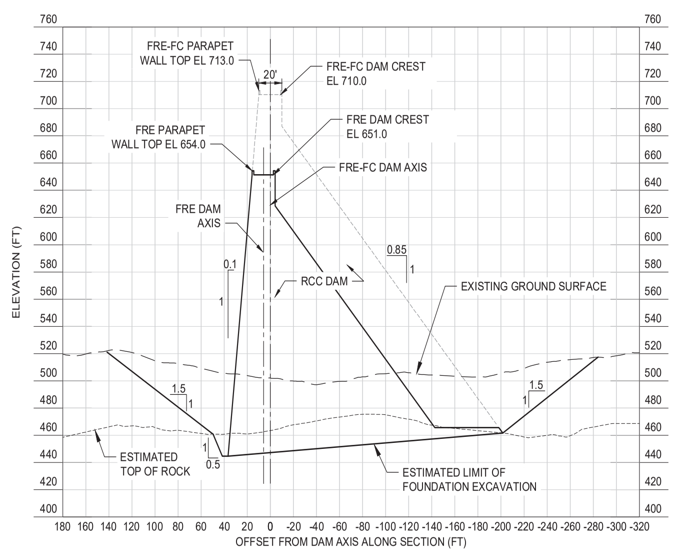

DAM EXCAVATION TYPICAL SECTION (3)

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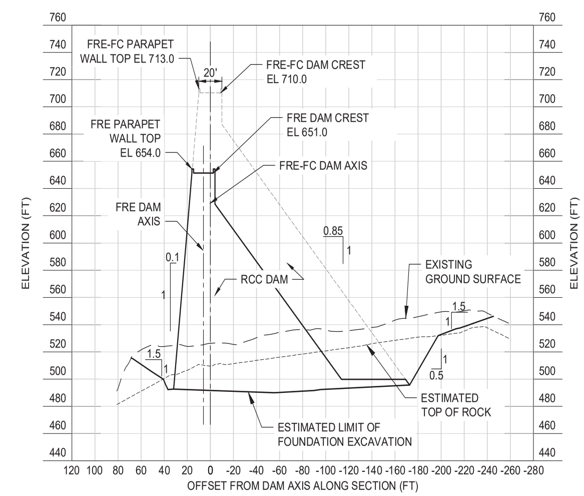
SCALE IN FEET



DAM EXCAVATION TYPICAL SECTION (4)

0 25 50 100
SCALE IN FEET

FRE Dam
Dam Excavation Profile and Typical Sections

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
See Appendix C for full list of property owners

Chehalis River Basin Flood Damage Reduction Project

REFERENCE #: NWS-2014-1118

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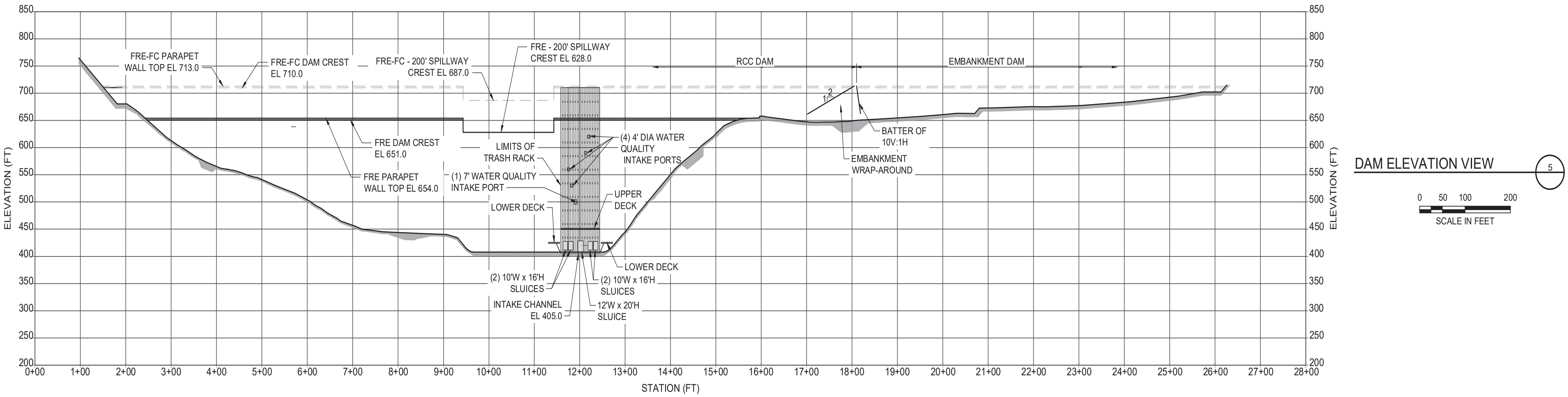
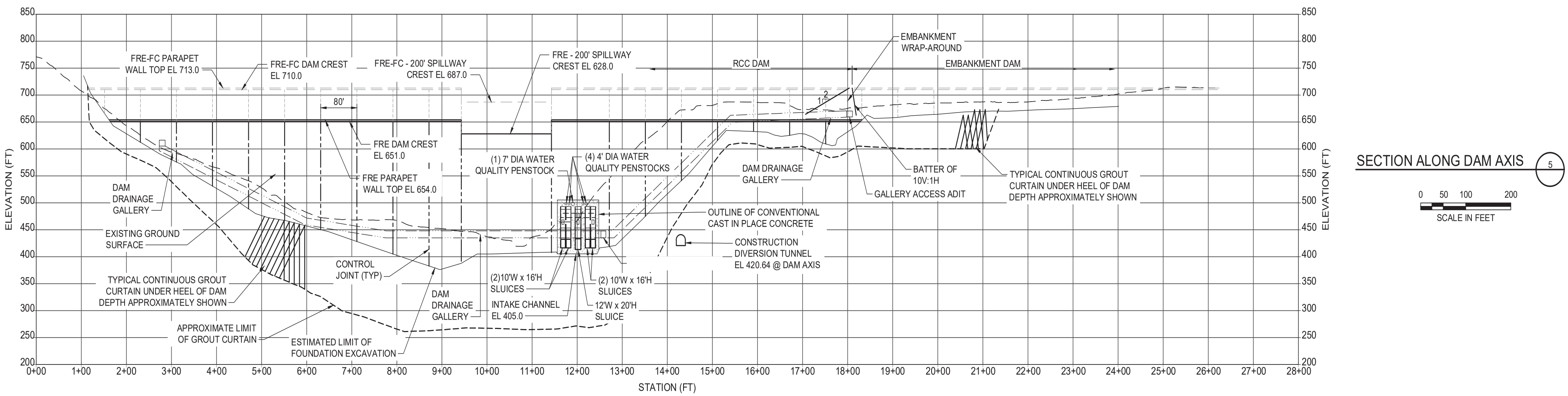
COUNTY: Pacific and Lewis County STATE: WA
SHEET: 13 of 22 DATE: 7/29/2020





FRE Dam
Dam Elevation View and Dam Exis Section

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
See Appendix C for full list of property owners

Chehalis River Basin Flood Damage Reduction Project

REFERENCE #: NWS-2014-1118

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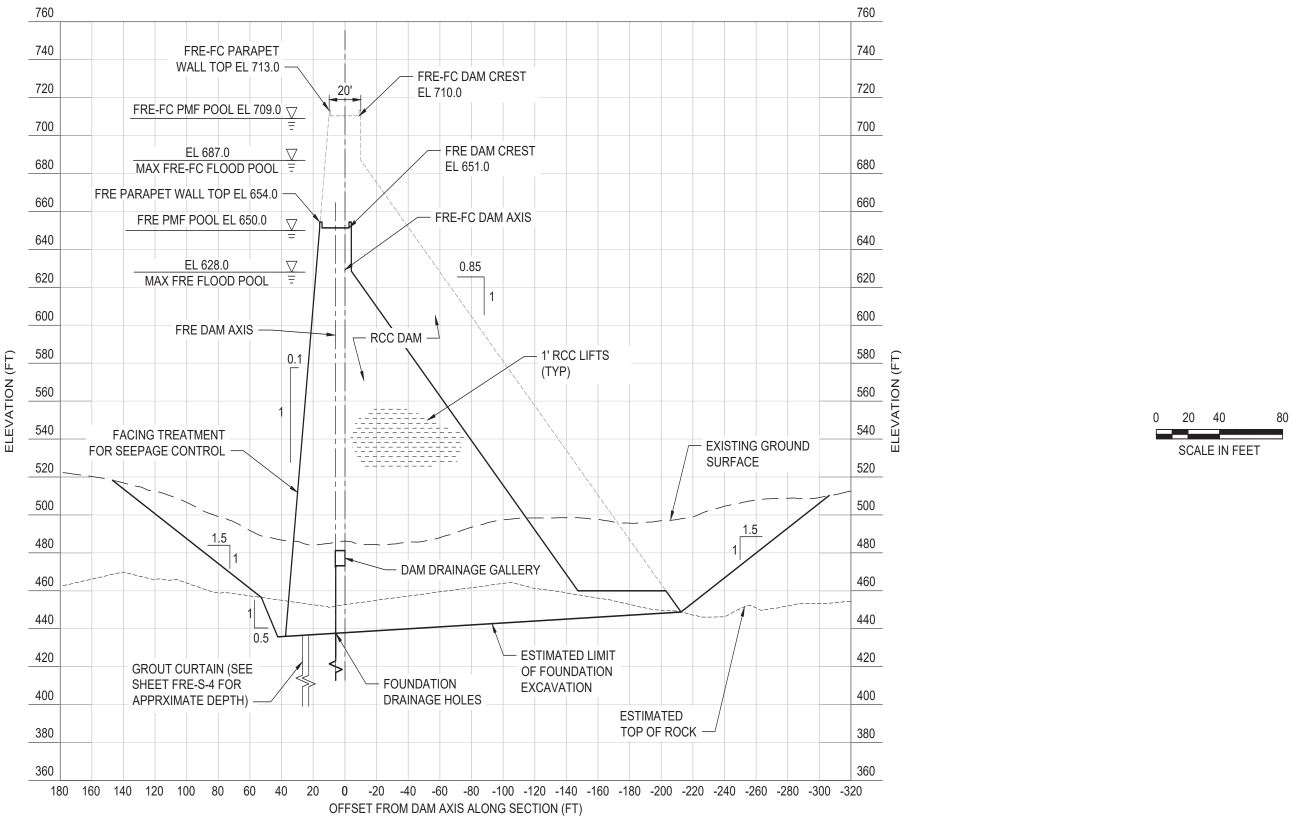
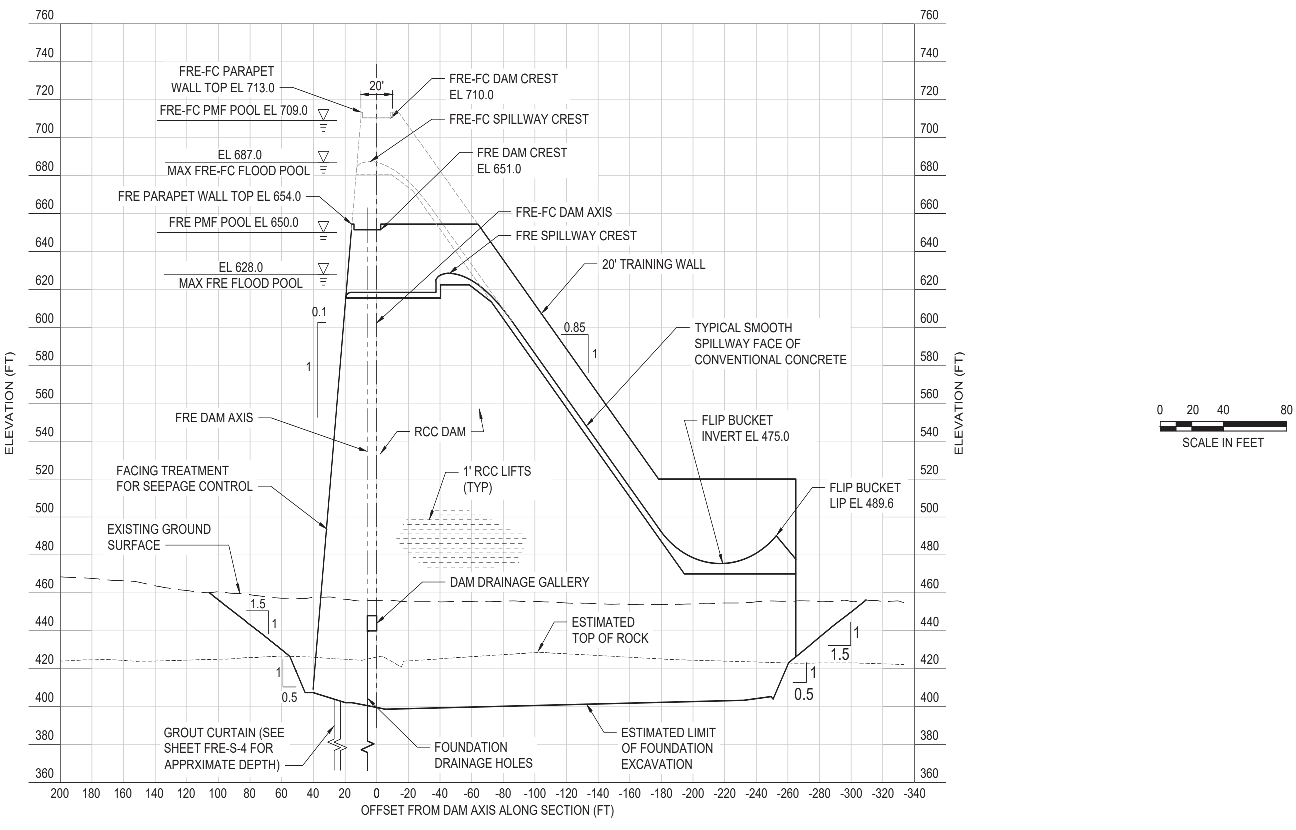
IN: Chehalis River, Tributaries, and Wetlands
NEAR: Pe Ell, and Chehalis
COUNTY: Pacific and Lewis County STATE: WA
SHEET: 14 of 22 DATE: 7/29/2020





FRE Dam
Typical Dam and Spillway

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
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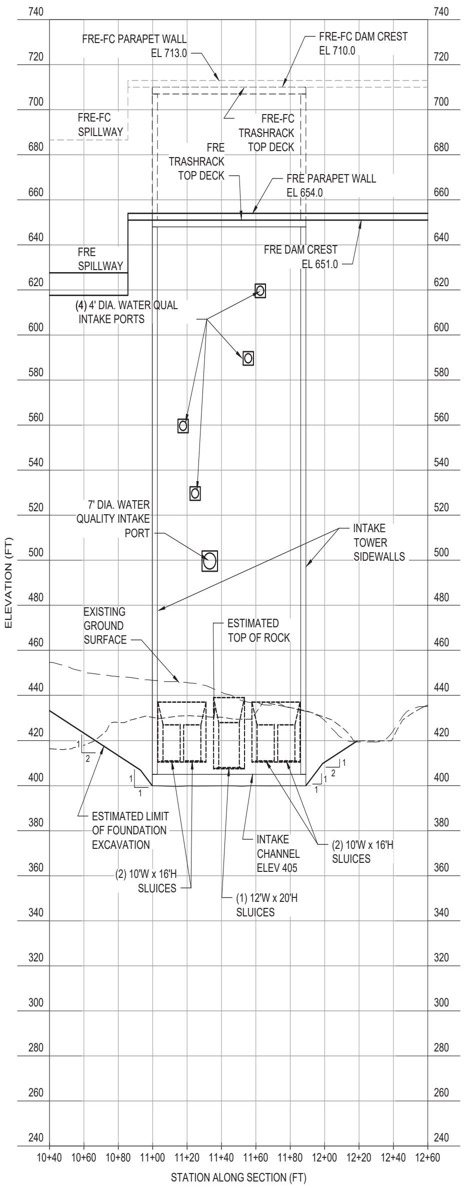
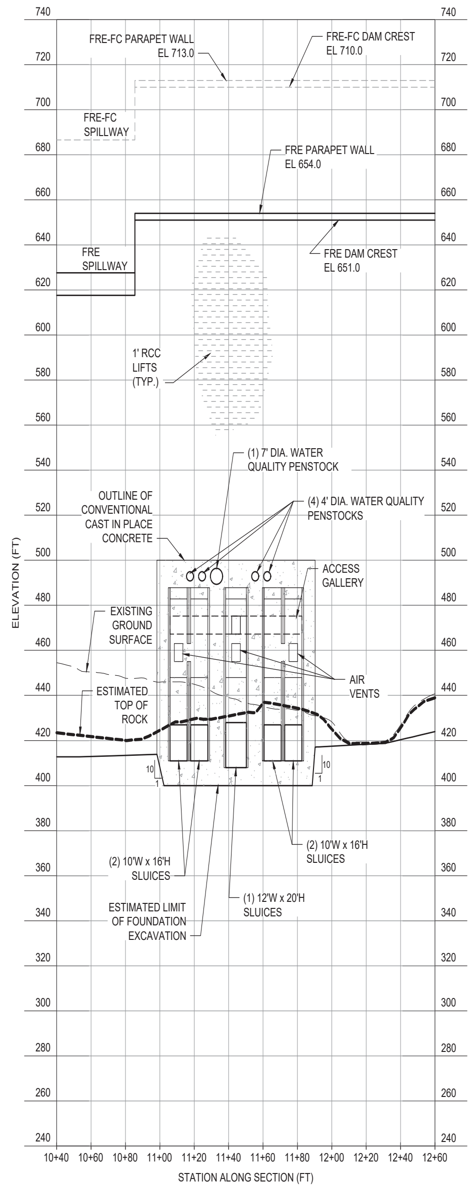
NEAR: Pe Ell, and Chehalis
COUNTY: Pacific and Lewis County STATE: WA
SHEET: 15 of 22 DATE: 7/29/2020



SECTION 6



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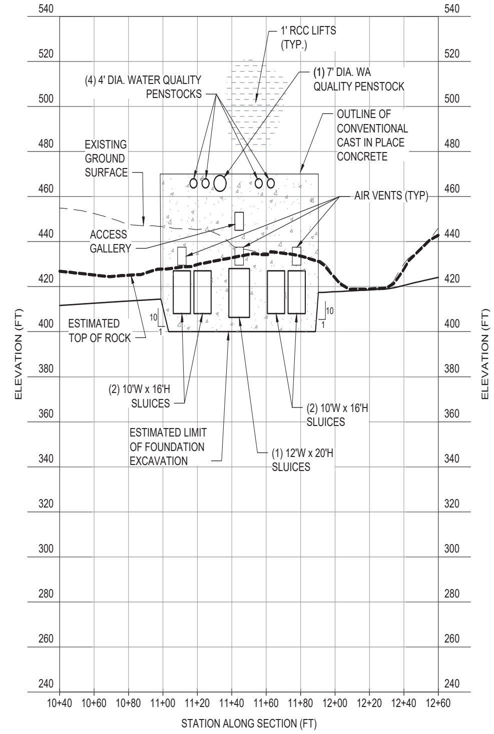

SECTION 8

FRE Dam
Intake Tower and Sluices

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
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Chehalis River Basin Flood Damage Reduction Project

REFERENCE #: NWS-2014-1118

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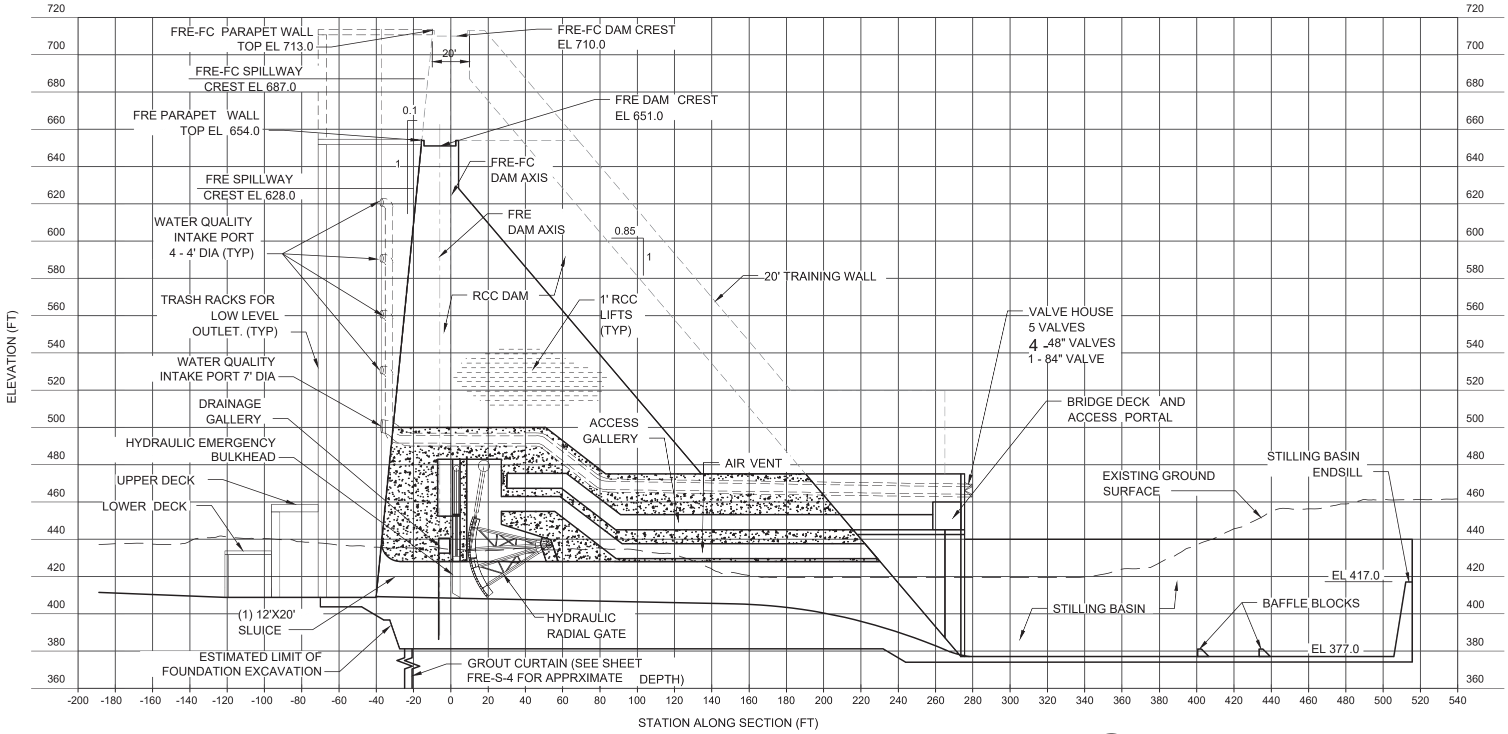
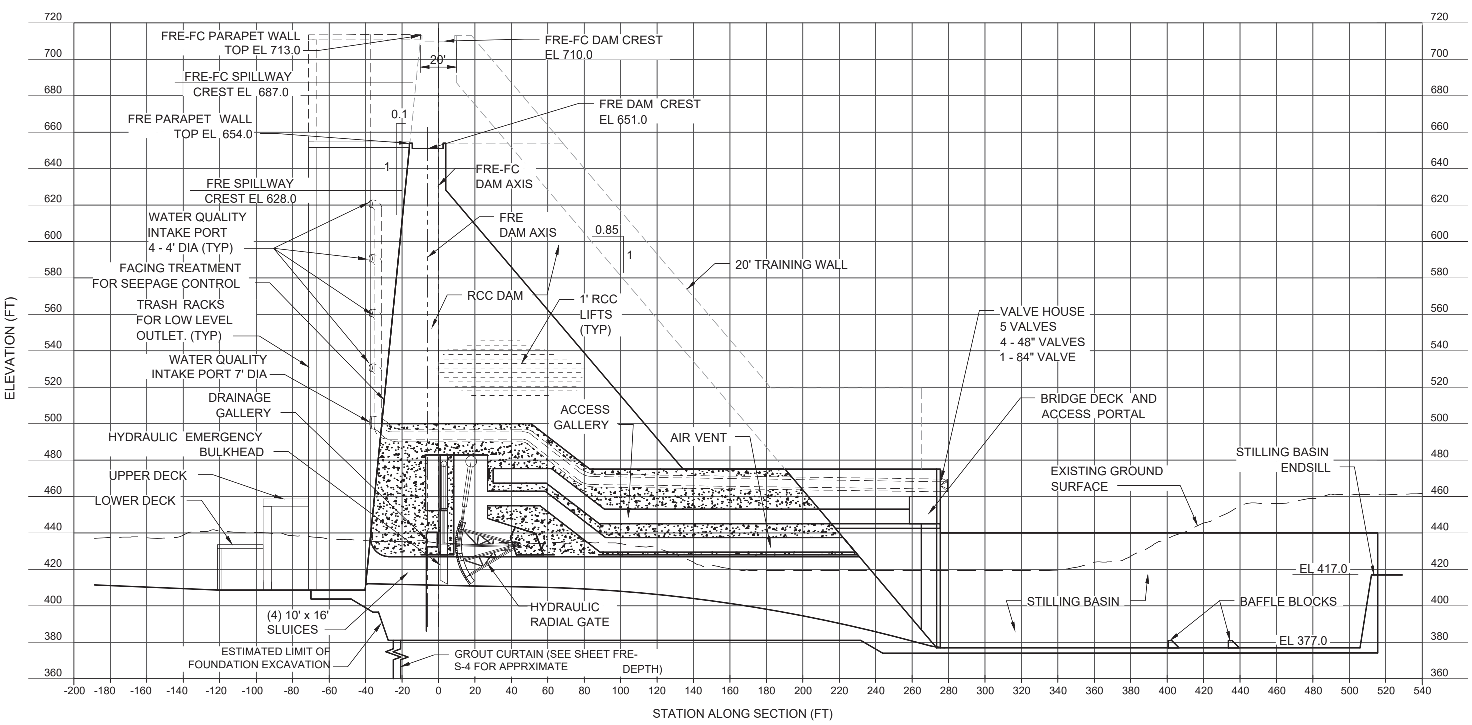
SHEET: 16 of 22 DATE: 7/29/2020



SECTION - 12'W x 20'H SLUICE 9

0 20 40 80
SCALE IN FEET



SECTION - 10'Wx16'H SLUICE 10

0 20 40 80
SCALE IN FEET

FRE Dam
Low Levels Sluices
Longitudinal Sections

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
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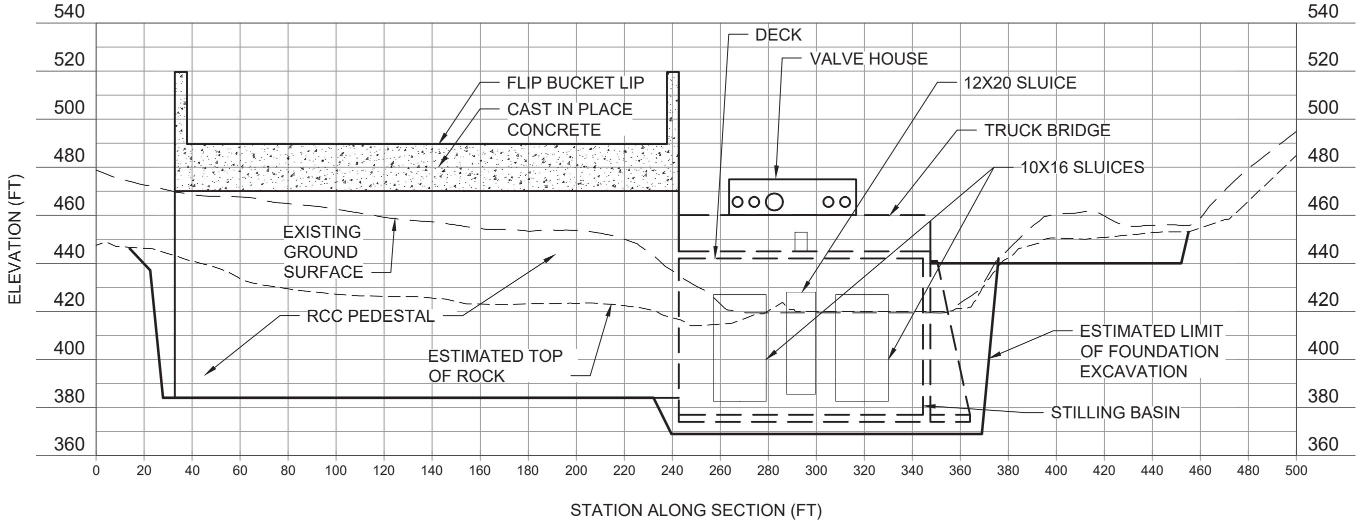

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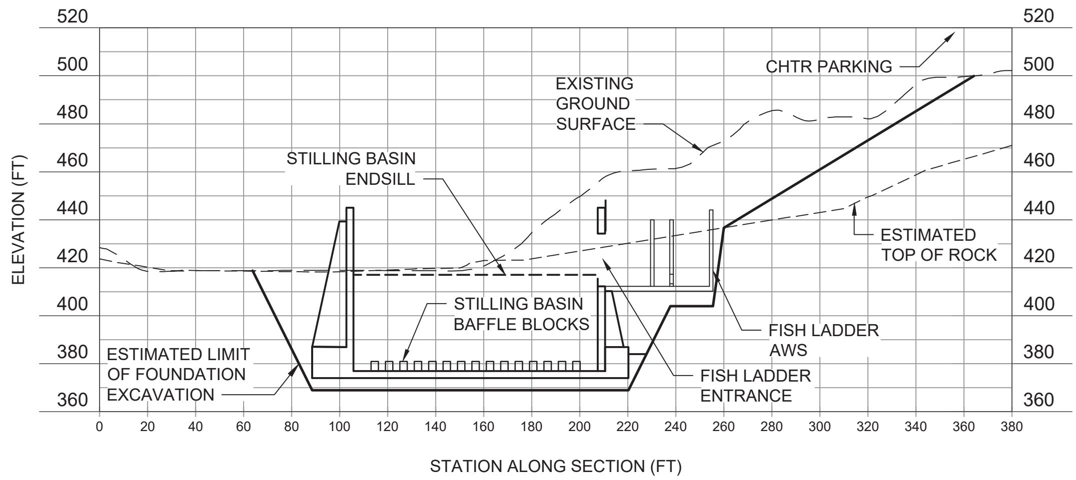

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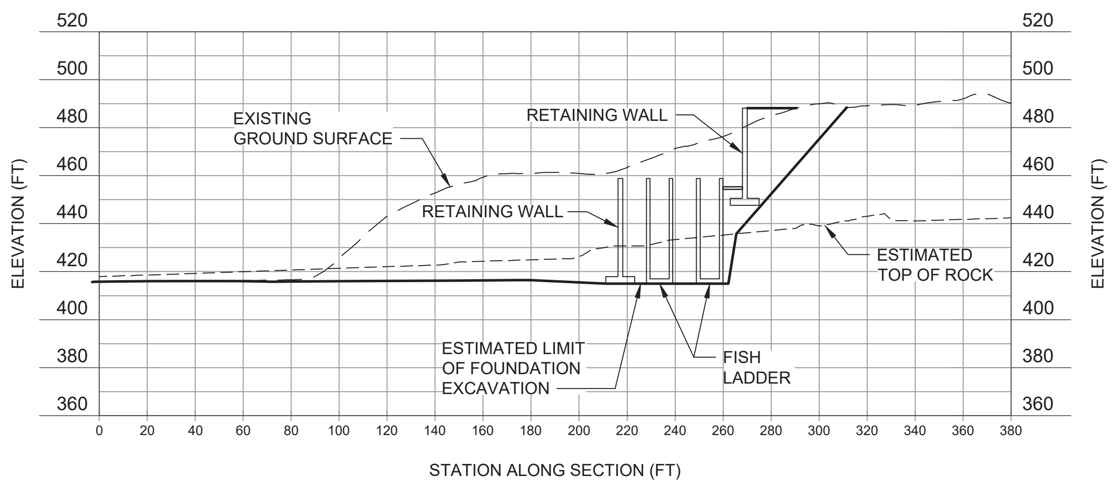

SECTION 13

FRE Dam
Stilling Basin Sections

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
See Appendix C for full list of property owners

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COUNTY: Pacific and Lewis County STATE: WA
SHEET: 18 of 22 DATE: 7/29/2020

N

0 125 250 500
Feet

DEBRIS MANAGEMENT SORTING YARD

TEMPORARY WETLAND IMPACT

DELINEATED OHWM (ANCHOR QEA 2018)

DELINEATED WETLAND (ANCHOR QEA 2018)

FRE Debris Management Sorting Yard

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
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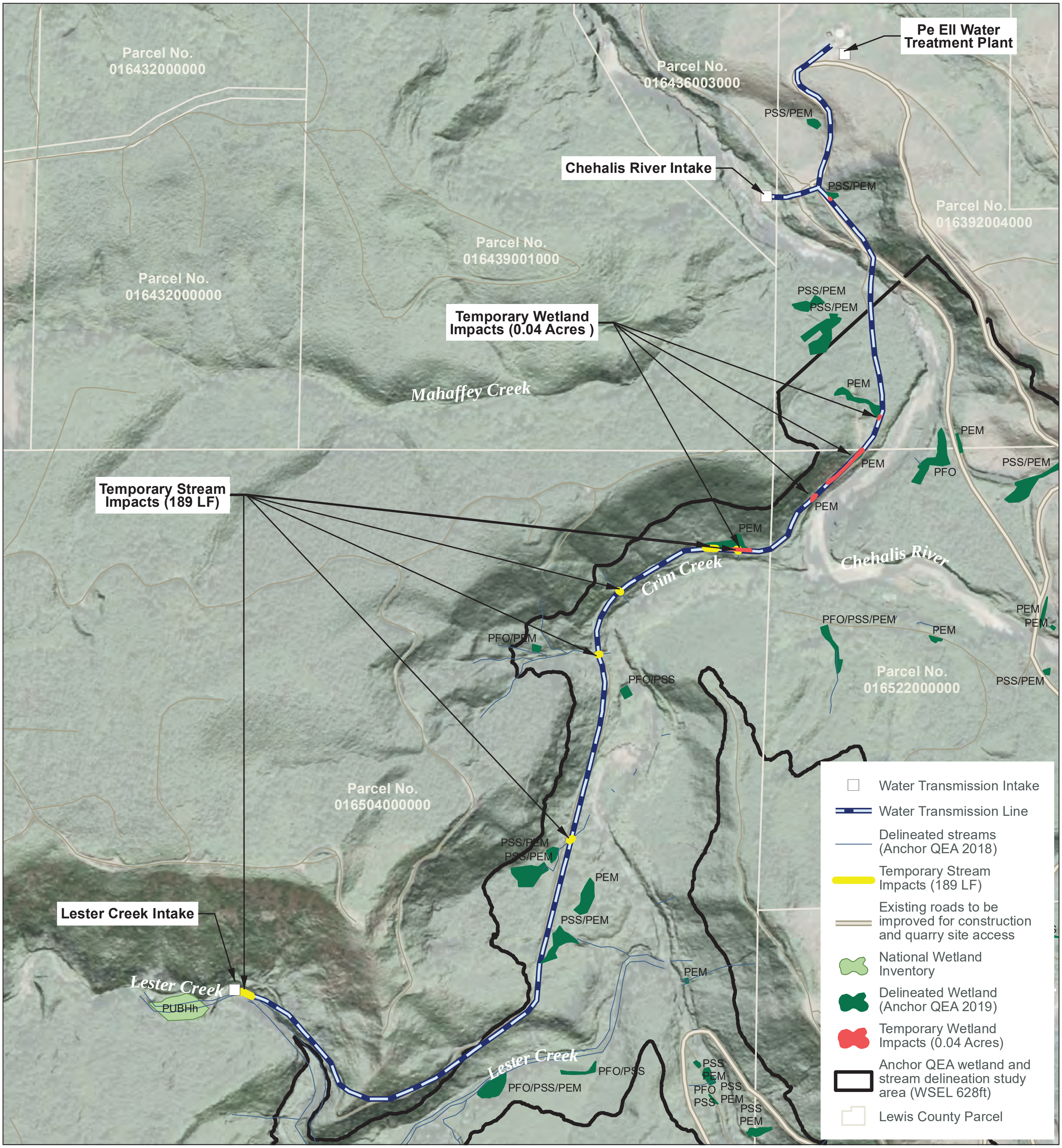

N

0 250 500 1,000
Feet

Pe Ell Water Line Plan View

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

ADJACENT PROPERTY OWNERS:
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IN: Chehalis River, Tributaries, and Wetlands
NEAR: Pe Ell, and Chehalis
COUNTY: Lewis County STATE: WA
SHEET: 20 of 22 DATE: 7/30/2020

Appendix B
Vegetation Management Plan

Conceptual Vegetation Management Plan

Chehalis River Basin Flood Damage Reduction Project

Submitted by the Chehalis River Basin Flood Control Zone District

November 2020

Preface

Preface

This document contains a draft Conceptual Vegetation Management Plan (VMP) for the Chehalis River Basin Flood Damage Reduction Project (Project) proposed by the Chehalis River Basin Flood Control Zone District. The purpose of the Conceptual VMP is to provide avoidance and minimization components to the overall ecosystem mitigation approach for the Project. A primary objective of the conceptual VMP is to minimize the extent of tree clearing and vegetation removal in the Flood Retention Expandable (FRE) facility and temporary reservoir footprint to the extent practical, while balancing the need to reduce the amount of woody material that would be generated within the area during a flood event that triggers FRE operation.

This document expands upon the *Technical Memorandum on Proposed Flood Retention Facility Pre-Construction Vegetation Management Plan* submitted by Anchor QEA, LLC, in 2016. The Conceptual VMP includes a summary of existing vegetation conditions in the proposed FRE Facility and temporary reservoir area, mapping of inundation in the FRE temporary reservoir during major flood events and the anticipated vegetation community responses likely to result from construction and operation of the Project, a conceptual pre-construction and facility operations selective tree harvest plan, and a conceptual adaptive management plan. The Conceptual VMP will be used for future stakeholder and agency coordination efforts and serve as the basis for a more detailed Final VMP once project permitting commences.

Acronyms and Abbreviations

Anchor QEA	Anchor QEA, LLC
BMPs	Best management practices
cfs	cubic feet per second
CMZ	channel migration zone
Corps	U.S. Army Corps of Engineers
DAHP	Washington State Department of Archaeology and Historic Preservation
dbh	diameter at breast height
DSM	digital surface model
DTM	digital terrain model
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
FCZD	Chehalis River Basin Flood Control Zone District
FEMA	Federal Emergency Management Agency
FRE	Flood Retention Facility - Expandable
GIS	geographic information system
HDR	HDR Engineering, Inc.
I-5	Interstate 5
LCC	Lewis County Code
LiDAR	light detection and ranging
mxd	map exchange document
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OHWM	ordinary high water mark
Project	Chehalis River Basin Flood Damage Reduction Project
RCW	Revised Code of Washington
RMZ	riparian management zone
SMP	Shoreline Master Program

Acronyms and Abbreviations

USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
VMP	Vegetation Management Plan
WAC	Washington Administrative Code
WDNR	Washington Department of Natural Resources
WMZ	wetland management zone
WSEL	water surface elevation

Contents

Tables

Figures

Appendices

1.0 Introduction

1.1 Project Background

The Chehalis River Basin Flood Control Zone District (FCZD) is proposing to construct a flood retention facility near the town of Pe Ell and conduct airport levee improvements at the Chehalis-Centralia Airport in Lewis County, Washington (Project). The Project would reduce the extent and intensity of flooding from the Chehalis River and improve levee integrity at the Chehalis-Centralia Airport to reduce potential flood damage in the Chehalis-Centralia area.

Flooding has become more frequent in the Chehalis-Centralia area in recent years. The three most recent floods in 1996, 2007, and 2009 were the largest on record and caused extensive physical, emotional, and economic damage. The 2007 and 2009 floods occurred only 13 months apart, affording the community a short window of opportunity to restore the area between floods. These extreme floods caused the loss of homes, farms, and businesses, and floodwater inundation resulted in the closure of Interstate 5 (I-5) for several days. These floods also caused damage to and closure of the Chehalis-Centralia Airport. Most of the flood damage occurred in the cities of Chehalis and Centralia, where there is more intensive development in the floodplain. Peak flows from the 1996, 2007, and 2009 floods rank in the top five ever observed at stream gages in the Chehalis River near Grand Mound, the Newaukum River near Chehalis, and the South Fork Chehalis River.

1.2 Project Location

The flood retention facility would be located on Weyerhaeuser and Panesko Tree Farm property, south of State Road 6 in Lewis County. It would be constructed on the mainstem Chehalis River at approximately River Mile 108, about 1 mile south of (upstream of) Pe Ell. The facility would be located in Section 3, Township 12N, Range 5W at parcel number 016392004000. The watershed area upstream of the flood retention facility location is 68.9 square miles. Property within the flood retention facility and reservoir footprint would no longer be managed as commercial forestland.

At the Chehalis-Centralia Airport, the FCZD is proposing to raise the existing airport levee and part of NW Louisiana Avenue. The property is located in Section 30, Township 14N, Range 2W, and the parcel number is 005605080001. This construction would take place concurrently with flood retention facility construction but could be completed within 1 construction year.

1.3 Project Description

The proposed Flood Retention Expandable (FRE) facility would temporarily store floodwater during major floods and then release retained floodwater following the flood peak. Specific flow release operations would depend on inflow and the need to hold water to relieve downstream flooding. Major floods include events with river flows forecasted to reach 38,800 cubic feet per second (cfs) or more as measured at the Chehalis River Grand Mound gage located in Thurston County. Events of this magnitude have a 15% probability of occurrence in any one year, or a 7-year recurrence interval. Major floods also include those with a lower frequency of occurrence, such as 10-year, 100-year, and 500-year floods. Except during flood reduction operations, the Chehalis River would flow through the structure's low-level outlet works at its normal rate of flow and volume, and no water would be stored in the temporary reservoir. This mode of operation would allow fish to pass both upstream and downstream.

The FRE facility would operate when flood forecasts predict a major or greater flood. The FRE facility conduit gates would begin to close and start holding water approximately 48 hours before flows at the Grand Mound gage (USGS 12027500) were predicted to exceed 38,800 cfs due to heavy rainfall in the Willapa Hills. Once conduit gates begin to close, flows through the conduit gates would be reduced until reaching a flow of 300 cfs. A 300-cfs flow is a naturally occurring winter low flow on the Chehalis River. The outflow rate would be adjusted based on observed flows and revised predictions. The FRE facility would be operated to keep river outflow at a reduced rate until the peak flood passes the Grand Mound gage.

FRE facility operation would cause the temporary reservoir to fill. The size of the temporary reservoir depends on the peak of the flood flow and its duration, but in no case would it be greater than 808 acres and would have a maximum depth of 212 feet (measured at conduit invert elevation 408 feet). Peak flood flows for major or greater floods are predicted to last on the order of 2 to 3 days. Once the peak flood flow has passed, a three-stage reservoir evacuation operation would be implemented (see Section 4.0). The duration of temporary reservoir evacuation would depend on the magnitude of the flood event and the amount of water temporarily stored. For catastrophic floods on the order of 75,100 cfs, it is estimated that inundation would last approximately 36 days total from closing of conduit gates through final reservoir evacuation.

The proposed construction of the FRE facility would require removal of vegetation for construction, staging, and access in and around the FRE facilities footprint, as well as selective vegetation removal and tree harvest within the temporary reservoir area before the project is commissioned and available for operation.

Operation of the FRE facility would also require routine vegetation management in the temporary reservoir area to ensure that the FRE facility could be safely operated. Vegetation management would involve periodic selective tree harvest in the temporary reservoir. This would happen about every 7 to 10 years to keep larger trees from growing in areas that would be frequently flooded when the FRE facility is activated.

2.0 Regulatory Considerations

The Conceptual Vegetation Management Plan (VMP) is a component of the overall ecosystem effects mitigation approach for the Project. Vegetation communities in the Project area, and specifically streamside riparian vegetation, can help moderate local temperatures, intercept runoff and rainfall and uptake nutrients that may affect downstream water quality. Vegetation also provides habitat for wildlife. Functions provided by vegetation affect a variety of natural resources that are regulated at the federal, state, and local level. The VMP aims to avoid and minimize impacts to vegetation communities to the extent practical at the FRE facility and within the temporary reservoir area.

The following agencies and stakeholders may use the VMP to inform permit reviews, but do not have discretionary authority to approve or deny the VMP as part of their permit approval process. The exception is Washington State Department of Natural Resources (WDNR), who will need to issue a Forest Practices Permit per the Washington State Forest Practices Rules (Title 222 Washington Administrative Code [WAC]) in order for the FCZD to conduct selective and tree harvest and long-term vegetation management during Project construction and operations. WDNR would approve the VMP as part of the Forest Practices Permit issuance. This permit is discussed in detail in Section 2.3.3.1.

2.1 Federal

2.1.1 U.S. Army Corps of Engineers

2.1.1.1 Section 404 Clean Water Act Permit

Section 404 of the Clean Water Act requires discharges of dredged and fill material into waters of the U.S. be done only under the authorization of a permit. Because construction of the FRE facility would involve excavation and fill placement in the Chehalis River and adjoining wetlands that are Waters of the U.S., the Project would require a Section 404 permit from the Corps. The Corps is expected to review the VMP as part of their evaluation of impacts to Waters of the U.S., and measures to avoid and minimize such impacts.

2.1.2 U.S. Fish and Wildlife Service and National Marine Fisheries Service

2.1.2.1 Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act

The Project could affect species listed under the Endangered Species Act (ESA) or designated critical habitats. The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) would evaluate the effects on listed and proposed species and critical habitats and require specific conservation measures for unavoidable impacts.

The Magnuson-Stevens Fishery Conservation and Management Act requires federal action agencies to consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency that may adversely affect Essential Fish Habitat. USFWS and NMFS may review the VMP as part of their evaluation of potential impacts to listed species and habitats.

2.2 Tribal

The Corps, as federal lead agency, is conducting a review of the Project under the National Environmental Policy Act (NEPA). This includes consultation under Section 7 of the federal Endangered Species Act with the USFWS and NMFS and under Section 106 of the NHPA with tribes and DAHP.

Washington's salmon and steelhead fisheries are also managed cooperatively in a unique co-management relationship. Co-management of fisheries occurs through government-to-government cooperation, communications, and negotiations. One government is the State of Washington, and the other is Indian tribes whose rights were preserved in treaties signed with the federal government in the 1850s. The Tribes may review the VMP as part of government-to-government consultation relating to project effects on fisheries.

2.3 State

2.3.1 Washington Department of Ecology

2.3.1.1 Shoreline Conditional Use and Substantial Development Permit

Chehalis River, Crim Creek, and Rogers Creek are Shorelines of the State located in the Project Area. The FRE facility would be considered an in-water structure within Lewis County's Shoreline Master Program (SMP), which is a conditional use within the Rural Conservancy shoreline designation (Lewis County 2017). Tree harvest conducted within shoreline jurisdiction must be in compliance with the Lewis County SMP. Forest practices are a permitted use within the Rural Conservancy shoreline environment designation (Lewis County 2017). Ecology has final approval for these permits under the Shoreline Management Act (Chapter 90.58 Revised Code of Washington [RCW]). Ecology may review the VMP as part of their evaluation of potential impacts to shoreline ecological functions.

2.3.1.2 Section 401 Clean Water Act Water Quality Certification

Because a federal (Corps) permit would be required to construct the Project, a Section 401 Water Quality Certification from Ecology would be needed to document the state's review of the Project and its concurrence that the FCZD has demonstrated that the Project and associated activities will meet state water quality standards. This certification is intended to provide reasonable assurance that the FCZD's project would comply with state water quality standards and other requirements for protecting aquatic resources, and covers both construction and operation of the facility. Ecology is expected to review the VMP as part of their evaluation of potential impacts to wetlands and aquatic waterbodies regulated by Ecology under Section 401.

2.3.2 Washington Department of Fish and Wildlife

2.3.2.1 Hydraulic Project Approval

A hydraulic project approval is required because the Project would use, divert, obstruct, and change the natural flow and bed of Chehalis River and its tributaries, which are regulated as waters of the state. The Project would include work in and adjacent to waters of the state. WDFW may review the VMP as part of their evaluation of potential impacts to waters of the state.

2.3.3 Washington Department of Natural Resources

2.3.3.1 Forest Practices Permit

Selective tree harvest within the reservoir footprint during pre-construction and facility operations would be subject to Forest Practices Act Rules administered by the Washington Department of Natural Resources (WDNR) through the Forest Practices Application. In addition, activities for construction and operation of the FRE facility taking place on private or state forestland, including development of quarries and expanding, maintaining, or abandoning roads, would also be subject to Forest Practices Act Rules. These rules provide direction on how to implement the Forest Practices Act (Chapter 76.09 RCW) and Stewardship of Non-Industrial Forests and Woodlands (Chapter 76.13 RCW), and are designed to protect public resources such as water quality and fish habitat while maintaining a viable timber industry in Washington.

It is anticipated that selective tree harvest required for the Project would deviate from prescribed Forest Practices Act Rules, and therefore an Alternate Plan would need to be developed in order to acquire a Forest Practices Permit. WDNR may convene an Interdisciplinary Team to advise the applicant on how to successfully complete and implement an alternate plan to adequately maintain functions of riparian corridors and other sensitive areas. The Interdisciplinary Team is typically led by a Forest Practices Forester who serves as the representative of WDNR, and may include stakeholders such as Ecology field staff, representative(s) of the affected Native American Tribe(s), local or federal authorities that have jurisdiction, and other interested parties that may participate at the discretion of the applicant. WDNR will need to approve the VMP as part of their Forest Practices Permit issuance.

2.4 Local and Regional

2.4.1 Lewis County

2.4.1.1 Critical Areas Review

The Project would be within, abutting, or likely to affect critical areas regulated by Lewis County (i.e., wetlands, wetland buffers, and Fish and Wildlife Habitat Conservation Areas [FWHCAs]). Therefore, review of critical areas and associated permits will be required in accordance with Lewis County Code (LCC) Chapter 17.38. Lewis County may review the VMP as part of their evaluation of potential impacts to critical areas.

2.4.1.2 Shoreline Conditional Use and Shoreline Substantial Development Permit

The FRE facility would be considered an in-water structure within Lewis County's SMP, which is a conditional use within the Rural Conservancy shoreline environment designation. Development of the FRE facility and forest practices associated with Conceptual VMP implementation would require a Shoreline Substantial Development Permit. Lewis County issues these permits in accordance with the Lewis County SMP. Lewis County may review the VMP as part of their evaluation of potential impacts to shoreline ecological functions.

3.0 Existing Conditions

3.1 Existing Vegetation Mapping

3.1.1 Vegetation Mapping Methods

Existing vegetation communities were documented in the FRE temporary inundation study area, which encompasses the temporary reservoir pool from water surface elevation (WSEL) 425 up to WSEL 620 feet, the maximum WSEL for the 2007 event of record. Vegetation mapping used geographic information system (GIS) data and aerial photography available from public sources. A map exchange document (mxd) was set up in GIS with an empty feature class with defined domains for each land cover community that would be digitized. The mxd was populated with the following GIS reference files from previous studies and publicly available information: digital surface models (DSMs) showing the height of tree canopy (WDNR 2020a); digital terrain models (DTMs) representing the ground elevation (WDNR 2020b); streams, wetlands, and ditches mapped by Anchor QEA, LLC (Anchor QEA 2018); and logging road data (WDNR 2020c).

Using the reference data above as well as Google Earth aerial imagery from 1990 through 2018 (Google, LLC 2019), vegetation was characterized in the study area and digitized into distinct land cover classes using the vegetation communities identified in the Proposed Flood Retention Facility Pre-construction Vegetation Management Plan (Anchor QEA 2016), as amended with additional land use classifications such as open water, bare ground/roads, and logged lands to accurately capture current conditions in the study area. A reconnaissance-level site visit was conducted by FCZD biologists in June 2020 to qualitatively ground-truth the desktop mapping of the land cover types.

Table 1 summarizes land cover classifications, typical vegetation within each cover classification, and distinct characteristics that were used to map identified land cover types in the study area.

Table 1. Summary of Land Cover Classifications

Land Cover Classification	% Cover in Study Area	Typical Vegetation	Distinct Characteristics
Wetlands	1%	See Anchor QEA (2018)	Wetlands delineated by Anchor QEA 2018.
Open Water/Sand Bar	10%	Unvegetated	Mapped aquatic features (Anchor QEA 2018) and associated sand bars, rock features, etc.
Terrestrial Bare Ground/Roads	4%	Unvegetated	Lack of vegetation over multiple growing seasons; often associated with wide logging roads and equipment staging areas.
Herbaceous/Grass	1%	Reed canarygrass (*Phalaris arundinacea*), colonial bentgrass	Grasses and forbs present during growing season;

Land Cover Classification	% Cover in Study Area	Typical Vegetation	Distinct Characteristics
		(*Agrostis capillaris*), sword fern (*Polystichum munitum*), western lady fern (*Athyrium angustum*), piggyback plant (*Tolmiea menziesii*), creeping buttercup (*Ranunculus repens*)	often found adjacent to wetlands, riparian corridors, and recently disturbed areas.
Deciduous Riparian Shrubland	<1%	Various willows (*Salix* spp.), young red alder (*Alnus rubra*), red-osier dogwood (*Cornus alba*), vine maple (*Acer circinatum*), Indian plum (*Oemleria cerasiformis*), thimbleberry (*Rubus parviflorus*), salmonberry (*Rubus spectabilis*)	Dominated by deciduous shrub/saplings less than 6 meters (20 feet) tall (>75% cover).
Deciduous Riparian Forest with Some Conifers	17%	Red alder, Western red cedar (*Thuja plicata*), Western hemlock (*Tsuga heterophylla*), black cottonwood (*Populus balsamifera*), cascara (*Frangula purshiana*), willows, big leaf maple (*Acer macrophyllum*), red elderberry (*Sambucus racemosa*), snowberry (*Symphoricarpos albus*)	Dominated by deciduous tree species 6 meters (20 feet) tall or taller (>75% cover).
Mixed Coniferous/Deciduous Transitional Forest	29%	Douglas fir (*Pseudotsuga menziesii*), red alder, big leaf maple	Approximately equal distribution of deciduous and coniferous species (not clearly dominated by one or the other).
Coniferous Forest	28%	Douglas fir	Dominated by coniferous species (>75% cover).
Logged, replanted 0–5 years	7%	Sun-tolerant grasses and forbs, Douglas fir seedlings	Evidence of logging (i.e., clearcutting) on historic aerial imagery; replanting visible within last 5 years (2015–2020) or not replanted.
Logged, replanted 5–15+ years	3%	Douglas fir saplings	Evidence of logging on historic aerial imagery; replanting identified 5 or more years ago (prior to 2015).

3.1.1.1 Wetland and Open Water/Sand Bar

Wetlands and streams mapped in the *Wetland, Water, and Ordinary High Water Mark Delineation Report* (Anchor QEA 2018) were imported into GIS to create the Wetland and Open Water/Sand Bar land cover classifications, respectively.

The ordinary high water marks (OHWM) for Crim Creek, Roger Creek, and the Chehalis River were not delineated in their entirety during field visits conducted by Anchor QEA due to access limitations and the length of reaches within the project area. Instead, Anchor QEA conducted a desktop-based GIS analysis using light detection and ranging (LiDAR)-generated topography to interpret the OHWM elevation between each point that was gathered in the field. Minor adjustments were made to GIS-based stream mapping to more accurately reflect the spatial extent of streams visible on aerial photography.

3.1.1.2 Terrestrial Bare Ground/Roads

The Terrestrial Bare Ground/Roads land cover class includes wide logging roads and equipment staging areas. Historic aerial imagery was used to identify areas lacking vegetation for multiple growing seasons that were not associated with aquatic areas. To account for the surface area of logging roads obscured by dense vegetation and not visible on aerial imagery, a 7.5-foot buffer was applied to the centerline of mapped road features.

3.1.1.3 Herbaceous/Grass

The Herbaceous/Grass class accounts for upland areas dominated by grasses and forbs that are not wetlands. Herbaceous vegetation was distinguished from bare ground by comparing multiple years of aerial imagery to confirm the presence of vegetation during the growing season. Herbaceous vegetation was also commonly associated with areas recently disturbed by logging operations, and was found adjacent to areas categorized as Terrestrial Bare Ground. Species typically found in these areas include reed canarygrass (*Phalaris arundinacea*), colonial bentgrass (*Agrostis capillaris*), sword fern (*Polystichum munitum*), western lady fern (*Athyrium angustum*), piggyback plant (*Tolmiea menziesii*), and creeping buttercup (*Ranunculus repens*).

3.1.1.4 Deciduous Riparian Shrubland

The Deciduous Riparian Shrubland class was modeled after the Cowardin "Scrub-Shrub" class, which includes areas dominated by woody vegetation less than 6 meters (20 feet) tall, including true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions (Cowardin et al. 1979). This class was identified and mapped based on the prevalence of deciduous shrub species and proximity (generally within 200 feet) to mapped streams and aquatic areas. Species typically found in these areas include various willows (*Salix* spp.), red-osier dogwood (*Cornus alba*), vine maple (*Acer circinatum*), Indian plum (*Oemleria cerasiformis*), thimbleberry (*Rubus parviflorus*), salmonberry (*Rubus spectabilis*), and red alder (*Alnus rubra*) saplings.

3.1.1.5 Deciduous Riparian Forest with Some Conifers

The Deciduous Riparian Forest classification was established based on the Cowardin "Forested" class, which includes forested areas characterized by woody vegetation that is 6 meters (20 feet) or taller (Cowardin et al. 1979). Deciduous forest stands were differentiated from scrub-shrub communities using the DSM GIS layer to determine approximate tree height. Although the class is dominated by deciduous tree species (approximately >75% deciduous cover), scattered conifer trees were also commonly observed in these areas. Deciduous species were distinguished from conifers using multiple years of aerial imagery to identify seasonal differences in canopy cover. Species typically found in the Deciduous Riparian Forest class includes red alder, Western red cedar (*Thuja plicata*), Western hemlock (*Tsuga heterophylla*), black cottonwood (*Populus balsamifera*), cascara (*Frangula purshiana*), willows, big leaf maple (*Acer macrophyllum*), red elderberry (*Sambucus racemosa*), and snowberry (*Symphoricarpos albus*).

3.1.1.6 Mixed Coniferous/Deciduous Transitional Forest

Mixed Coniferous/Deciduous Transitional Forest represents areas with an approximately equal distribution of coniferous and deciduous tree species. Tree heights were estimated using the DSM layer, and the distribution of coniferous and deciduous species was determined using seasonal differences in canopy cover from historic aerial imagery. Species typically found in these areas include Douglas fir (*Pseudotsuga menziesii*), red alder, and big leaf maple.

3.1.1.7 Coniferous Forest

Areas dominated by coniferous tree species (>75% cover) were characterized as Coniferous Forest. The Coniferous Forest class is typically dominated by Douglas fir and often includes stands of various age classes managed for logging.

3.1.1.8 Recently Logged Areas

Areas with evidence of recent logging activity (i.e., clearcutting) were identified by comparing multiple years of aerial imagery. Recently logged areas with evidence of replanting within the last 5 years (2015 to present) or no evidence of replanting were characterized as "Logged, replanted 0-5 years." Areas with evidence of replanting more than 5 years ago (prior to 2015) were characterized as "Logged, replanted 5-15+ years." The 5-year threshold represents an approximation of time required for logged lands in the Pacific Northwest to transition from an early seral stage, in which grasses and forbs are predominant, to a shrub-sapling stage in which Douglas-fir seedlings accelerate in growth (Burns and Honkala 1990; Lam and Maguire 2011; USDA Forest Service 2012).

3.1.2 Existing Vegetation Mapping Results

An existing land cover map of the study area is presented in Appendix A.

4.0 FRE Temporary Reservoir Inundation Impacts

4.1 Inundation Mapping

4.1.1 Inundation Mapping Methods

The methods described below were used to generate the temporary reservoir inundation limits anticipated for the regulation of flood events by the proposed FRE facility. The inundation limits are the same as the vegetation study area, encompassing WSEL 425 to 620 feet.

Topography data were obtained from public light detection and ranging (LiDAR) databases. A series of digital terrain models (DTMs) provided by the Washington State Department of Natural Resource's LiDAR program were used to generate contour lines (datum: North American Vertical Datum of 1988 [NAVD88]). HDR Engineering, Inc. (HDR), used ArcGIS's "Mosaic to New Raster" tool to merge multiple DTMs into a single DTM that covers the entire project area. Once created, the new DTM was used to derive contours using the ArcGIS Contour tool. This tool was used to define the base contour, contour interval, and maximum vertices per contour. No unit conversion factor (Z factor) was used to generate the project contours. For the purpose of modeling, contours at a 5-foot contour interval were created with a base contour of zero.

The contour files were imported to AutoCAD 2018 and used to generate the inundation contour lines and show the aerial extent of these inundation limits. The following key WSEL contours were selected to illustrate the aerial (i.e., planform) extent of inundation during each of the three stages of temporary reservoir evacuation that would be implemented to evacuate the reservoir after a major flood event (i.e., events with river flows forecasted to reach 38,800 cfs or more) when the FRE facility is activated:

1. **Initial Reservoir Evacuation (Max. WSEL to WSEL 528 feet):** The maximum WSEL for each major flood event will vary depending on the intensity of the flood event. To evacuate the temporary reservoir after a major flood event, the partially closed reservoir outlet gates will open and increase outflow by 1,000 cfs each hour, from 300 cfs (minimum outflow during flood operations) to a maximum outflow of 5,000 to 6,500 cfs. This will cause evacuation of the temporary reservoir from its peak WSEL at the maximum pool, which will be limited to 10 feet per day (5 inches per hour) to reduce risk of landslides. During all major flood events, the 10-feet-per-day evacuation rate will continue until the pool elevation reaches 528 feet. Once the pool elevation reaches 528 feet, debris management operations will begin.

2. **Debris Management Evacuation (WSEL 528–500 feet):** During major flood events, debris from surrounding tributaries and hillsides may be swept into the reservoir. Debris management procedures will be used to ensure that large woody debris will not impact dam operations or cause damage to the FRE facility.

Debris management will begin once the pool elevation falls to 528 feet. At this time, evacuation rates will be slowed to 2 feet per day (1 inch per hour) for a 14-day period. During this period, crews operating from boats will move large debris to an existing log-sorting yard within the reservoir area previously operated previously by Weyerhaeuser. The slowed evacuation rate will continue until the pool elevation fall to 500 feet. Once the pool elevation reaches 500 feet, debris management operations will conclude.

3. **Final Reservoir Evacuation (WSEL 500–425 feet):** When the pool elevation falls to WSEL of 500 feet, evacuation rates will increase to 10 feet per day (5 inches per hour) once debris management operations are complete. Evacuation will continue at this rate until the pool elevation returns to 425 feet (empty reservoir). At this point, the reservoir will no longer be impounding water and the Chehalis River will return to a free-flowing state.

The State Environmental Policy Act Draft Environmental Impact Statement: Proposed Chehalis River Basin Flood Damage Reduction Project (EIS; Ecology 2020) analyzed three historical flood events and two theoretical events, the 10-year event and the 100-year event (see Table 2). To determine the predicted maximum reservoir pool WSELs resulting from FRE operations for each of these flood events, the regulated and unregulated flood hydrographs were obtained from the EIS and notations were added to the hydrograph plots to clarify key evacuation stages. Similar information was applied to the inundation limit map created in AutoCAD 2018. Additionally, the total inundation time above each of the three key reservoir evacuation elevations—maximum WSEL, WSEL 528 feet, and WSEL 500 feet—was determined from the time steps obtained from the flood hydrographs provided in the EIS.

4.1.2 Inundation Mapping Results

Table 2 shows the acreage and duration of inundation expected during the three stages of temporary reservoir drawdown for each major flood event evaluated. Inundation maps for historical and modeled flood events are presented in Appendix B. The figures show the Initial Reservoir Evacuation, Debris Management Evacuation, and Final Reservoir Evacuation areas in blue, yellow, and orange, respectively. Hydrographs for each major flood event are provided in Appendix C.

The terms used in Table 2 are defined as follows:

- **Area of inundation** refers to the area (in acres) of reservoir inundated during each stage of temporary reservoir drawdown. As described above, the Debris Management Evacuation and Final Reservoir Evacuation stages will have uniform operation during all major flood events; therefore, the acreage will be consistent during these operational milestones. The area inundated at the start of the Initial Reservoir Evacuation stage differs based on the severity of the flood event.
- **Duration of inundation** represents the maximum number of days of inundation during each stage of reservoir evacuation. The duration differs depending on the severity of the historical or

Table 2. Acreage and Duration of Inundation for Historical and Modeled Flood Events during Temporary Reservoir Evacuation Stages

Historical/Modeled Event	Initial Reservoir Evacuation (WSEL >528 feet)				Debris Management Evacuation (WSEL 528–500 feet)			Final Reservoir Evacuation (WSEL 500–425 feet)		
	Area of Inundation above WSEL 528 feet	Duration of Inundation above WSEL 528 feet	Total Reservoir Area[a]	Maximum WSEL[b]	Area of Inundation at WSEL 500–528 feet	Duration of Inundation at WSEL 520–500 feet[c]	Total Reservoir Area	Area of Inundation at WSEL 425–500 feet	Duration of Inundation at WSEL 500–425 feet[d]	Total Reservoir Area
10-year event	238 acres	Up to 5.9 days	519 acres	568 feet	122 acres	Up to 20.2 days	281 acres	159 acres	Up to 26.9 days	159 acres
100-year event	426 acres	Up to 10.7 days	707 acres	604 feet	122 acres	Up to 25.0 days	281 acres	159 acres	Up to 31.8 days	159 acres
1996 flood event	410 acres	Up to 9.8 days	691 acres	601 feet	122 acres	Up to 24.5 days	281 acres	159 acres	Up to 31.0 days	159 acres
2007 flood event	527 acres	Up to 11.1 days	808 acres	620 feet	122 acres	Up to 25.2 days	281 acres	159 acres	Up to 32.3 days	159 acres
2009 flood event	324 acres	Up to 7.8 days	605 acres	585 feet	122 acres	Up to 22.0 days	281 acres	159 acres	Up to 28.8 days	159 acres

[a] This value also represents the maximum area of inundation for the modelled flood event.

[b] This value also represents the maximum WSEL for the modelled flood event.

[c] Includes 14 days for debris-clearing activities starting when evacuation following flood peak falls to WSEL 528 feet.

[d] This value also represents the maximum number of days of flooding for the modelled flood event.

- modeled flood event. For the Debris Management Evacuation stage, this number includes 14 days for debris-clearing activities.
- **Maximum WSEL** gives the peak temporary reservoir pool WSEL for each flood event prior to the start of the Initial Reservoir Evacuation stage.

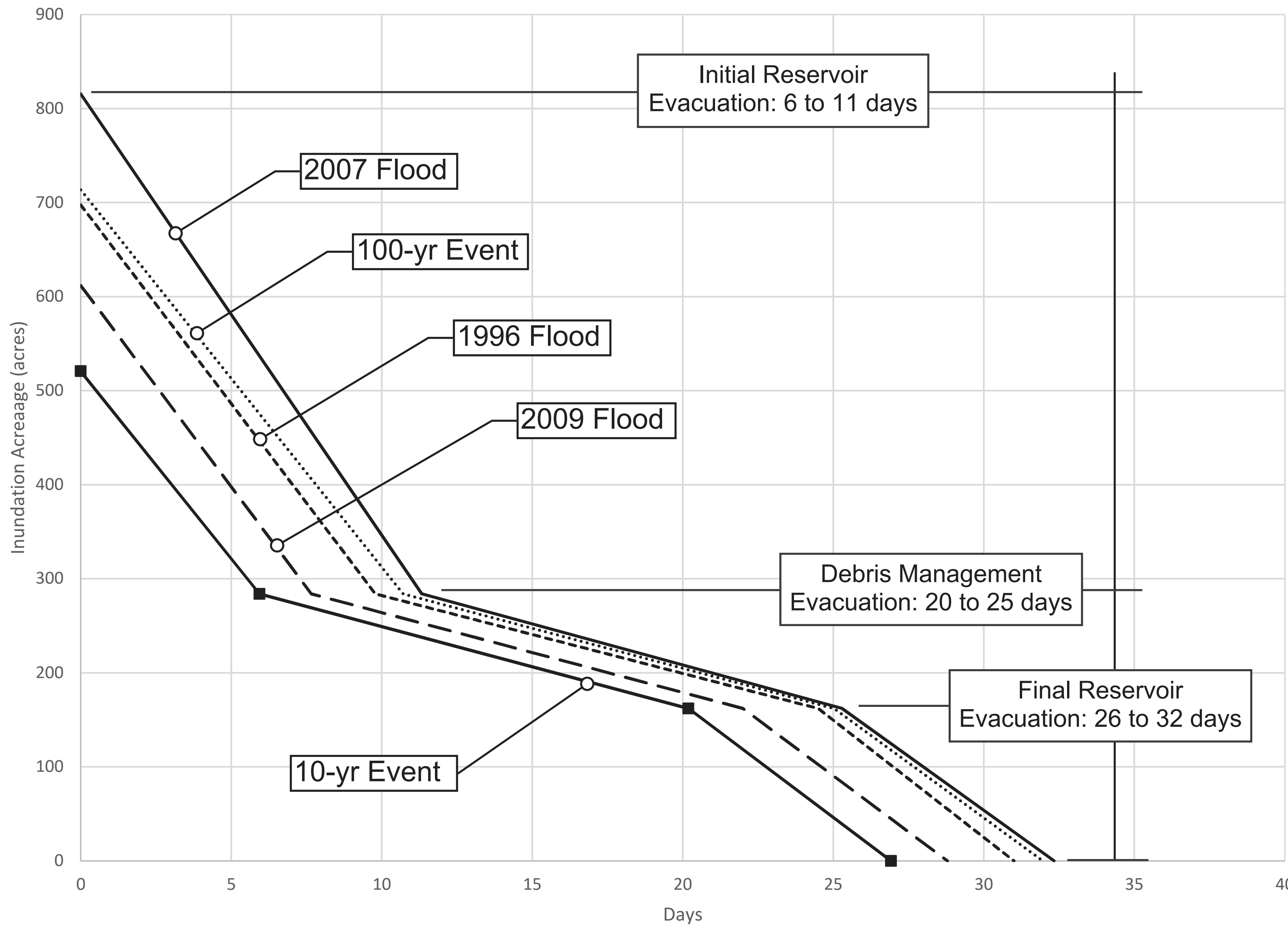
The results of the inundation mapping show that the maximum pool WSEL of the Initial Reservoir Evacuation area will range between 620 and 568 feet. The acreage of inundation above 528 feet (lower limit of the Initial Reservoir Evacuation area) will range between 238 and 527 acres, and the duration of inundation will range between 5.9 and 11.1 days. The Debris Management Evacuation area will have 122 acres of inundation between WSEL 528 and 500 feet, and will be inundated between 20.2 and 25.2 days. The Final Reservoir Evacuation area will have 159 acres of inundation between WSEL 500 and 425 feet. This area will be inundated at least 26 days under each flood event, and up to 32 days under the event of record (historic 2007 flood event).

Table 3 summarizes the range of acreage, inundation extent, and duration at each evacuation stage from the more frequent (10% chance) major flood event to the least frequent (<1% chance) major flood event. Figure 1 graphically depicts each evacuation stage for each flood event plotted as acreage of inundation over time. The standardized three-stage evacuation operations that will be implemented when the dam is activated during all major flood events provides a more accurate depiction of the duration and extent of inundation to evaluate impacts during operation of the dam. During any major flood event, nearly half of the reservoir or more will be inundated for only 6 to 11 days. Longer periods of inundation that will have greater potential effects on vegetation will commence at the Debris Management Evacuation stage.

Table 3. Inundation Zones Based on Temporary Reservoir Evacuation Stages

Temporary Reservoir Drawdown Stage	% Chance of being Flooded in a Year	Duration	WSEL Range	Total Reservoir Area
Initial Reservoir Evacuation	10%	Up to 5.9 days	568–528	238 acres
	<1%	Up to 11.1 days	620–528	527 acres
Debris Management Evacuation	10%	Up to 20.2 days	528–500	122 acres
	<1%	Up to 25.2 days	528–500	122 acres
Final Reservoir Evacuation	10%	Up to 26.9 days	500–425	159 acres
	<1%	Up to 32.3 days	500–425	159 acres

Figure 1. FRE Temporary Reservoir Inundation Acreage Over Time



4.2 Vegetation Responses to Flooding

4.2.1 General Flood Tolerance Themes

The likelihood of woody vegetation to survive a flood event is dependent on a variety of factors, including time of year, soil type, age and health of plants, frequency, duration and depth of inundation, and plant species. Flooding also causes mechanical destruction of vegetation through the direct impact of flood waters and the debris they transport, and through the erosion of substrate (Bendix 1998). It has also been noted that standing water is more harmful than moving flood water and that flood-tolerant plants are often injured by flooding in standing water (Kozlowski 1982, as cited in Kozlowski 1984).

Flooding also contributes to changes in the physical status of soil, as waterlogging causes large aggregates to break into smaller particles. As flood levels recede, the small particles are rearranged into a more dense structure, creating smaller soil-pore diameters, higher mechanical resistance to root penetration, low oxygen concentrations and the inhibition of resource use (Engelaar et al. 1993).

Flooding that occurs during the growing season is significantly more harmful to plant survival than flooding that occurs during the dormant season (Kozlowski 1984, 1997). The growing season for the project area was determined based on the period in which temperatures are above 28 degrees Fahrenheit in 5 out of 10 years using the long-term climatological data collected by the U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) (2020a). Using the USDA NRCS Climate Analysis for Wetlands table for the nearest station (Centralia), the growing season was approximated to be typically between March 6 and November 23, or a total of 262 days.

The depth of flooding also introduces stresses to vegetation. Partially to fully submerged plants have partial to full loss of direct contact with atmospheric oxygen, which limits the ability for gas exchange to occur in leaves. Sunlight is also greatly reduced or extinguished, hampering photosynthesis (Parolin 2009). Trees that are submerged only partially during a flood event generally have greater survivability than fully submerged trees (Siebel et al. 1998; North Dakota State University 2000).

The types of soils found in the inundated area and their ability to drain or retain water also influences vegetation survival. Sandy soils drain much faster than predominantly clay-based soils, which hold water and remain wet for longer periods (Jull 2008). Soils in the study area are mapped by USDA NRCS as Winston loam (45.6%), Bunker loam (20.3%), Katula-Rock outcrop complex (10.9%), Aquic Xerofluvents (5.0%), and others (USDA NRCS 2019). In their natural state, nearly all soils found in the study area are classified as "well drained," meaning that water is removed from the soil readily but not rapidly (Soil Science Division Staff 2017).

The age and health of the plants also contribute to an individual plant's ability to survive a flood event. Young seedlings have been found to be more sensitive to flooding injury than older seedlings (Kozlowski 1997). Established, healthy trees and shrubs are also more tolerant of flooding than old, stressed, or young plants of the same species (Jull 2008).

4.2.2 Flood Tolerance of Plant Species in the FRE Temporary Reservoir

Flood-tolerant plants survive in anaerobic environments using various morphological and physiological adaptations, depending on the species and environmental conditions. Specifically, red alder exhibits adaptations that permit flood tolerance, including the formation of adventitious roots when subject to flooding (Batzli and Dawson 1997; Harrington 2006). Other studies recorded 100% survival of red alder seedlings when subjected to a 20-day flood and a 20-day recovery period (Harrington 1987).

In a controlled flooding experiment conducted by Minore in 1968, winter inundation did not significantly affect the survival or growth of western hemlock, red alder, Sitka spruce, lodgepole pine, or western redcedar, but even 1 week of winter inundation was detrimental to Douglas fir. In the same experiment, summer flooding survival rates for both western redcedar and lodgepole pine were significantly better than Douglas fir after 4 weeks of summer flooding. Minore (1968) concluded that short periods of winter flooding will likely not injure western hemlock, red alder, Sitka spruce, lodgepole pine, or western redcedar seedlings, but found that Douglas fir seedlings are very intolerant of flooding. It was also found that photosynthesis and transpiration of Douglas fir have been shown to decrease within 4 to 5 hours after flooding, indicating rapid stomatal closure (Zaerr 1983, as cited in Kozlowski and Pallardy 2002).

Based on a comprehensive literature review, existing vegetation species commonly found in the project area were sorted into three categories of anticipated flood tolerance:

- Low: 1–7 days of inundation
- Moderate: 8–14 days of inundation
- Medium-High: 6–30 days of inundation
- High: 15–30+ days of inundation

Table 4 summarizes the relative flood tolerance of common native woody plants found in the project area. Species with low anticipated flood tolerance, including Douglas fir, are likely to exhibit signs of flood stress after only a few days. Signs of flood stress in plants includes yellowing or browning of leaves, curled leaves, leaf wilt and drop, reduced size of new leaves, early fall color, branch dieback, formation of sprouts along stems or trunk, and gradual decline and death (Jull 2008). Stressed trees are also more susceptible to secondary organisms such as canker fungi and insects that bore into phloem and wood (Jull 2008).

Table 4. Relative Flood Tolerance of Common Native Woody Plants in the FRE Temporary Reservoir

Common Name	Scientific Name	Tilley et al. 2012	Walters et al. 1980	Withrow-Robinson et al. 2011	Whitlow and Harris 1979	Wenger 1984	USDA PLANTS Database[a]	Miscellaneous Sources
Red-osier dogwood	*Cornus alba*	High (10–30+ days)	Very tolerant (2+ growing seasons)	High tolerance	Very tolerant (>1 year)	N/A	High	N/A
Narrow leaf willow	*Salix exigua*	Medium-high (6-–30 days)	Very tolerant (all willows; 2+ growing seasons)	High tolerance (all willows)	Very tolerant (>1 year)	Moderately tolerant	High	94.9 days of maximum flooding at elevations where species was most common[b]
Hooker's willow	*Salix hookeriana*	N/A	Very tolerant (all willows; 2+ growing seasons)	High tolerance (all willows)	Very tolerant (>1 year)	Moderately tolerant	High	N/A
Pacific willow	*Salix lasiandra*	Medium-high (6–30 days)	Very tolerant (all willows; 2+ growing seasons)	High tolerance (all willows)	Very tolerant (>1 year)	Moderately tolerant	High	146.3 days of maximum flooding at elevations where species was most common[b]
Lodgepole pine	*Pinus contorta*	N/A	Intermediately tolerant (1–3 months during growing season)	N/A	Tolerant (1 growing season)	Moderately tolerant	Low	100% survival of seedlings inundated 1–4 weeks in winter; 100% survival after 4 weeks in summer; 50% survival after 8 weeks in summer;[c] tolerated submergence for 14 days[d]
Black cottonwood	*Populus balsamifera ssp. Trichocarpa*	Medium (6–10 days)	Tolerant (most of 1 growing season)	High tolerance	Tolerant (1 growing season)	Moderately tolerant	Medium	100% survival but varied growth response after 20-day flooding and 20-day recovery period[e]
Red elderberry	*Sambucus racemosa*	Medium (6–10 days)	N/A	High tolerance	Tolerant (1 growing season)	N/A	N/A	N/A
Hardhack	*Spiraea douglasii*	N/A	N/A	High tolerance	Tolerant (1 growing season)	N/A	High	Suffered no obvious injury after being inundated and covered in fine layer of silt during flood event[f]

Common Name	Scientific Name	Tilley et al. 2012	Walters et al. 1980	Withrow-Robinson et al. 2011	Whitlow and Harris 1979	Wenger 1984	USDA PLANTS Database[a]	Miscellaneous Sources
Western red cedar	*Thuja plicata*	N/A	Tolerant (most of 1 growing season)	High tolerance	Tolerant (1 growing season)	Weakly tolerant	N/A	100% survival of seedlings inundated 1–4 weeks in winter and 4 and 8 weeks in summer[c]
Sitka spruce	*Picea sitchensis*	N/A	Tolerant (most of 1 growing season)	N/A	Slightly tolerant (30 days)	Weakly tolerant	Low	100% survival of seedlings inundated 1–4 weeks in winter; 84% survival after 4 weeks in summer; 34% after 8 weeks in summer;[c] actively growing seedlings were alive after 22 days of root flooding[g]
Ponderosa pine	*Pinus ponderosa*	N/A	Intermediately tolerant (1–3 months during growing season)	Medium tolerance	Slightly tolerant (30 days)	Intolerant	N/A	N/A
Western hemlock	*Tsuga heterophylla*	N/A	Tolerant (most of 1 growing season)	N/A	Slightly tolerant (30 days)	Weakly tolerant	N/A	100% seedling survival after 1–4 weeks inundation in winter; 34% survival after 4 weeks in summer; 16% survival after 8 weeks in summer[c]
Big leaf maple	*Acer macrophyllum*	N/A	Intermediately tolerant (1–3 months during growing season)	Medium tolerance	Intolerant (no more than a few days)	Weakly tolerant	Medium	In repeated flood events in British Columbia, Canada, some maples succumbed, particularly if they were growing very actively[f]
Vine maple	*Acer circinatum*	N/A	Tolerant (most of 1 growing season)	Low tolerance	N/A	N/A	N/A	N/A
Red alder	*Alnus rubra*	Medium (6–10 days)	Very tolerant (2+ growing seasons)	High tolerance	Intolerant (no more than a few days)	Moderately tolerant	Low	Recovered after 50-day flood and 20-day recovery;[h] 100% seedling survival but varied growth response after 20-day flood and 20-day

Common Name	Scientific Name	Tilley et al. 2012	Walters et al. 1980	Withrow-Robinson et al. 2011	Whitlow and Harris 1979	Wenger 1984	USDA PLANTS Database[a]	Miscellaneous Sources
								recovery;[e] 100% seedling survival after 1–4 weeks in winter; 50% survival after 4 weeks in summer; 65% survival after 8 weeks in summer;[c] static flooding killed 2-year-old saplings after 4–6 days of flooding when water was above soil surface;[i] suffered "markedly" in flooded lowland forest after inundation; died in large numbers and regarded as one of the trees most susceptible to damage by flooding[f]
Indian plum	*Oemleria cerasiformis*	N/A	N/A	Low to Medium	N/A	N/A	Medium	N/A
Snowberry	*Symphoricarpos albus*	Medium (6–10 days)	Intermediately tolerant (1–3 months during growing season)	Medium tolerance	N/A	N/A	N/A	N/A
Thimbleberry	*Rubus parviflorus*	N/A	N/A	Low tolerance	N/A	N/A	Low	N/A
Salmonberry	*Rubus spectabilis*	N/A	N/A	High tolerance	N/A	N/A	Medium	N/A
Mock orange	*Philadelphus L.*	Unknown	N/A	Medium tolerance	Intolerant (no more than a few days)	N/A	N/A	N/A
Bitter cherry	*Prunus emarginata*	N/A	Intermediately tolerant (1–3 months during growing season)	N/A	Intolerant (no more than a few days)	N/A	N/A	N/A

Common Name	Scientific Name	Tilley et al. 2012	Walters et al. 1980	Withrow-Robinson et al. 2011	Whitlow and Harris 1979	Wenger 1984	USDA PLANTS Database[a]	Miscellaneous Sources
Douglas fir	*Pseudotsuga menziesii*	N/A	N/A	Low tolerance	Intolerant (no more than a few days)	Intolerant	Low	Winter flooding for 1–4 weeks causes severe injury; 0% seedling survival after 4 or 8 weeks during summer;[c] tolerated submergence for 14 days[d]
Cascara	*Frangula purshiana*	N/A	N/A	Medium tolerance	Intolerant (no more than a few days)	N/A	N/A	N/A
Oregon ash	*Fraxinus latifolia*	N/A	Tolerant (most of 1 growing season)	High tolerance	N/A	Weakly tolerant	High	Static flooding killed 2-year-old saplings after 4–6 days of flooding when water was above soil surface[i]

[a]USDA NRCS 2020b.

[b]Wakefield 1966, as cited in Whitlow and Harris 1979. Looks at days of average maximum flooding at elevations where species was found to be most common.

[c]Minore 1968.

[d]McCaughey and Weaver 1991.

[e]Harrington 1987.

[f]Brink 1954.

[g]Coutts 1981, as cited in McCaughey and Weaver 1991.

[h]Batzli and Dawson 1997.

[i]Ewing 1996.

4.3 Inundation Effects in FRE Temporary Reservoir and Proposed Pre-Construction Tree Harvest Rationale

Figure 2 shows land cover acreage mapped within the project area at each evacuation stage. An existing land cover map of the study area is presented in Appendix A.

The Initial Reservoir Evacuation area consists mainly of Coniferous Forest, dominated by Douglas fir, and Mixed Coniferous/Deciduous Transitional Forest, dominated by Douglas fir, red alder, and big leaf maple. The Initial Reservoir Evacuation area would be inundated between 6 to 11 days during a flood event and some trees could be partially submerged, depending on the severity of the flood. As such, species with low anticipated flood tolerance (e.g., Douglas fir) would likely exhibit signs of flood stress and some mortality in the Initial Reservoir Evacuation area. These trees should be monitored and removed if they exhibit significant injury or mortality during facility operations. Species with moderate flood tolerance are not expected to experience significant mortality in the Initial Reservoir Evacuation area, but should be monitored for signs of flood stress after periods of prolonged inundation. Monitoring methods are described in more detail in Section 5.2.1.

The Debris Management Evacuation area consists primarily of Mixed Coniferous/Deciduous Transitional Forest, dominated by Douglas fir, red alder, and big leaf maple, and Deciduous Riparian Forest with Some Conifers, including species such as red alder, Western red cedar, Western hemlock, black cottonwood, willows, and big leaf maple. The Debris Management Evacuation area would be inundated between 20 and 25.2 days, and most trees throughout this area would be partially or fully submerged for the duration of this time. Submergence introduces additional novel stresses to trees, decreasing their likelihood of survival. Therefore, all tree species that are not highly tolerant of flooding—all species except for willows and black cottonwood—would need to be removed throughout the area.

The Final Reservoir Evacuation area consists mainly of Deciduous Riparian Forest with Some Conifers, Mixed Coniferous/Deciduous Transitional Forest, and Open Water land cover classifications. The Final Reservoir Evacuation area would be inundated between 26 and 32 days and trees in this zone would be fully submerged. It is highly unlikely that any trees would be able to survive in this area after prolonged inundation and full submergence. Therefore, all trees in this area would need to be removed.

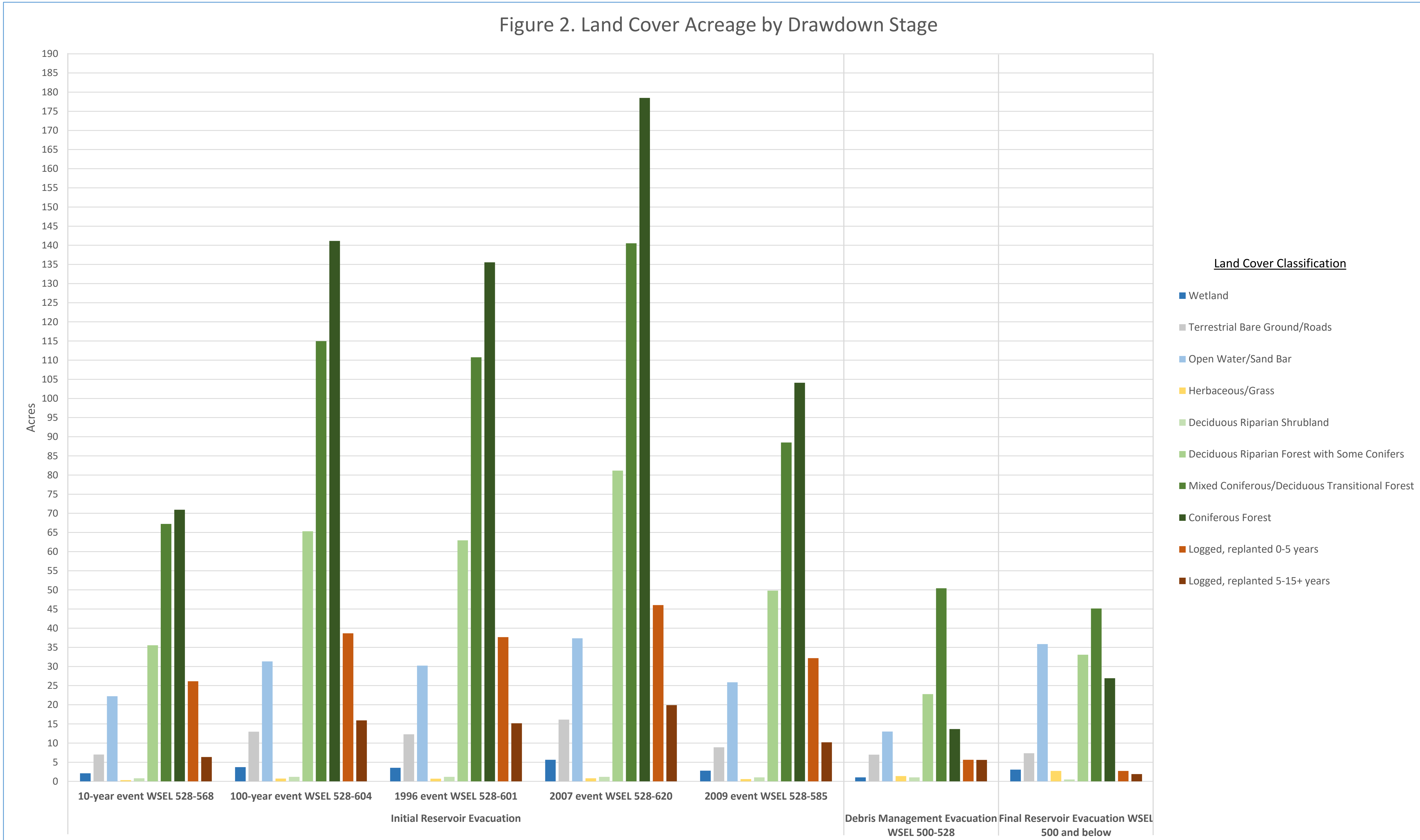


Figure 2. Land Cover Acreage by Drawdown Stage
Acres
190
185
180
175
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
10-year event WSEL 528-568
100-year event WSEL 528-604
1996 event WSEL 528-601
2007 event WSEL 528-620
2009 event WSEL 528-585
Initial Reservoir Evacuation
Debris Management Evacuation WSEL 500-528
Final Reservoir Evacuation WSEL 500 and below
Land Cover Classification
Wetland
Terrestrial Bare Ground/Roads
Open Water/Sand Bar
Herbaceous/Grass
Deciduous Riparian Shrubland
Deciduous Riparian Forest with Some Conifers
Mixed Coniferous/Deciduous Transitional Forest
Coniferous Forest
Logged, replanted 0-5 years
Logged, replanted 5-15+ years

5.0 Pre-Construction and Facility Operations Selective Tree Harvest Plan

Selective tree harvest within the reservoir footprint during pre-construction and facility operations would be subject to Forest Practices Act Rules administered by the Washington Department of Natural Resources (WDNR) through the Forest Practices Application.

The Project would likely require deviations from the methods and requirements prescribed in the Forest Practices Act Rules. Through the use of alternate plans, applicants are permitted to develop management prescriptions that will achieve resource protection through alternative methods from the Forest Practices Act. The alternate plan policy for WDNR is outlined in WAC 222-12-040 and also discussed in the Forest Board Practices Manual Section 21 (WDNR 2013). To be approved, alternate plans must provide protection for public resources at least equal in overall effectiveness to the protection provided by the Forest Practices Act and rules (WAC 222-12-040(1)). Alternate plans should be submitted with the Forest Practices Application and must include a site map showing affected resources and proposed management activities. The plan must also include descriptions of current site conditions and proposed management activities, a list of the Forest Practices Act Rules that the alternate plan is intended to replace, and, if applicable, a monitoring and adaptive management plan and corresponding implementation schedule.

The selective tree harvest plan below describes the conceptual approach for selective tree harvest, and an overview of Forest Practices Act Rules that will need to be considered in development of the Alternate Plan for acquisition of a Forest Practices Permit.

5.1 Pre-Construction Selective Tree Harvest Plan

The proposed Project would require clearing of all vegetation from the proposed FRE facility and construction access and staging areas. As discussed in Section 4.3, most trees in the Debris Management Evacuation and Final Reservoir Evacuation areas of the temporary reservoir would experience significant stress or mortality resulting from prolonged inundation during a flood event. Dead or dying trees and woody debris pose a hazard to dam operations personnel and could potentially damage dam facilities (e.g., intake structure, flood gates). Due to these safety and logistical concerns, the FCZD proposes to selectively harvest trees from the Debris Management Evacuation area and harvest all trees from the Final Reservoir Evacuation area (Figure 3). This Pre-Construction Selective Tree Harvest Plan provides methods to identify trees within different inundation areas that will need to be targeted for removal prior to commencement of facility operations. The plan also outlines options for tree removal using guidance from the WDNR Forest Practices Board Manual and the Washington State Forest Practices Rules (Title 222 WAC).

The FCZD commits to the avoidance of burning of trees and other cleared vegetation at the FRE facility site, along routes of new roads, and within the FRE temporary reservoir area. To the extent practical, harvested trees would be used in the construction of mitigation measures or released downstream to resupply woody material to maintain natural aquatic habitats. Any surplus material would be sold.

Additional best management practices (BMPs) to avoid and minimize impacts on threatened and endangered species during vegetation management activities are in the *DRAFT Biological Assessment and Essential Fish Habitat Assessment – Chehalis River Basin Flood Damage Reduction Project: Flood Retention Facility, Airport Levee Improvements, and Mitigation Actions* (HDR 2020).

5.1.1 Tree Removal Methods and Guidelines

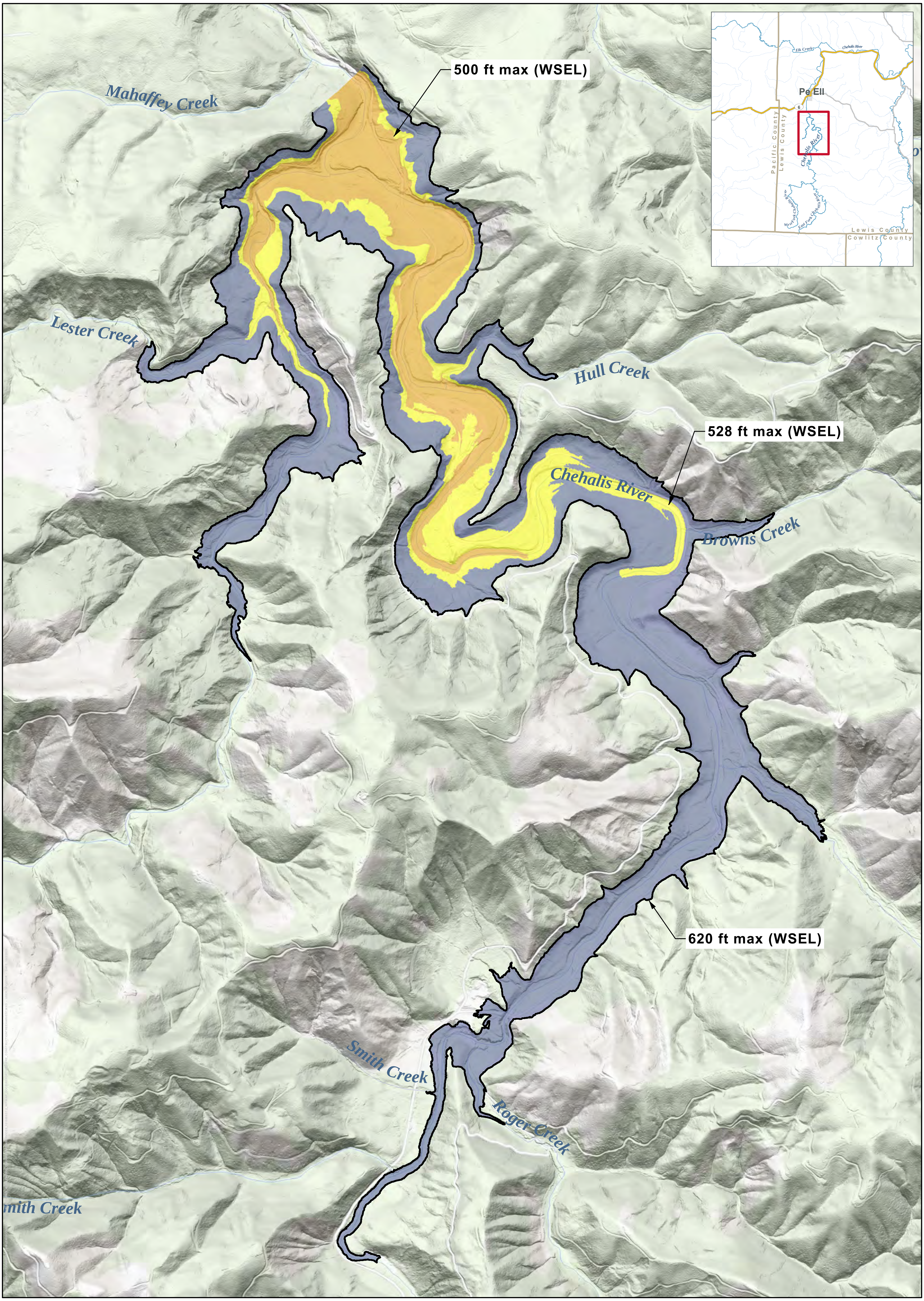
Trees and other vegetation would be completely cleared from the FRE facility site footprint and construction areas. In the Initial Reservoir Evacuation area, where inundation is expected to last between 6 to 11 days during a flood event, selective tree harvest is not proposed to occur prior to construction of the FRE facility. Species with low flood tolerance, such as Douglas fir, should be monitored and removed if they exhibit significant injury or mortality during facility operations, as outlined in the Facility Operations Selective Tree Harvest Plan below.

Selective tree harvest in the Debris Management Evacuation area would need to target all tree species that are not highly flood-tolerant (i.e., all tree species except for willows and black cottonwood). All trees in the Final Reservoir Evacuation area would need to be removed. Project pre-construction and facility operations tree harvest would require a Forest Practices Permit from WDNR under the Forest Practices Act; therefore, the selective tree harvest plans would need to comply, to the extent practical, with applicable timber harvest requirements outlined in the WDNR Forest Practices Board Manual and the Washington State Forest Practices Rules (Title 222 WAC).

5.1.1.1 Washington State Forest Practices Rules

5.1.1.1.1 Riparian Management Zones

The Forest Practices Rules designate a Riparian Management Zone (RMZ) on each side of a stream that to retain riparian function after timber harvest. In Western Washington, the RMZ is measured horizontally from the outer edge of the bankfull width or the outer edge of the Channel Migration Zone (CMZ), whichever is greater (WAC 222-16-010). The width of the RMZ is based on the “site-potential tree height” of a typical tree at age 100 and stream size (i.e., bankfull width) (Washington Forest Protection Association 2004). Site-potential tree height is derived by WDNR’s site classes, which refer to the growing conditions of the soil as described by the USDA NRCS (2019), and is a measure of the forest site productivity or growth potential of the forest.



Source: Landcover, FRE Facility - HDR; Streams - DNR; Basemap - ESRI Online; Hillshade - DNR LiDAR Portal

Final reservoir evacuation area. Total inundation up to 32.3 days (776.0 hrs) from elevation 500 ft to 425 ft. Pre-construction harvest of all trees.

Debris managment evacuation area Inundation up to 25.2 total days (605.0 hrs) above elevation 500 ft. Pre-construction harvest of all trees that are not highly flood-tolerant.

Initial reservoir evacuation area Inundation up to 11.1 days (266.0 hrs) above elevation 528 ft No pre-construction tree harvest

Maximum inundation limit

0 1,000 2,000
Feet

FIGURE 3:PRE-CONSTRUCTION TREE HARVEST PLAN

Chehalis River Basin Flood Damage Reduction Project

Date: 10/2/2020

Review of WDNR Site Class GIS Data (WDNR 2018) determined that the site class along the Chehalis River is primarily Site Class II, with some areas of Site Classes III and IV at higher elevations and along tributaries such as Crim Creek and Rogers Creek. Based on this assessment, the RMZ along the Chehalis River is generally 170 feet wide in areas categorized as Site Class II, with a width of 140 feet and 110 feet in areas of Site Classes III and IV, respectively (Table 5).

The RMZ is comprised of three different zones: the core zone, inner zone, and outer zone, defined below per WAC 222-16-010:

- In Western Washington, the **RMZ core zone** is defined as the 50-foot buffer of a Type S or F water, measured horizontally from the outer edge of the bankfull width or the outer edge of the channel migration zone, whichever is greater.
- In Western Washington, the **RMZ inner zone** is the area measured horizontally from the outer boundary of the core zone of a Type S or F water to the outer limit of the inner zone. The outer limit of the inner zone is determined based on the width of the affected water, site class, and management option chosen for timber harvest within the inner zone.
- The **RMZ outer zone** is the area measured horizontally between the outer boundary of the inner zone and the RMZ width, measured from the outer edge of the bankfull width or the outer edge of the channel migration zone, whichever is greater.

No timber harvest or construction is allowed in the 50-foot core zone except operations related to forest roads as detailed in WAC 222-30-021(1).

Forest practices in the inner zone must be conducted in such a way as to meet or exceed stand requirements to achieve the goal outlined in WAC 222-30-010(2), which seeks to "protect aquatic resources and related habitat to achieve restoration of riparian function; and the maintenance of these resources once they are restored." To harvest in the inner zone, adequate shade must be present based on the guidelines outlined in WAC 222-30-040. Furthermore, harvest is permitted within the inner zone of an RMZ adjacent to a Type S or F[1] water in Western Washington only if the timber stand exceeds the "stand requirements" described in WAC 222-30-021(1). To determine inner zone harvest opportunity, detailed tree data must be entered into the WDNR Desired Future Condition Worksheet (WDNR 2009) for each stream segment within the reservoir footprint. If inner zone harvest is permitted, trees can be harvested using one of two options: thinning from below or leaving trees closest to the water.

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[1] Type S waters means all waters, within their bankfull width, that are inventoried as "shorelines of the state" under chapter 90.58 RCW. The segments of the Chehalis River, Crim Creek, and Rogers Creek that occur in the Project area are designated as Type S waters. Type F waters means segments of natural waters other than Type S Waters that are known to be used by fish, or meet the physical criteria to be potentially used by fish per WAC 222-16-030. For the purposes of this Conceptual VMP, it is assumed that all waters within the temporary reservoir area are Type S or Type F waters. Stream typing will be refined and confirmed with WDNR and WDFW during the permitting phase of the Project.

For the purposes of this VMP, the option to thin from below will be used as feasible, as this option reduces the amount of woody debris that could come loose and damage dam facilities following prolonged inundation, starting with smaller-diameter trees. Under this option, thinning must retain a minimum of 57 conifer trees per acre. Since the Chehalis River is more than 10 feet wide, the inner zone varies from 33 to 78 feet wide, depending on site class (WAC 222-30-021(I); Table 5).

Using the option of thinning from below in the inner zone, the outer zone width will vary depending on stream width and site class, outlined in Table 5. Timber harvest in the outer zone must leave 20 conifer riparian-leave trees per acre after harvest, either dispersed or clumped. Riparian-leave trees must be at least 12 inches diameter at breast height (dbh) and must be left uncut throughout all future harvests (WAC 222-30-021(1)(c)).

Table 5. Riparian Management Zone (RMZ) Widths in the Project Area[a]

Site Class[b]	RMZ Width	Core Zone Width[c]	Inner Zone Width[d]		Outer Zone Width[e]	
			Stream bankfull width ≤ 10 feet	Stream bankfull width > 10 feet	Stream bankfull width ≤ 10 feet	Stream bankfull width > 10 feet
II	170 feet	50 feet	63 feet	78 feet	57 feet	42 feet
III	140 feet	50 feet	43 feet	55 feet	47 feet	35 feet
IV	110 feet	50 feet	23 feet	33 feet	37 feet	27 feet
V	90 feet	50 feet	10 feet	18 feet	30 feet	22 feet

[a] RMZ widths from WAC 222-30-021(1)(b)(ii)(B)(1). For the purposes of this Conceptual VMP, the following are assumed: (1) all waters within the temporary reservoir area are Type S or Type F waters and (2) thinning from below in the inner zone is the treatment for tree harvest that will be required within the 50-foot core zone. Stream typing will be refined and confirmed with WDNR and WDFW during the permitting phase of the Project.

[b] Site Class I not present in project study area.

[c] Core zone measured from outer edge of bankfull width or outer edge of CMZ of water (WAC 222-16-010).

[d] Inner zone measured from outer edge of core zone to the outer limit of the inner zone.

[e] Outer zone measured from outer edge of inner zone to outer limit of the RMZ.

5.1.1.1.2 Wetland Management Zone

Selective tree harvest occurring near wetlands is also subject to wetland management zone (WMZ) requirements outlined in WAC 222-30-020 and WAC 222-16-035. The width of the WMZ is determined based on the size of the wetland and the wetland type, as described in WAC 222-30-020. Under the Washington State Forest Practices Rules, wetlands that require protection are categorized as Type A (nonforested), Type B (nonforested), or Forested Wetlands, defined below per WAC 222-16-035:

- **Nonforested wetlands** means any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of less than 30%.
    - **Type A Wetland** classification applies to all nonforested wetlands that are greater than 0.5 acre in size, including acreage of open water where the water is completely surrounded by

the wetland; and are associated with at least 0.5 acre of ponded or standing open water. The open water must be present on the site for at least 7 consecutive days between April 1 and October 1 to be considered for the purposes of these rules.

   - **Type B Wetland** classification applies to all other nonforested wetlands greater than 0.25 acre.

- **Forested wetland** means any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of 30% or more.

WMZ protection applies to Type A and Type B wetlands, and is measured horizontally from the wetland edge or the point where a nonforested wetland becomes a forested wetland (WAC 222-30-020(8)). The WMZ width for Type A wetlands ranges from 25 to 200 feet, depending on wetland size and if the wetland meets the definition of a bog. For Type B wetlands with more than 0.5 acre of nonforested wetland, the WMZ width ranges from 25 to 100 feet; no WMZ is required for Type B wetlands with less than 0.5 acre of nonforested wetland (WAC 222-30-020). No WMZ is required for forested wetlands; however, unless otherwise approved in writing by WDNR, harvest methods shall be limited to low-impact harvest or cable systems (WAC 222-30-020(7)).

In Western Washington, a total of 75 trees greater than 6 inches dbh must be left per acre of WMZ (WAC 222-30-020(8)(b)). Of these, 25 trees must be greater than 12 inches dbh and 5 must be greater than 20 inches dbh. Furthermore, ground-based equipment cannot be used within the minimum WMZ without written permission from WDNR (WAC 222-30-020(8)(e)). In areas where WMZ and RMZ protections overlap, the one providing the most protection to the resource shall be used (WAC 222-30-020(8)).

5.1.1.1.3 Other Considerations for Tree Removal

The Forest Practices Rules stipulate that no harvest or construction is permitted within the boundaries of a channel migration zone or within the bankfull width of any Type S or F water (WAC 222-30-020). There are also minimum shade requirements to prevent excessive increases in water temperature within a proposed harvest area. Shade requirements outlined in WAC 222-30-040 must be met regardless of harvest opportunities provided in the inner zone RMZ rules (WDNR 2000; WAC 222-30-021). Based on regional water temperature characteristics and the elevation of the Chehalis River and the tributaries where selective tree harvest is proposed, a minimum of 75% tree canopy cover is required after harvest (WDNR 2000, 2019; WAC 222-30-040(2)).

Landowners are also required to leave a minimum number and size of trees and down logs to provide current and future wildlife habitat within the harvest area. In Western Washington, for each acre of timber harvested, three wildlife reserve trees, two green recruitment trees, and two down logs must be left after harvest (Table 6; WAC 222-30-020(12)(b)). Wildlife reserve trees are defined as defective, dead, damaged, or dying trees that provide or have the potential to provide habitat for those wildlife species dependent on standing trees (WAC 222-16-010). Green recruitment trees are trees left after harvest for the purpose of becoming future wildlife reserve trees under WAC 222-30-020(12).

As outlined in Table 6, wildlife reserve trees must be at least 10 feet in height and 12 or more inches dbh to be counted toward wildlife reserve tree retention requirements (WAC 222-30-020(12)(c)). Green recruitment trees must be at least 10 inches dbh and 30 feet in height, with at least one-third of their height in live crown to be counted toward green recruitment tree requirements (WAC 222-30-020(12)(c)). Large, live defective trees with broken tops, cavities, or other severe defects are preferred as green recruitment trees. Down logs must have a small end diameter greater than or equal to 12 inches and a length greater than or equal to 20 feet or equivalent volume to be counted.

Table 6. Requirements for Retaining Leave Trees and Down Logs in Western Washington

Wildlife Tree Type	Number per acre	Minimum Height	Minimum Diameter
Wildlife Reserve Tree	3	10 feet	12 inches dbh
Down Log	2	20 feet	12 inches dbh at small end
Green Recruitment	2	30 feet with 1/3 live crown	10 inches dbh

Source: WAC 222-30-020(12).

To facilitate safe and efficient harvesting operations, wildlife reserve trees and green recruitment trees may be left in clumps. For the purposes of distribution, no point within the harvest unit shall be more than 800 feet from a wildlife reserve tree or green recruitment tree retention area (WAC 222-30-020(12)(e)).

5.1.2 Pre-Construction Vegetation Removal Goals and Objectives

The following goals and objectives for pre-construction vegetation removal have been established to minimize impacts on environmental resources in the Project area while meeting the safety and operational needs of the FRE facility.

5.1.2.1 Goal 1: Reduce potential for future damage to dam facilities and ensure safety of dam operations personnel.

Objective: Completely clear woody vegetation from the dam site and from any areas where temporary construction and associated access and staging will be required.

Objective: Remove vegetation that could pose a hazard to dam operations personnel, especially those responsible for wood material collection and transport.

Objective: Avoid burning of all cleared vegetation.

5.1.2.2 Goal 2: Harvest marketable timber in areas where projected inundation depths and durations would be expected to kill tree species that do not tolerate extended flooding or submersion.

Objective: Coordinate with landowners and WDNR to allow for removal of trees within RMZs along the Chehalis River and tributaries in the reservoir footprint.

Objective: Remove all tree species that are not highly flood-tolerant (all tree species except for willows and black cottonwood) in the Debris Management Evacuation area (Figure 3).

Clearly mark highly flood-tolerant trees that are designated to be retained.

Objective: Remove all trees in the Final Reservoir Evacuation area.

Objective: Avoid disturbing understory upland vegetation.

Objective: Harvest trees so as to retain stumps in order to minimize ground disturbance and potential sedimentation.

Objective: Avoid burning of all removed trees.

5.1.2.3 Goal 3: Harvest timber in a manner to avoid and minimize impacts to aquatic and riparian functions along the Chehalis River and its tributaries in the reservoir footprint.

Objective: Apply applicable BMPs as described in WAC 222-30-030 through 222-30-090 to all waterbodies and riparian management zones. Key BMPs include, but are not limited to:

(1) Avoid disturbing understory riparian vegetation.

(2) Avoid disturbing stumps and root systems and any logs embedded in the bank.

(3) Leave high stumps where necessary to prevent felled and bucked timber from entering the water.

(4) Leave any retained trees that display large root systems embedded in the bank.

(5) Use reasonable care during timber yarding to minimize damage to the vegetation providing shade to the stream or open water areas and to minimize disturbance to understory vegetation, stumps, and root systems.

(6) Minimize the release of sediment to waters downstream from the yarding activity.

5.1.2.4 Goal 4: Harvest timber in a manner to avoid and minimize impacts to wetland functions in the temporary reservoir footprint to the extent practical.

Objective: Apply applicable BMPs as described in WAC 222-30-030 through 222-30-090 to all wetlands and wetland management zones. Key BMPs include, but are not limited to:

(1) Avoid disturbing understory wetland vegetation.

(2) Avoid cable yarding timber in or across Type A or B wetlands except with approval by the WDNR.

(3) Minimize the release of sediment to waters downstream from the yarding activity.

5.1.2.5 Goal 5: Minimize temporal loss of tree canopy in the temporary reservoir footprint.

Objective: 20% of the proposed selective tree harvest would occur each construction year over the five-year construction period. Selective tree harvest would be sequenced such that trees within the Riparian Management Zones of the Chehalis River and its tributaries (Figure 4) are harvested last.

Objective: Replace trees removed each construction year at a 1:1 ratio with tree saplings. Replaced trees will be planted during the planting season (October-March) immediately following tree harvest. Tree species selection will be based on the reservoir evacuation area where replanting is needed (Table 7 in Section 6.4.2.1).

5.2 Facility Operations Selective Tree Harvest Plan

5.2.1 Monitoring Methods

During facility operations, trees in the temporary reservoir area would be monitored for significant stress and mortality in areas where selective harvest was not conducted prior to construction. Flood stress in plants can cause yellowing or browning of leaves, curled leaves, leaf wilt and drop, reduced size of new leaves, early fall color, branch dieback, the formation of sprouts along stems or trunk, and greater susceptibility to harmful organisms such as canker fungi and insects (Jull 2008). There would be uncertainty in predicting an elevation at which trees would likely be severely stressed or killed once the FRE facility is activated during major flood events. The uncertainty is due in part to the unpredictable nature of flood events and in part to the difficulty in predicting how individual trees will respond to inundation.

Trees in the FRE temporary reservoir should be monitored by a forester or other WDNR-approved professional annually and after periods of prolonged inundation for signs of flood stress. Unhealthy and dead trees should be marked and removed on an as-needed basis to eliminate potential risks to dam operations personnel and facility infrastructure. Monitoring efforts should also evaluate the reestablishment of tree species in areas where selective harvest was conducted prior to construction (i.e., Debris Management Evacuation and Final Reservoir Evacuation areas).

Since a small portion of trees must be left in place in the Debris Management Evacuation and Final Reservoir Evacuation areas to comply with Forest Practices Rules, it is anticipated that a number of these trees will experience significant stress and mortality. Leave trees in the RMZ and WMZ and those selected to serve as wildlife habitat should be identified and evaluated annually and after periods of prolonged inundation. These trees should be removed if they become a safety hazard or pose a risk of damage to dam facilities.

5.2.2 Facility Operations Selective Tree Harvest Plan

The FCZD proposes that every 7 to 10 years, trees that are not highly tolerant of flooding (all tree species except for willows and black cottonwood) larger than 6 inches in diameter within the Debris Management Evacuation area and all trees in the Final Reservoir Evacuation area be removed to reduce accumulation of woody material at the FRE conduits. Tree harvest conducted during facility operations would be subject to the Forest Practices Rules outlined in Section 5.1.1.1, and would adhere to pre-construction vegetation removal Goals and Objectives described in Section 5.1.2.

6.0 Conceptual Adaptive Management Plan

6.1 Overview

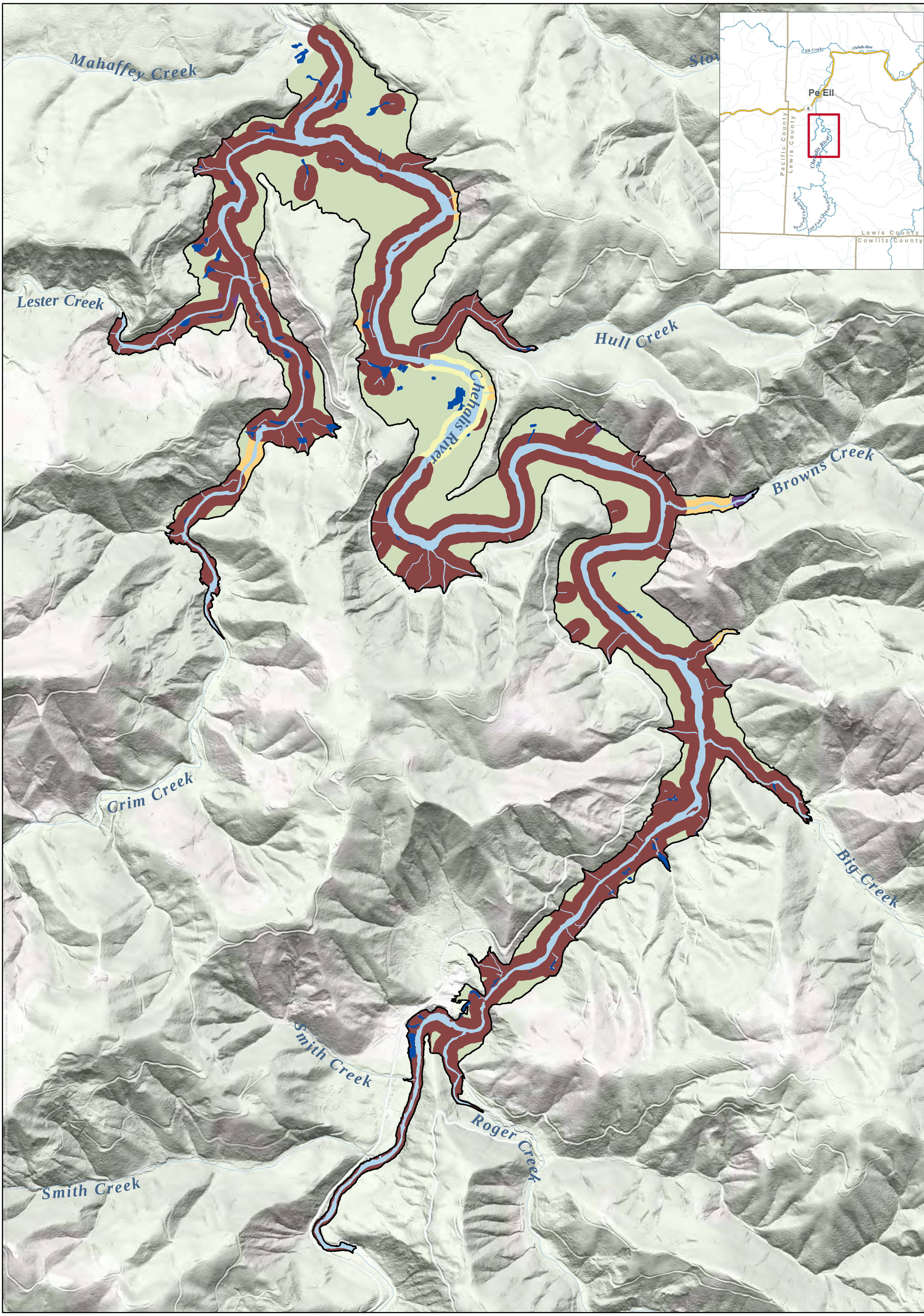
As described in Chapter 5, the FCZD anticipates that an Alternate Plan will need to be developed with an Interdisciplinary Team in order to acquire a Forest Practices Permit from WDNR since tree harvest activities during pre-construction and facility operation would likely vary from prescribed Forest Practices Rules. Therefore, the framework of the adaptive management plan focuses primarily on criteria that would be required for an Alternate Plan.

This adaptive management plan addresses how uncertainties regarding the frequency, duration, and intensity of future flood events and resulting impacts to vegetation will be considered in order to inform the management of vegetation in the reservoir footprint. For the purposes of this plan, "adaptive management" refers to actions taken as part of the project to:

- Establish long-term ecological goals and objectives to avoid and minimize long-term impacts to riparian, wetland, and upland habitats;
- Identify uncertainties associated with future flood events and potential impacts to vegetation in the temporary reservoir footprint;
- Identify potential problems, possible solutions, and site management adjustments to rectify foreseeable issues based on results of long-term monitoring;
- Provide contingency plans if needed for proposed vegetation management; and
- Serve as part of the feedback loop between vegetation monitoring and management actions that will lead to appropriate adjustment.

Figure 4 delineates proposed zones for which pre-construction monitoring, adaptive management goals and objectives, and replanting treatments will be applied:

- Riparian Vegetation Management Zone (RMZ): these zones are established based on the RMZ widths outlined in Section 5.1.1.1. The RMZ's would encompass approximately 16.3 river miles of streams and 444 acres of adjoining riparian lands.
- Wetland Vegetation Management Zone: these zones are established based on wetlands identified and delineated by Anchor QEA (2018).
- Upland Vegetation Management Zone: remaining lands within the FRE temporary reservoir extent that are not wetlands, waterbodies, or RMZs.



Source: Landcover, FRE Facility - HDR; Streams - DNR; Basemap - ESRI Online; Hillshade - DNR LiDAR Portal

Streams

Maximum Inundation Limit

Vegetation Management Zones

Upland Vegetation Management Zones

Wetland Vegetation Management Zones

Riparian Vegetation Management Zones

WDNR Site Class

II (RMZ 170 ft wide)

III (RMZ 140 ft wide)

IV (RMZ 110 ft wide)

VIII (RMZ 90 ft wide)

N

0 1,000 2,000

Feet

FIGURE 4: VEGETATION MANAGEMENT ZONES

Chehalis River Basin Flood Damage Reduction Project

Date: 10/5/2020

The conceptual adaptive management plan described below presents basic plan elements that will be developed in more detail into a Final Adaptive Management Plan in coordination with the Project's WDNR Interdisciplinary Team once permitting is underway.

6.2 Pre-Construction Monitoring

Monitoring will be conducted throughout the FRE Temporary Reservoir to document pre-construction riparian functions, wetland management zone conditions, and upland habitat conditions as they pertain to vegetation community composition.

6.2.1.1 Methods

6.2.1.1.1 Riparian Functions

Pre-construction riparian functions will be documented along the Riparian Management Zones of streams in the FRE temporary reservoir footprint (Figure 4). The following functions will be assessed using the "Assessing Riparian Function" guidelines presented in Section 21, Guidelines for Alternate Plans, in the *Forest Practices Board Manual* (WDNR 2000):

- Stream shading
- Stream bank stability
- Woody debris availability and recruitment
- Sediment filtering
- Nutrients and leaf litter fall

6.2.1.1.2 Wetland Management Zone Existing Conditions

Pre-construction monitoring of wetland management zones in the FRE temporary reservoir footprint shall be coordinated with the wetland impact analyses required for federal, state, and local wetland permitting. Pre-construction wetland functions have been documented in the Anchor QEA (2018) *Wetland, Water, and Ordinary High Water Mark Delineation Report.* Pre-construction monitoring will confirm status of wetland functions as they pertain to vegetation communities, as documented in the delineation report.

6.2.1.1.3 Uplands Existing Conditions

Pre-construction monitoring of uplands in the FRE temporary reservoir footprint will evaluate the condition and extent of upland habitats as presented in Section 3.1. Similar desktop and field reconnaissance methods will be utilized to confirm current upland habitat conditions. Pre-construction monitoring of upland conditions will be conducted in conjunction with the pre-construction marbled murrelet nesting habitat suitability surveys described in the *DRAFT Biological Assessment and Essential Fish Habitat Assessment – Chehalis River Basin Flood Damage Reduction Project: Flood Retention Facility, Airport Levee Improvements, and Mitigation Actions* (HDR 2020).

6.2.1.2 Monitoring Schedule

Pre-construction monitoring should be conducted once, 1 to 2 years prior to start of construction activities during the growing season.

6.3 Adaptive Management Goals and Objectives

Adaptive Management Goals describe the overall intent of the adaptive management plan; Adaptive Management Objectives describe individual components of the adaptive management plan designed to achieve the goals. Performance standards, which identify measurable, quantifiable indicators of performance relative to the restoration goals and objectives, will be developed as part of the final VMP once proposed goals and objectives are confirmed with the Interdisciplinary Team during permitting.

6.3.1 Goals and Objectives

6.3.1.1 Goal 1: Maintain the minimal acceptable level of riparian function in the temporary FRE reservoir footprint compared to pre-construction conditions.

Objective: Maintain the following functions in Riparian Management Zones at the minimal acceptable level as determined with the Interdisciplinary Team:

(1) Stream shading

(2) Stream bank stability

(3) Woody debris availability and recruitment

(4) Sediment filtering

(5) Nutrients and leaf litter fall

6.3.1.2 Goal 2: Minimize loss of tree and shrub wetland vegetation communities in the FRE temporary reservoir compared to pre-construction conditions.

Objective: The net acreage of wetlands identified as forested wetlands during pre-construction monitoring shall be retained as forested or forested, scrub-shrub wetlands per the definitions in Cowardin et al. (1979).

Objective: There will be no net loss of acreage of scrub-shrub wetlands as defined by Cowardin et al. (1979) pre-construction monitoring.

6.3.1.3 Goal 3: Minimize loss of forested and shrub upland vegetation communities in the Upland Vegetation Management Zones compared to pre-construction conditions.

Objective: The net acreage of forested upland vegetation communities quantified during the pre-construction monitoring shall not degrade to a condition below shrubland.

Objective: There will be no net loss of acreage of shrubland vegetation communities quantified during pre-construction monitoring.

6.3.1.4 Goal 4: Limit the establishment of noxious and invasive weeds throughout the FRE

temporary reservoir footprint following periods of prolonged inundation.

Objective: Eradicate all Class A weeds and control selected Class B weeds on Lewis County's noxious weed list (2020) if identified in the reservoir footprint.

6.4 Adaptive Management Monitoring

6.4.1 Methods

Long-term monitoring will be conducted annually to evaluate vegetation conditions in the FRE temporary reservoir footprint during FRE facility operations, especially following periods of prolonged inundation. Monitoring efforts will focus on evaluating whether performance standards are being met; performance standards will be identified in the final VMP. The monitoring phase of the project is expected to consist of iterative and corrective measures, such as removing invasive species, and is expected to occur for the lifetime of the FRE facility operations. Performance standards will be identified in the final VMP.

6.4.2 Revegetation Guidelines

This section presents concepts for potential revegetation treatments if long-term adaptive management goals and objectives are not being met. Detailed planting plans are not proposed to be developed at this time, since the actual frequency, intensity, and extent of flood events over time will determine which areas need to be revegetated and cannot be predicted during the design phase. It is anticipated that some areas that are subject to more frequent flooding may need to be revegetated soon after start of facility operations to allow establishment of more flood-tolerant species. Conversely, some vegetation communities will likely show slower transition over time and not need immediate or whole-scale revegetation efforts.

6.4.2.1 Conceptual Plant Palette

Areas within the FRE temporary reservoir that are determined to require revegetation with trees and/or shrubs will need to be primarily assessed based on the evacuation area where revegetation is needed, as duration, extent, and frequency of flooding will be the primary drivers for survival of vegetation in replanted areas. Therefore, the plant palettes presented below are based on respective evacuation zones as opposed to specific Vegetation Management Zones. Revegetation in the Debris Management Evacuation and Final Reservoir Evacuation areas likely will experience more prolonged and deeper flooding after major flood events, and therefore will require revegetation with more flood- tolerant species. The Initial Reservoir Evacuation area will experience shorter, shallower periods of flooding and therefore moderately flood-tolerant species are expected to survive in this zone. Plant species identified in Section 4.2.2 and other flood-tolerant native species found in wetlands in the study area (Anchor QEA 2018) have been selected for proposed plant palettes by replanting zone (see Table 7).

Table 7. Proposed Plant Palette by Replanting Zone

Replanting Zone	Scientific Name	Common Name
Initial Evacuation Area	***Trees***	
	Alnus rubra	Red alder
	Picea sitchensis	Sitka spruce
	Thuja plicata	Western red cedar
	Shrubs	
	Acer circinatum	Vine maple
	Oemleria cerasiformis	Indian plum
	Frangula purshiana	Cascara
	Rubus spectabilis	Salmonberry
	Sambucus racemosa	Red elderberry
	Symphoricarpos albus	Snowberry
Debris Management Evacuation Area	***Trees***	
	Fraxinus latifolia	Oregon ash
	Populus balsamifera	Black cottonwood
	Salix lasiandra	Pacific willow
	Shrubs	
	Cornus alba	Red-osier dogwood
	Lonicera involucrata	Twinberry
	Rubus spectabilis	Salmonberry
	Rosa nutkana	Nootka rose
	Rubus parviflorus	Thimbleberry
	Rubus spectabilis	Salmonberry
Final Reservoir Evacuation Area	***Trees***	
	Salix lasiandra	Pacific willow
	Shrubs	
	Cornus alba	Red-osier dogwood
	Salix exigua	Narrow-leaf willow
	Salix hookeriana	Hooker's willow
	Spiraea douglasii	Hardhack

6.4.2.2 Site Preparation and Planting Details

Site preparation will be focused mainly on preparing revegetation areas so that plantings can successfully establish with minimal maintenance, and avoid disturbance to surrounding live vegetation. Site preparation methods shall include use of native soils and stockpiling native soils if necessary, scarifying or disking to break up any compacted soils, and use of compost or other soil amendments to improve soil media.

Plant material will be provided from commercial nurseries. Inspection of all woody plants will be conducted to ensure compliance with the revegetation plan specifications regarding size requirements, root ball mass, and overall health of the plant. Planting zones will be delineated per the revegetation plan, with planting conducted under the supervision of FCZD biologists or other qualified staff. Planting is to occur from October through March, avoiding times of FRE operation.

6.4.3 Contingency Plan

Contingency plans describe what actions can be taken to correct deficiencies in achieving a plan's goals and objectives. The adaptive management plan goals, objectives, and performance standards create a baseline by which to measure whether the site is performing as proposed and whether or not a contingency plan is necessary. All contingencies cannot be anticipated.

The contingency plan will be flexible so that modifications can be made if portions of the adaptive management plan do not produce the desired results. Problems or potential problems will be evaluated by the FCZD and Interdisciplinary Team. Specific contingency actions will be developed, agreed to by consensus, and implemented based on all scientifically and economically feasible recommendations.

Table 8. Potential Contingency Actions for the Vegetation Management Zones

Resource/Issue	Contingency Action [a]
Sites do not meet goals and objectives for scrub-shrub or forested cover	• Revegetate with appropriate woody plant species. • Re-evaluate the suitability of the plant species for site conditions. • Consider use of alternate species. • Undertake additional monitoring.
Over-competition by invasive species	• Identify/Evaluate predominant invasive species in the mitigation areas. • Initiate invasive species control protocols appropriate to species type, conditions of infestation area, and level of infestation (e.g., herbicide application, mowing).

[a] Contingency actions listed are only a subset of potential actions. All contingency actions discussed above should be considered and the appropriate actions taken based on an understanding of the actual causes of poor performance.

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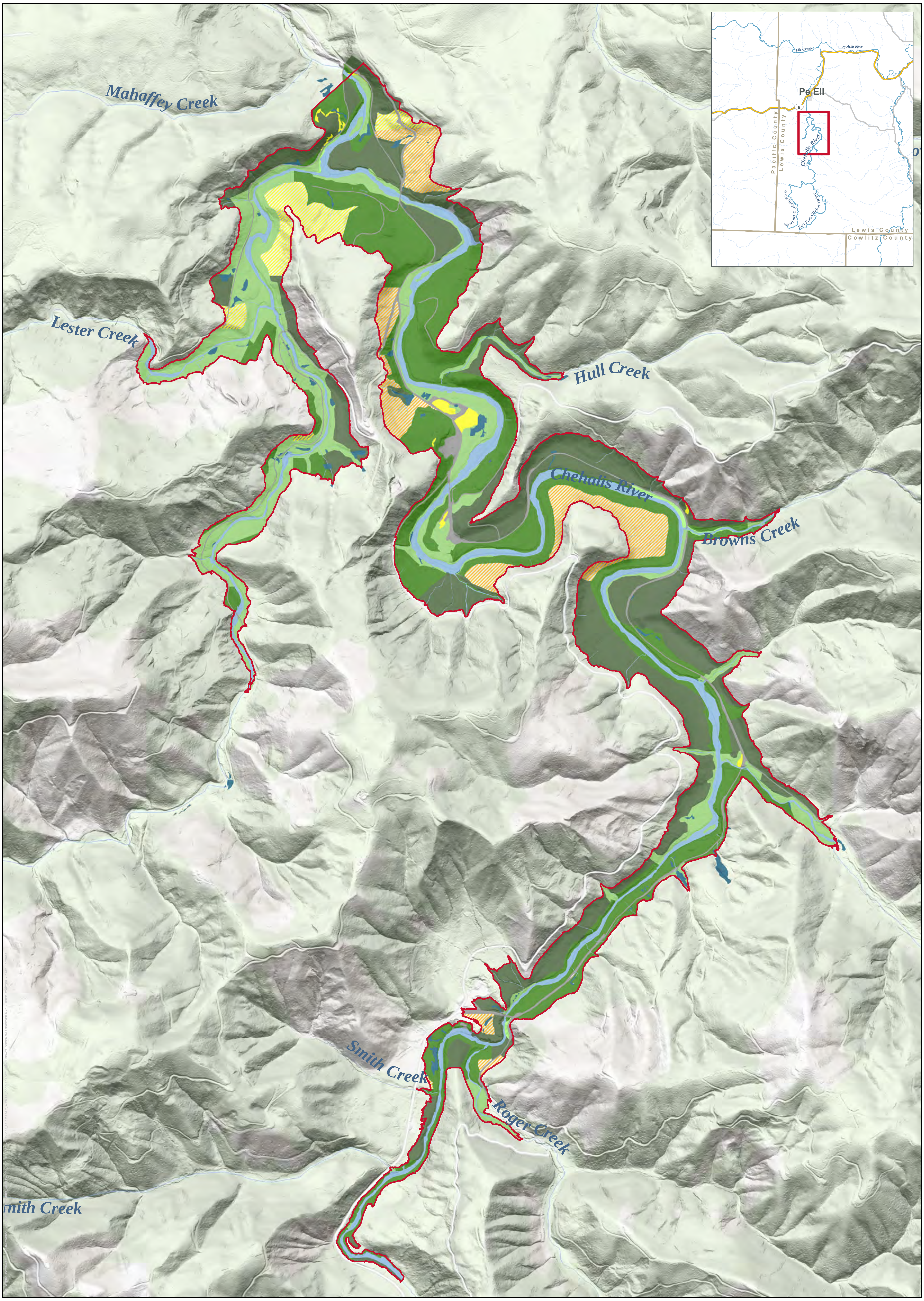
Appendix A. Existing Vegetation Mapping



Source: Landcover, FRE Facility - HDR; Streams - DNR; Basemap - ESRI Online; Hillshade - DNR LiDAR Portal

Landcover

- Coniferous Forest
- Mixed Coniferous/Deciduous Transitional Forest
- Deciduous Riparian Forest w/some Conifers
- Deciduous Riparian Shrubland
- Herbaceous/Grass
- Wetland
- Logged, replanted 5-15+ years
- Logged, replanted 0-5 years
- Open Water/Sand Bar
- Terrestrial Bare Ground/Roads
- Streams
- Study Area (WSEL: 628ft)

N

0 1,000 2,000
Feet

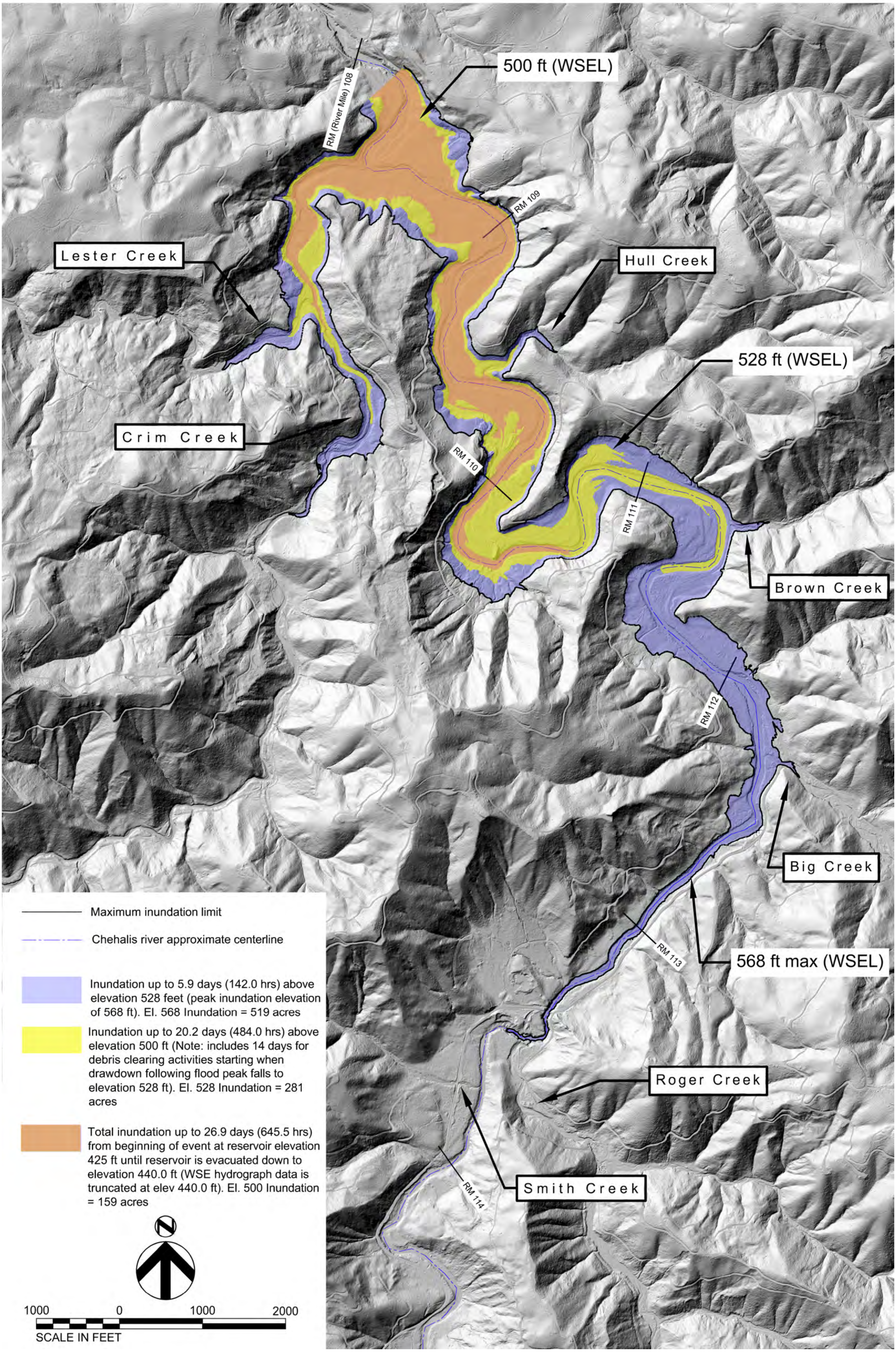
LAND COVER CLASSIFICATION

Chehalis River Basin Flood Damage Reduction Project

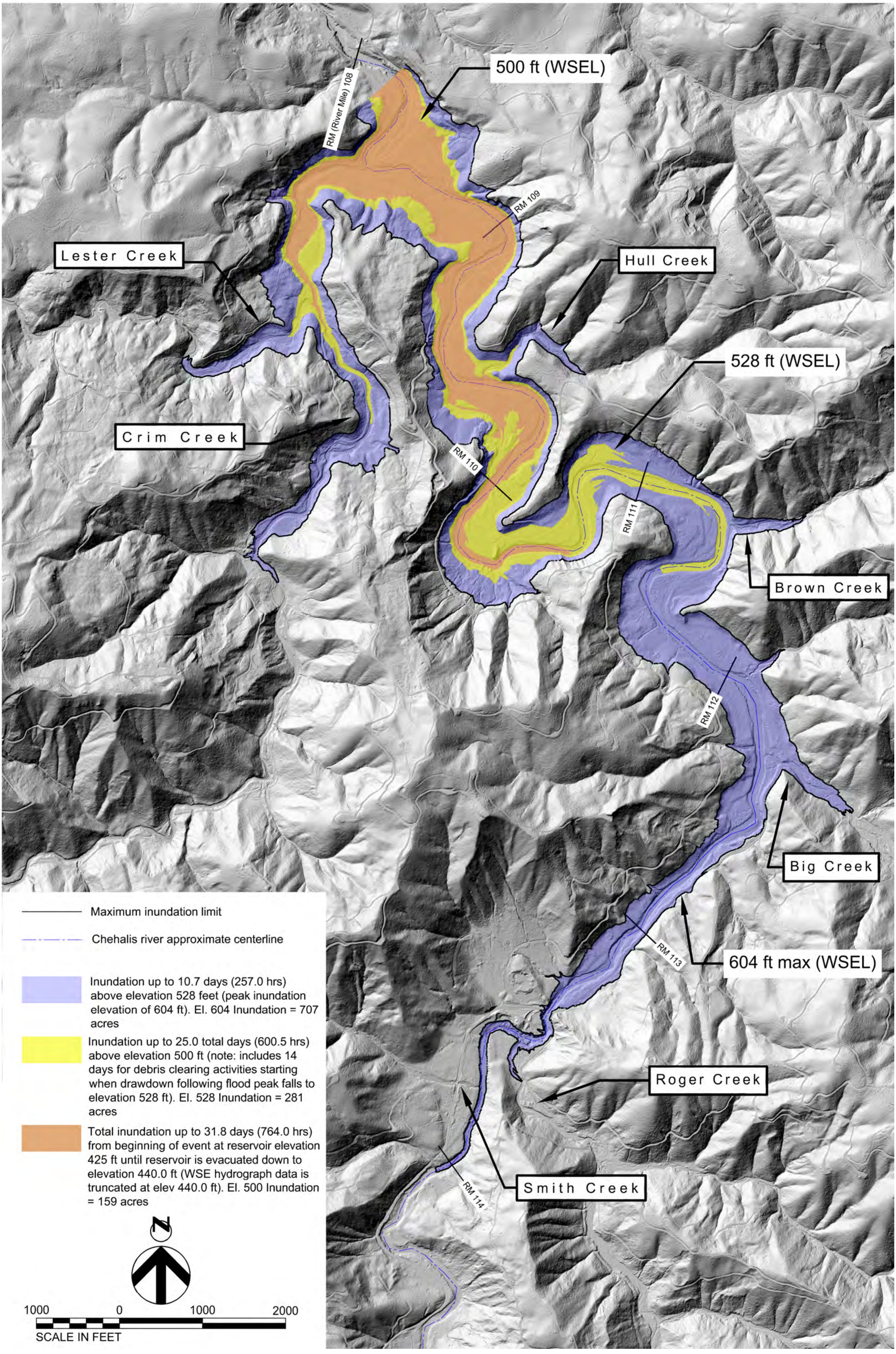
Date: 10/2/2020

Appendix B. Inundation Maps for Historic and Modeled Major Flood Events

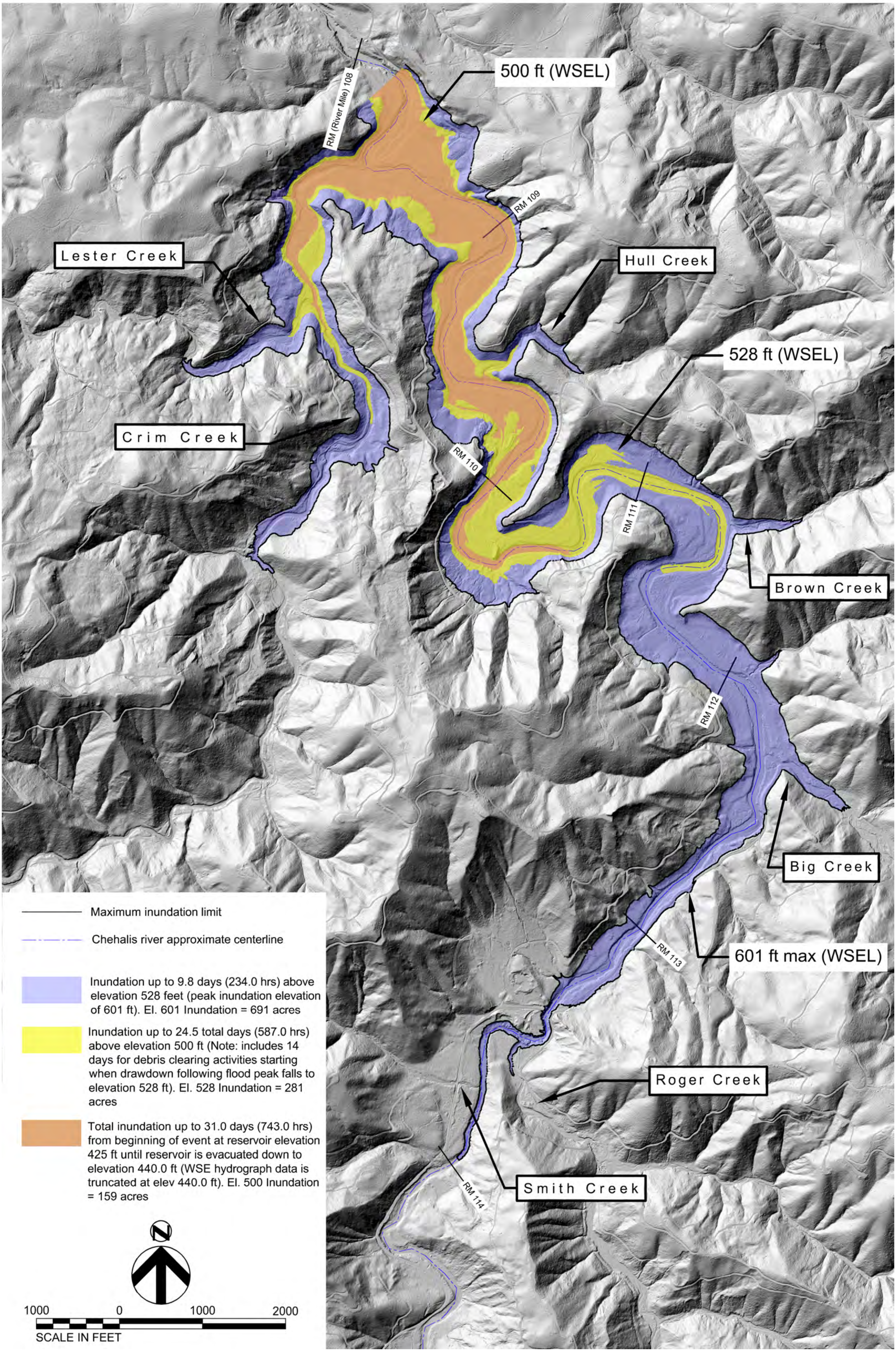
10 Year Event Inundation Map for Proposed Dam (FRE)



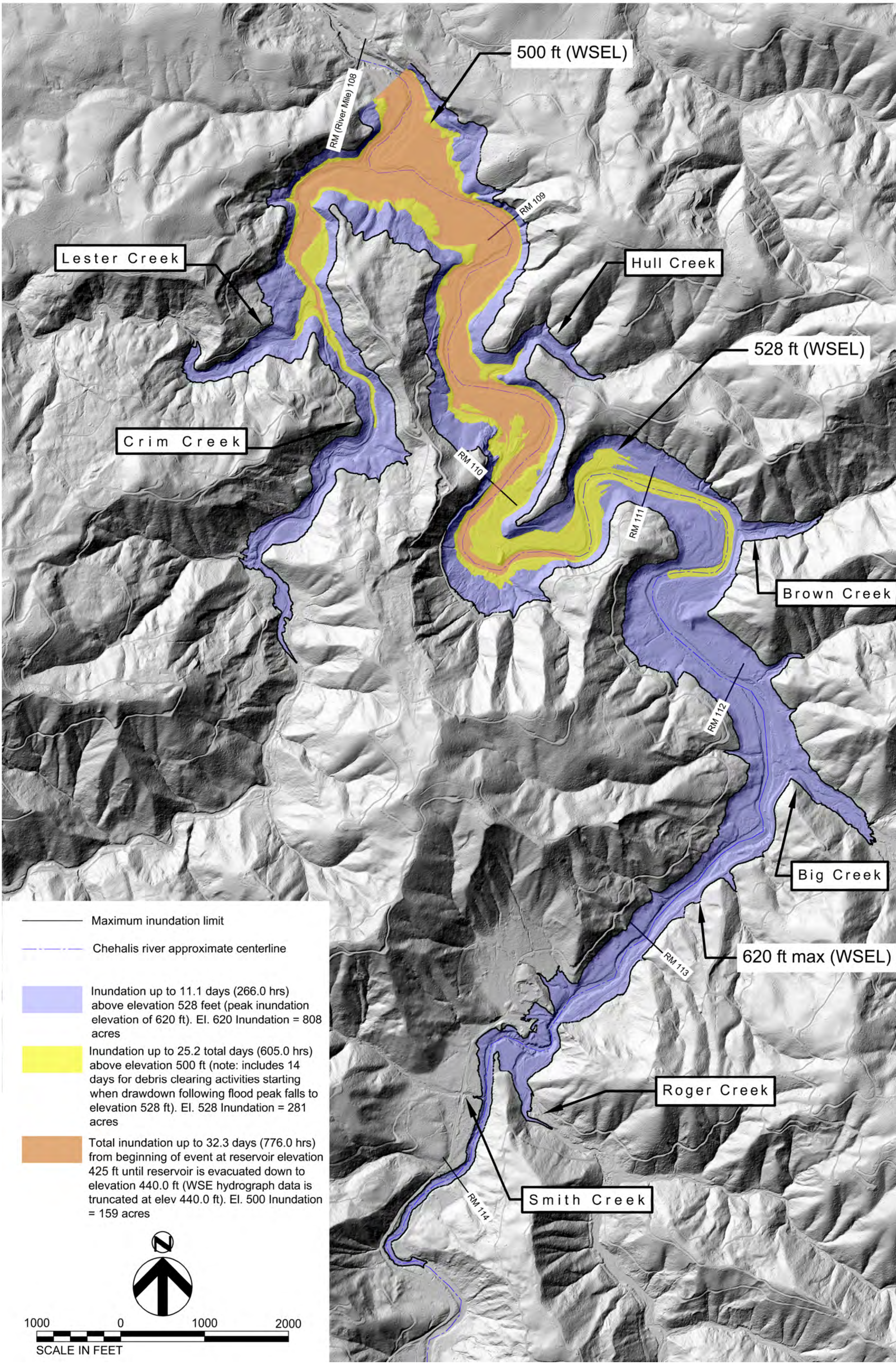
100 Year Event Inundation Map for Proposed Dam (FRE)



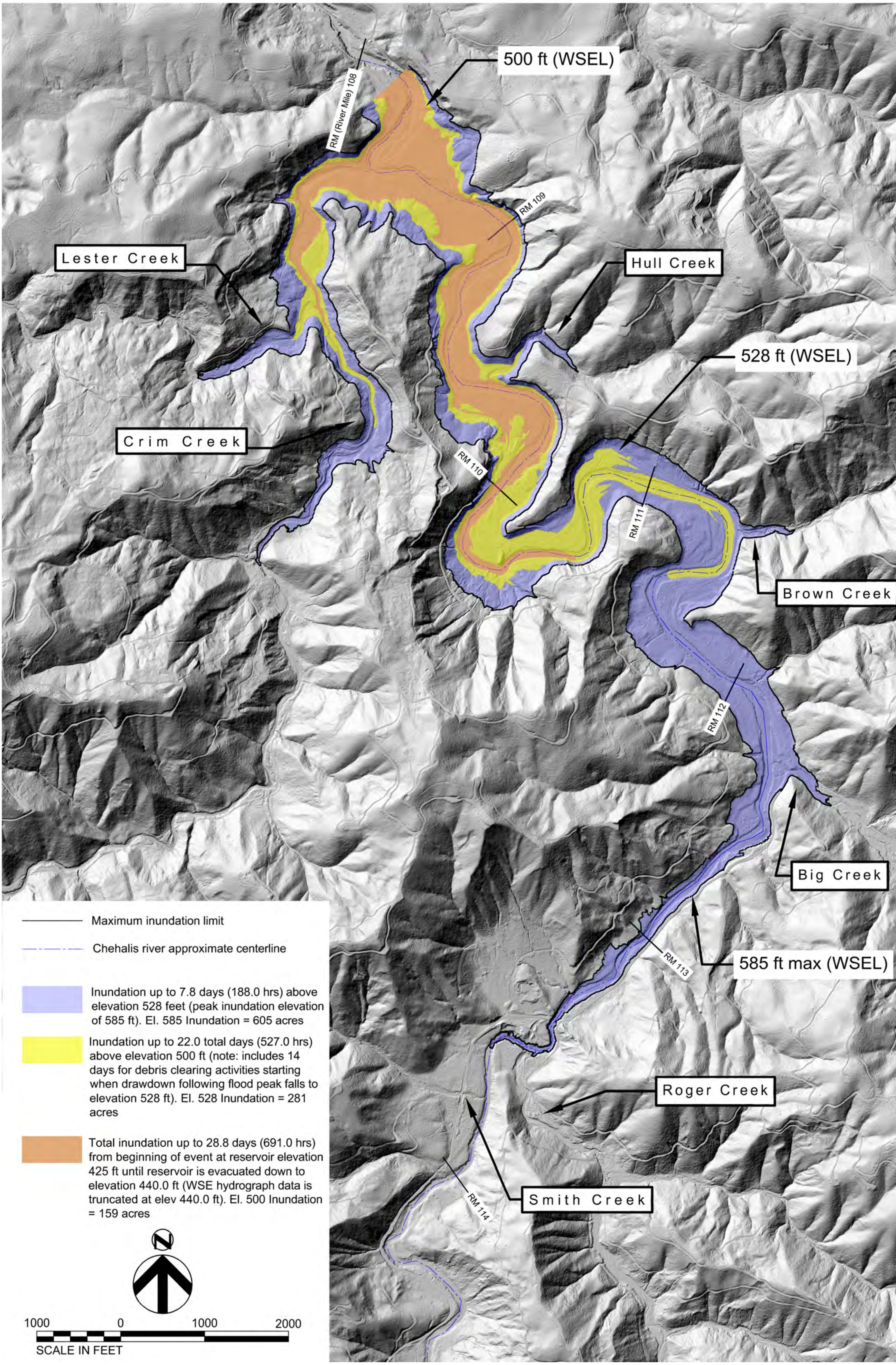
1996 Event Inundation Map for Proposed Dam (FRE)



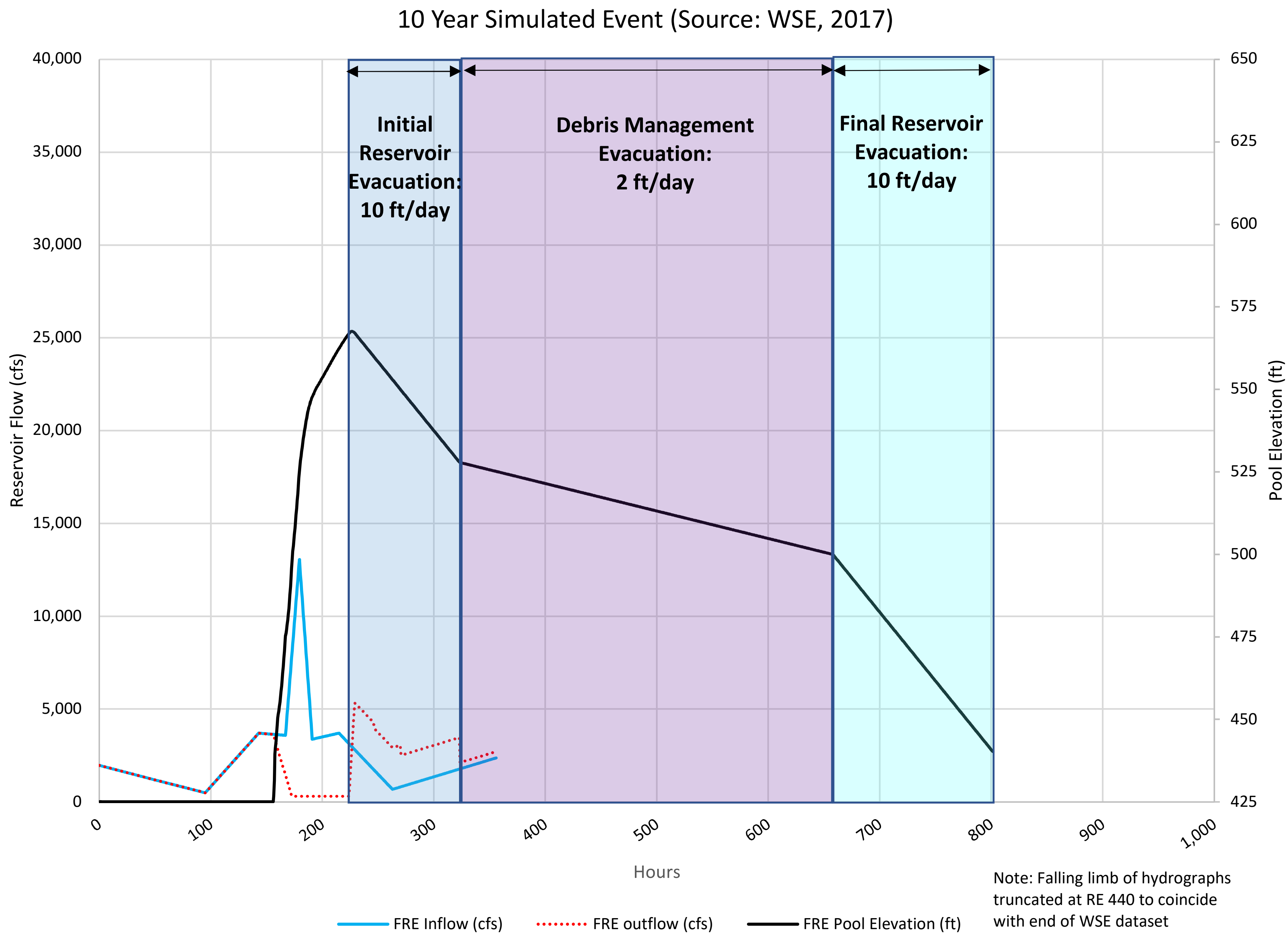
2007 Event Inundation Map for Proposed Dam (FRE)

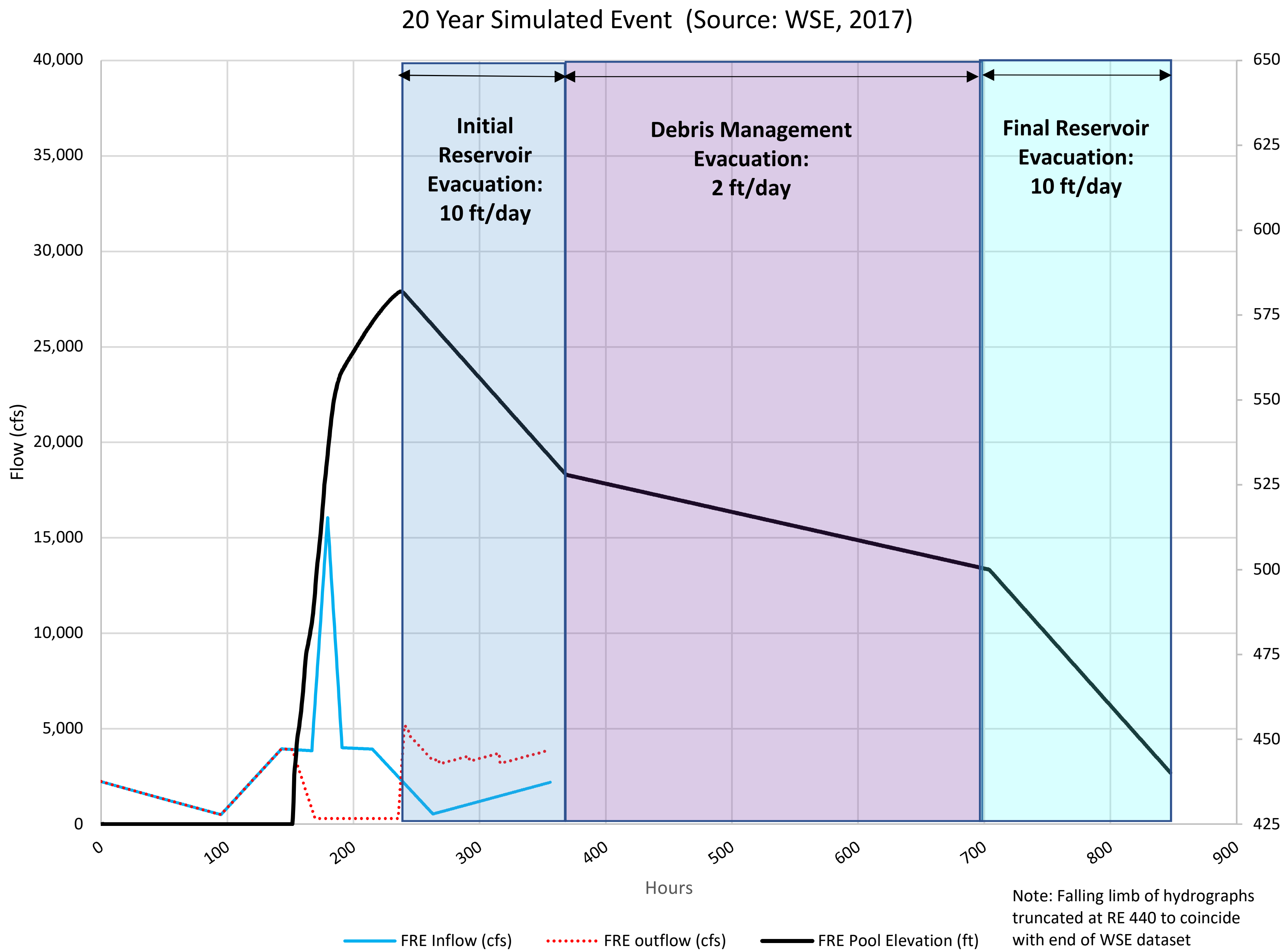


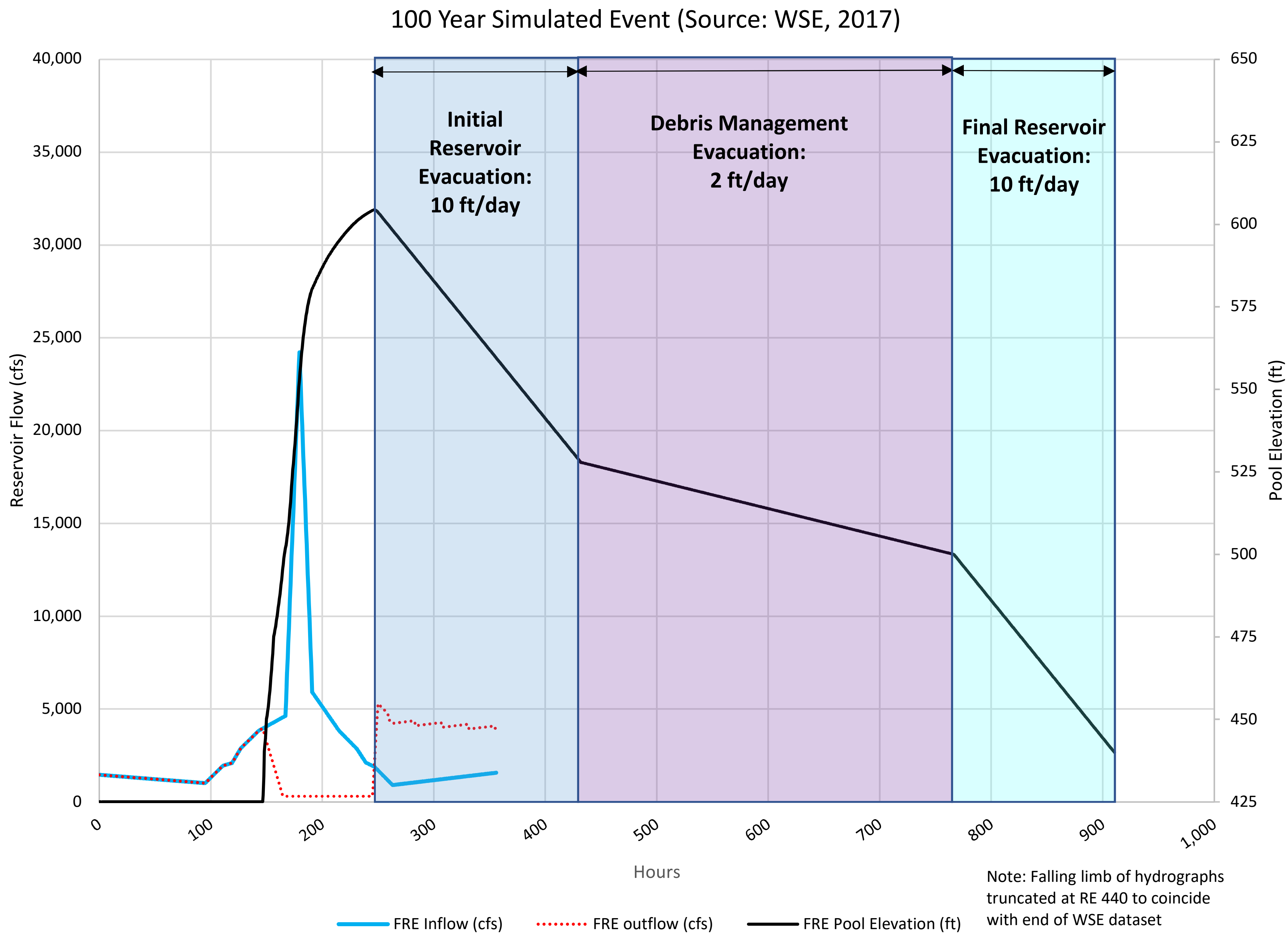
2009 Event Inundation Map for Proposed Dam (FRE)

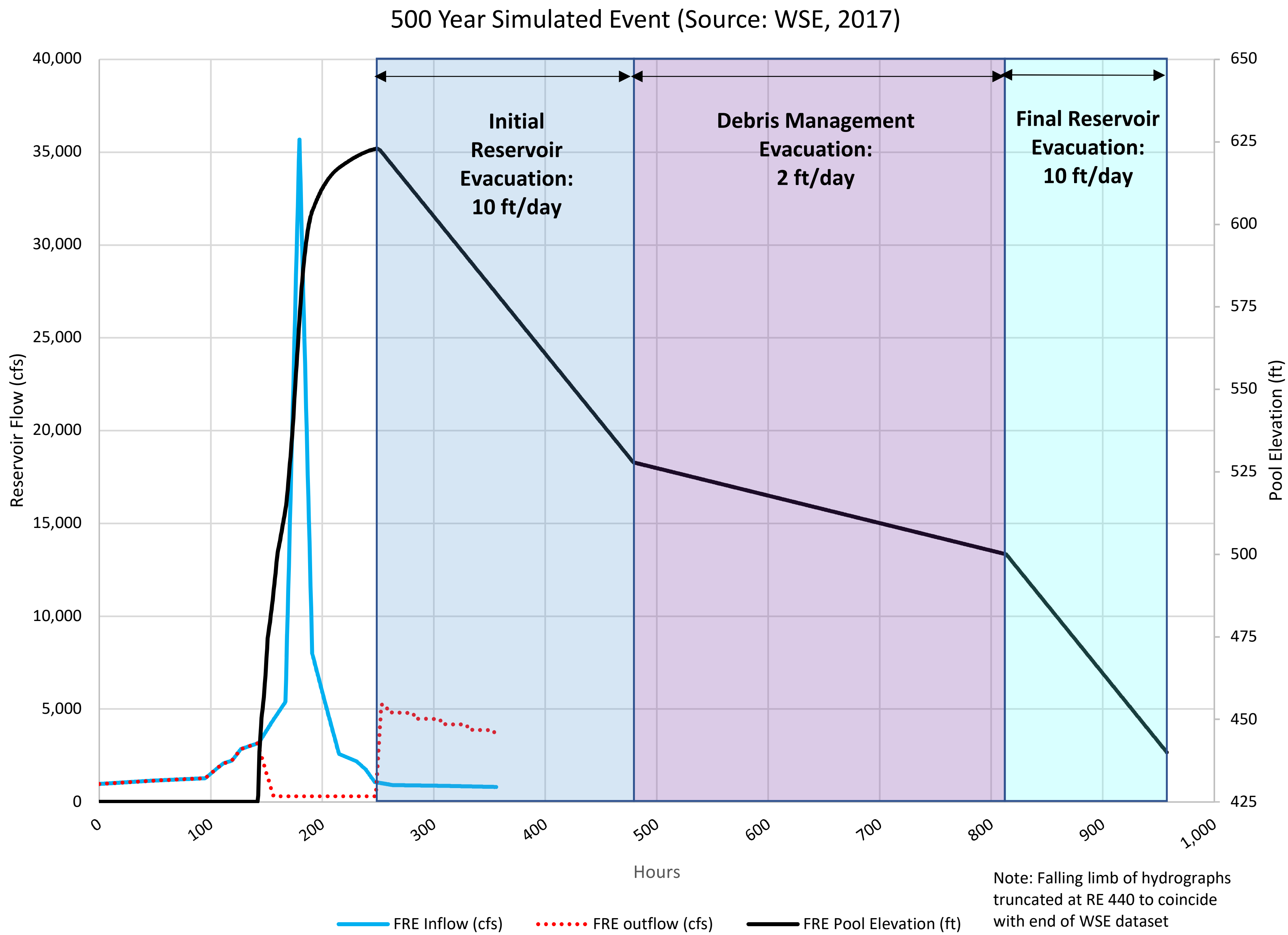


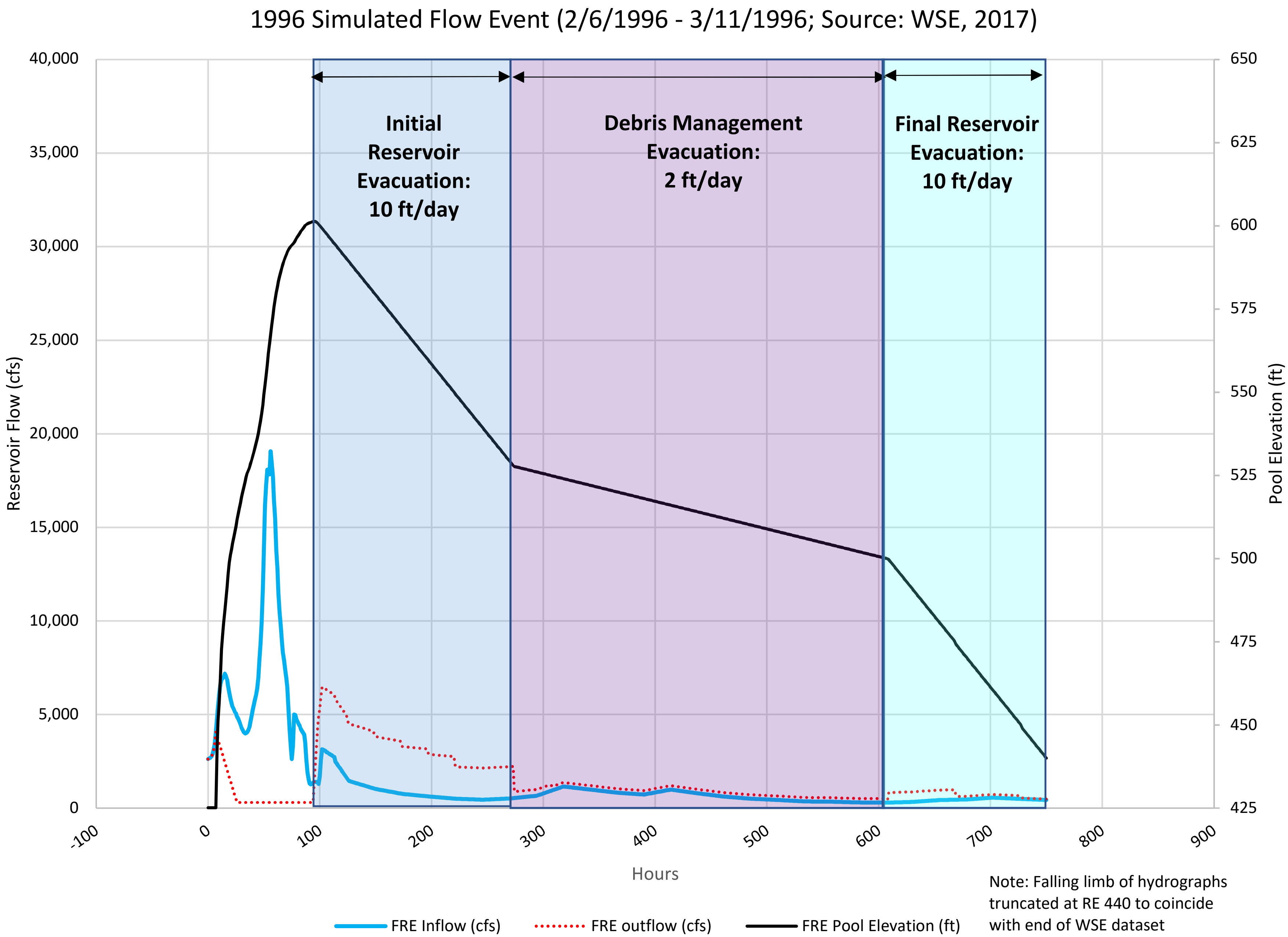
Appendix C. Hydrographs for Major Flood Events


10 Year Simulated Event (Source: WSE, 2017)
Initial Reservoir Evacuation: 10 ft/day
Debris Management Evacuation: 2 ft/day
Final Reservoir Evacuation: 10 ft/day
Reservoir Flow (cfs)
Pool Elevation (ft)
Hours
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
425
450
475
500
525
550
575
600
625
650
0
100
200
300
400
500
600
700
800
900
1,000
FRE Inflow (cfs)
FRE outflow (cfs)
FRE Pool Elevation (ft)
Note: Falling limb of hydrographs truncated at RE 440 to coincide with end of WSE dataset

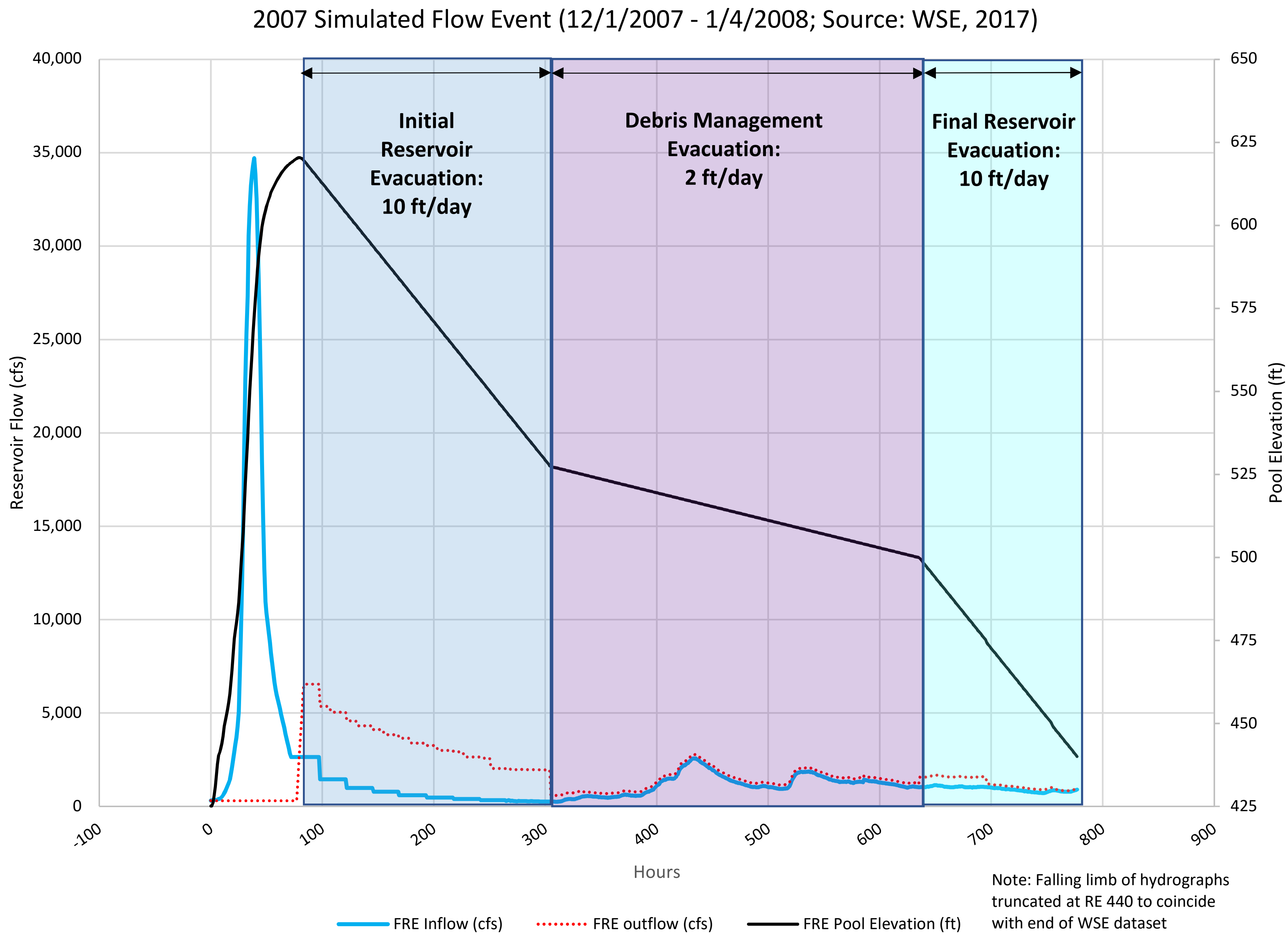

20 Year Simulated Event (Source: WSE, 2017)
Initial Reservoir Evacuation: 10 ft/day
Debris Management Evacuation: 2 ft/day
Final Reservoir Evacuation: 10 ft/day
Flow (cfs)
Pool Elevation (ft)
Hours
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
650
625
600
575
550
525
500
475
450
425
0
100
200
300
400
500
600
700
800
900
FRE Inflow (cfs)
FRE outflow (cfs)
FRE Pool Elevation (ft)
Note: Falling limb of hydrographs truncated at RE 440 to coincide with end of WSE dataset

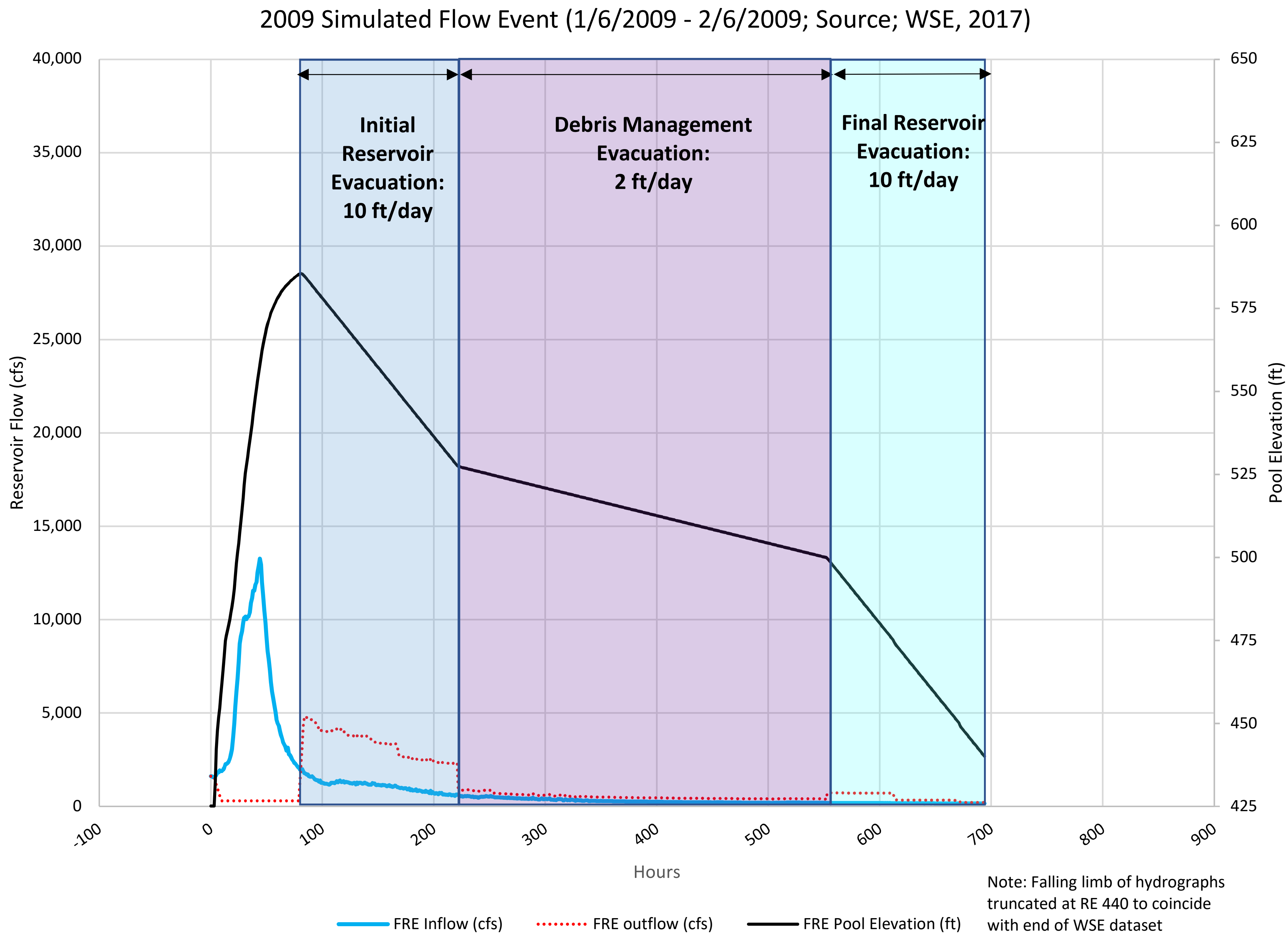

100 Year Simulated Event (Source: WSE, 2017)
Initial Reservoir Evacuation: 10 ft/day
Debris Management Evacuation: 2 ft/day
Final Reservoir Evacuation: 10 ft/day
Reservoir Flow (cfs)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Pool Elevation (ft)
650
625
600
575
550
525
500
475
450
425
0
100
200
300
400
500
600
700
800
900
1,000
Hours
Note: Falling limb of hydrographs truncated at RE 440 to coincide with end of WSE dataset
FRE Inflow (cfs)
FRE outflow (cfs)
FRE Pool Elevation (ft)


500 Year Simulated Event (Source: WSE, 2017)
Initial Reservoir Evacuation: 10 ft/day
Debris Management Evacuation: 2 ft/day
Final Reservoir Evacuation: 10 ft/day
Reservoir Flow (cfs)
Pool Elevation (ft)
Hours
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
425
450
475
500
525
550
575
600
625
650
0
100
200
300
400
500
600
700
800
900
1,000
FRE Inflow (cfs)
FRE outflow (cfs)
FRE Pool Elevation (ft)
Note: Falling limb of hydrographs truncated at RE 440 to coincide with end of WSE dataset



Note: Falling limb of hydrographs truncated at RE 440 to coincide with end of WSE dataset


2007 Simulated Flow Event (12/1/2007 - 1/4/2008; Source: WSE, 2017)
Initial Reservoir Evacuation: 10 ft/day
Debris Management Evacuation: 2 ft/day
Final Reservoir Evacuation: 10 ft/day
Reservoir Flow (cfs)
Pool Elevation (ft)
Hours
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
650
625
600
575
550
525
500
475
450
425
-100
0
100
200
300
400
500
600
700
800
900
FRE Inflow (cfs)
FRE outflow (cfs)
FRE Pool Elevation (ft)
Note: Falling limb of hydrographs truncated at RE 440 to coincide with end of WSE dataset



2009 Simulated Flow Event (1/6/2009 - 2/6/2009; Source; WSE, 2017)
Initial Reservoir Evacuation: 10 ft/day
Debris Management Evacuation: 2 ft/day
Final Reservoir Evacuation: 10 ft/day
Reservoir Flow (cfs)
Pool Elevation (ft)
Hours
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
650
625
600
575
550
525
500
475
450
425
-100
0
100
200
300
400
500
600
700
800
900
FRE Inflow (cfs)
FRE outflow (cfs)
FRE Pool Elevation (ft)
Note: Falling limb of hydrographs truncated at RE 440 to coincide with end of WSE dataset

Appendix C
Airport Levee Wetland Avoidance Technical Memorandum

Technical Memorandum

Date:	February 22, 2022
Project:	Chehalis River Basin Flood Damage Reduction Project
To:	Chehalis Basin Flood Control Zone District
From:	HDR
Subject:	Airport Levee Wetland Avoidance

1.0 Introduction and Purpose

As part of the proposed Chehalis-Centralia Airport Levee (Airport Levee) improvement project (Airport Levee Project), the Chehalis River Flood Control Zone District (District) proposes to improve and raise the existing Airport Levee approximately 5 feet and raise the elevation of a section of connected road embankment (NW Airport Road) as part of the Chehalis River Basin Flood Damage Reduction Project, which also includes construction of a flood control retention facility (Flood Retention Expandable [FRE]) on the Chehalis River near Pe Ell, Washington. The current FRE facility proposal would permit run-of-the-river conditions with no impoundment except when large flood events are predicted. The Airport Levee Project improvements would protect the airport and area inside the levee from flooding up to the 100-year flood with the FRE facility in operation.

As part of the proposed Flood Damage Reduction Project, the District proposes to increase the height of the flood protection levee on the west side of the Chehalis-Centralia Airport (Airport) airfield. The Draft Environmental Impact Statements (DEISs) prepared by the Washington Department of Ecology (Ecology; pursuant to the State Environmental Policy Act) and the U.S. Army Corps of Engineers (USACE; pursuant to the National Environmental Policy Act) assumed that to raise the airport levee to increase flood protection for the airport, the levee footprint would need to be widened leading to a potential impact to adjacent regulated wetlands.

This memorandum provides additional information regarding the ability to use standard levee design/construction methods to avoid affecting regulated wetlands and update assumptions used in the development of the DEISs regarding effects on wetlands.

2.0 Summary of Findings

Based on more detailed information regarding careful design and construction management, the proposed Airport Levee improvements can be constructed within the existing Airport Levee footprint eliminating the need to extend any construction activity or permanent facilities into the jurisdictional wetland. Given the limited height of the proposed (Phase 2) levee raise and the available space within the footprint of the existing levee, there are multiple options for achieving the required levee height within the existing levee footprint without affecting the wetlands. Based on the existing levee top-width and required raise, preliminary plans and cross sections were developed for each of the representative segments identified. With careful design and construction management including best management practices to protect the wetland, a concept could be implemented that would avoid impacts to jurisdictional wetlands.

3.0 Background

The Airport Levee was originally constructed in 1943 by the USACE Seattle District for the U.S. Department of the Navy under *Development of Landing Areas for National Defense* authority. Lewis County is the sponsor of record for the levee system, but maintenance is primarily performed by Chehalis-Centralia Airport staff. The levee is periodically inspected by the USACE as part of the Rehabilitation & Inspection Program under Public Law 84-99, which provides reimbursement for specific damages to levees that result from high-water events. The Airport Levee was most recently inspected by USACE in February 2019 and found to be in acceptable condition (USACE 2019).

The levee starts at a tie into high ground near NW Airport Road at the southeast corner of the airport property (Figure 1; all figures located in Attachment A). The levee follows a northwest direction and parallels the airport runway, before turning east/northeast toward the Interstate 5 road embankment at the far end. The levee embankment is set back approximately 500 yards from the right bank of the Chehalis River. The Airport Levee protects about 464 acres, most of which is comprised of the Chehalis-Centralia Airport property.

The existing Airport Levee provides protection from smaller (less than 100-year) flood events and was most recently improved in 2014 during Phase 1 (levee base improvement) of the Airport Levee Project. Phase 1 expanded the top width of the existing levee while restoring the top to the original intended design elevation. A vicinity map for the current Airport Levee configuration is provided in Figure 1. The existing 100-year flood inundation zone is shown affecting the inside of the levee area under the current levee elevation (Figure 2). The Washington State Office of Financial Management grant for Phase 1 anticipated a possible future levee raise to provide 100-year flood protection. Phase 2 of the Airport Levee Project would build on the work completed during Phase 1.

In order to provide future flood protection for the airport, businesses, and transportation corridors enclosed by the levee, Phase 2 of the Airport Levee Project proposes to raise the existing levee from 1.3 to 5.3 feet depending on the location along the existing levee. The Phase 2 height raise and final elevation was determined using hydrologic modeling of future scenarios for the Chehalis Basin.

The hydrologic modeling effort was initiated by Watershed Sciences and Engineering (WSE) who developed the Chehalis River Basin hydrologic model and RiverFlow2D model (WSE 2019a and 2019b, respectively) and used them to study future conditions, including the District's proposed Flood Damage Reduction Project (which includes both a temporary flood flow storage reservoir upstream and the increased levee height at the Airport) and climate change. WSE considered Airport Levee Project conditions to include the proposed Flood Retention Only -

Expandable (FRE) facility, and an estimated 4-foot height raise to the existing Airport Levee. An Anchor QEA memorandum documents the preparation of streamflow and flooding estimates under future climate change conditions (Anchor QEA 2019a):

> *"The streamflow estimates use the information contained in the Chehalis River Basin Hydrologic Modeling (WSE 2019a) technical memorandum combined with U.S. Geological Survey (USGS) flow records to develop flows under future climate change conditions. The flows were input to the 2D model developed for the Chehalis River Basin Existing Conditions RiverFlow2D Model Development and Calibration (WSE 2019b) technical memorandum to estimate flooding conditions under future climate change conditions."*

Figure 3 provides a vicinity map for the Airport Levee Project that shows the 100-year flood inundation zone includes the forecasted effects of climate change and with project conditions. This figure demonstrates protection of the airport property with an initially assumed 4-foot levee height raise. The results of these analyses were used to determine the actual required raise of the Airport Levee to protect against a 100-year flood event including climate change and implementation of the FRE facility. Using model results received from WSE and the existing levee elevations based on Lewis County Public Works' cross sections for the Phase 1 design elevation, HDR determined the necessary design levee elevation at each station along the length of the levee by determining the difference in elevation between the existing levee and the modeled 100-year flood event (Attachment B). The design levee top elevation includes a 3-foot freeboard allowance to accommodate FEMA certification guidelines.

Certification refers to the FEMA National Flood Insurance Program process for establishing that a levee has been designed in accordance with established federal standards. These standards include geotechnical investigations at intervals along the levee as well as seepage and stability analyses to provide documentation and adequate level of protection for a 100-year flood. Additionally, construction, maintenance, and operation standards will need to be met by the Phase 2 design. The USACE is authorized to inspect and evaluate levees to determine whether they meet the National Flood Insurance Program certification eligibility requirements for operations and maintenance.

4.0 Phase 2 Levee Raise

Phase 2 of the Airport Levee Project proposes to raise the existing levee between 1.3 and 5.3 feet depending on the location along the levee with most of the levee raise between 3 and 4 feet. The function of the levee is to provide a stable structure that will resist flow through the levee body and foundation. When designing a levee raise, the existing levee material and foundation needs to be investigated to determine if there is sufficient strength in the existing levee and its foundation to support the raised levee height and increased water pressure during a flood. Standard levee design requires a levee crest width of 10 to 12 feet, depending on local and emergency vehicle access requirements.

To evaluate the Phase 2 concept, HDR reviewed design cross sections from Phase 1 of the Airport Levee Improvement Project provided by the Lewis County Department of Public Works. Where possible, Phase 1 widened the levee crest between 19 and 30 feet, with most of the finished crest widths between 26 and 28 feet. The proposed Phase 2 design side slopes proposed were typically 2H:1V (Horizontal:Vertical) except where restricted by wetlands or right-of-way constraints. Where space allows, a 4-foot levee raise can be achieved with 2H:1V side slopes by reducing the new crest width to 10 feet and regrading side slopes to the recommended 2H:1V. Construction of the levee raise in this manner can be completed within the existing levee footprint and achieve standard levee design criteria.

A total of 17 cross sections representing the levee existing cross sectional geometry at 50-foot intervals were reviewed to identify which segments within the existing levee could be raised with a 2H:1V fill slope and those that would require an alternate approach. The proposed levee raise for each cross section was assessed to determine if adequate levee crest width would remain on top of the existing levee. Although a 10-foot crest would meet standard design practice, for this analysis, a more conservative 12-foot minimum width criteria was used. Representative cross sections were identified based on the required levee raise and the existing crest width. A summary of the results is provided in Table 1.

Table 1. Potential Levee Raise Configuration by Levee Segment

Segment	Stations		Required Raise (ft)[1]	Reduction in Top-Width (ft)[2]	Existing Top-Width (ft)[3]	Remaining Top-Width (ft)	Levee Toe Setback (Ditch)[3]	Levee Toe Setback (Road)[4]
1	0+00	1+00	5	20	30	10	5-10	n/a
2	1+50	15+00	4	16	28-30	12-14		
3	15+50	15+50	4	16	23	7	2-3	20
4	16+00	28+50	3.5	14	21-24	7-10	0	20+
5	29+00	34+00	3.5	14	28	14		
6	34+50	35+50	3.5	14	22-24	8-10	2-5	40
7	36+00	36+50	4	16	25-26	9-10	5-7	30
8	37+00	45+00	4	16	27	11	2-5	30
9	45+50	58+50	4	16	29	13		
10	59+00	64+50	3	12	29	17		
11	65+00	78+00	3	12	27	15		
12	78+50	85+50	3	12	32	20		
13	86+00	91+40	3	12	21-22	9-10	0	10-30
14	92+00	92+50	n/a	n/a	n/a	n/a	n/a	n/a

Segment	Stations		Required Raise (ft)[1]	Reduction in Top-Width (ft)[2]	Existing Top-Width (ft)[3]	Remaining Top-Width (ft)	Levee Toe Setback (Ditch)[3]	Levee Toe Setback (Road)[4]
15	93+00	94+50	2	8	20-22	12-14		
16	95+00	95+50	3	12	21	9	10	
17	96+00	96+80	2	8	19-20	11-12		

- (green) At least 12 feet (6,000 feet)
- (yellow) Between 10 and 12 feet (1,000 feet)
- (red) Less than 10 feet (2,100 feet)

[1] Per 'Airport Levee station and height' table
[2] Assuming 2:1 slope on both sides of levee
[3] Per 'Levee Cross Sections' document
[4] Per Airport Levee Phase 1B Environmental Quantities

As provided in Table 1, two-thirds of the levee would meet the minimum crest width after the proposed raise. The remaining one-third, however, would require an alternate approach to accomplish the levee raise without expanding the existing levee footprint. Table 1 also includes approximate setback distances from the existing levee toe to the edge of the jurisdictional wetland on the airport side of the levee, as well as to the roadway right-of-way on the river side of the levee. Although the levee footprint could be widened on either side without encroaching into either of these limits, widening the levee footprint could result in unintended impacts to the wetland and/or the floodplain. As such, the focus of this analysis is on alternatives that maintain the existing footprint.

5.0 Phase 2 Levee Raise Alternatives

For the segments of the levee what would not meet the 12-foot minimum crest width (highlighted in yellow and red in Table 1), alternative approaches were considered, including: Type I levee fill (including fill within the existing floodplain), mechanically stabilized backfill, and concrete floodwalls.

Alternative 1 – Type I Levee Fill

Type I levee fill is proposed for all segments where the levee can be raised within the existing footprint while maintaining the 12-foot minimum crest width. Type I Levee Fill refers to select fine grained low permeable fill that meets USACE guidance for levee fill. Where widening the levee crest 1 to 2 feet is required, the Type I levee fill would still be used by allowing some fill on the floodplain side of the levee. Although placing extensive fill in the existing floodplain could result in an increase in the river water surface, minimal fill as required for the 1- to 2-foot widening would likely have little to no adverse impact on the water surface elevations. The proposed fill would have to be modeled to confirm the impacts, which is outside the scope of this analysis; however, this alternative was included for cost comparison purposes. This method of construction could be completed within the existing levee footprint without impact to the wetlands.

Alternative 2 – Mechanically Stabilized Backfill

In areas where the footprint is restricted by wetlands or right-of-way constraints, a mechanically stabilized backfill may be used to raise the levee while remaining within the existing levee footprint (Figure 4). This type of construction would allow steeper slopes (e.g., 1.5H:1V) for segments where a 2H:1V cross section would not meet the minimum 12-foot crest width within the existing levee footprint. The stabilized backfill method utilizes one or more layers of flat reinforcing material (geogrids or welded wire fabric) placed between the layers of engineered fill (Type I Levee Fill) to improve the strength and stability of the combined soil and reinforcing that allows steeper (potentially even vertical) construction. An impervious cutoff, such as a sheet pile wall, may be required to be installed through the existing levee below the mechanically stabilized backfill cross section to cut off seepage flow through potential permeable layers in the foundation and/or levee to maintain USACE minimum standard seepage gradients for the raised water level. The requirement for such additional structures would be determined during final design. This method of construction could be completed within the existing levee footprint without impact to the wetlands.

Alternative 3 – Concrete Flood Wall

A concrete flood wall could be a potential levee raise option constructed within the existing levee footprint (Figure 5); however this would restrict access to the top of the levee and into the airport for segments where such construction was implemented if access was required. This type of wall has a small footprint and could easily be constructed on top of the existing Phase 1 levee. An impervious cutoff, such as a sheet pile wall may be required below the flood wall to provide a flow gradient sufficient for the raised water level. The requirement for such additional structures would be determined during final design. This method of construction could be completed within the existing levee footprint without impact to the wetlands.

6.0 Opinion of Probable Construction Cost Analysis

A representative cross section was selected for each of the segments to estimate quantities and unit costs. For the yellow and red segments in Table 1, nine representative cross sections were selected based on the existing levee crest width and required raise. For the green segments in Table 1, an average levee raise of 4 feet was assumed. A summary of the representative cross section(s) for each segment is provided in Table 2.

Table 2. Summary of Representative Cross Sections

Segment	Stations		Representative Cross-Section
1	0+00	1+00	1+00
2	1+50	15+00	n/a
3	15+50	15+50	15+50
4	16+00	28+50	21+00, 27+00
5	29+00	34+00	n/a
6	34+50	35+50	35+00
7	36+00	36+50	37+00

Segment	Stations		Representative Cross-Section
8	37+00	45+00	44+00
9	45+50	58+50	n/a
10	59+00	64+50	n/a
11	65+00	78+00	n/a
12	78+50	85+50	n/a
13	86+00	91+40	88+00
14	92+00	92+50	n/a
15	93+00	94+50	n/a
16	95+00	95+50	95+50
17	96+00	96+80	n/a

Unit costs for the three alternatives, along with the standard levee raise approach for the green segments, were developed for the range of levee raises and crest widths and a representative (i.e., average) cost was identified. A summary of these costs is provided in Table 3.

Table 3. Summary of Alternative Unit Costs

Alternative	Unit Cost
1	$520/LF
2	$505/LF
3	$600/LF

The unit costs provided in Table 3 have been developed to provide a preliminary high level (AACE Class 5 Opinion of Probable Construction Cost) cost comparison between the alternatives and are not intended to be used to estimate total project costs. The unit costs are not all-inclusive of all required work to deliver the project, as the level of design definition is not detailed enough to inform these costs. The following costs have not been included in the development of the unit costs above: mobilization, project indirect costs, contractor margin, non-construction contract costs (i.e., construction management services, testing, permitting), escalation, market conditions, market volatility, and contingencies.

The work breakdown structure for each alternative is as follows:

- Alternative 1 - erosion and sediment control, topsoil stripping, borrow, place, compact, hydroseeding, and crest roadway.
- Alternative 2 - erosion and sediment control, topsoil stripping, borrow, place, compact, geogrid, hydroseeding, and crest roadway.
- Alternative 3 - erosion and sediment control, topsoil stripping, footing excavation, borrow, place, compact, reinforced concrete, hydroseeding, and crest roadway.

The unit costs used to develop the alternative's comparison were obtained from RSMeans and professional estimating judgement based on similar scopes of work from previous projects.

The unit costs in Table 3 are similar and could vary within their differences depending on multiple factors. The size of the project, as well as contractor interest in the project may have a considerable effect on the project cost. For example, contractors that are aware of the project well in advance of the bid, can be more competitive and schedule their workload/workforce (A-B team players) to be more cost effective. Solicitation of contractors whose primary work is aligned with the project will likely provide better costs, as well. Obtaining three or more bids will help make the project more competitive.

7.0 Comparison of Alternatives

All of the alternatives meet the project purpose of constructing the requisite levee raise within the existing Airport Levee footprint to avoid wetlands and cultural resource impacts, so the comparison of alternatives is based on the following elements:

- Access – deals with impact to levee access for inspection, maintenance, and flood fighting
- Constructability – deals with ease of construction within existing levee footprint
- Cost – compares unit costs as provided in Table 3
- Risk – deals with potential risk of design and performance based on known and unknown geotechnical information

The Pros and Cons of each alternative are summarized in Table 4.

Table 4. Summary of Comparison of Alternatives

Alternative	Pros	Cons
1 – Type I Fill	• Results in the least impact to access by maintaining the existing slopes • Standard construction from top of existing levee • Within 3% of least expensive alternative	• Fill could extend into the floodplain on the river side of the levee (impact would have to be confirmed) • Potential conflicts with adjacent utilities, etc. on the river side of the levee
2 - Mechanically Stabilized Backfill	• Least expensive alternative • Little to no impact to access • Provides more stable fill which could offset geotechnical uncertainty	• Ability to construct from the top of levee could be somewhat complicated by placement of geogrid
3 - Concrete Flood Wall	• Least impact to floodplain or adjacent infrastructure	• Most expensive of the three alternatives, but within reasonable degree of tolerance • Construction requirements could have greater impact on existing levee (e.g., forms) • Would likely be used for the entire project to avoid change of construction methods and transition between levee types issues

Based on the above comparison, defaulting to Alternative 1 wherever possible is recommended. If fill in the floodplain or utility conflicts are an issue, then incorporating the steeper slope of Alternative 2 may be preferable. The use of a floodwall (Alternative 3) could be considered for the entire project, as long as access to and along the levee crest could be maintained.

8.0 Restrictions, Limitations, and Additional Studies

This alternatives analysis is appropriate for use in the environmental review stage of the project, but is based on limited information. Further investigations are required to advance the design of the Phase 2 levee raise to better understand existing conditions, including as-built conditions and if the foundation soil needs to be improved to accommodate the raised levee and potential higher water levels. FEMA certification requires levee improvements be designed in accordance with established federal standards. These standards include geotechnical investigations at intervals along the levee as well as seepage and stability analyses to provide documentation and adequate level of protection for a 100-year flood. These investigations would be required to progress the selected alternative to final design. Additionally, construction, maintenance, and operation standards will need to be met by the Phase 2 design. The USACE is authorized to inspect and evaluate levees to determine whether they meet the FEMA certification eligibility requirements for operations and maintenance.

Specialized construction limitations are also needed to avoid temporary impacts to the wetlands during construction. Exclusion zones and best management practices will be identified that restrict any construction activities (including staging areas) within or affecting the existing wetlands. All access points to the levee will be identified and limited to the river-side of the levee (i.e., no direct access from the airport).

Additional consideration is also needed for the segment of levee north of the existing airport runway (approximate levee stations 60+00 to 65+00). The existing Airport Levee extends into the protected airspace for the main runway (Runway 16), indicating an existing obstruction. The proposed Airport Levee Project would further extend into the protected airspace and may intrude into the protected airspace over the length of the Runway Protection Zone. Consultation with the Federal Aviation Administration (FAA), subsequent aeronautical studies to determine the extent of the intrusion into the Runway 16 approach, and consideration of feasible mitigation actions would be required before moving forward with the proposed Airport Levee Project. There are no foreseen conflicts on Runway 34; however, the airport sponsor (City of Chehalis) is still required to submit the proposed Airport Levee elevation changes to the FAA for approval.

To meet FAA regulations discussed above and avoid intrusion into protected airspace, previous conceptual layouts for the Phase 2 Airport Levee Project included a potential alignment of the Airport Levee that extended outside of its current footprint in the northwest corner (also referred to as the bump out) which is not being considered as part of this memo. Methods to avoid intruding into the protected airspace for Runway 16 could include temporary flood barrier options. The Airport Sponsor in consultation with the FAA may consider measures to satisfy FAA regulations without needing to extend the footprint of the Airport Levee. Temporary flood barrier options that may satisfy FAA are discussed in Attachment C.

9.0 Conclusions

The DEIS assumptions regarding footprint can be updated based on the more detailed review of the existing facility and consideration of three different standard, proven, feasible construction methods that will provide for increased levee height without extending temporary or permanent construction impacts into delineated, regulated wetlands. Given the limited height of the proposed Phase 2 levee raise and the available space within the footprint of the existing levee, options for achieving the Phase 2 levee height within the existing levee footprint without impacts to the wetlands were evaluated. Based on the existing levee top-width and required raise, preliminary plans and cross sections were developed for each of the representative segments identified in Table 1 and Table 2, based on the Alternative 1 and 2 concepts previously identified (Attachment D). With careful design and construction management, including best management practices to protect the wetland, a concept can be implemented that would avoid impacts to jurisdictional wetlands.

10.0 Literature Cited

Anchor QEA

2019a Memorandum to: Andrea McNamara Doyle and Chrissy Bailey, Office of Chehalis Basin. Regarding: Chehalis River Basin Climate Change Flows and Flooding Results. May 6, 2019.

2019b Chehalis-Centralia Airport Levee Wetland Delineation Report. Chehalis River Basin Flood Damage Reduction Proposed Project. Prepared for Washington Department of Ecology and U.S. Army Corps of Engineers. Prepared by Anchor QEA, LLC. May 2019.

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U.S. Army Corps of Engineers (USACE)

2019 Levee Inspection Report. Chehalis-Centralia Airport Levee. Routine Inspection. March 8, 2019.

Watershed Sciences and Engineering (WSE)

2019a Memorandum to: Bob Montgomery, Anchor QEA, LLC. Regarding: Chehalis River Basin Hydrologic Modeling. February 28, 2019.

2019b Memorandum to: Bob Montgomery, Anchor QEA, LLC. Regarding: Chehalis River Existing Conditions RiverFlow2D Model Development and Calibration. February 28, 2019.

Attachment A. Figures

Figure 1. Chehalis Airport Levee Configuration and Wetland Map

Figure 2. Chehalis Airport Levee 100-Year Floodplain (No Action)

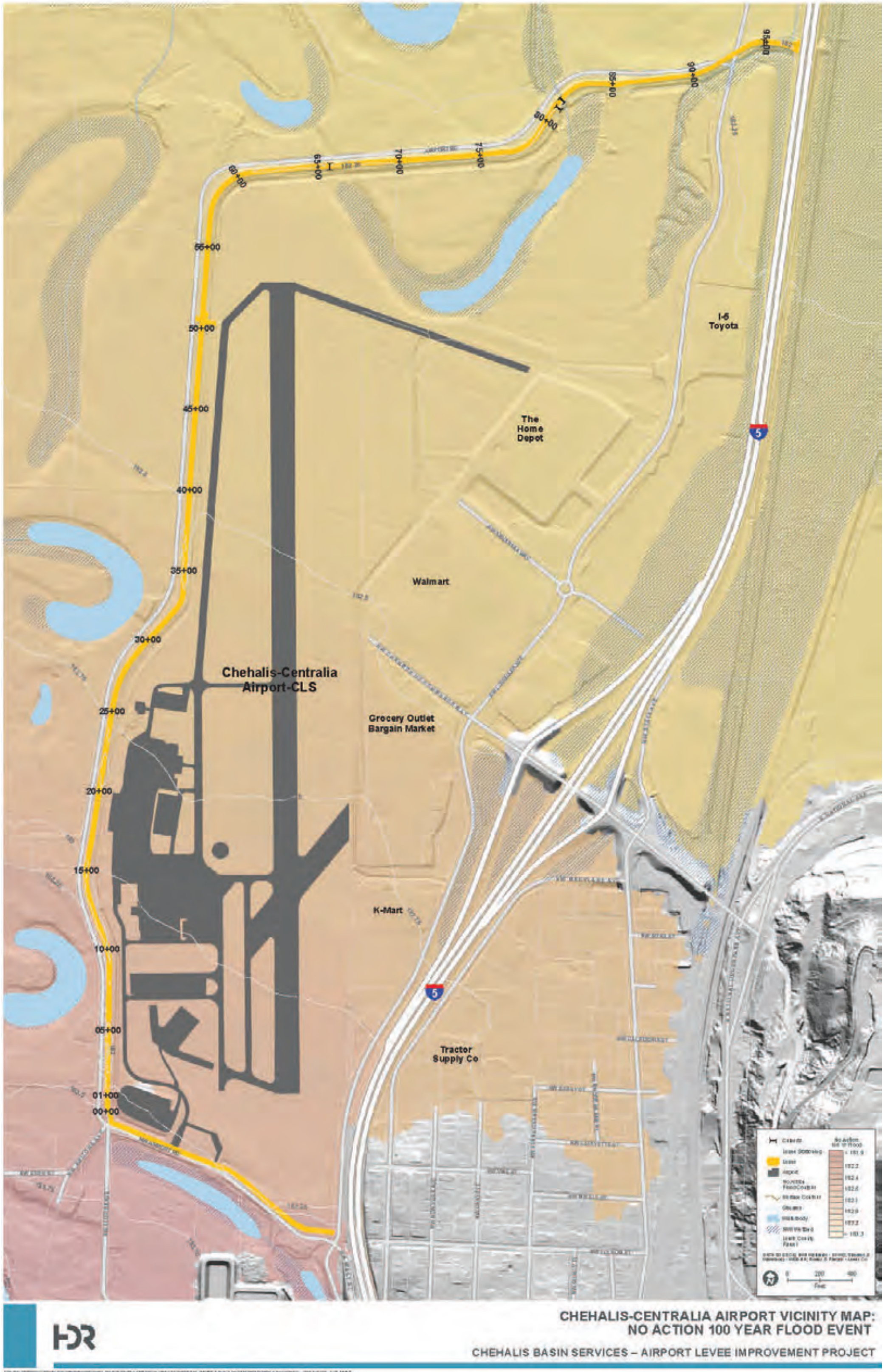


Figure 3. Chehalis Airport Levee 100-Year Floodplain (Proposed Action)

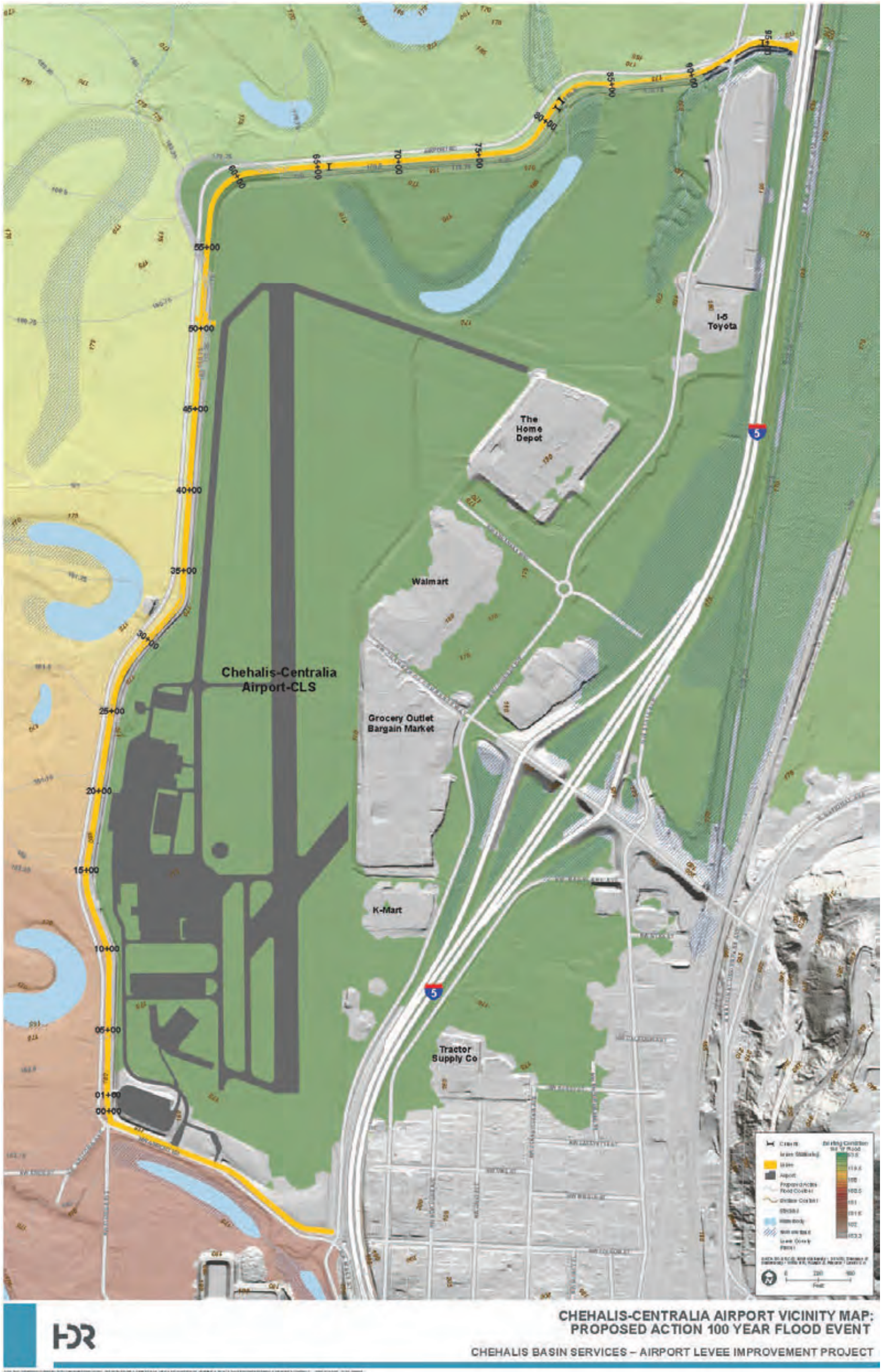
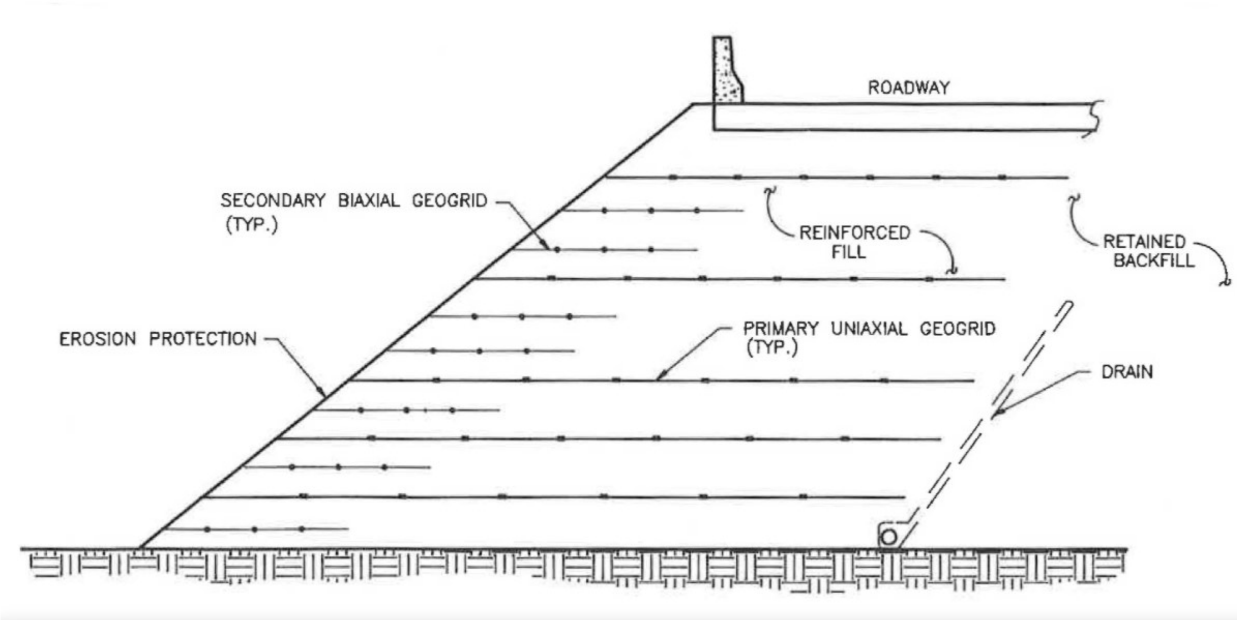
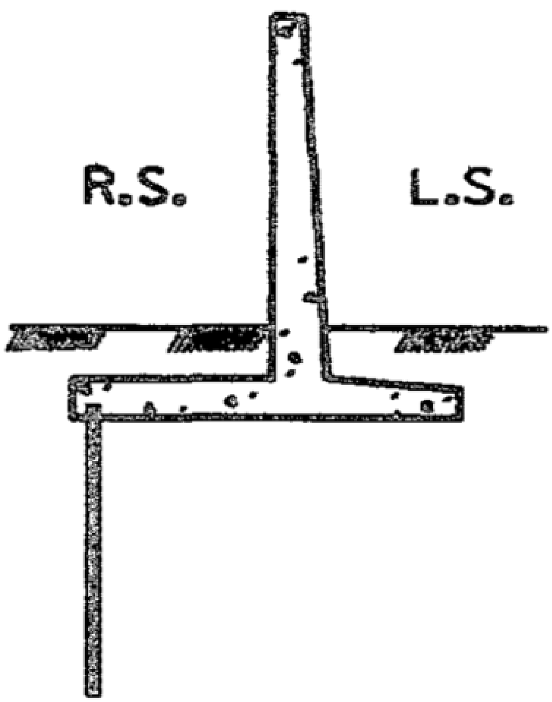


Figure 4. Mechanically Stabilized Earth Levee Raise Concept



Source: Reinforced Soil Highway Slopes, R. Berg, Ronald P Anderson, Robert J Race, V. Chouery-Curtis (1990)



Source: USACE EM 1110-2-2502
R.S – River Side
L.S. – Land Side

Attachment B. Airport Levee Project Design Elevation and Levee Height Raise Data

Airport Levee Project Design Elevation and Levee Height Raise Data

Station	No Action 100 Year Flood Height Elevation	With Project and Climate Change 100 Year Flood Height Elevation	Phase 1 Levee Design Elevation	Approximate Final Elev. w/ project	Estimated Levee Height Raise
00+00.00	183.49	182.80	180.5	185.8	5.3
00+50.00	183.39	182.70	180.75	185.75	5
01+00.00	183.34	182.68	181	185.7	4.7
01+50.00	183.20	182.64	181.25	185.65	4.4
02+00.00	183.07	182.57	181.5	185.6	4.1
02+50.00	182.97	182.51	181.5	185.5	4
03+00.00	182.90	182.51	181.5	185.5	4
03+50.00	182.91	182.51	181.5	185.5	4
04+00.00	182.91	182.51	181.5	185.5	4
04+50.00	182.92	182.50	181.5	185.5	4
05+00.00	182.93	182.49	181.5	185.5	4
05+50.00	183.07	182.47	181.5	185.5	4
06+00.00	183.07	182.47	181.5	185.5	4
06+50.00	183.09	182.47	181.5	185.5	4
07+00.00	183.08	182.48	181.5	185.5	4
07+50.00	183.06	182.48	181.5	185.5	4
08+00.00	183.03	182.48	181.5	185.5	4
08+50.00	183.04	182.47	181.5	185.5	4
09+00.00	183.02	182.47	181.5	185.5	4
09+50.00	182.99	182.47	181.5	185.5	4
10+00.00	182.98	182.46	181.5	185.5	4
10+50.00	182.96	182.47	181.5	185.5	4
11+00.00	182.89	182.47	181.5	185.5	4
11+50.00	182.87	182.47	181.5	185.5	4
12+00.00	182.92	182.46	181.5	185.5	4
12+50.00	182.92	182.45	181.5	185.4	3.9
13+00.00	182.85	182.43	181.5	185.4	3.9
13+50.00	182.80	182.36	181.5	185.4	3.9
14+00.00	182.88	182.24	181.5	185.2	3.7
14+50.00	182.97	182.14	181.5	185.1	3.6
15+00.00	182.99	182.07	181.5	185.1	3.6
15+50.00	182.99	182.00	181.5	185	3.5
16+00.00	182.96	181.95	181.5	184.9	3.4
16+50.00	182.93	181.92	181.5	184.9	3.4
17+00.00	182.91	181.91	181.5	184.9	3.4
17+50.00	182.90	181.81	181.5	184.8	3.3
18+00.00	182.92	181.86	181.5	184.9	3.4
18+50.00	182.92	181.80	181.5	184.8	3.3

Station	No Action 100 Year Flood Height Elevation	With Project and Climate Change 100 Year Flood Height Elevation	Phase 1 Levee Design Elevation	Approximate Final Elev. w/ project	Estimated Levee Height Raise
19+00.00	182.90	181.80	181.5	184.8	3.3
19+50.00	182.87	181.80	181.5	184.8	3.3
20+00.00	182.83	181.79	181.5	184.8	3.3
20+50.00	182.72	181.78	181.5	184.8	3.3
21+00.00	182.65	181.76	181.5	184.8	3.3
21+50.00	182.60	181.73	181.38	184.68	3.3
22+00.00	182.71	181.67	181.25	184.65	3.4
22+50.00	182.76	181.62	181.13	184.63	3.5
23+00.00	182.76	181.60	181	184.6	3.6
23+50.00	182.74	181.59	181	184.6	3.6
24+00.00	182.73	181.56	181	184.6	3.6
24+50.00	182.71	181.53	181	184.5	3.5
25+00.00	182.69	181.51	181	184.5	3.5
25+50.00	182.68	181.49	181	184.5	3.5
26+00.00	182.67	181.46	181	184.5	3.5
26+50.00	182.68	181.42	181	184.4	3.4
27+00.00	182.69	181.37	181	184.4	3.4
27+50.00	182.69	181.34	181	184.3	3.3
28+00.00	182.68	181.31	181	184.3	3.3
28+50.00	182.67	181.29	181	184.3	3.3
29+00.00	182.66	181.28	181	184.3	3.3
29+50.00	182.66	181.23	181	184.2	3.2
30+00.00	182.65	181.28	181	184.3	3.3
30+50.00	182.65	181.27	181	184.3	3.3
31+00.00	182.64	181.29	181	184.3	3.3
31+50.00	182.62	181.27	181	184.3	3.3
32+00.00	182.61	181.26	181	184.3	3.3
32+50.00	182.60	181.21	181	184.2	3.2
33+00.00	182.57	181.26	181	184.3	3.3
33+50.00	182.53	181.25	181	184.3	3.3
34+00.00	182.51	181.24	181	184.2	3.2
34+50.00	182.46	181.22	181	184.2	3.2
35+00.00	182.49	181.21	181	184.2	3.2
35+50.00	182.46	181.20	180.75	184.15	3.4
36+00.00	182.47	181.17	180.5	184.2	3.7
36+50.00	182.50	181.15	180.25	184.15	3.9
37+00.00	182.49	181.14	180	184.1	4.1
37+50.00	182.48	181.13	180	184.1	4.1
38+00.00	182.43	181.11	180	184.1	4.1
38+50.00	182.44	181.10	180	184.1	4.1

Station	No Action 100 Year Flood Height Elevation	With Project and Climate Change 100 Year Flood Height Elevation	Phase 1 Levee Design Elevation	Approximate Final Elev. w/ project	Estimated Levee Height Raise
39+00.00	182.41	181.07	180	184.1	4.1
39+50.00	182.43	181.04	180	184	4
40+00.00	182.45	181.01	180	184	4
40+50.00	182.46	181.00	180	184	4
41+00.00	182.46	180.99	180	184	4
41+50.00	182.45	180.98	180	184	4
42+00.00	182.44	180.97	180	184	4
42+50.00	182.43	180.95	180	184	4
43+00.00	182.41	180.93	180	183.9	3.9
43+50.00	182.42	180.92	180	183.9	3.9
44+00.00	182.41	180.91	180	183.9	3.9
44+50.00	182.40	180.90	179.87	183.87	4
45+00.00	182.41	180.89	179.75	183.85	4.1
45+50.00	182.41	180.88	179.62	183.92	4.3
46+00.00	182.40	180.88	179.5	183.9	4.4
46+50.00	182.38	180.87	179.5	183.9	4.4
47+00.00	182.37	180.87	179.5	183.9	4.4
47+50.00	182.37	180.85	179.5	183.9	4.4
48+00.00	182.39	180.83	179.5	183.8	4.3
48+50.00	182.40	180.82	179.5	183.8	4.3
49+00.00	182.39	180.81	179.5	183.8	4.3
49+50.00	182.37	180.80	179.5	183.8	4.3
50+00.00	182.37	180.79	179.5	183.8	4.3
50+50.00	182.36	180.79	179.5	183.8	4.3
51+00.00	182.36	180.79	179.5	183.8	4.3
51+50.00	182.37	180.78	179.5	183.8	4.3
52+00.00	182.37	180.77	179.5	183.8	4.3
52+50.00	182.37	180.77	179.5	183.8	4.3
53+00.00	182.37	180.53	179.5	183.5	4
53+50.00	182.36	180.74	179.5	183.7	4.2
54+00.00	182.36	180.71	179.5	183.7	4.2
54+50.00	182.35	180.68	179.5	183.7	4.2
55+00.00	182.34	180.64	179.5	183.6	4.1
55+50.00	182.33	180.60	179.5	183.6	4.1
56+00.00	182.33	180.56	179.5	183.6	4.1
56+50.00	182.35	180.53	179.5	183.5	4
57+00.00	182.36	180.50	179.5	183.5	4
57+50.00	182.36	180.43	179.5	183.4	3.9
58+00.00	182.36	180.29	179.5	183.3	3.8
58+50.00	182.36	180.09	179.5	183.1	3.6

Station	No Action 100 Year Flood Height Elevation	With Project and Climate Change 100 Year Flood Height Elevation	Phase 1 Levee Design Elevation	Approximate Final Elev. w/ project	Estimated Levee Height Raise
59+00.00	182.35	179.82	179.5	182.8	3.3
59+50.00	182.34	179.76	179.5	182.8	3.3
60+00.00	182.31	179.75	179.5	182.8	3.3
60+50.00	182.29	179.75	179.5	182.8	3.3
61+00.00	182.27	179.75	179.5	182.8	3.3
61+50.00	182.27	179.75	179.5	182.8	3.3
62+00.00	182.25	179.75	179.5	182.8	3.3
62+50.00	182.27	179.75	179.5	182.8	3.3
63+00.00	182.28	179.37	179.5	182.4	2.9
63+50.00	182.27	179.61	179.5	182.6	3.1
64+00.00	182.27	179.67	179.5	182.7	3.2
64+50.00	182.27	179.67	179.5	182.7	3.2
65+00.00	182.29	179.67	179.5	182.7	3.2
65+50.00	182.29	179.65	179.5	182.7	3.2
66+00.00	182.27	179.63	179.5	182.6	3.1
66+50.00	182.28	179.62	179.5	182.6	3.1
67+00.00	182.29	179.62	179.5	182.6	3.1
67+50.00	182.28	179.63	179.5	182.6	3.1
68+00.00	182.28	179.62	179.5	182.6	3.1
68+50.00	182.28	179.63	179.5	182.6	3.1
69+00.00	182.26	179.63	179.5	182.6	3.1
69+50.00	182.25	179.62	179.5	182.6	3.1
70+00.00	182.22	179.62	179.5	182.6	3.1
70+50.00	182.19	179.61	179.5	182.6	3.1
71+00.00	182.20	179.60	179.5	182.6	3.1
71+50.00	182.21	179.60	179.5	182.6	3.1
72+00.00	182.19	179.61	179.5	182.6	3.1
72+50.00	182.20	179.64	179.5	182.6	3.1
73+00.00	182.21	179.65	179.5	182.7	3.2
73+50.00	182.20	179.65	179.5	182.6	3.1
74+00.00	182.20	179.65	179.5	182.6	3.1
74+50.00	182.21	179.64	179.5	182.6	3.1
75+00.00	182.22	179.64	179.5	182.6	3.1
75+50.00	182.23	179.63	179.5	182.6	3.1
76+00.00	182.24	179.62	179.5	182.6	3.1
76+50.00	182.23	179.60	179.5	182.6	3.1
77+00.00	182.23	179.59	179.5	182.6	3.1
77+50.00	182.23	179.61	179.5	182.6	3.1
78+00.00	182.24	179.62	179.5	182.6	3.1
78+50.00	182.25	179.61	179.5	182.6	3.1

Station	No Action 100 Year Flood Height Elevation	With Project and Climate Change 100 Year Flood Height Elevation	Phase 1 Levee Design Elevation	Approximate Final Elev. w/ project	Estimated Levee Height Raise
79+00.00	182.25	179.63	179.5	182.6	3.1
79+50.00	182.26	179.65	179.5	182.6	3.1
80+00.00	182.26	179.63	179.5	182.6	3.1
80+50.00	182.26	179.62	179.5	182.6	3.1
81+00.00	182.25	179.64	179.5	182.6	3.1
81+50.00	182.24	179.61	179.5	182.6	3.1
82+00.00	182.23	179.59	179.5	182.6	3.1
82+50.00	182.20	179.57	179.5	182.6	3.1
83+00.00	182.17	179.50	179.5	182.5	3
83+50.00	182.17	179.43	179.5	182.4	2.9
84+00.00	182.16	179.46	179.5	182.5	3
84+50.00	182.18	179.46	179.5	182.5	3
85+00.00	182.18	179.45	179.5	182.4	2.9
85+50.00	182.17	179.41	179.5	182.4	2.9
86+00.00	182.17	179.38	179.5	182.4	2.9
86+50.00	182.16	179.38	179.5	182.4	2.9
87+00.00	182.18	179.38	179.5	182.4	2.9
87+50.00	182.17	179.41	179.5	182.4	2.9
88+00.00	182.16	179.38	179.5	182.4	2.9
88+50.00	182.17	179.38	179.5	182.4	2.9
89+00.00	182.20	179.36	179.5	182.4	2.9
89+50.00	182.21	179.32	179.5	182.3	2.8
90+00.00	182.21	179.35	179.5	182.3	2.8
90+50.00	182.19	179.37	179.5	182.4	2.9
91+00.00	182.18	179.53	179.5	182.5	3
91+50.00	182.18	179.53	179.9	182.5	2.6
92+00.00	182.18	179.53	No Stationing - Road	NA	NA
92+50.00	182.21	179.53	No Stationing - Road	NA	NA
93+00.00	182.19	179.53	180.5	182.5	2
93+50.00	182.18	179.53	180.5	182.5	2
94+00.00	182.16	179.52	180.5	182.5	2
94+50.00	182.16	179.53	180.23	182.53	2.3
95+00.00	182.17	179.53	179.77	182.57	2.8
95+50.00	182.17	179.53	179.72	182.52	2.8
96+00.00	182.12	179.53	180.27	182.57	2.3
96+50.00	181.99	179.53	180.82	182.52	1.7
96+80.36	182.04	179.53	181.16	182.56	1.4

Attachment C. Temporary Flood Barrier Options

Appendix C – Temporary Flood Barrier Options

Sandbags have traditionally been selected method for temporarily raising the height of levees to protect against rising flood waters. However, even if sandbags are readily available, filling and placing them are labor intensive and time consuming. Moreover, a significant clean-up effort is needed to remove the sandbags when the flood event is over and store them for the next event. More recently, the industry has developed several other temporary flood protection products that have proven effective and, in many cases, more efficient to install than sandbag systems. The following factors should be taken into account to select the most suitable solution for the specific situation:

- Stability – related to sliding/overturning, seepage, and soil loading
- Constructability – including access, manpower, equipment, on-site preparation, storage, and flexibility
- Cost – including materials, labor (installation and removal), maintenance, and storage
- Durability –related to short-term and long-term use/reuse
- Environmental Impact – both temporary and long-term impacts
- Previous Experiences/Applications – in terms of both testing/certifications, as well as real applications

Temporary flood protection products typically fall into three main categories:

- Cellular Barrier Systems
- Flood Walls/Barriers
- Air/Water Filled Tubes

Each category is briefly described below.

Cellular Barrier Systems

Cellular Barrier Systems are prefabricated cellular structures (e.g., wire-mesh cages) filled with rock, soil, or water. Essentially, these are collapsible multi-cellular structures, made of panels of wire mesh reinforced with vertical steel bars. Flexibility of the metal cage and hinged structural connections enable good adaptation to local terrain. Impermeability of the structure is achieved by geotextile lines and fill material. Examples of these products are shown below.

Flood Walls/Barriers

Temporary flood walls are made of free-standing and/or interlocking heavy duty sections. The wall material is impermeable and can be either rigid or flexible. The stability of these barriers depends on either the weight of the water acting on a long skirt on the water side of the wall resisting the water loading on the barrier or by vertical supports that may be permanently or temporarily placed along the levee.

Air/Water Filled Tubes

These flood protection products are typically pre-fabricated geomembrane tubes filled with air or water to restrain flood waters. The tubes can be portable or left in place and inflated as needed using pumps. If filled with water, the tubes act as gravity dams, which use the weight of water to provide stability. To prevent rolling, these systems typically require some form of anchoring. Air-filled tubes can also be used in conjunction with gates to allow raising and lowering the wall height as needed.


There are many advantages and disadvantages to each of these products which should be considered before making a final selection for a specific application.

Attachment D. Conceptual Plans

OVERALL LEVEE SITE PLAN

Culverts
Levee Stationing
Levee
Airport
Proposed Action Flood Contour
Surface Contour
Streams
Waterbody
NWI Wetland
Lewis County Parcel

Existing Condition 100 Yr Flood
53.5
179.5
180
180.5
181
181.5
182
183.3

DATA SOURCE: NWI Wetlands - DFWS; Streams & Waterbody - WSDNR; Roads & Parcels - Lewis Co

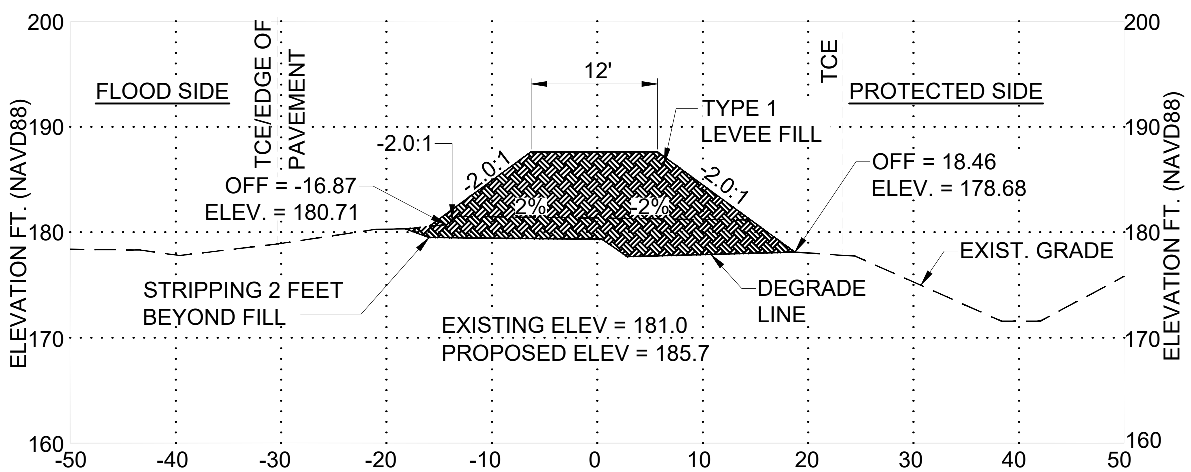
HDR

OFFICE OF CHEHALIS BASIN
AIRPORT LEVEE 10% CONCEPTUAL DESIGN

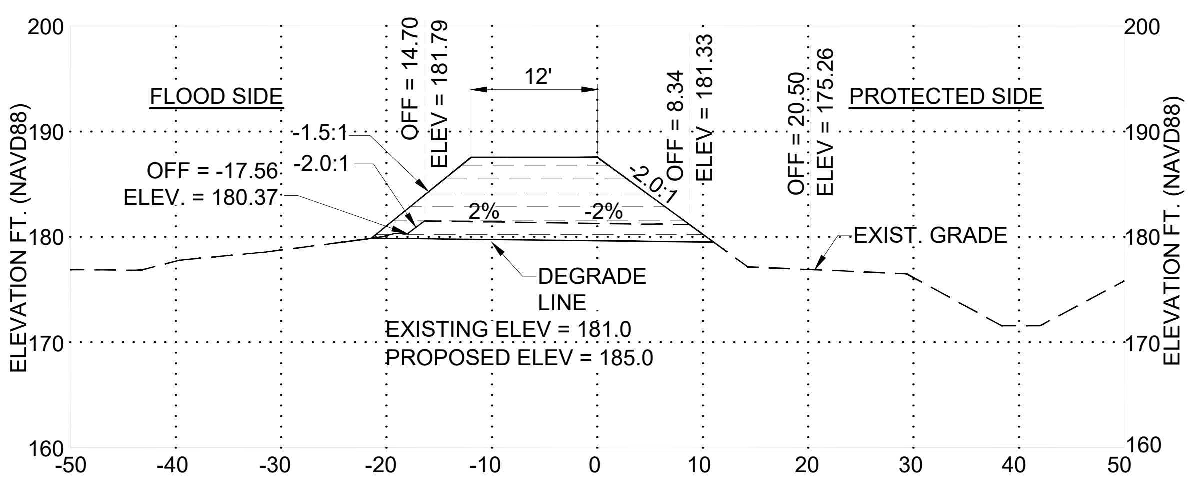
OVERALL LEVEE SITE PLAN

DATE 2/2022

FIGURE PLAN-01



STA. 0+00 - 1+00



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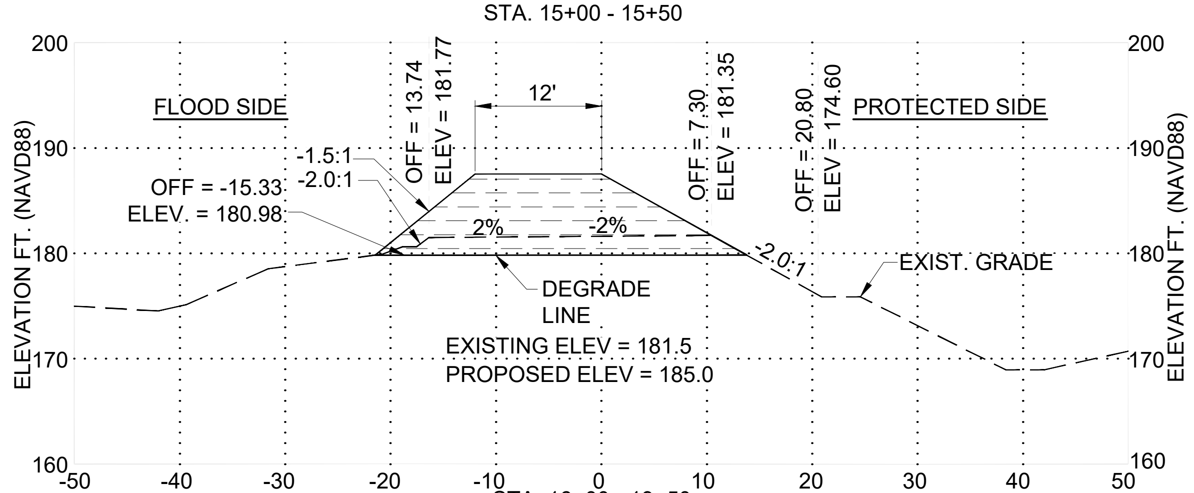
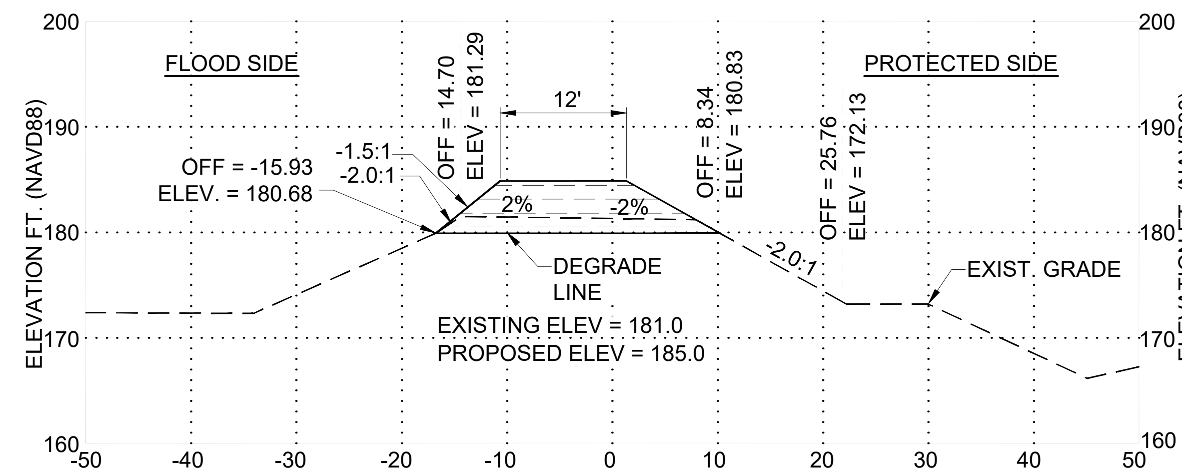
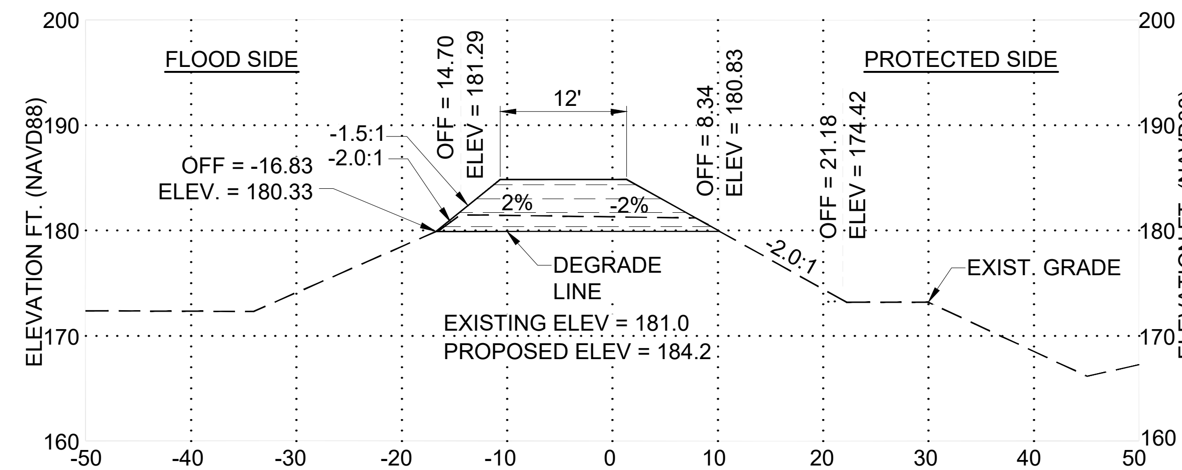


STA. 16+00 - 19+50
STA. 22+50 - 28+50



STA. 19+50 - 22+50



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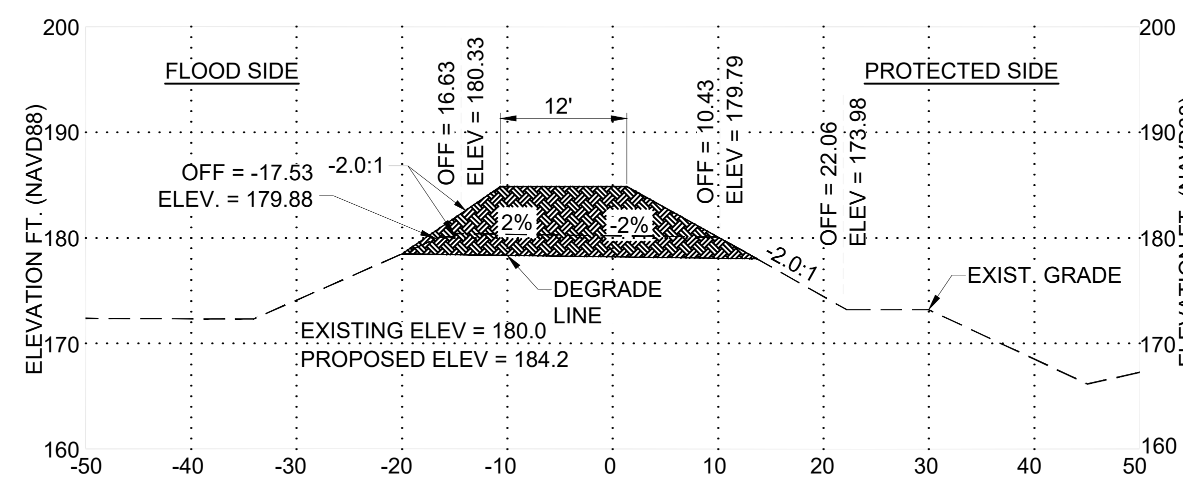


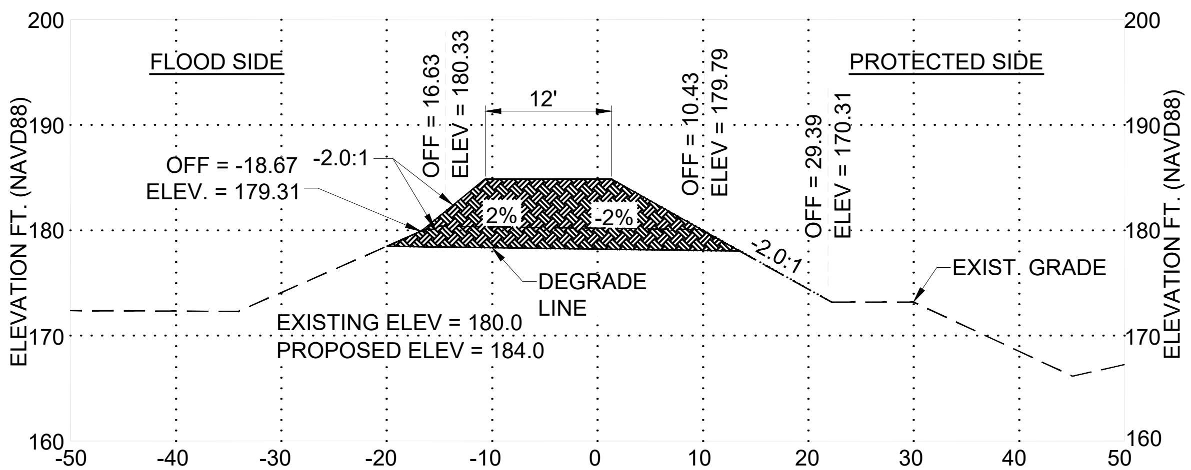
STA. 36+00 - 37+00

OFFICE OF CHEHALIS BASIN
AIRPORT LEVEE 10% CONCEPTUAL DESIGN

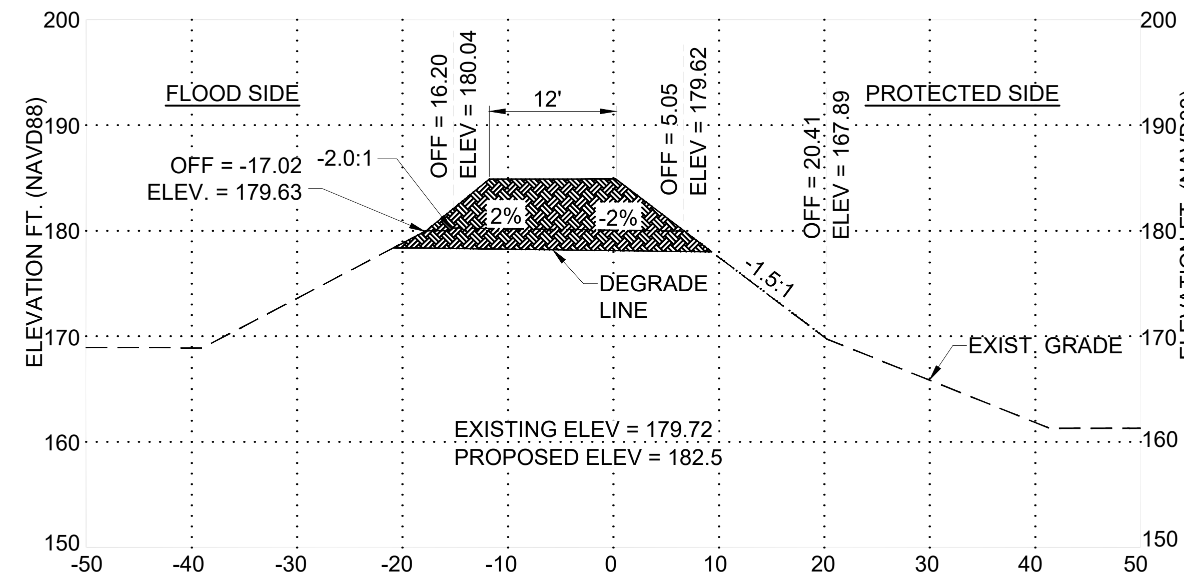
PROFILES

DATE 2/2022

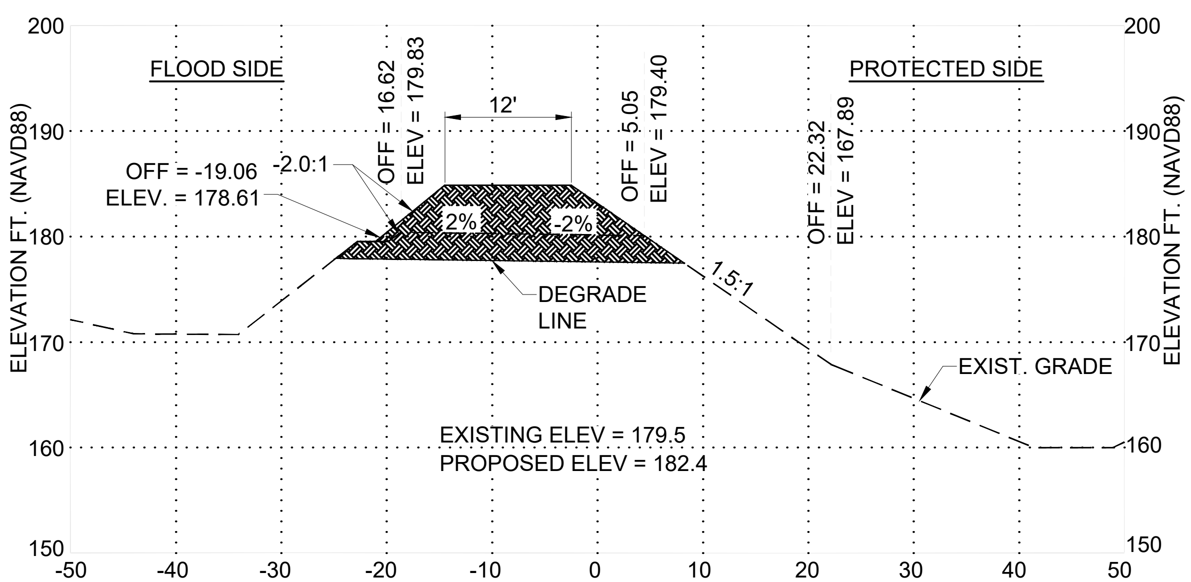
FIGURE CP-01



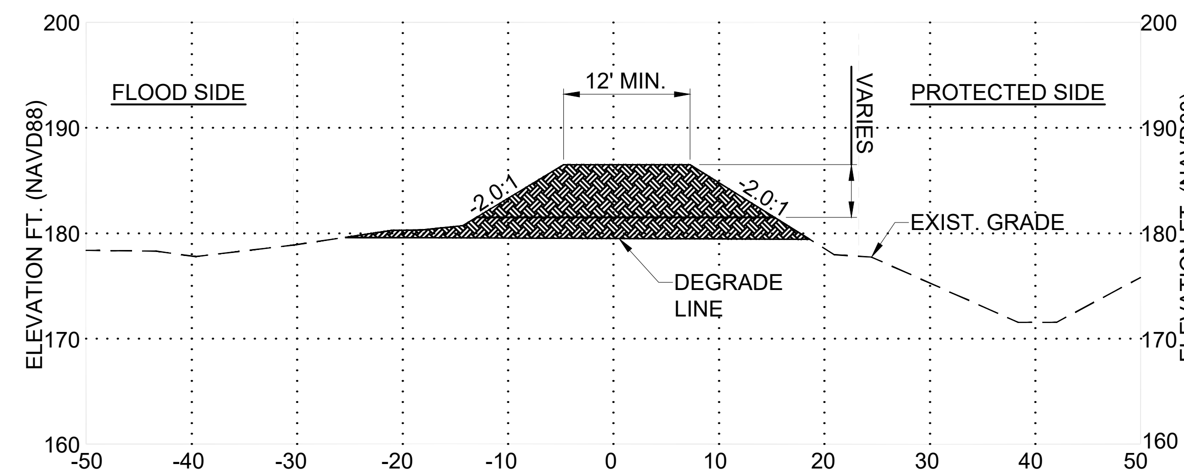
STA. 37+00 - 45+00



STA. 95+00 - 95+50



STA. 86+00 - 91+40



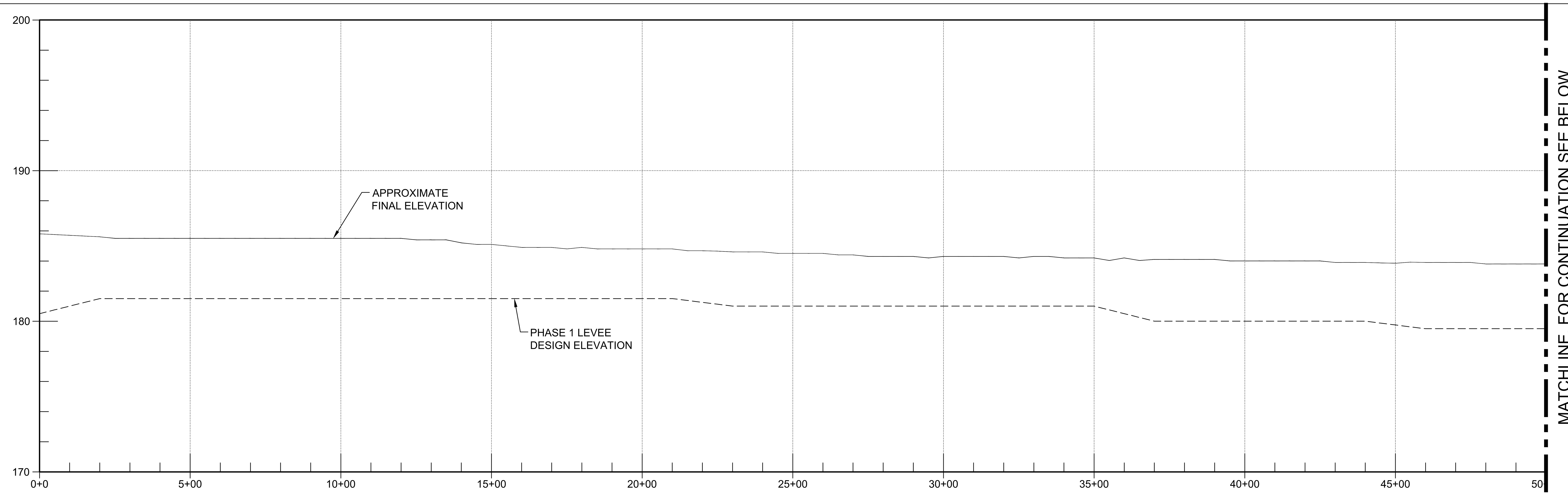
STA. 1+50 - 15+00
STA. 29+00 - 34+00
STA. 45+50 - 85+50
STA. 93+00 - 94+50

OFFICE OF CHEHALIS BASIN
AIRPORT LEVEE 10% CONCEPTUAL DESIGN

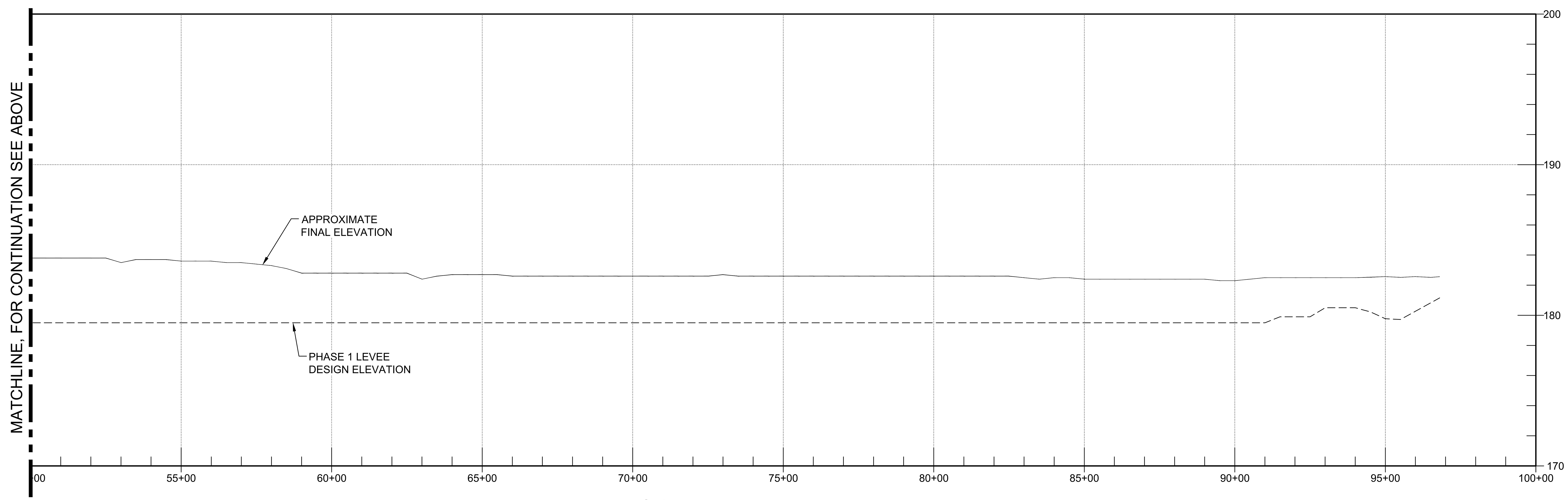
PROFILES

DATE 2/2022

FIGURE CP-01B



PROFILE
SCALE: ½"=1'-0"



PROFILE
SCALE: ½"=1'-0"

0 1' 2' 4'

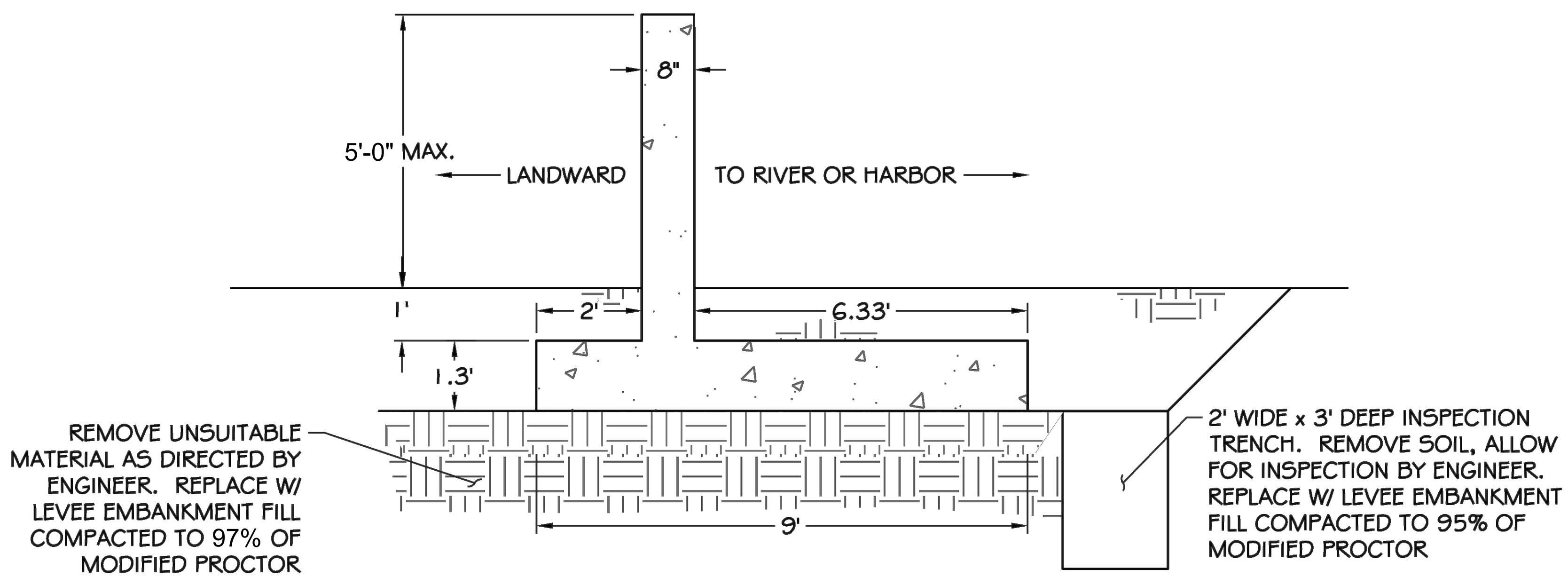
HDR

OFFICE OF CHEHALIS BASIN
AIRPORT LEVEE 10% CONCEPTUAL DESIGN

PROFILE

DATE 2/2022

FIGURE CP-02



TYPICAL CONCRETE FLOOD WALL SECTION

SCALE: 1" = 3'

HDR

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DETAILS

DATE 2/2022

FIGURE FW-01

Appendix D
Adaptive Management Plan Outline

ADAPTIVE MANAGEMENT PLAN OUTLINE

Note: the Adaptive Management Plan outline presented here is an example for illustration that may be used as a basis for developing an adaptive management plan for site-specific wetland mitigation actions when they are more fully planned and designed. The following is a general outline of what would likely be required in an Adaptive Management Plan for the proposed wetland mitigation.

1. Introduction
   - 1.1 Purpose of the Project Monitoring and Adaptive Management Plan
     - Purpose of the Adaptive Monitoring Plan
     - Overview of the Programmatic Adaptive Management Plan
     - Project-level Adaptive Management
   - 1.2 Restoration Type Goals, Project Purpose and Need, and Restoration Objectives
   - 1.3 Conceptual Ecological Model
     - Purpose of the Conceptual Ecological Model
     - Components of the Conceptual Ecological Model
     - Purpose of the Adaptive Monitoring Plan
     - Overview of the Programmatic Adaptive Management Plan
     - Project-level Adaptive Management
   - 1.4 Sources of Critical Uncertainty
     - Environmental Driver Uncertainty
     - Uncertainty in the Degree of Altered Hydrology (Stressor)
     - Uncertainties in the Responses of Environmental Resources to Project Inputs
     - Uncertainties in Human System Response
   - 1.5 Use of Numerical Models within Project Adaptive Management Area
     - Numerical Models Used in Project Planning
     - Use of Data and Numerical Models to Inform Project Monitoring and Adaptive Management
2. Project Operational and Adaptive Management and Governance
   - 2.1 Description and Scope
   - 2.2 Data Information Requirements
   - 2.3 Governance Structure
     - Project Implementation Team
     - Other Teams
3. Project Monitoring Plan
   - 3.1 Monitoring Plan Development
   - 3.2 Baseline and Project Monitoring Approach
   - 3.3 Monitoring and Assessment Design
     - Sampling Stratification
     - Estimation of Project Delta Development and Project Influence Areas
   - 3.4 Data Sources
     - Coordinated Monitoring Data
     - Other Monitoring and Survey Data

- 3.5 Pre-operations (Baseline) Monitoring
- 3.6 Post-construction (Operations) Monitoring
- 3.7 Parameters for Evaluating Project Effectiveness and Ecosystem Response
  - Objective #1
    - Empirical Monitoring Parameters in Support of Objective 1
    - Multi-Parameter Calculations in Support of Objective 1
  - Object #2
    - Empirical Monitoring Parameters in Support of Objective 1
    - Multi-Parameter Calculations in Support of Objective 1
  - Compliance Monitoring

4. Evaluation of Project-level Decisions for Conducting Management Actions
   - 4.1 Evaluation of Project Effectiveness Monitoring Data
     - Evaluation of Monitoring Data in Support of Project Objective #1
     - Evaluation of Monitoring Data in Support of Project Objective #2
   - 4.2 Evaluation of Context Variables
   - 4.3 Evaluation of Compliance Monitoring Data
5. Monitoring and Adaptive Management Schedule
   - 5.1 Project Monitoring Schedule
     - Pre-operational Monitoring
     - Post-operational Monitoring
   - 5.2 Timeline of Adaptive Management Decision Making and Implementation
     - Event Timeline
     - Annual Timeline
     - Multi-year Project Synthesis Reporting
6. Data Management
   - 6.1 Data Description
   - 6.2 Data Review and Clearance
   - 6.3 Data Storage and Accessibility
   - 6.4 Data Sharing
7. Reporting
   - 7.1 Reporting Requirements
   - 7.2 Annual Operations Plans
   - 7.3 Annual Operations Performance Reports
   - 7.4 Annual Operations, Maintenance and Monitoring Reports
   - 7.5 Multi Year Monitoring and Adaptive Management Reports
   - 7.6 Compliance Reporting
     - Federal
     - State
8. Monitoring and Adaptive Management Budget
9. References
10. Inventory of Project Related Studies
11. Project Adaptive Management Decision Log and Catalog of Updates to the Monitoring and Adaptive Management Plan