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

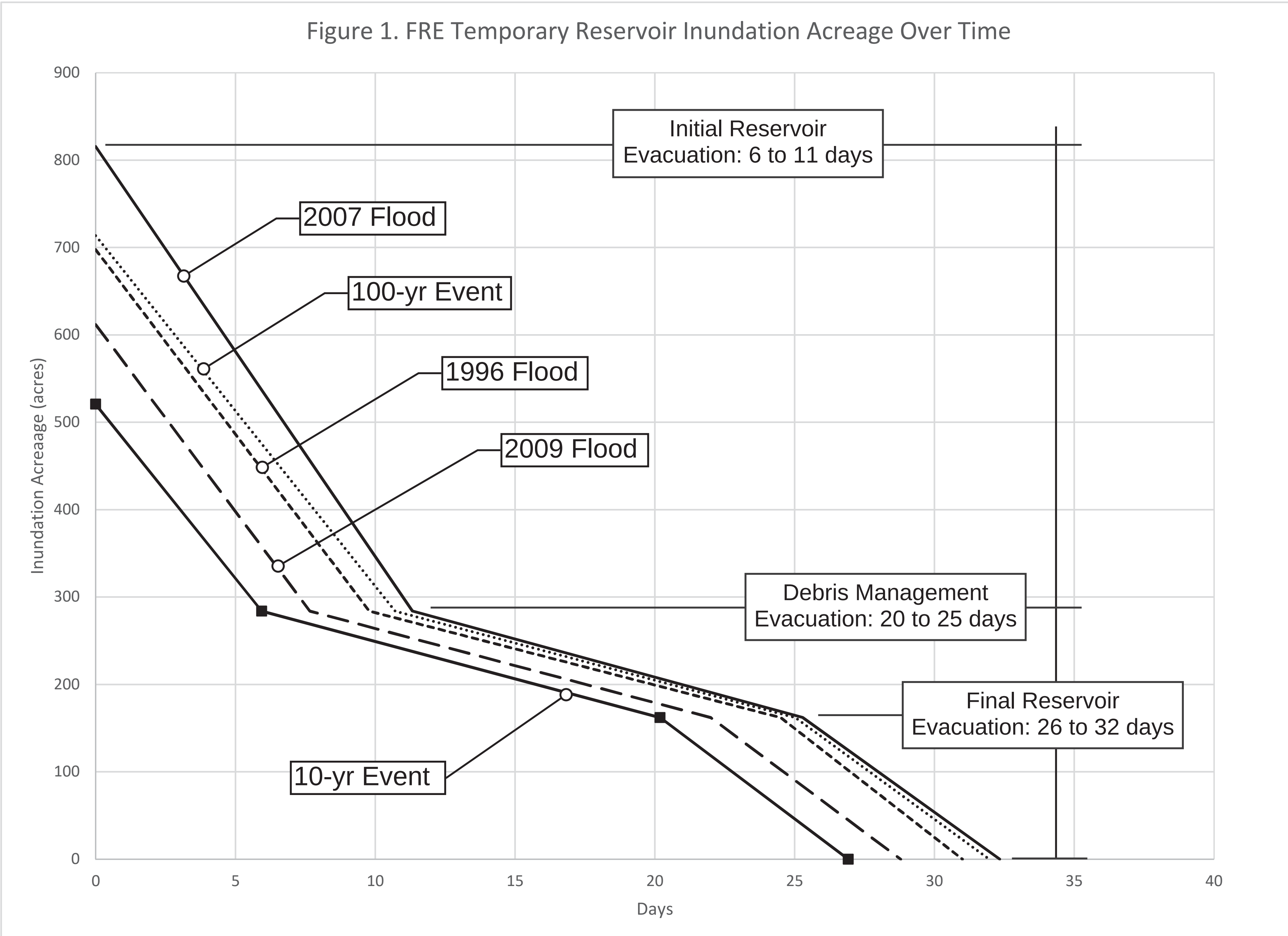


Figure 1. FRE Temporary Reservoir Inundation Acreage Over Time
Initial Reservoir Evacuation: 6 to 11 days
2007 Flood
100-yr Event
1996 Flood
2009 Flood
Debris Management Evacuation: 20 to 25 days
Final Reservoir Evacuation: 26 to 32 days
10-yr Event
Inundation Acreage (acres)
Days
0
100
200
300
400
500
600
700
800
900
0
5
10
15
20
25
30
35
40

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.

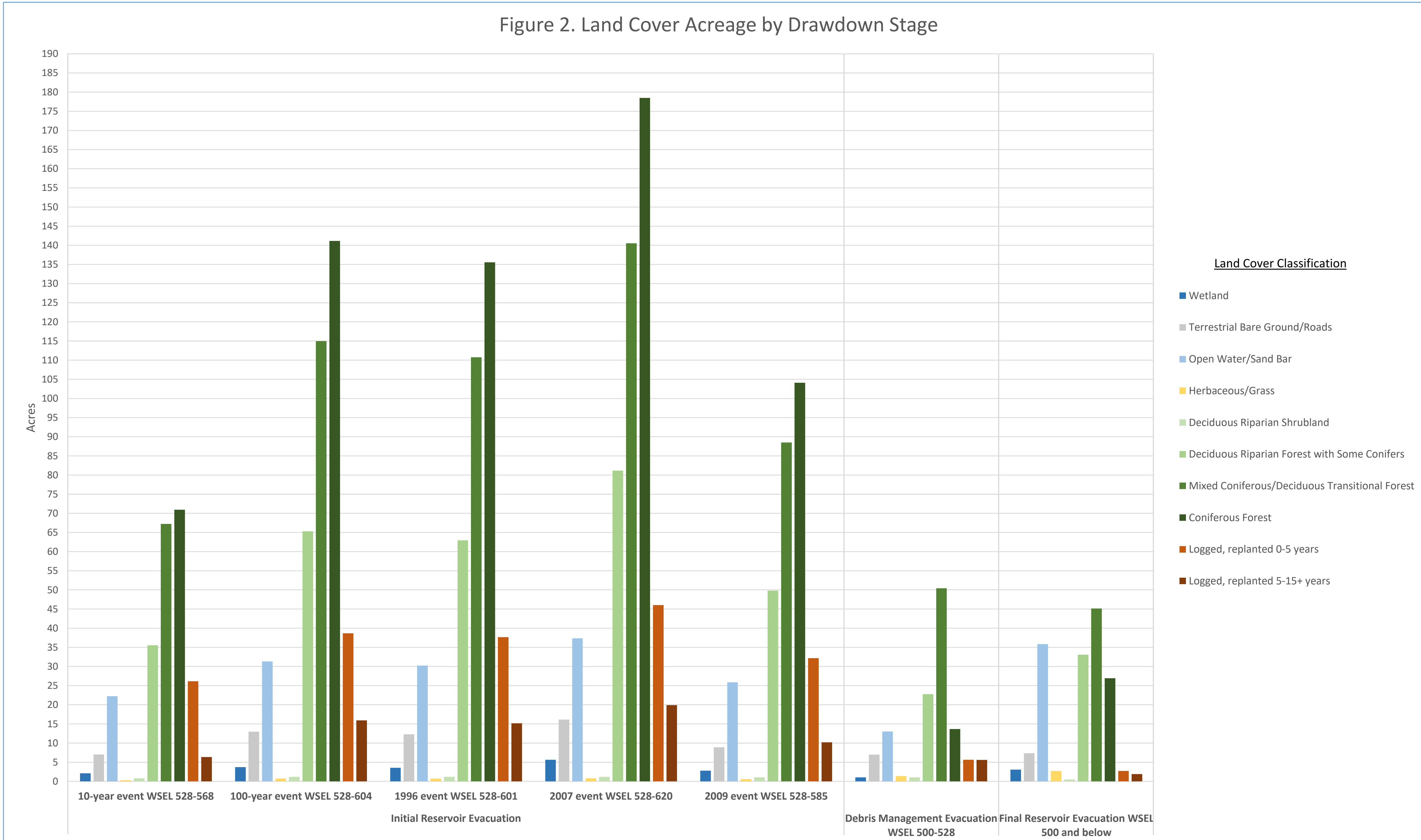


Figure 2. Land Cover Acreage by Drawdown Stage
Acres
190
185
180
175
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
10-year event WSEL 528-568
100-year event WSEL 528-604
1996 event WSEL 528-601
2007 event WSEL 528-620
2009 event 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

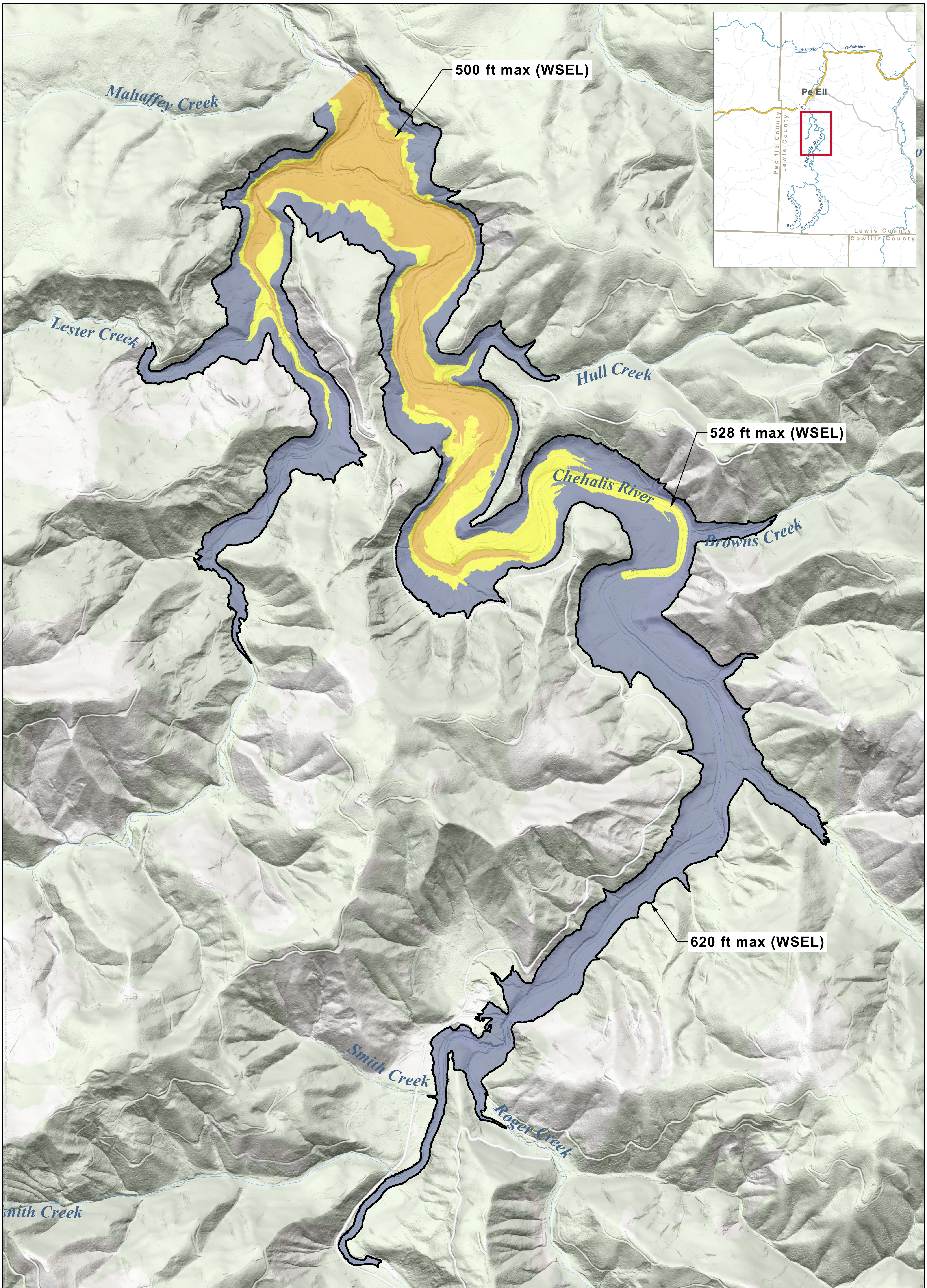
Trees and other vegetation would be completely cleared from the FRE facility site footprint and construction areas. In the Initial Reservoir Evacuation area, where inundation is expected to last between 6 to 11 days during a flood event, selective tree harvest is not proposed to occur prior to construction 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

N

0 1,000 2,000
Feet

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

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.

[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

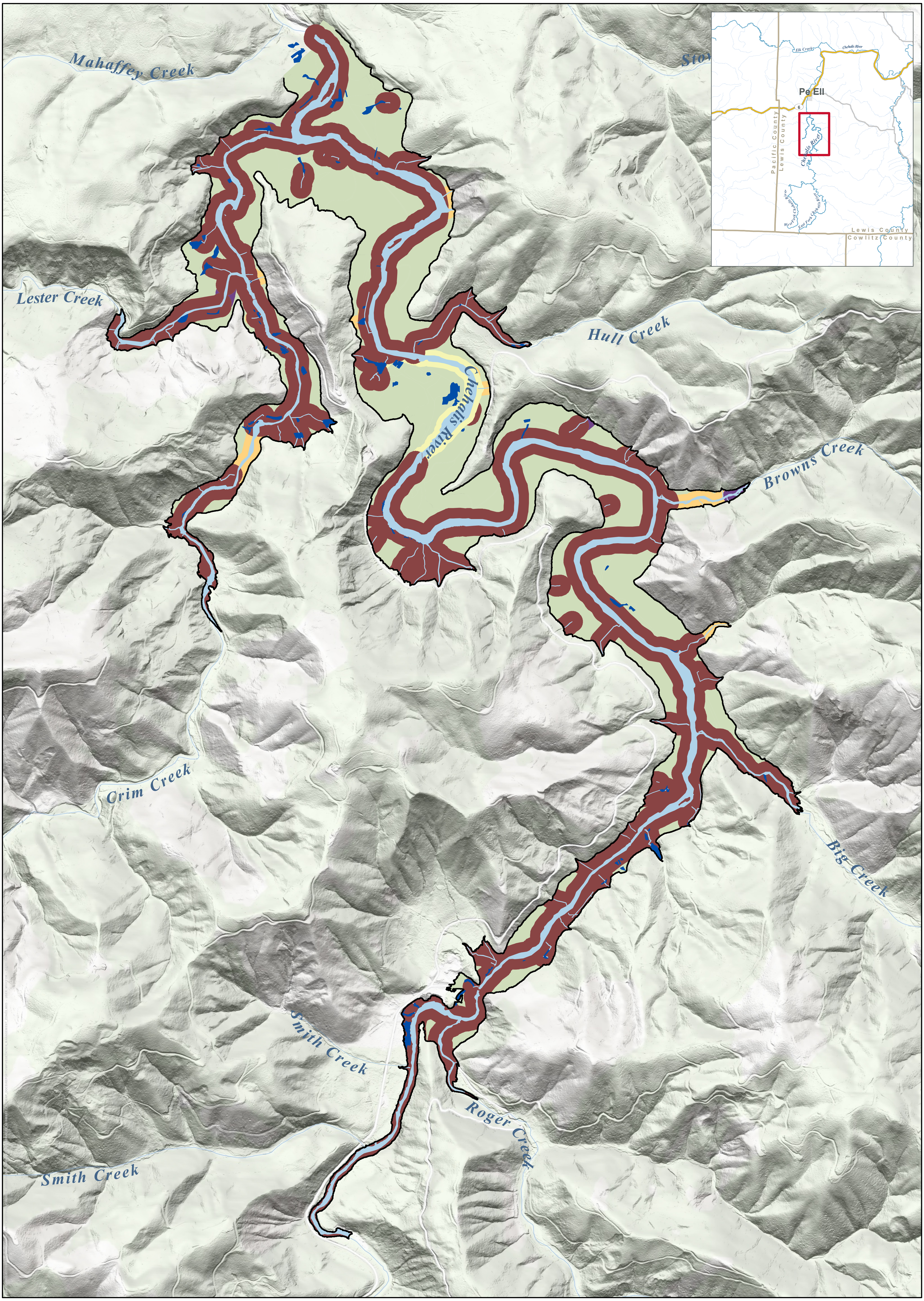
As described in Chapter 5, the FCZD anticipates that an Alternate Plan will need to be developed with an Interdisciplinary Team in order to acquire a Forest Practices Permit from WDNR since tree harvest activities during pre-construction and facility operation would likely vary from prescribed Forest 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.

<u>Objective</u>: 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.

<u>Objective</u>: 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).

<u>Objective</u>: 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.

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

<u>Objective</u>: 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.

7.0 References

Anchor QEA (Anchor QEA, LLC). 2016. Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species, Technical Memorandum on Proposed Flood Retention Facility Pre-construction Vegetation Management Plan. Prepared for the Washington State Recreation and Conservation Office and Chehalis Basin Work Group.

Anchor QEA. 2018. Wetland, Water, and Ordinary High Water Mark Delineation Report. Prepared for the U.S. Army Corps of Engineers, Washington Department of Ecology, and Washington Department of Fish and Wildlife. December 2018.

Batzli, J.M., and J.O. Dawson. 1997. Physiological and morphological responses of red alder and sitka alder to flooding. *Physiologia Plantarum* 99:653-663.

Bendix, J. 1998. Impact of a flood on southern California riparian vegetation. *Physical Geography* 19:162–174.

Brink, V.C. 1954. Survival of Plants under Flood in the Lower Fraser River Valley, British Columbia. *Ecology* 35(1):94–95. January 1954.

Burns, R.M., and B.H. Honkala, tech. coords. 1990. Silvics of North America: 1. Conifers; 2. Hardwoods. Agriculture Handbook 654, Volume 2. U.S. Department of Agriculture, Forest Service, Washington, DC.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. Government Printing Office, Washington, DC.

Ecology (Washington State Department of Ecology). 2020. State Environmental Policy Act Draft Environmental Impact Statement: Proposed Chehalis River Basin Flood Damage Reduction Project. Ecology Publication 20-06-002. February.

Engelaar, W.M.H.G., M.W. Van Bruggen, W.P.M. Van Den Hoek, M.A.H. Huyser, and C.W.P.M. Blom. 1993. Root porosities and radial oxygen losses of Rumex and Plantago species as influenced by soil pore diameter and soil aeration. *New Phytologist* 125:565–574.

Ewing, K. 1996. Tolerance of Four Wetland Plant Species to Flooding and Sediment Deposition. *Environmental and Experimental Botany* 36(2):131–146.

Google, LLC. 2019. Google Earth Pro (Version 7.3.2.5776) [Software].

Harrington, C.A. 1987. Responses of red alder and black cottonwood seedlings to flooding. *Physiologia Plantarum* 69:35-48. Copenhagen 1987.

Harrington, C.A. 2006. Biology and Ecology of Red Alder. In Red Alder - a State of Knowledge. General Technical Report PNW-GTR-669. U.S. Department of Agriculture, Pacific Northwest Research Station, Portland, Oregon, pp 21–43.

HDR. 2020. DRAFT Biological Assessment and Essential Fish Habitat Assessment – Chehalis River Basin Flood Damage Reduction Project: Flood Retention Facility, Airport Levee Improvements, and Mitigation Actions. September 2020.

Hruby, T. 2014. Washington State Wetland Rating System for Western Washington: 2014 Update. Washington State Department of Ecology Publication #14-06-029. Olympia, Washington: Washington Department of Ecology.

Jull, L.G. 2008. Effects of flooding on woody landscape plants. University of Wisconsin Extension Bulletin A3871.

Kozlowski, T.T. 1984. Responses of woody plants to flooding. Pp. 129–163 in T.T. Kozlowski (ed.), Flooding and plant growth. Academic Press, Orlando, FL.

Kozlowski, T.T. 1997. Responses of woody plants to flooding and salinity. Tree Physiology Monograph No. 1. Heron Publishing, Victoria, Canada.

Kozlowski, T.T., and S.G. Pallardy. 2002. Acclimation and Adaptive Responses of Woody Plants to Environmental Stresses. *Botanical Review* 68(2):270–334.

Lam, T.Y., and D.A. Maguire. 2011. Thirteen-Year Height and Diameter Growth of Douglas-Fir Seedlings under Alternative Regeneration Cuts in Pacific Northwest. *Western Journal of Applied Forestry* 26(2):57–63.

Lewis County. 2017. Lewis County Shoreline Master Program: Environment Designations, Policies, & Regulations. Ecology Grant G1200468. Available at: https://lewiscountywa.gov/media/oldSite/default/files/users/commdev/2017_10_16_smp_bocc_adopted.pdf.

Lewis County Noxious Weed Control Board. 2020. Draft 2020 Lewis County Noxious Weed List. Available at: https://lewiscountywa.gov/media/documents/2020__Lewis_Co_Weed_List_whole_page.pdf.

McCaughey, W.W., and T. Weaver. 1991. Seedling Submergence Tolerance of Four Western Conifers. *Tree Planter's Notes* 42(2):45–48.

Minore, D. 1968. Effects of artificial flooding on seedling survival and growth of six northwestern tree species. Research Note PNW-92. U.S. Department of Agriculture Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. October 1968.

North Dakota State University. 2000. Flooding of Trees. Available at: https://www.ag.ndsu.edu/archive/entomology/ndsucpr/Years/2000/June/22nd/hort_22june00.htm.

Parolin, P. 2009. Submerged in darkness: adaptations to prolonged submergence by woody species of the Amazonian floodplains. *Annals of Botany* 103:359–376.

Siebel, H.N., M. Van Wijk, and C.W.P.M. Blom. 1998. Can tree seedlings survive increased flood levels of rivers? *Acta botanica neerlandica* 47:219–230.

Soil Science Division Staff. 2017. Soil survey manual. C. Ditzler, K. Scheffe, and H.C. Monger (eds.). USDA Handbook 18. Government Printing Office, Washington, DC.

Tilley, D., D. Ogle, L. St. John, J.C. Hoag, and J. Scianna. 2012. Native Shrubs and Trees for Riparian Areas in the Intermountain West. Technical Note Plant Materials No. 32. U.S. Department of Agriculture, Natural Resources Conservation Service. Boise, Idaho. August 2012.

USDA (U.S. Department of Agriculture) Forest Service. 2012. A Stage Is A Stage Is A Stage…Or Is It? Successional Stages, Structural Stages, Seral Stages. White Paper F14-SO-WP-Silv-10. November 2012.

USDA NRCS (U.S. Department of Agriculture, Natural Resources Conservation Service). 2019. Web Soil Survey. Available at: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx. Accessed May 22, 2020.

USDA NRCS. 2020a. Field Office Climate Data for Centralia, WA – Wets Tables 2020. AgACIS for Lewis County. Available at: http://agacis.rcc-acis.org/?fips=53041. Accessed May 1, 2020.

USDA NRCS. 2020b. The PLANTS Database. National Plant Data Team, Greensboro, NC 27401-4901 USA. Available at: http://plants.usda.gov. Accessed May 2020.

Walters, M.A., R.O. Teskey, and T.M. Hinkley. 1980. Impact of water level changes on woody riparian and wetland communities. Volume VIII: Pacific Northwest and Rocky Mountain Regions. Biological Services Program, U.S. Fish and Wildlife Service FWS/OBS-78/94.

Washington Forest Protection Association. 2004. Forest Facts and Figures. Available at: https://www.wfpa.org/wp-content/uploads/2017/11/forestfacts-and-figures10.pdf. December 2004.

WDNR (Washington Department of Natural Resources). 2000. Forest Practices Board Manual Section 1: Method for Determination of Adequate Shade Requirements on Streams. March 2000. Available at: https://www.dnr.wa.gov/publications/fp_board_manual.pdf?a7nfd.

WDNR. 2009. Desired Future Condition Worksheet Version 3.0. Last Updated March 2009. Available at: https://fortress.wa.gov/dnr/protection/dfc/Version.aspx.

WDNR. 2013. Forest Practices Board Manual Section 21: Guidelines for Alternate Plans. August 2013. Available at: https://www.dnr.wa.gov/publications/fp_board_manual_section21.pdf?on0zn.

WDNR. 2018. Site Class data. Available at: https://geo.wa.gov/datasets/wadnr::site-class?geometry=-123.334%2C46.523%2C-123.253%2C46.543. June 2020.

WDNR. 2019. Stream Temperature Class data. Available at: https://data-wadnr.opendata.arcgis.com/datasets/Accessed January and June 2020.

WDNR. 2020a. Digital Surface Model data: 2014-2019. Available at: https://www.dnr.wa.gov/lidar. Accessed January and March of 2020.

WDNR. 2020b. Digital Terrain Model data: 2014-2019. Available at: https://www.dnr.wa.gov/lidar. Accessed January and March of 2020.

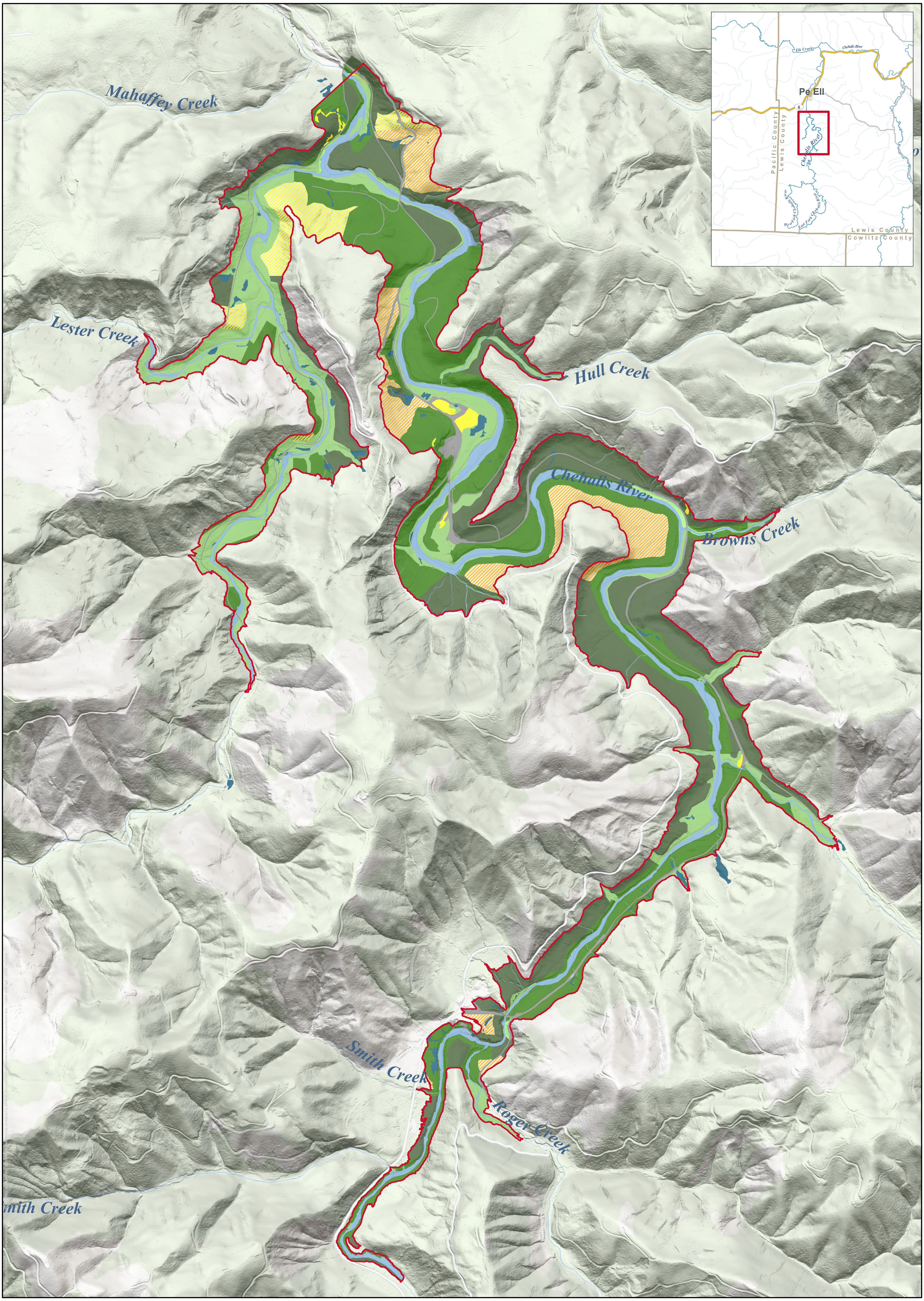
WDNR. 2020c. WADNR Active Roads. Available at: http://data-wadnr.opendata.arcgis.com/datasets/wadnr-active-roads?geometry=-141.641%2C44.462%2C-99.871%2C49.693. Accessed January of 2020.

Wenger, K.F. (editor). 1984. *Forestry Handbook*. Society of American Foresters. New York: John Wiley and Sons, Inc.

Whitlow, T.H., and R.W. Harris. 1979. Flood Tolerance in Plants: A State of the Art Review. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi. Technical Report E-79-2.

Withrow-Robinson, B., M. Bennett, and G. Ahrens. 2011. A Guide to Riparian Tree and Shrub Planting in the Willamette Valley: Steps to Success. EM 9040. Oregon State University Extension Service. Corvallis, Oregon. October 2011.

Appendix A. Existing Vegetation Mapping



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

0 1,000 2,000
Feet

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)

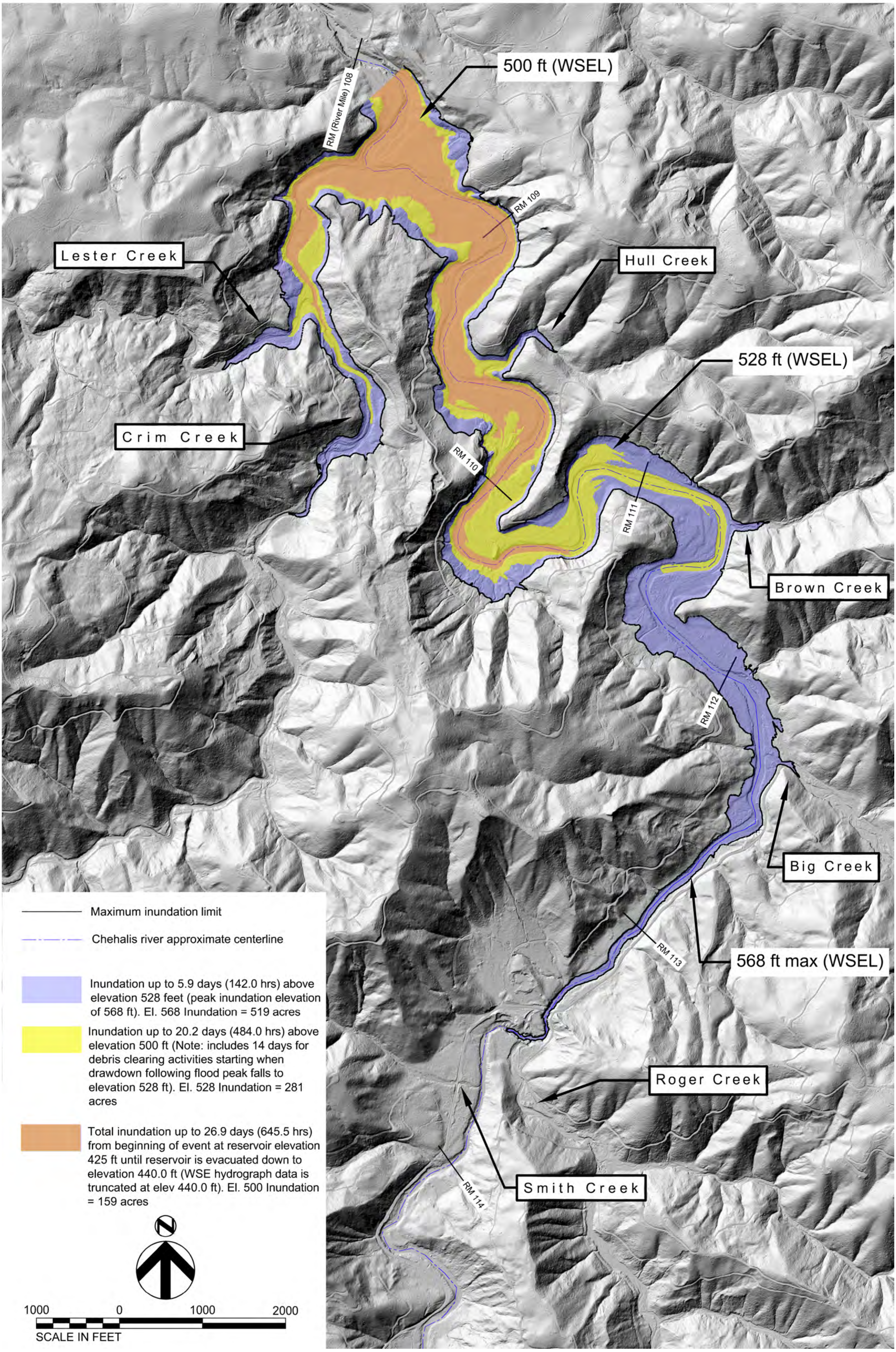
LAND COVER CLASSIFICATION

Chehalis River Basin Flood Damage Reduction Project

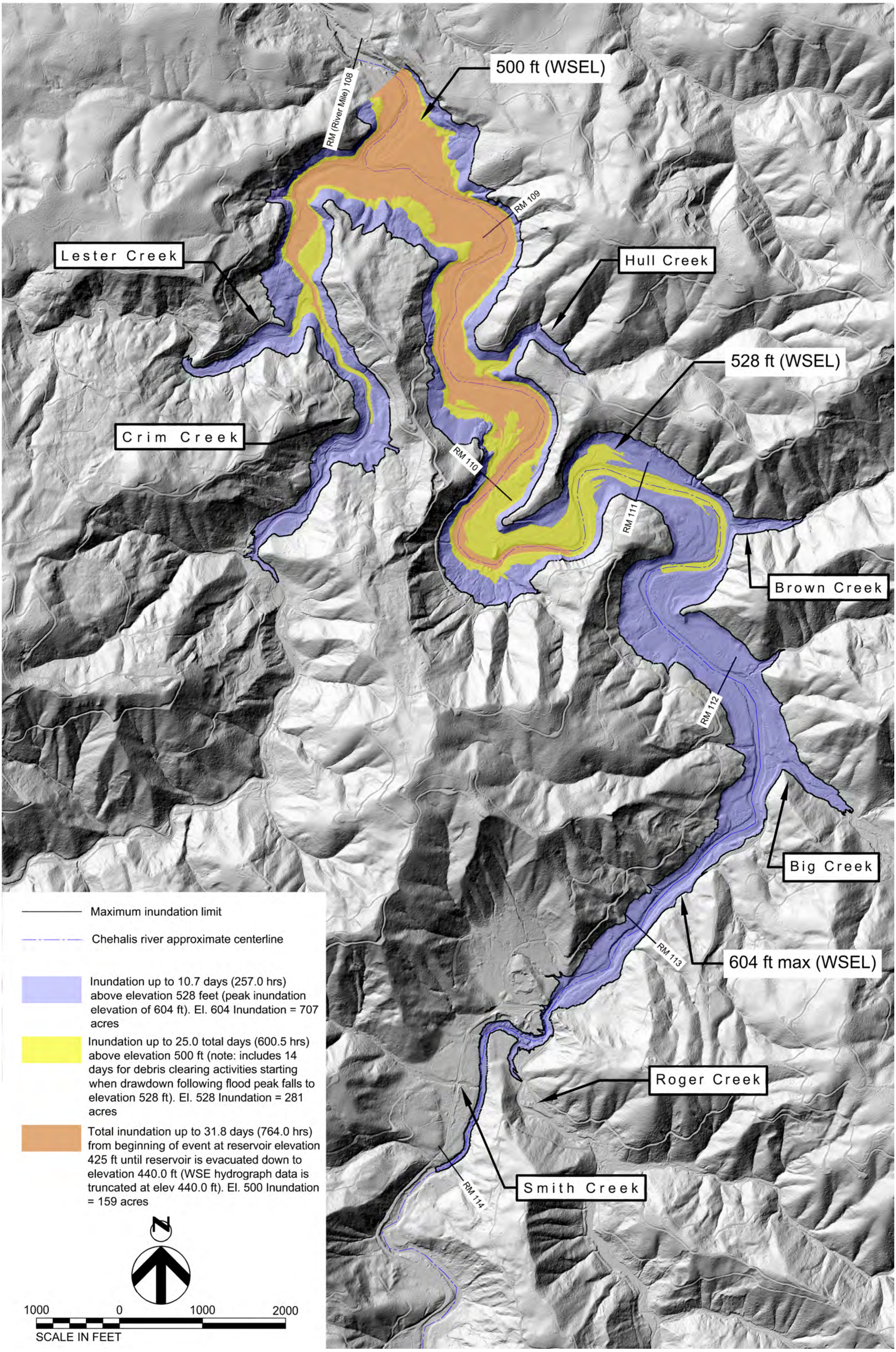
Date: 10/2/2020

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

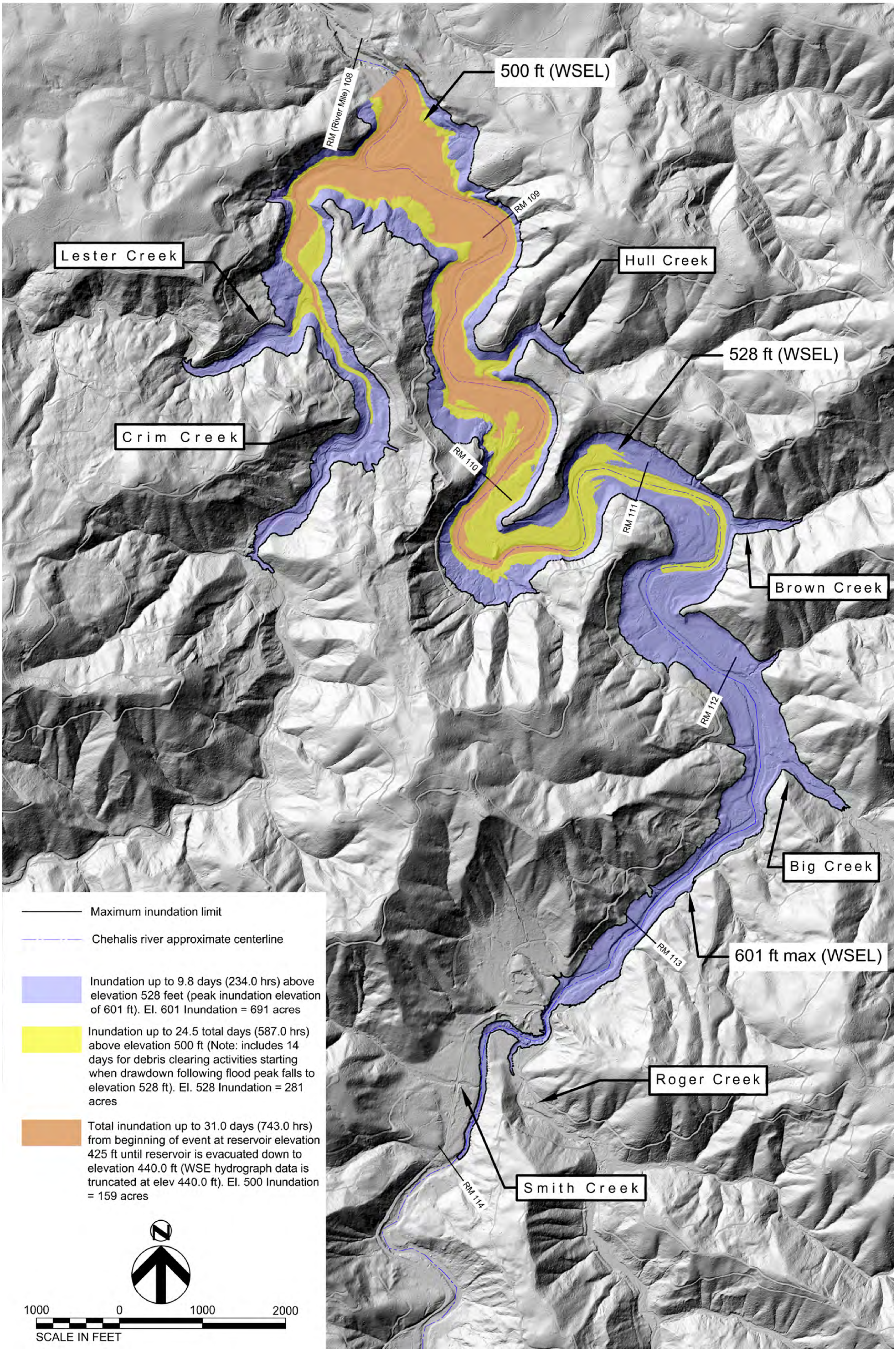
10 Year Event Inundation Map for Proposed Dam (FRE)



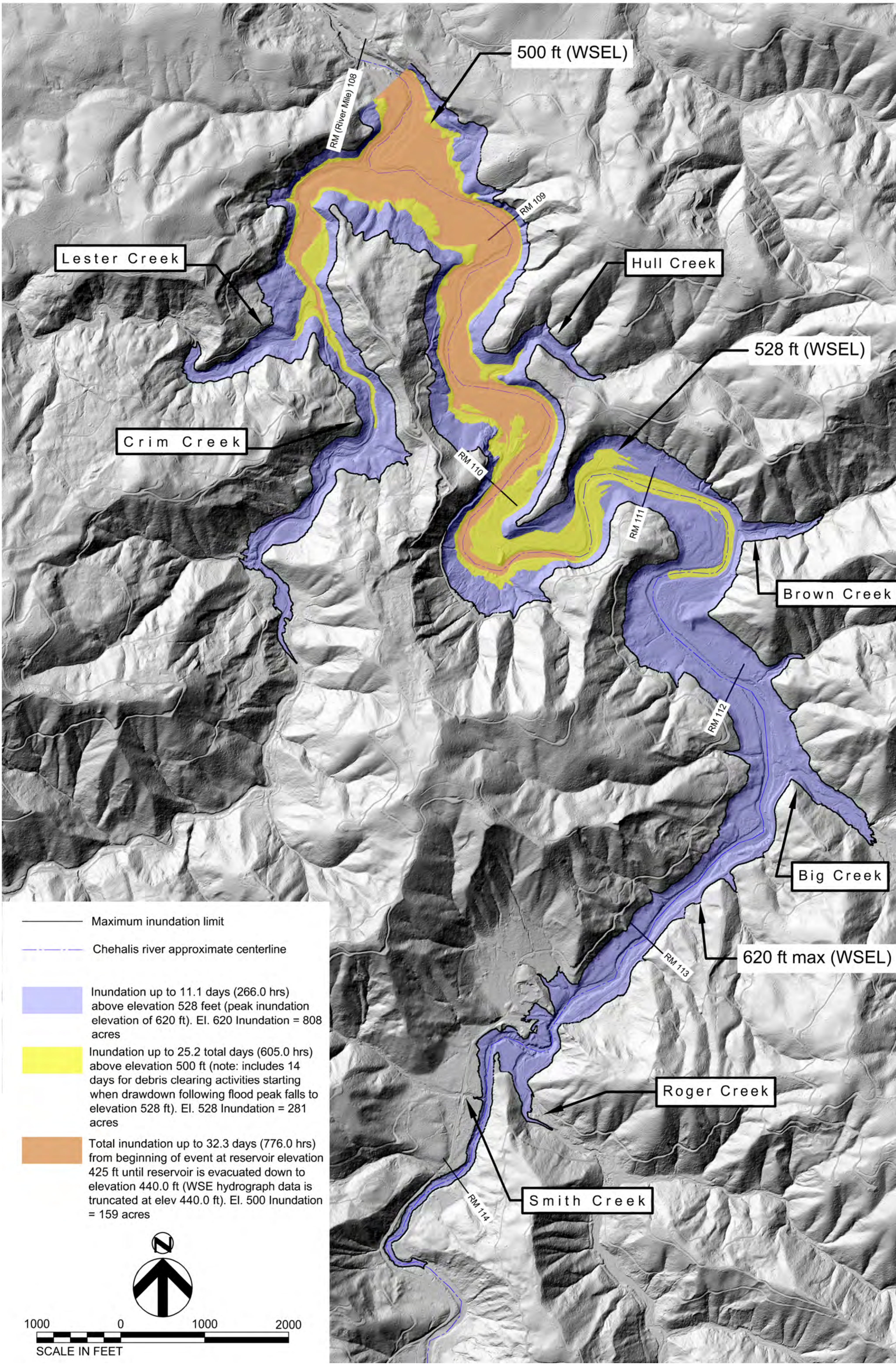
100 Year Event Inundation Map for Proposed Dam (FRE)



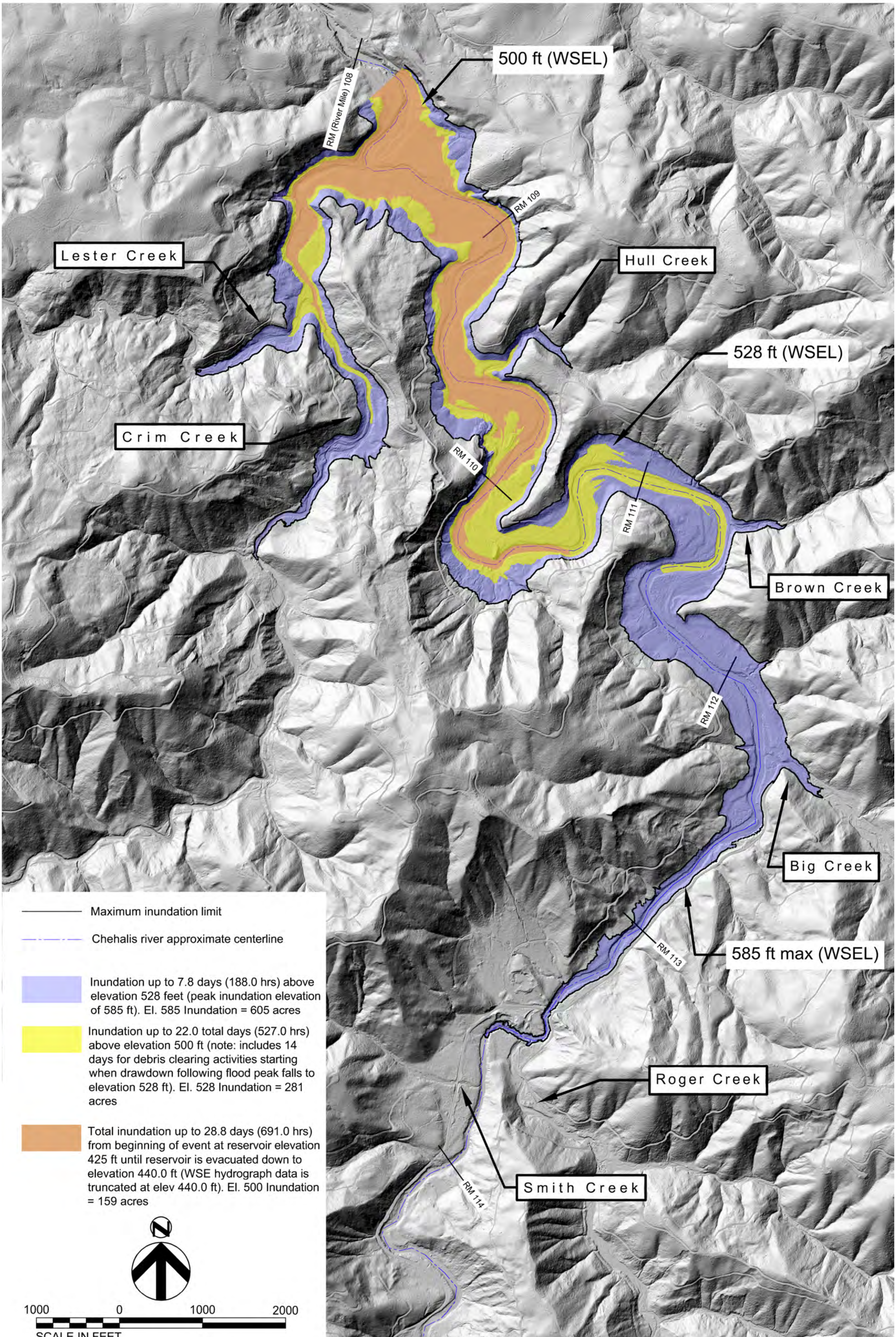
1996 Event Inundation Map for Proposed Dam (FRE)



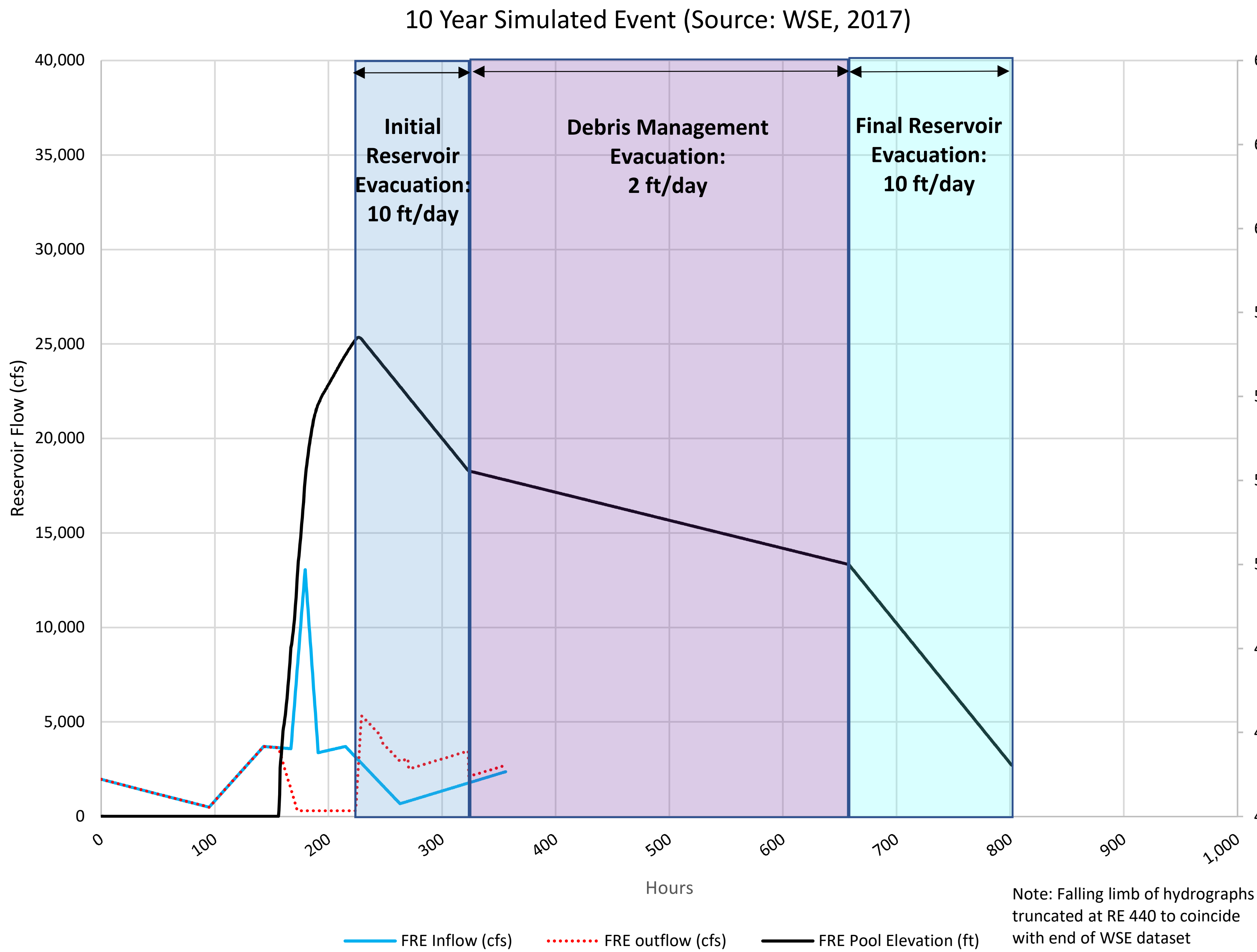
2007 Event Inundation Map for Proposed Dam (FRE)

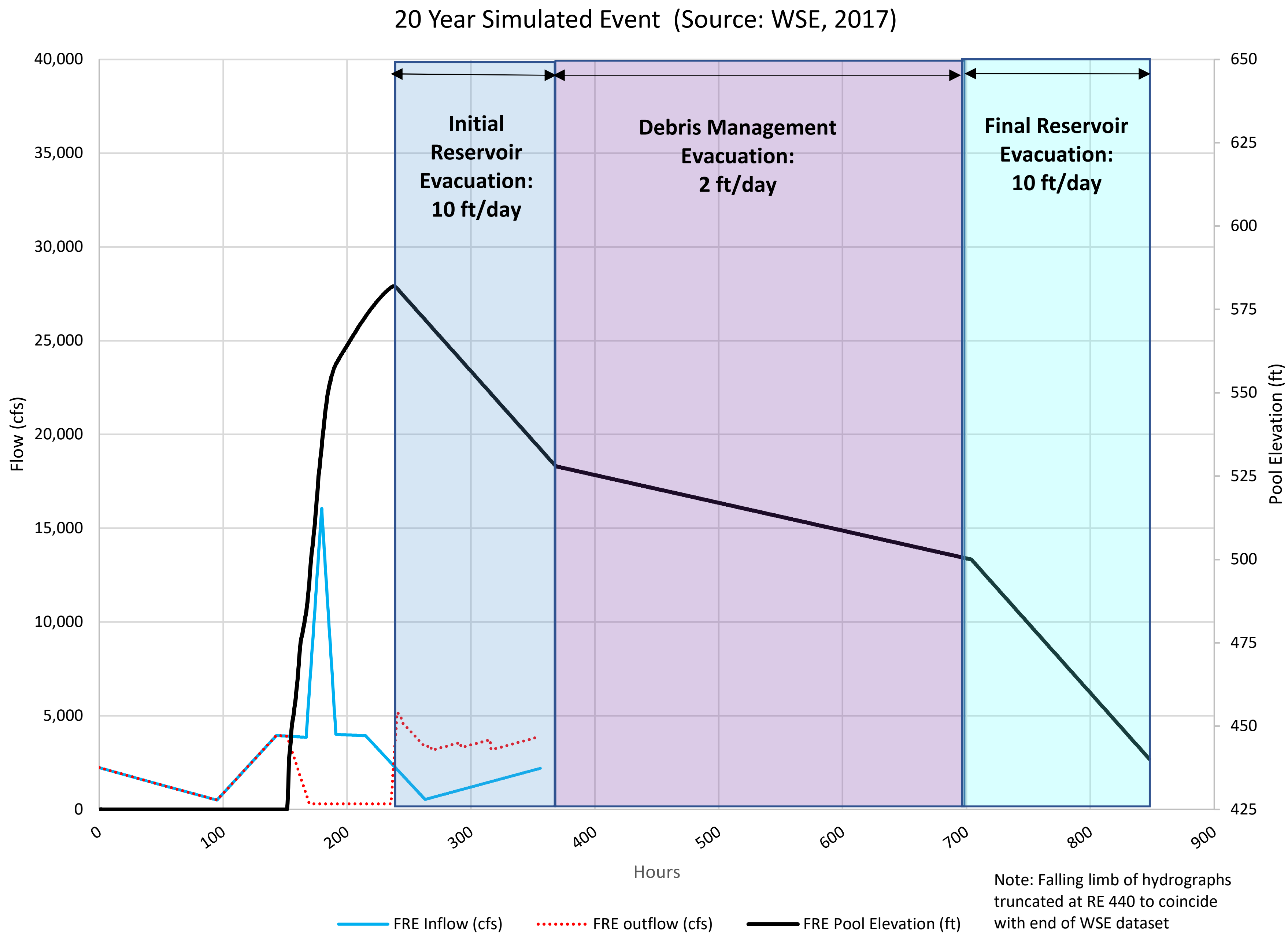


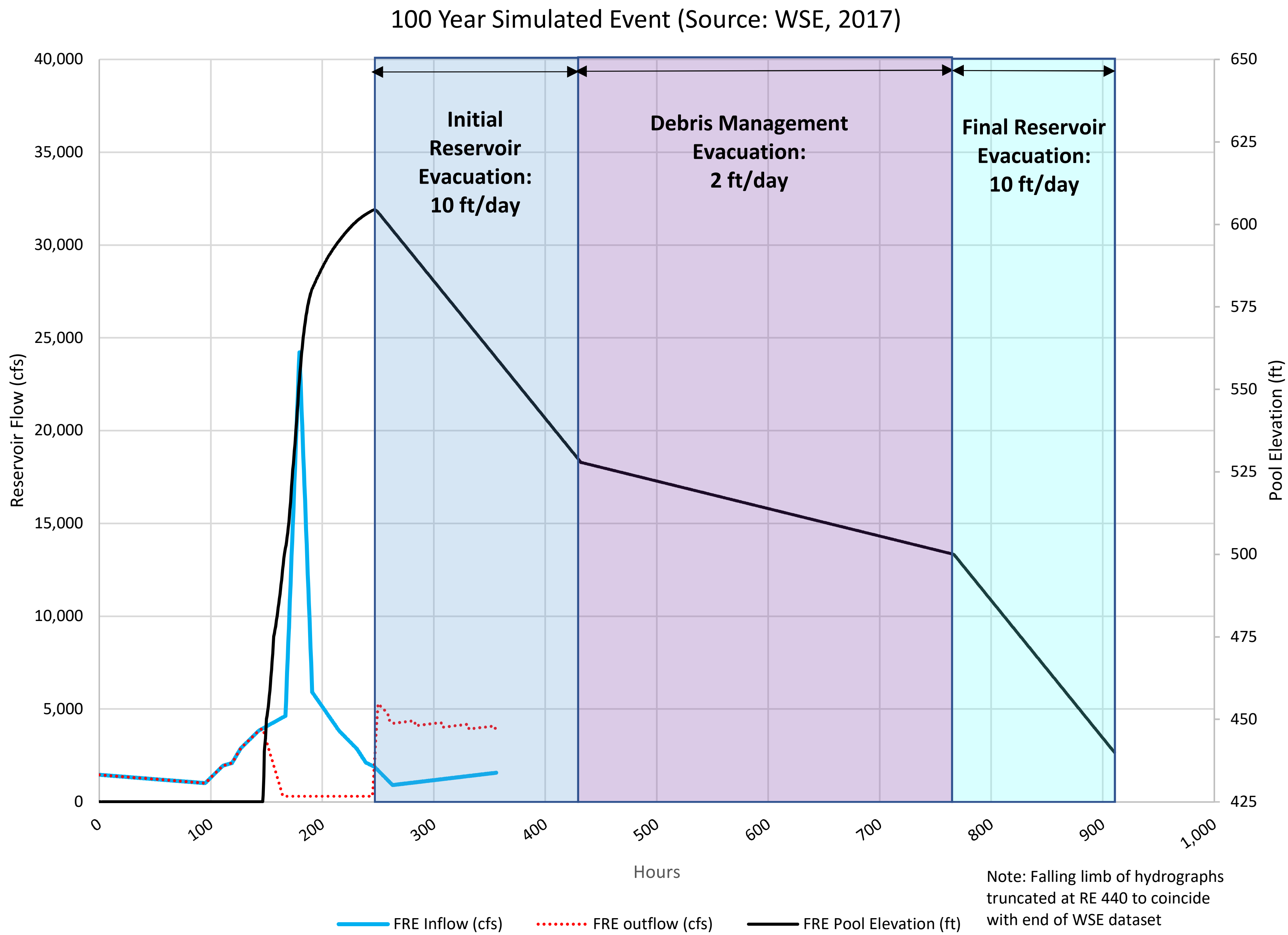
2009 Event Inundation Map for Proposed Dam (FRE)

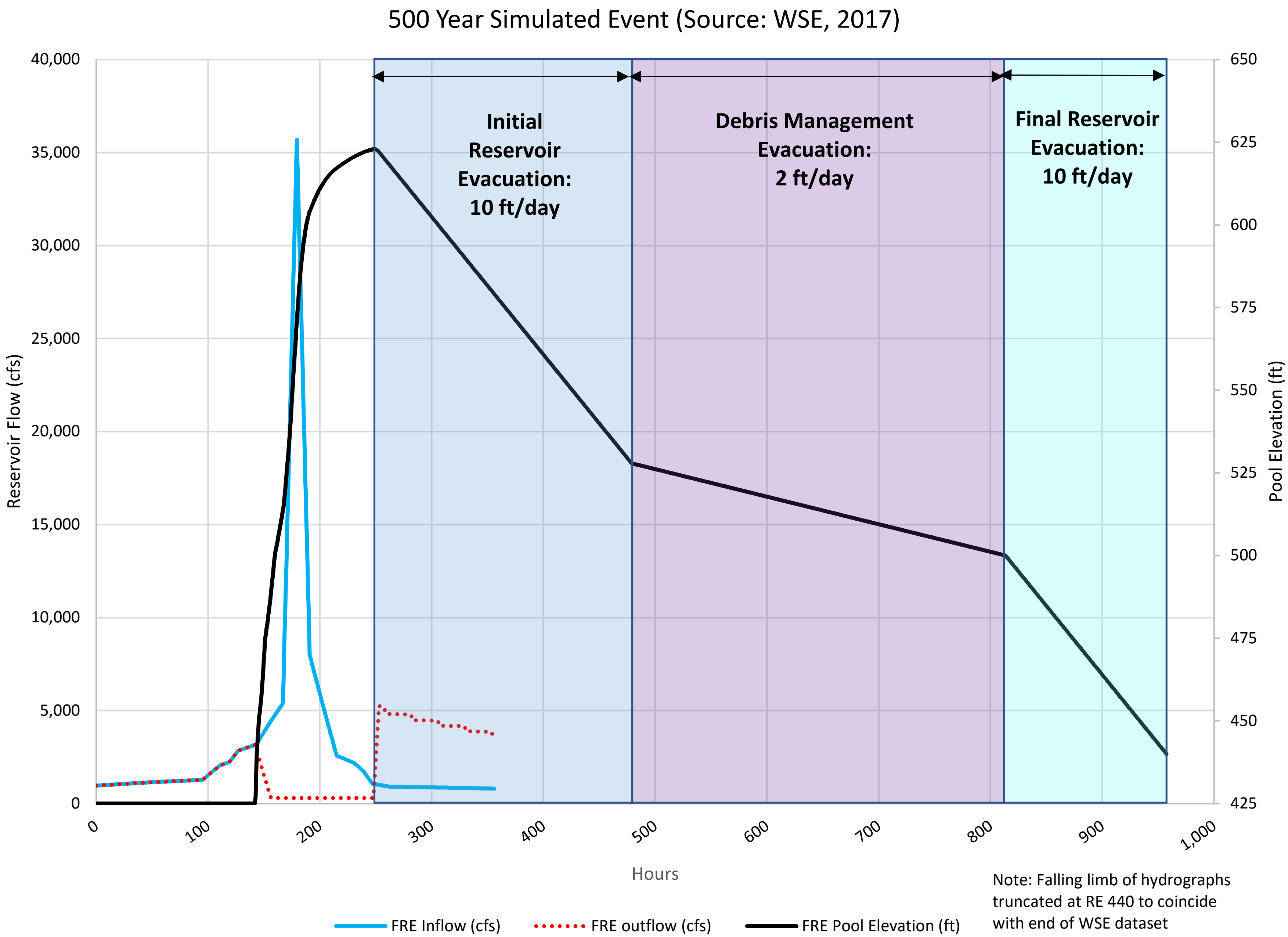


Appendix C. Hydrographs for Major Flood Events

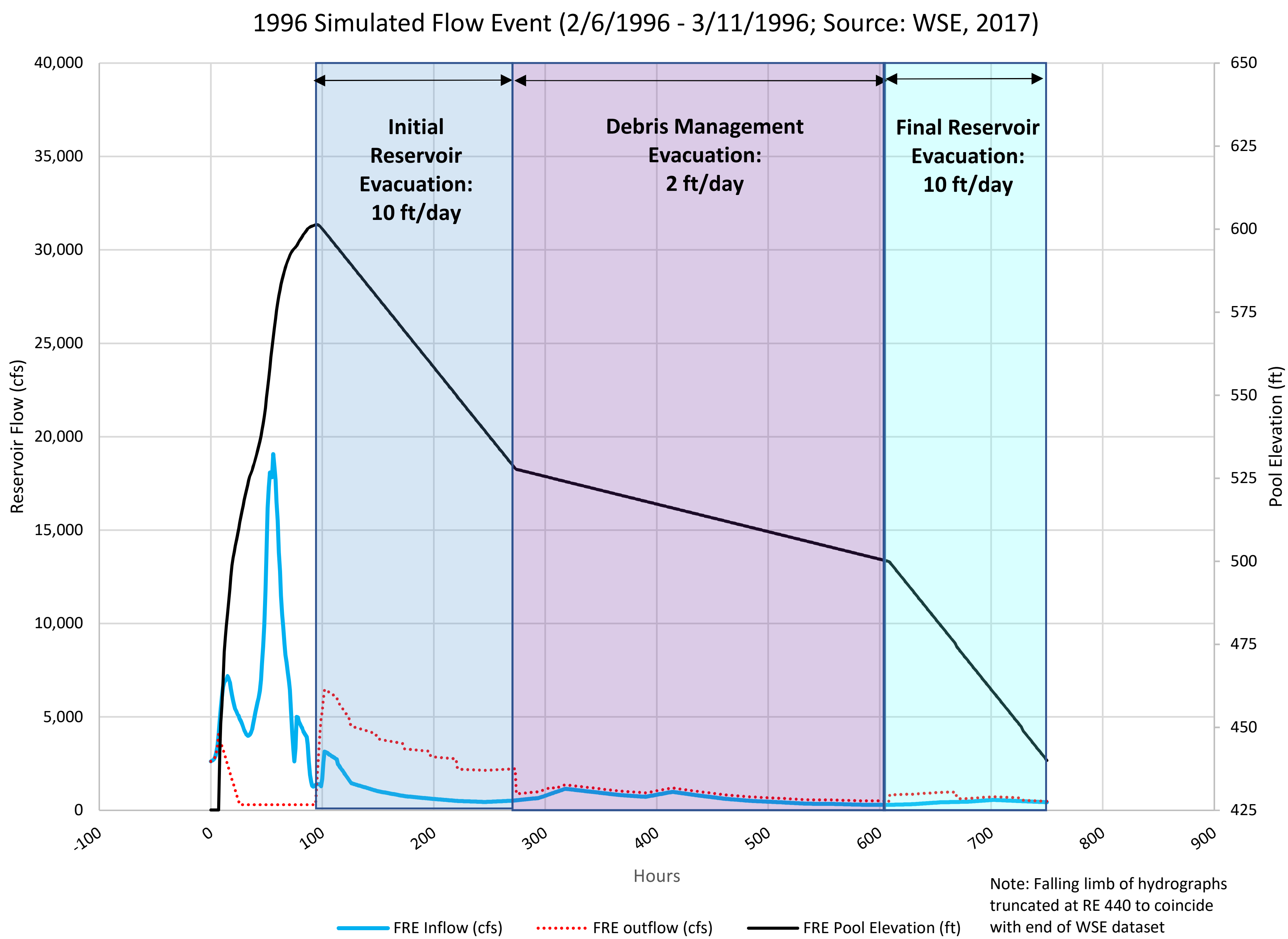

10 Year Simulated Event (Source: WSE, 2017)
Reservoir Flow (cfs)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Pool Elevation (ft)
650
625
600
575
550
525
500
475
450
425
Initial Reservoir Evacuation: 10 ft/day
Debris Management Evacuation: 2 ft/day
Final Reservoir Evacuation: 10 ft/day
0
100
200
300
400
500
600
700
800
900
1,000
Hours
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

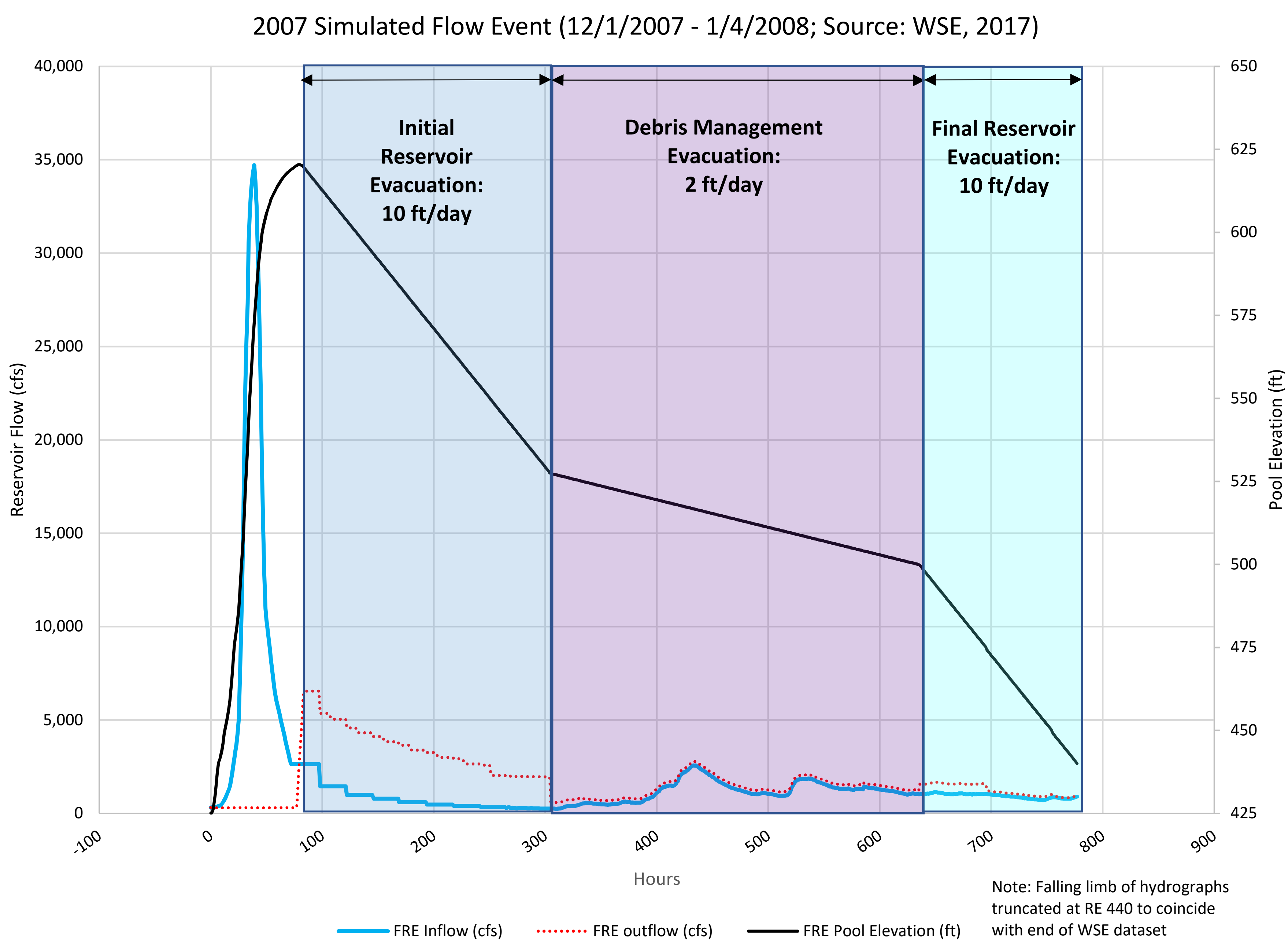

100 Year Simulated Event (Source: WSE, 2017)
Initial Reservoir Evacuation: 10 ft/day
Debris Management Evacuation: 2 ft/day
Final Reservoir Evacuation: 10 ft/day
Reservoir Flow (cfs)
Pool Elevation (ft)
Hours
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
650
625
600
575
550
525
500
475
450
425
0
100
200
300
400
500
600
700
800
900
1,000
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)

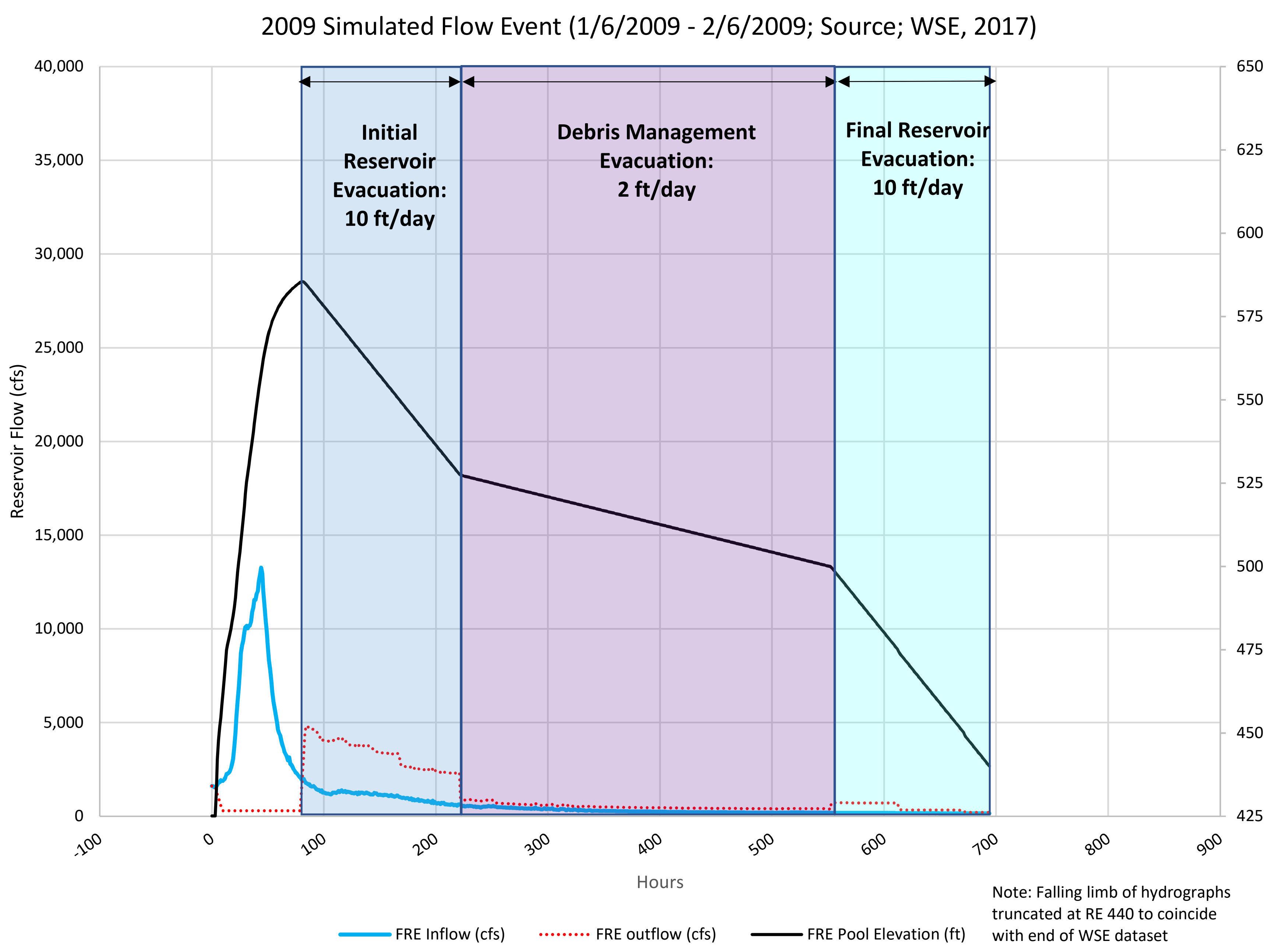


Note: Falling limb of hydrographs truncated at RE 440 to coincide with end of WSE dataset



1996 Simulated Flow Event (2/6/1996 - 3/11/1996; 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


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
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)



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