Technical Memorandum

Date:	August 26, 2021
Project:	Chehalis River Basin Flood Damage Reduction Project
To:	Chehalis Basin Flood Control Zone District
From:	HDR Engineering
Subject:	Plant Replacement Plan

1.0 Introduction and Purpose

As part of a strategy to reduce flood damage to life and property along the Chehalis River, the Chehalis River Basin Flood Control Zone District (District) proposes to construct a flood retention facility near the town of Pe Ell on the mainstem of the Chehalis River. The Draft Environmental Impact Statements (DEISs) prepared by the Washington State Department of Ecology (Ecology), pursuant to the State Environmental Policy Act (SEPA) and the U.S. Army Corps of Engineers (USACE), pursuant to the National Environmental Policy Act (NEPA), evaluate anticipated impacts associated with construction and operation of the proposed Flood Retention Only - Expandable (FRE) facility (i.e., the Chehalis River Basin Flood Damage Reduction Project [proposed project]). The SEPA and NEPA DEISs documented moderate and significant impacts to fish and aquatic resources, geomorphology and sediment transport, and water quality parameters (temperature, turbidity), driven in part by the assumption that all of the existing vegetation in the riparian and upland areas of the temporary inundation zone of the FRE would be removed.[1]

Following release of the DEISs, the District has provided additional documentation to Ecology and USACE (herein, the Agencies) to clarify the assumptions of vegetation management in the temporary inundation area, inundation durations and extent, and the subsequent impacts on water quality. This additional information has been provided with the intent to refine assumptions made for the impacts analysis of the Final EISs that the Agencies are preparing. The previously submitted documentation includes:

- *SEPA DEIS Review: FRE Facility Temporary Reservoir Inundation and Vegetation Analysis Clarification* (HDR 2020a) provided with the District's comments to Ecology's DEIS submitted on May 27, 2020, and included as Appendix D to the Biological Assessment and the Essential Fish Habitat Assessment submitted to USACE on September 18, 2020.

[1] The *Pre-Construction Vegetation Management Plan* (Anchor QEA 2016) informed assumptions made in the SEPA DEIS that construction activities would include the removal of all non-flood-tolerant trees within approximately 420 acres of the temporary inundation area and all other trees greater than 6 inches diameter breast height throughout the temporary inundation area as a conservative approach (Ecology 2020). The NEPA analysis assumes 485 acres of clearing and limited (2-meter height) vegetative shading throughout the entire temporary inundation area (USACE 2020).

- *Conceptual Vegetation Management Plan* (HDR 2020b) provided with the District's comments to USACE's DEIS submitted on November 16, 2020.
- *Water Temperature Model Sensitivity Analysis: Chehalis River Basin Flood Damage Reduction Project* (HDR and PSU 2021) to be submitted to the USACE in September 2021 as an appendix to the updated Biological Assessment and Essential Fish Habitat Assessment.

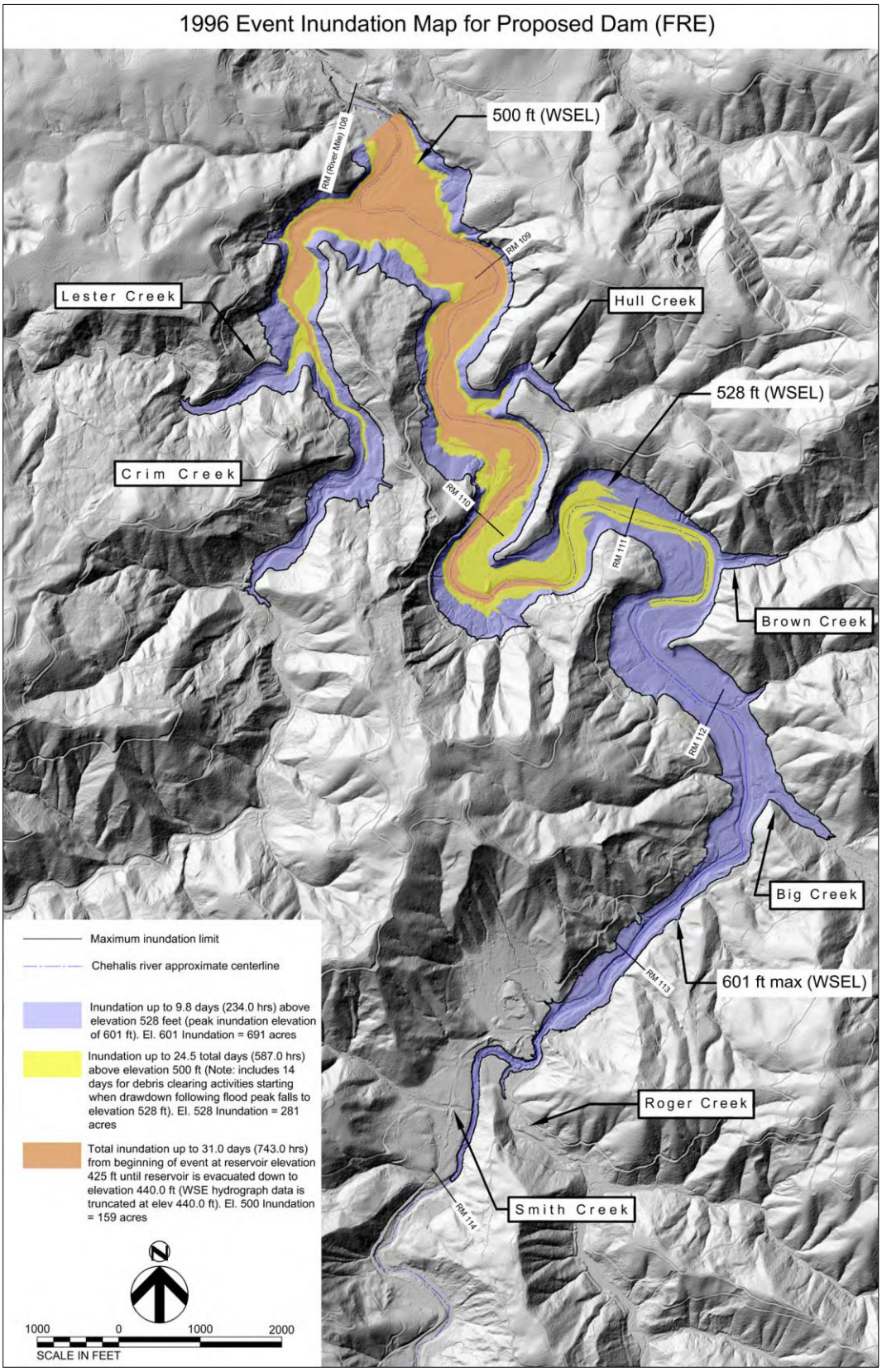
Subsequently, the Agencies have requested additional information to support revised assumptions for the future vegetation conditions within the temporary inundation area. Specifically, the Agencies requested additional information regarding expected vegetation species survivability based on the proposed frequency and duration of the FRE operations and have requested a proposed growth timeline based on expected species survivability during and following FRE operations. The Agencies also requested a firm commitment from the District to implement an adaptive management plan for vegetation within the temporary inundation area.

This memo is intended to further refine earlier assumptions concerning the expected vegetation that will viably persist within the proposed temporary inundation area of the FRE facility once it has been constructed and provides a timeline for vegetation growth at the new facility. A more detailed planting schedule is also provided for each of the inundation areas, which were previously described in HDR 2020a.

2.0 Expected Vegetation

Vegetation management within the affected area for the FRE includes anticipating the expected influence of flood waters on existing vegetation, planning for these effects, and ameliorating any degradation by instituting a proactive harvest and replanting program. Plant species, particularly trees, that would be removed are those species less tolerant of flood inundation, and species that would be planted are more tolerant. Figure 1 shows the three inundation zones that have been identified for the proposed FRE facility (HDR 2020a). These zones have not changed since the development of the *Conceptual Vegetation Management Plan* (Conceptual VMP) (HDR 2020b).

Figure 1. Project Area Inundation Map



The Conceptual VMP lays out this foundation. To help visualize an implementation scenario, a series of actions is proposed in the Conceptual VMP that establish the sequence of management activities over time and allow for tree establishment and growth within the temporary inundation area. The vegetation management sequence and timeline presented in this memo are intended to inform the subsequent impact analysis of the Final EISs, which will consider the proposed future vegetation conditions. A 30-year growth timeline is presented in Table 1 that captures temporal impacts associated with this tree cover conversion, such as riparian shading.

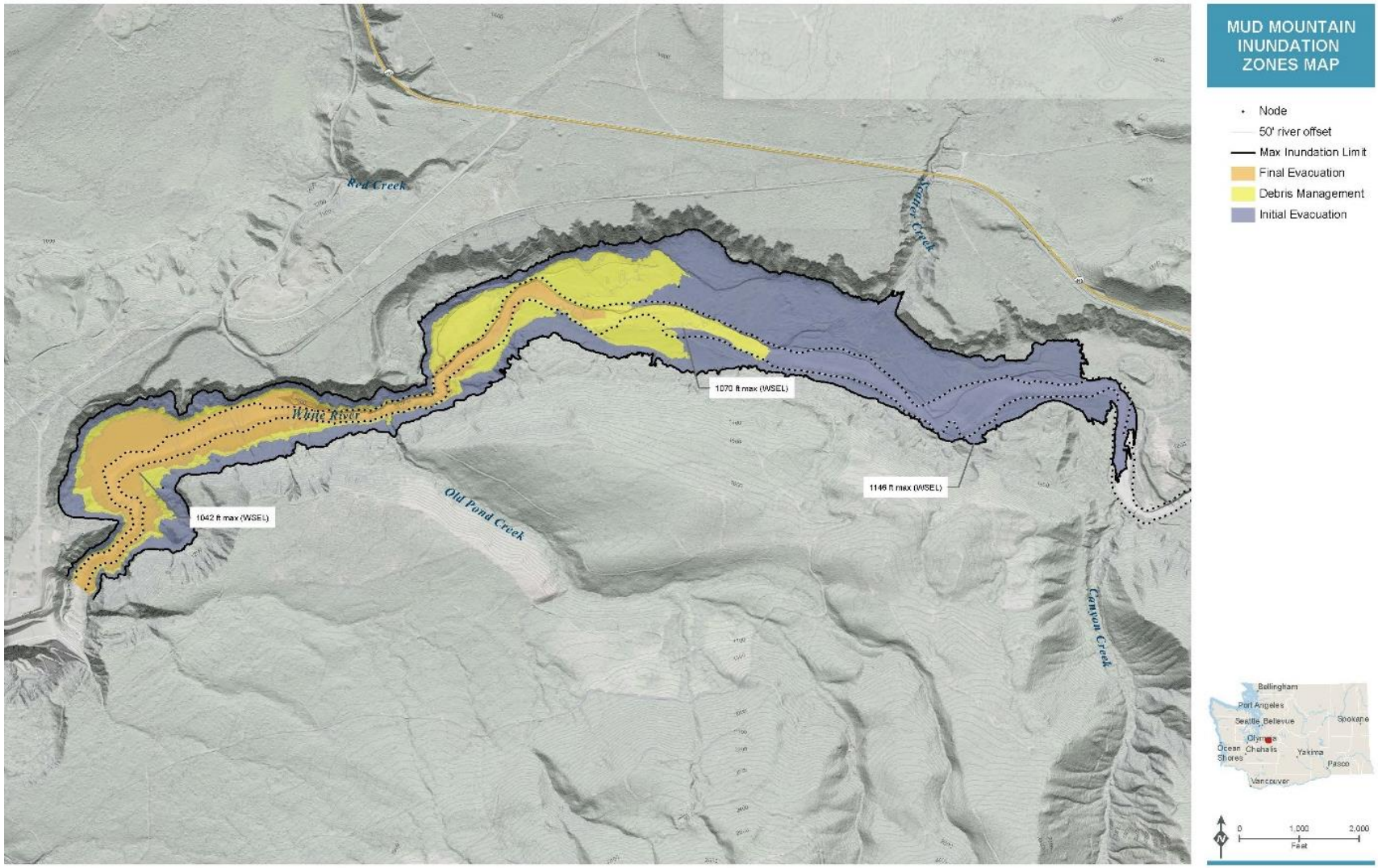
2.1 Mud Mountain Example

The Mud Mountain Dam located on the White River, Washington, is a nearby example of a flood control facility similar to the proposed FRE. As discussed in the *Water Temperature Model Sensitivity Analysis*, the Mud Mountain facility actively manages high flows that occur within the White River several times annually compared with the proposed FRE facility, which would impound water only once every few years (Ecology 2020).

The *Water Temperature Model Sensitivity Analysis* included a map (Figure 2) that depicts Mud Mountain Dam inundation zones, which are analogous to the proposed FRE inundation. Tree species were identified that are present within the Mud Mountain reservoir as target species for the proposed FRE facility within each corresponding inundation zone. The vegetation that is currently present at the Mud Mountain Dam was used to validate the tree species that are expected to persist, given the proposed flood retention operations of the FRE facility.

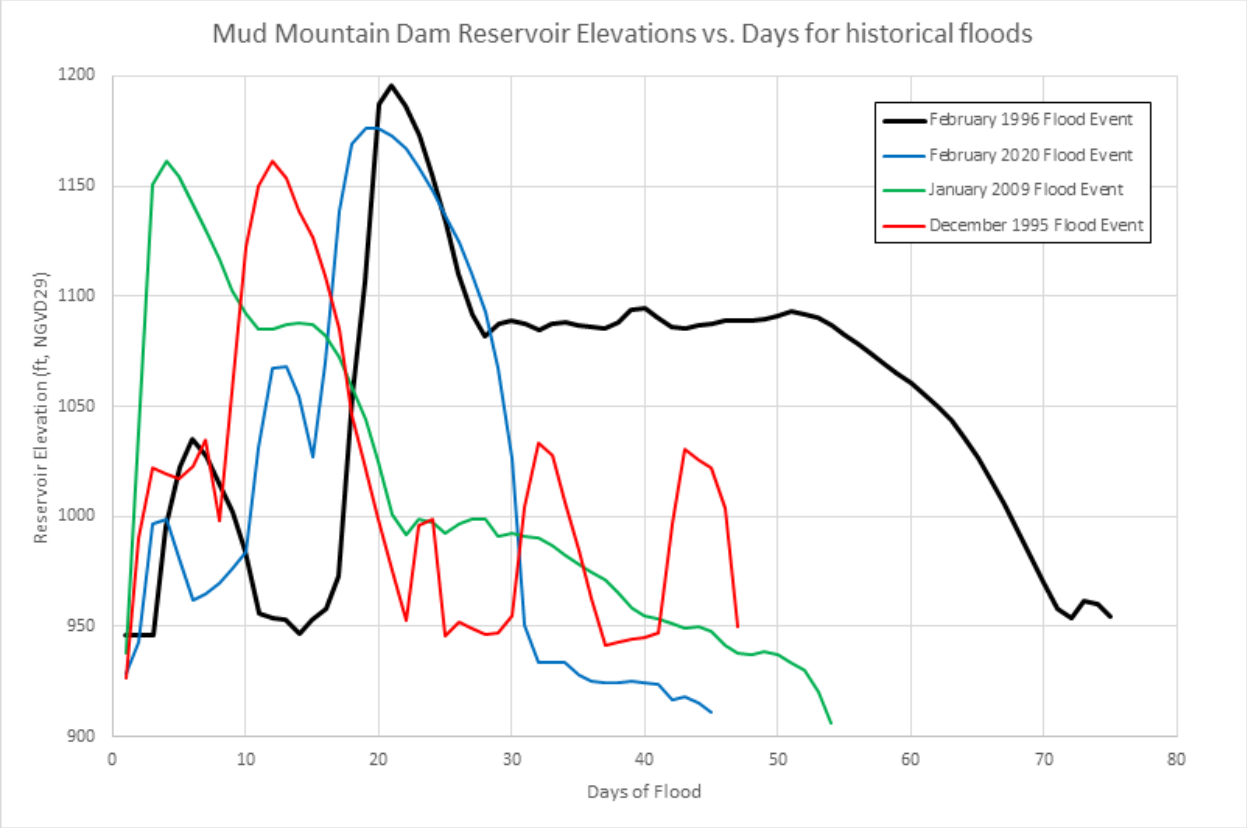
Mature tree heights used for the *Water Temperature Model Sensitivity Analysis* were selected based on a review of the Mud Mountain Dam reservoir and a recent study by the USACE Engineer Research and Development Center (USACE-ERDC; 2019) that mapped and described the vegetation growing within the reservoir, taking these species and projecting a mature tree height using conservative yearly growth rates and then selecting an appropriate time horizon. Table 1 presents these assumptions over a 30-year growth horizon. Heights of vegetation for any given year could be approximated by using the yearly growth rates.

Figure 2. Mud Mountain Inundation Zones



The Agencies have commented that, in addition to the increased frequency of flooding and operation of the Mud Mountain facility, there are differences in the duration of inundation at the Mud Mountain facility. Figure 3 shows the Mud Mountain reservoir water surface elevations over time for several large flood events since 1995. This graph shows that the peak flood durations (when the inundation exceeds 1,070 feet and floods the Initial Evacuation Zone at Mud Mountain) last for approximately 8 to 11 days. This duration is very similar to the projected inundation of the Initial Evacuation Zone (highest part of the reservoir) at the proposed FRE facility. Depths of inundation are also similar. In this zone, the ERDC study found the proliferation of black cottonwood and Sitka spruce trees, indicating that these species can tolerate this level and duration of flooding. The Mud Mountain facility does flood more frequently—several times in a typical year—but large floods such as those depicted on the graph are similar to the expected flooding regime at the FRE facility on the Chehalis River.

Figure 3. Mud Mountain Reservoir Historic Flood Durations



3.0 Tree Harvest and Planting Plan

Once the temporary reservoir site has been "converted" from designated forest land to land that supports the flood control facility, the Washington Department of Natural Resources (WDNR) Forest Practices Rules would not apply. The WDNR Forest Practices Rules would unnecessarily restrict tree removal within a 170-foot to 200-foot "Riparian Zone" where some of the logging would be required to develop this type of facility. This memorandum assumes that

the area has been converted. As stated in the Conceptual VMP, different vegetation management strategies would be initiated within each of the identified inundation zones. Different species of trees would be planted and encouraged close to the river as opposed to farther up the slope within each of the inundation zones. The riparian zone includes land within 150 to 200 feet from the ordinary high water mark of the Chehalis River and the tributary streams. Terraces are flat areas either adjacent to the riparian zone or just above flood stages where sediment may accumulate and moisture may be retained by fine sediment of organic accumulations. Wetlands may also form on flooded terraces and within the riparian zones over time, and these areas will require species that are tolerant of prolonged soil saturation. Slope areas are expected to contain the thinnest soils and experience the most drought conditions during the summer months. Plant species proposed for each inundation zone and landscape position are listed in Table 2.

The tree and shrub species that have been selected for installation at the FRE facility inundation zones are colonizing species that tend to grow rapidly once they have been established and provide dense cover over a short period. For instance, the Oregon State University – Oregon Wood Innovation Center (Oregon State University 2021) states that red alder may add 6 feet of height per year at favorable sites. Growth height estimates listed in Table 1 represent (conservative) limited growth attainments that assume that the inundation areas may not represent the most suitable conditions. Conditions are expected to be more suitable for faster tree growth within the Initial Evacuation Zone than within the Final Evacuation Zone.

The *Water Temperature Model Sensitivity Analysis* (HDR and PSU 2021) conducted for this project presents three tree height scenarios. The Vegetation Management Scenario listed mature tree heights of target tree species (high vegetation) as 80 feet tall for the Initial Evacuation Zone (purple in Figure 1), 60 feet tall for the Debris Management Zone (yellow in Figure 1), and 25 feet tall for the Final Evacuation Zone (orange in Figure 1). The mature tree heights presented in that memo also assumed a 30-year growth timeline, and the expected growth heights over time are presented in Table 1 below.

Table 1. Expected Tree Heights Over Time

Tree Species	Year 0	Year 5	Year 10	Year 20	Year 30
Red alder	5 feet	15 feet	35 feet	50 feet	60 feet
Western red cedar	5 feet	15 feet	35 feet	50 feet	60 feet
Sitka spruce	5 feet	25 feet	45 feet	65 feet	80 feet
Black cottonwood	5 feet	25 feet	45 feet	65 feet	80 feet
Oregon ash	5 feet	15 feet	35 feet	50 feet	60 feet
Pacific willow	5 feet	15 feet	35 feet	50 feet	60 feet

Table 2. Proposed Plant Schedule Replanting Zone

Replanting Zone	Scientific Name	Common Name	Size	Condition	Spacing	Habitat
Initial Evacuation Area	**Trees**					
	Alnus rubra	Red alder	5 feet	Bare root	12–15 feet o.c.	Riparian, slopes
	Picea sitchensis	Sitka spruce	5 feet	Bare root	12–15 feet o.c.	Riparian, terraces
	Thuja plicata	Western red cedar	5 feet	Bare root	12–15 feet o.c.	Riparian, terraces
	Fraxinus latifolia	Oregon ash	5 feet	Bare root	12–15 feet o.c.	Riparian, terraces
	Populus balsamifera	Black cottonwood	5 feet	Bare root	12–15 feet o.c.	Riparian, terraces
	Shrubs					
	Acer circinatum	Vine maple		Bare root	6–10 feet o.c.	Slopes
	Oemleria cerasiformis	Indian plum	3 feet	Bare root	6–10 feet o.c.	Slopes
	Frangula purshiana	Cascara	3 feet	Bare root	6–10 feet o.c.	Slopes
	Rubus spectabilis	Salmonberry	3 feet	Bare root	6–10 feet o.c.	Riparian, slopes
	Salix sitchensis	Sitka willow	3 feet	Bare root	6–10 feet o.c.	Riparian, wetlands
	Sambucus racemosa	Red elderberry	3 feet	Bare root	6–10 feet o.c.	Slopes
	Symphoricarpos albus	Snowberry	3 feet	Bare root	6–10 feet o.c.	Riparian, slopes
Debris Management Evacuation Area	**Trees**					
	Fraxinus latifolia	Oregon ash	5 feet	Bare root	12–15 feet o.c.	Riparian, terraces
	Populus balsamifera	Black cottonwood	5 feet	Bare root	12–15 feet o.c.	Riparian, terraces
	Salix lasiandra	Pacific willow	5 feet	Bare root	12–15 feet o.c.	Riparian, wetlands
	Shrubs					
	Cornus alba	Red-osier dogwood	3 feet	Bare root	6–10 feet o.c.	Riparian, terraces
	Lonicera involucrata	Twinberry	3 feet	Bare root	6–10 feet o.c.	Riparian, wetlands
	Spiraea douglasii	Hardhack	3 feet	Bare root	6–10 feet o.c.	Riparian, wetlands
	Rosa nutkana	Nootka rose	3 feet	Bare root	6–10 feet o.c.	Slopes
	Rubus spectabilis	Salmonberry	3 feet	Bare root	6–10 feet o.c.	Riparian, terraces

Replanting Zone	Scientific Name	Common Name	Size	Condition	Spacing	Habitat
Final Reservoir Evacuation Area	**Trees**					
	Salix lasiandra	Pacific willow	5 feet	Bare root	12–15 feet o.c.	Riparian, wetlands
	Shrubs					
	Cornus alba	Red-osier dogwood	3 feet	Bare root	6–10 feet o.c.	Riparian, terraces
	Salix exigua	Narrow-leaf willow	3 feet	Bare root	6–10 feet o.c.	Riparian, wetlands
	Salix hookeriana	Hooker's willow	3 feet	Bare root	6–10 feet o.c.	Riparian, wetlands
	Salix sitchensis	Sitka willow	3 feet	Bare root	6–10 feet o.c.	Riparian, wetlands
	Spiraea douglasii	Hardhack	3 feet	Bare root	6–10 feet o.c.	Riparian, wetlands

Note: o.c. = on center

3.1 Final Evacuation Zone

The vegetation within Final Evacuation Zone will be most affected by the operation of the proposed FRE facility. This area will be flooded most frequently and for a longer duration than the other inundation zones. This zone would also experience a loss of shading vegetation for a period of time since the entire area would be logged, prior to and during construction. The first goal of the preconstruction vegetation removal stated in the Conceptual VMP is to reduce the potential for debris and vegetation to damage the new facility and to reduce the safety risk for operations personnel. Full removal of large trees within the Final Evacuation Zone is recommended to achieve this primary goal and because this area will be fully converted to species of trees and shrubs more tolerant of flooding than the existing vegetation. Shrub and organic material may be retained in this zone and provide soil stabilization during the overstory conversion. Large woody debris removed from this area may be harvested in a manner that is conducive for reuse of the material in habitat restoration or enhancement efforts associated with the overall project. For instance, some trees may be removed with their root balls attached so these may be used for engineered logjams or other instream habitat features. Instream habitat restoration actions are being developed as part of a comprehensive mitigation program in coordination with agency stakeholders. Once the large trees have been removed, appropriate vegetation can be installed.

The Mud Mountain example indicates that Sitka willow, a shrub species that reaches a mature height of approximately 30 feet, is present within the most flooded zone, but many areas at Mud Mountain are devoid of woody vegetation. Sitka willow grow rapidly in a variety of wet to mesic habitats and could be expected to grow to a height of 25 feet in 30 years or less. Areas that do not support woody vegetation at Mud Mountain may be due to flooding or other site-specific aspects such as excess sedimentation or soil fertility.

3.2 Debris Management Zone

The Debris Management Zone will also require preconstruction logging, but some of the existing vegetation will be retained. Tree species that are expected to be intolerant of flooding, such as Douglas fir, will be removed and replaced with more flood-tolerant species, such as Sitka spruce, red alder, or Oregon ash. Since logging is expected to be more selective than within the Final Evacuation Zone, replanting could occur before or after the logging has been completed. In-planting trees prior to logging can assist in the establishment of species that may require some shade during establishment, such as Western red cedar. This zone will also include the establishment of a Debris Management Facility that will intercept and stockpile woody debris that may be transported downstream during a flood event. The woody debris that is stockpiled may be used for habitat enhancement associated with the overall project. Selective replacement of overstory near the river will help moderate the temporal impacts to stream shading and river temperature associated with tree removal in the Debris Management Zone.

3.3 Initial Evacuation Zone

The Initial Evacuation Zone is not slated for preconstruction logging. This portion of the reservoir will be inventoried and monitored following construction. Flood-tolerant species, such as black cottonwood or Oregon ash, will be planted in anticipation that future logging may be needed. These trees will be planted along the riparian fringe and in flatter areas that may experience sedimentation during flooding events that inundate lower portions of the reservoir. Tree retention is proposed to help limit temporal impacts to shading and river temperature associated with the tree removal in the Initial Evacuation Zone. Monitoring will reveal the need for tree replacements once the facility is operational.

4.0 Ongoing Adaptive Management

The conceptual adaptive management strategy outlined in the Conceptual VMP will be expanded, and more concrete and detailed monitoring and management pathways will be developed once more detailed design elements have been determined. The project vegetation management is a central part of the overall adaptive management strategy for the project. The vegetation portion of the facility adaptive management plan will be intended to maximize the functions provided by vegetation through careful monitoring and corrective actions. Early actions will seek to anticipate changes in the plant community due to flooding, but more subtle or unanticipated effects will be detected through the adaptive management process. If, for instance, a tree species that was not installed during the pre-planning phase naturally reseeds and appears through monitoring to thrive within the new conditions, managers may prescribe additional planting of this species in other portions of the basin. Or if a species that was expected to withstand the new flooding regime is observed to be stressed or dying, these plants may be removed and the areas replanted with other, more appropriate species. Easily repeatable metrics will be developed and included within the monitoring plan based on more detailed design of the facility.

5.0 Summary

Conversion of the vegetation within the proposed FRE will take time and should be initiated in the early phases of the project. Regulating the land under the purview of the Washington State Department of Natural Resources – Forest Practices Rules (Title 222 Washington Administrative Code) would inhibit the early logging and may extend the timeline of conversion efforts. Converting the land to local Lewis County land use control early in the decision-making process will be critical for the success of vegetation management at the proposed FRE facility site. In-planting desired species into the existing vegetation may be another method to jump start the conversion efforts. A 30-year growth timeline for the desirable plant species to reach mature heights as described in the *Water Quality Sensitivity Analysis* is achievable if growing conditions are amenable and appropriate for target species. Factors of the design and operations may limit suitability and should be evaluated during subsequent design phases.

Flood frequency and duration data from the Mud Mountain Dam appear to validate plant survivability and persistence assumptions that are included in the Conceptual VMP and the Water Quality Sensitivity Analysis for the FRE facility. The Mud Mountain vegetation was not replanted but has been allowed to naturally recolonize the reservoir following construction and thus has self-selected the species that can tolerate the flooding disturbance. A more detailed reconnaissance of the other species at Mud Mountain may be warranted, and even including plants transplanted from the Mud Mountain site may be an interesting case study as design for the facility advances.

6.0 References

Anchor QEA

2016 *Pre-Construction Vegetation Management Plan.* Chehalis River Basin Flood Damage Reduction Project. Chehalis River Flood Control District.

HDR, Inc. (HDR)

2020a FRE Facility Temporary Reservoir Inundation and Vegetation Analysis Clarification. Chehalis River Basin Flood Damage Reduction Project. Chehalis River Flood Control District.

2020b *Conceptual Vegetation Management Plan*. Chehalis River Basin Flood Damage Reduction Project. Chehalis River Flood Control District.

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