Technical Memorandum

Date:	August 20, 2021
Project:	Chehalis River Basin Flood Damage Reduction Project
To:	Chehalis Basin Flood Control Zone District
From:	HDR Engineering
Subject:	Large Woody Material Downstream Passage and Placement Clarification
Attachment A:	Figures A-1 through A-4

1.0 Introduction and Purpose

As part of a strategy to reduce flood damage along the Chehalis River, the Chehalis River Basin Flood Control Zone District (District) proposes to construct a flood retention expandable (FRE) facility (i.e., the Chehalis River Basin Flood Damage Reduction Project [proposed project]) near the town of Pe Ell on the mainstem of the Chehalis River. The Draft Environmental Impact Statements (EISs) prepared by the Washington Department of Ecology and the United States Army Corps of Engineers (USACE) identified anticipated impacts to aquatic habitats downstream of the proposed FRE facility from the reduction of large woody material (LWM) inputs from the upstream reach of the Chehalis River. To inform the impacts analysis for the Final EIS, the purpose of this memo is to clarify assumptions regarding the project description, including:

1) LWM passage through the FRE under non-operating conditions,
2) Debris removal from trash racks during non-operating and operating conditions, and
3) Identification of temporary storage, staging, and distribution of LWM for downstream habitat enhancement.

In September 2020, the District submitted a *Department of Army Permit Application* (DAPA) to the USACE, including several figures depicting the proposed project. Attachment A includes selected DAPA figures that depict related project features associated with the management of LWM (see Attachment A, Figures 1–4). Additional information has been compiled from the *Combined Dam and Fish Passage Supplemental Design Report, FRE Dam Alternative* (HDR 2018) and the *Aquatic and Terrestrial Mitigation Opportunities Assessment* (Kleinschmidt 2020).

2.0 LWM Passage

2.1 Non-operating Conditions

The FRE facility would include five outlet works, or sluice conduits (hereafter, “conduits”), through the FRE to convey flow and provide uninhibited fish passage, with radial closure gates for flood regulation. These five conduits would be located at the base of the structure and would

convey flow, sediment, and woody debris through the FRE facility. The conduits would include a single, larger 12-foot-wide by 20-foot-high structure at invert elevation 408 feet and two pairs of 10-foot-wide by 16-foot-high conduits at invert elevation 411 feet, with one pair on each side of the larger center conduit. These gated conduits would be approximately 310 feet long and would have the capacity to convey a total of up to approximately 12,500 cubic feet per second (cfs) without backwatering upstream of the FRE (or transitioning to orifice or pressurized conduit flow in any of the sluice conduits) (see Attachment A, Figures A-1, A-2, A-3).

Additionally, the FRE facility includes a full-height trashrack upstream of the conduits to prevent larger LWM from entering and impeding gate movement if it becomes necessary to commence flood regulation. During non-operating periods, most smaller debris will be either passed through the conduits or removed from the trashracks and hauled downstream to be released back into the river. The reach immediately downstream of the proposed FRE facility (RM 108) is a steep, bedrock channel with some step pools and minimal sediment deposition. Considering downstream channel topography, at flows under 12,500 cfs that do not trigger FRE operations, all flows and all sediment would be passed directly through the FRE's fully open conduits the vast majority of the time at roughly the same velocity and depth as the natural channel at the current location of the proposed FRE facility. Therefore, the flow depth and velocities are expected to be similar to those of the natural channel downstream of the FRE facility.

The full-height trashrack extending from the riverbed to the crest of the FRE facility would exclude most large trees from the sluice conduits and provide excess open area under all temporary reservoir elevations to pass the desired project outflows. The larger conduit in the center would be used to pass the majority of bedload sediment in the river due to its lower vertical setting compared to the adjacent pairs of conduits on either side of the large center conduit. Woody debris is expected to pass through all conduits, proportional to the flow passing through each. It is estimated that most woody material smaller than about 24 inches in diameter would be able to pass through the trashrack and center conduit, given the large spacing between the columns of the trashrack. The lower 50 feet of the trashrack extends well out into the forebay area to ensure that the distance between the rack columns and the radial sluice gates is maximized within the overall footprint of the structure. This should limit the length of penetration of large debris and trees to less than the distance between the gates and the trashrack, such that a treetop with root wad lodged in the trashrack would not become lodged under the gate when operated at less than fully open.

The working deck on top of the lower trashrack structure serves as an equipment platform from which debris removal equipment can access the rack to remove debris at low or no reservoir elevations. This deck extends upstream from the much larger upper trashrack above this lower deck that extends to the top of the dam. The lower trashrack provides for debris exclusion from the sluices, while the large full-height trashrack provides additional exclusion of debris across the full range of temporary reservoir elevations. Some sediment is expected to pass through the smaller sluice outlets as well, but the center sluice with a lower invert elevation would intentionally receive the most wear from sediment passage over time. Except during flood control operations, the sluice gates would remain fully open, freely passing sediment, smaller woody debris that can readily pass through the trashrack, and fish both upstream and downstream.

3.0 Debris Removal

3.1 Non-operating Conditions

The lower 50 feet of accommodates and simplifies the debris removal process during non-operating conditions (HDR 2018). LWM that becomes lodged against the trashrack would be removed as needed to keep the channel clear, permit unobstructed fish passage, and maintain sediment transport continuity through the FRE facility. Debris would be removed periodically from the lower trashrack with tracked or wheeled equipment from the lower deck. Should debris levels during larger flood events reach the upper trashrack, a wheeled or tracked machine or rake system and hoist could be used similarly to remove debris from the top of the intake tower. For reference, the Mud Mountain Dam project has a very similar lower trashrack and working deck design with a full-height trashrack and full-height outlet tower. Debris management methods are anticipated to be very similar to those implemented at Mud Mountain Dam, though the frequency and volume of flood-borne debris is expected to be considerably less at the FRE facility.

3.2 Operating Conditions

The FRE facility would be operated when flood forecasts predict a major or greater flood, as defined in the National Environmental Policy Act and State Environmental Policy Act Draft EISs. 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. It is anticipated that the gates on the four smaller conduits would be completely closed and only the larger center gate would be slightly open to pass this flow. This is intended to constrain abrasive sediment passage to the center conduit, to limit periodic repairs to only the larger conduit as much as possible. 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 formation of a temporary reservoir upstream of the structure. The size of the temporary reservoir would depend on the volume of inflow and the temporal shape of the inflow hydrograph, but in no case would the temporary reservoir expanse be greater than 808 acres with 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 drawdown operation would be implemented. The three stages include (1) Initial Reservoir Evacuation, (2) Debris Management Evacuation, and (3) Final Reservoir Evacuation (HDR 2020). It is anticipated that removal of large woody material from the temporary inundation zone would occur during the Debris Management Evacuation stage.

3.2.1 Debris Management Evacuation (Water Surface Elevation 528–500 feet)

During major flood events, some debris from surrounding tributaries and hillsides would likely be swept into the temporary reservoir. Debris management procedures would be used to ensure that LWM would not impact FRE facility operations or cause damage to the FRE facility.

During all major flood events, floating debris management would begin once the temporary reservoir elevation falls to elevation 528 feet. After this point in the event, drawdown rates would be slowed to 2 feet per day (1 inch per hour) for as much as 14 days to corral and move debris to designated management areas. During this period, crews would use a boat to move large debris from the temporary reservoir to an existing log-sorting yard, previously operated by Weyerhaeuser, within the temporary inundation area footprint. An anchored log boom would capture LWM floating on the surface of the temporary reservoir. The steel trashrack columns would protect the gated outlets of the FRE facility from LWM that could not pass through to downstream areas. The slowed drawdown rate would continue until the temporary reservoir reaches elevation 500 feet. Once the temporary reservoir elevation reaches 500 feet, debris management operations would conclude.

Upstream fish passage would be provided by the fish ladder and trap-and-haul facility until the temporary reservoir is fully drained and woody debris and sediment could be cleared from the trashrack opening to permit free flow again. Large flood events that carry significant volumes of debris to the reservoir would require that the temporary reservoir drawdown be slowed until debris can be corralled and moved to the containment and handling area discussed above, whereupon the drawdown rate would be increased again to continue the process of regulating releases to achieve the desired flood regulation. Given the wide variability in flood peaks from the other tributaries of the Chehalis River basin, it would be expected that the pause in FRE temporary reservoir drawdown would be similarly variable in response to the desired downstream flood regulation needs. Some flood events causing the activation of the FRE facility might not generate significant debris, and thus the pause or slowing of drawdown rate to manage debris might be truncated in certain events or even eliminated. As flows from downstream tributaries decline, the temporary reservoir would be evacuated up to the maximum drawdown rate. This would allow mainstem Chehalis River flows to fill in behind the peak downstream flows as dictated by the varying falling limb of the flood hydrographs in the other tributaries below the FRE project.

4.0 LWM for Downstream Habitat Enhancement

4.1 Temporary Storage

Following major flood retention events, the temporary reservoir would be drawn down and accumulated debris would be removed. The debris management storage area identified in the DAPA and the floating plant equipment staging areas would support the deployment of boats and barges from existing access roads. Debris would be contained within a log-sorting yard located between River Mile 109.6 and 109.9 (see Attachment A, Figure A-4), where sorting and processing would occur following flood events. Wood that is suitable for habitat projects in the

Chehalis Basin would be sorted and trucked out of the temporary reservoir area. The remainder of the debris would be hauled off site and disposed of at an approved facility.

4.2 Distribution for Downstream Habitat Enhancement

The District plans to implement a suite of aquatic, riparian, and upland habitat mitigation and enhancement actions to address the potential for negative effects from construction and operation of the FRE facility on aquatic habitat upstream and downstream from the facility. These actions would be implemented in specific geographic focus areas determined to have high potential to provide measurable benefits to aquatic and terrestrial habitat resource functions. The 2020 *Draft Mitigation Opportunities Report* (Kleinschmidt 2020) considers the following mitigation action types:

- Riparian buffer expansion
- Hyporheic exchange enhancements
- Cold-water retention structures
- Instream modifications
- Off-channel modifications
- Gravel retention jams
- Fish passage
- Wetland enhancement (floodplain)

The District is proposing instream LWM placement for several of these actions, including hyporheic exchange enhancements, instream modifications, and gravel retention jams. The District is committed to the development of a comprehensive mitigation program that would continue to refine the use and placement of LWM for habitat enhancement projects identified in Kleinschmidt (2020). The following information is incorporated from the *Mitigation Opportunities Report* (Kleinschmidt 2020).

4.2.1 Hyporheic Exchange Enhancements

Hyporheic flow exchange may be enhanced to improve thermal diversity and refugia, nutrient cycling, and primary production to mitigate potential degradation caused by elements of the Proposed Action, including operation of the FRE facility. Several types of hyporheic enhancement are possible based on different channel and floodplain landforms and are further detailed in Kleinschmidt 2020. Proposed hyporheic enhancements that incorporate LWM include the following:

- Gravel bars with side channels:
    - Install engineered log jams, log weirs, rock weirs, or beaver dam analogs to increase hydraulic head at the upstream ends of target reaches.
    - Decrease mainstem flow through side channel through restrictions or plugs at the upper end of the channel.
    - Excavate deeper channels or pools at the lower ends of side channels.
    - Beaver dam analogs may not be applicable on larger streams.

- Channel splits with gravel islands:

- Install engineered log jams, log weirs, rock weirs, or beaver dam analogs to increase hydraulic head at the upstream ends of islands.
- Decrease mainstem flow through side channels through restrictions or plugs at the upper ends of channels.
- Excavate deeper channels or pools at the lower ends of side channels.
- Beaver dam analogs may not be applicable on larger streams.

- Large-degree (greater than 90°) meander bends with long cross-peninsula flow paths:
  - Install engineered log jams, log weirs, or rock weirs to increase hydraulic head at the upstream ends of bends.

- Incised channels with adjacent disconnected floodplain:
  - Restore floodplain activation frequency and extent by installing in-channel hydraulic roughness and/or lowering the floodplain within the hyporheic zone through excavation and re-grading.
  - Install roughness elements on the floodplain to reduce floodway flow velocity and encourage overbank deposition of organic material. Install grade control structures to reduce further incision.

- Cold water tributaries, seeps, and springs:
  - Excavate pools between the cold water source and the mainstem channel and install wood structures or boulders to minimize dilution with mainstem surface water to provide holding areas for fish.

4.2.2 Instream Modifications

Instream modifications would involve the construction of habitat features within the perennial wetted channel to achieve several ecological purposes such as enhancement, restoration, inducement, or creation of habitat-forming processes and habitat elements such as complexity, cover, hydraulic diversity, pool formation, cold-water refuge pockets, and spawning gravel retention (Kleinschmidt 2020). Instream modifications would involve placement of large wood within the channel with or without anchoring mechanisms depending on the size of the channel, risk factors, and the intended function of the wood. Additional construction activities may include supplementation of stream gravel to enhance spawning habitat, minor earthwork to embed large wood pieces into the riverbed and banks, site work to provide heavy equipment access, and construction staging.

Instream modifications are intended to provide multiple benefits to aquatic species with particular focus on salmonids. Large wood structures would provide hydraulic diversity, substrate diversity, in-stream cover, high flow refugia, pool formation, and gravel retention. Some specific instream modifications may be designed to benefit western toad and other still-water breeding amphibians.

4.2.3 Gravel Retention Jams

Gravel retention jams are large in-stream structures composed of large wood pieces and rock located and designed to provide hydraulic roughness and promote accumulation and retention of salmonid spawning gravels (Kleinschmidt 2020). Gravel retention jams would involve placement of large wood within the channel, with anchoring mechanisms if needed to retain the jam at the selected location. Additional activities may include minor earthwork to embed large wood pieces into the riverbed and banks, site work to provide access, and construction staging.

Gravel retention jams are a specific type of in-stream modification intended to enhance spawning habitat. Such structures would provide multiple secondary benefits to aquatic species with focus on salmonids such as hydraulic diversity, substrate diversity, in-stream cover, high-flow refugia, and pool formation. The vertical hydraulic gradient created by gravel deposition upstream of the jam creates an opportunity to integrate hyporheic exchange enhancement into this type of action. Prior to final selection of potential candidate sites, a sediment transport analysis would be needed for each site to determine if natural gravel transport is sufficient to form the spawning habitat or if placement of additional spawning gravel would be needed to supplement the natural supply.

5.0 Summary

This memo clarifies assumptions regarding LWM transport, management, and use in mitigation and enhancement projects associated with construction and operation of the proposed FRE facility. These assumptions include the following:

- The FRE facility would include a trashrack that would pass LWM up to 24 inches in diameter through the main conduit during non-operating conditions (i.e., non-flood retention periods).
- Debris removal from trash racks during non-operating conditions would be implemented when LWM becomes lodged against the trashrack to keep the channel clear, permit unobstructed fish passage, and maintain sediment transport continuity through the FRE facility.
- Debris removal during operating conditions would occur during the Debris Management Evacuation Phase, the duration of which would be determined by the hydrologic characteristics of specific flood events. LWM would be captured, staged, and sorted for use in downstream habitat enhancement projects as determined by the proposed mitigation program (Kleinschmidt 2020).
- The District is committed to implementing a comprehensive mitigation program, including the use of LWM for downstream aquatic habitat enhancement projects, in coordination with agency stakeholders.

6.0 Literature Referenced or Cited

HDR

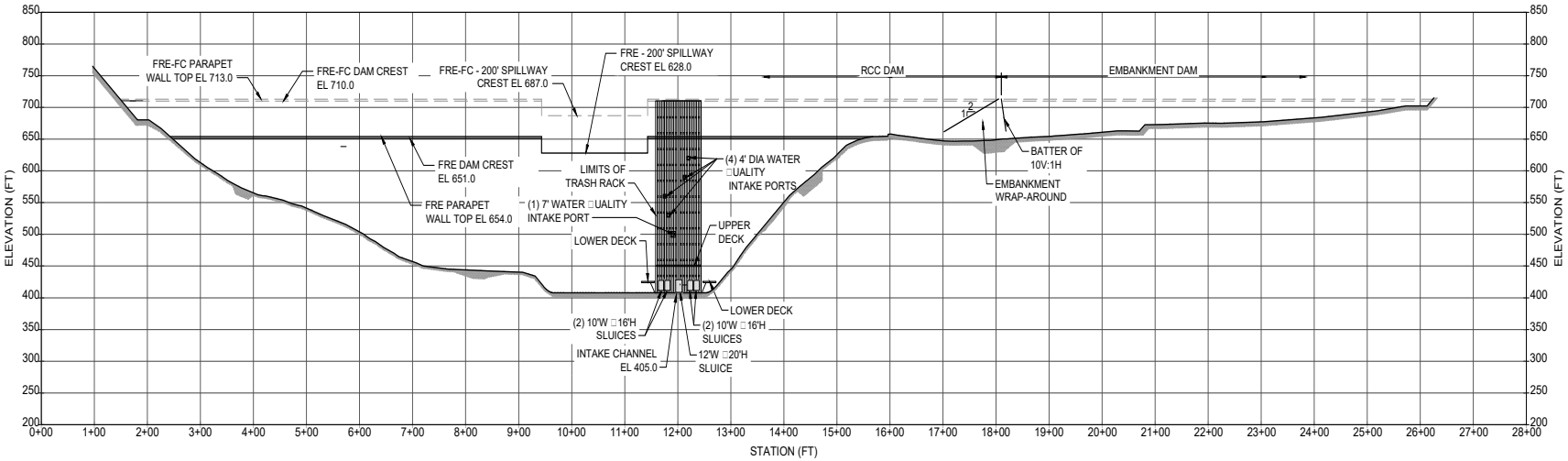
2018 Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species, Combined Dam and Fish Passage Supplemental Design Report, FRE Dam Alternative. Prepared for the Washington State Recreation and Conservation Office and Chehalis Basin Work Group (FRE Report).

2020 FRE Facility Temporary Reservoir Inundation and Vegetation Analysis Clarification. Comments on the SEPA Draft EIS. May 2020. Provided by the Lewis County Flood Control Zone District. Provided to Washington State Department of Ecology. May 2020. Provided to US Army Corps of Engineers, as Appendix D to the Biological Assessment and the Essential Fish Habitat Assessment submitted to the USACE on September 18, 2020.

Kleinschmidt (Kleinschmidt Associates)

2020 *Aquatic and Terrestrial Mitigation Opportunities Assessment.* Submitted to the Lewis County Flood Control Zone District. August 2020.

Attachment A. Figures A-1 through A-4



DAM ELEVATION VIEW 5

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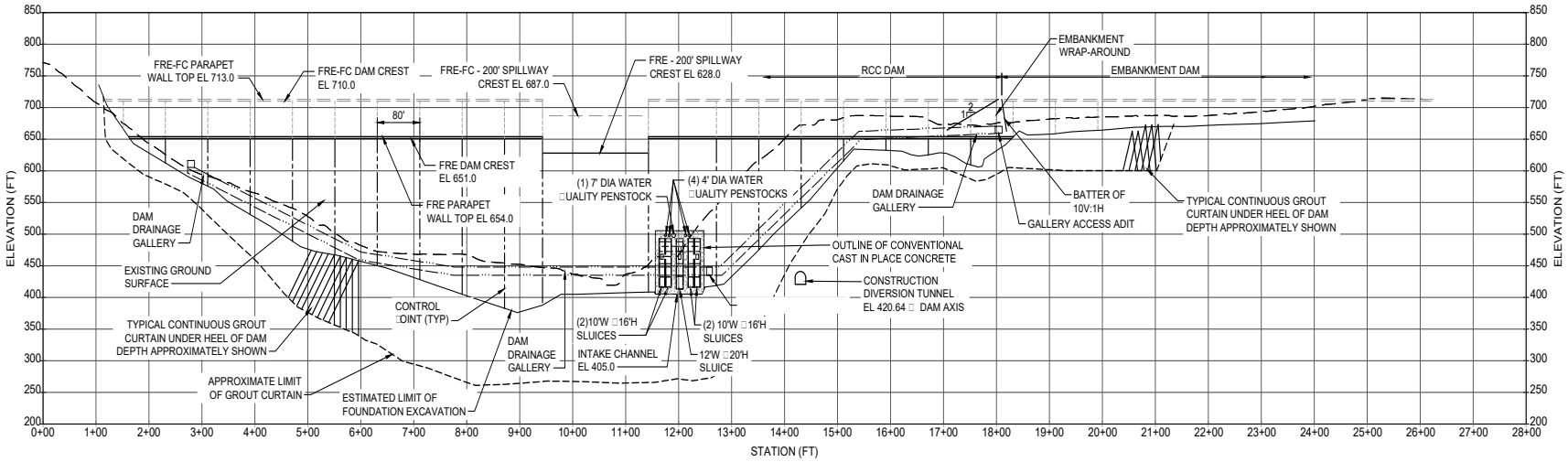
SCALE IN FEET



SECTION ALONG DAM AXIS 5

0 50 100 200
SCALE IN FEET

Attachment A
Figure A-1

FRE Dam
Dam Elevation View and Dam Exis Section

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

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

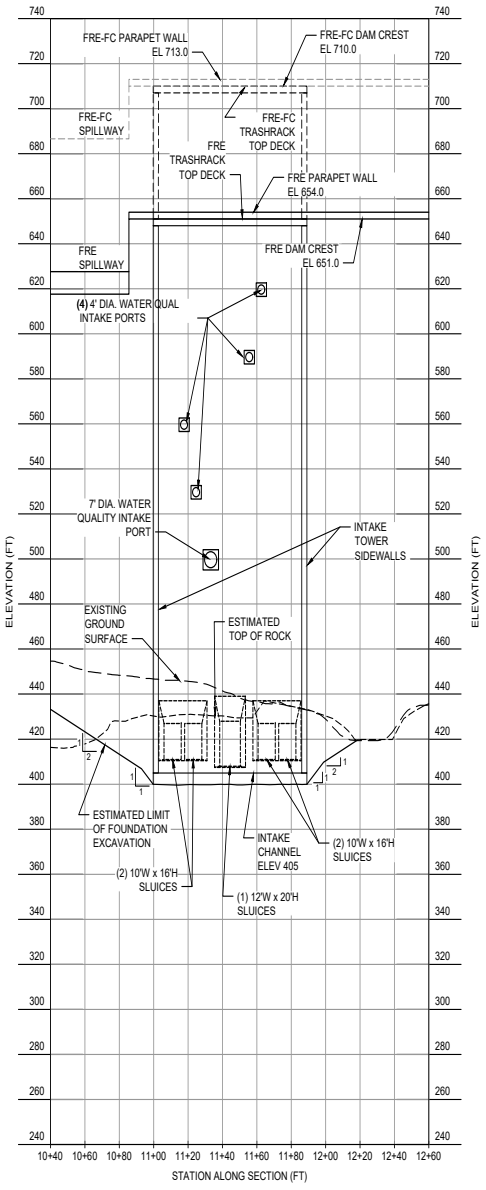
Chehalis River Basin Flood Damage Reduction Project

REFERENCE #: NWS-2014-1118

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

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

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



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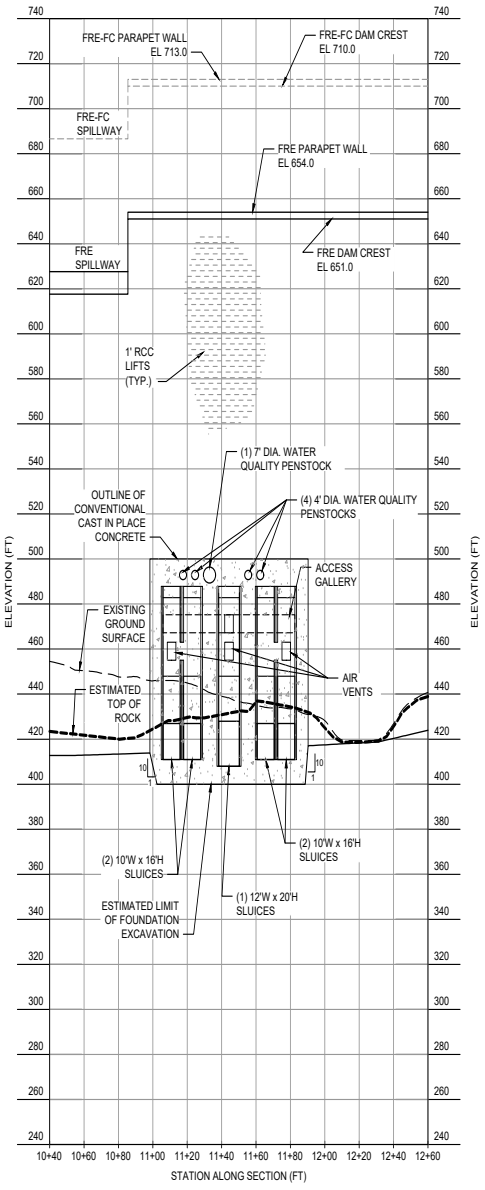

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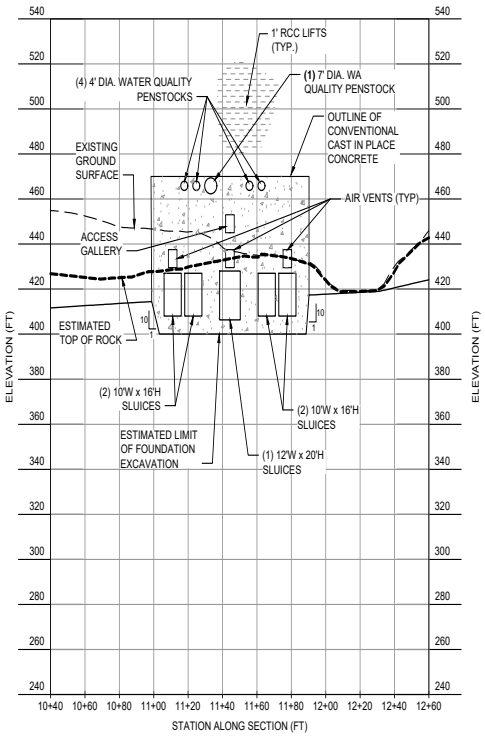

SECTION 8

Attachment A
Figure A-2

FRE Dam
Intake Tower and Sluices

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

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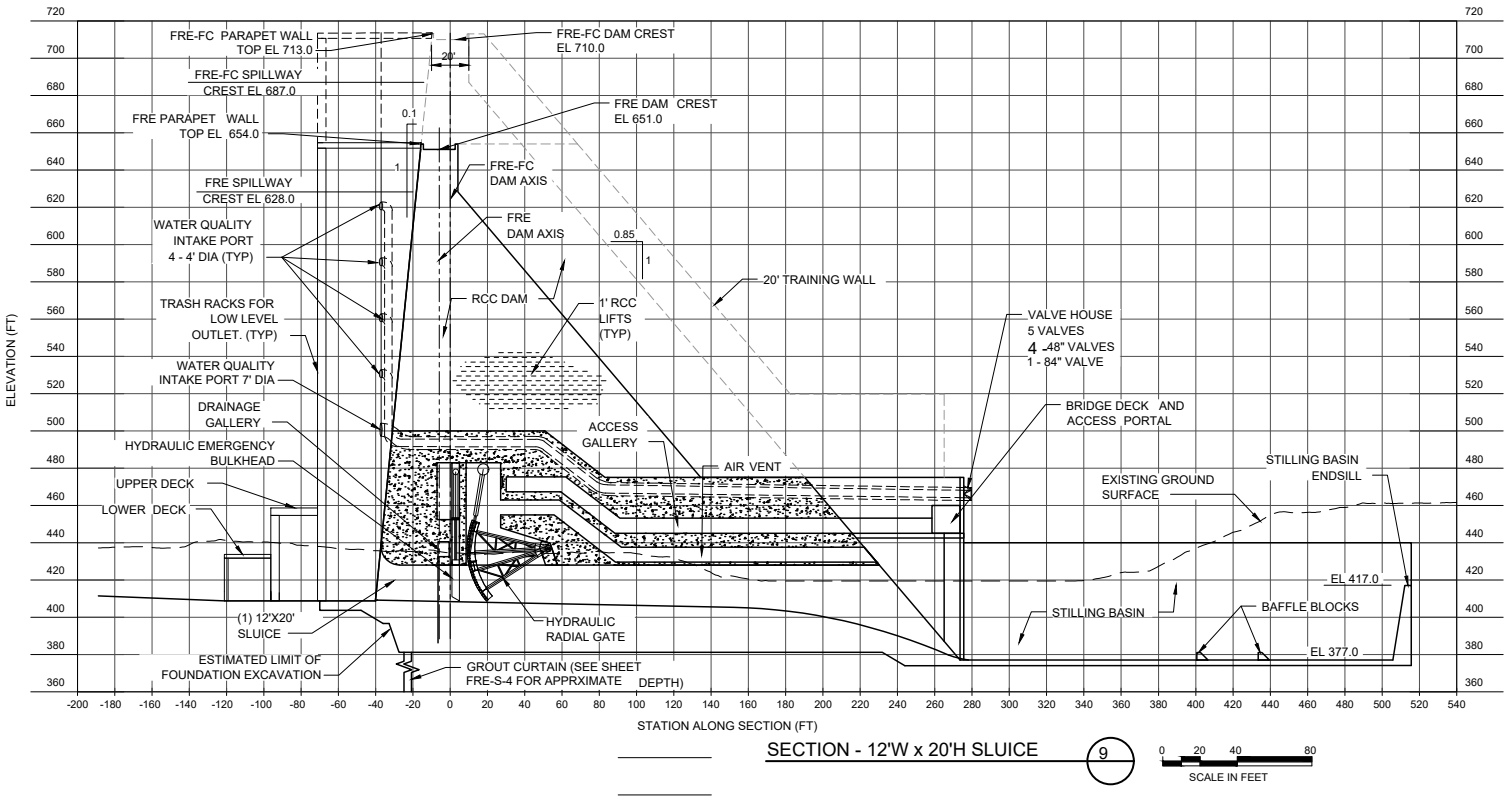
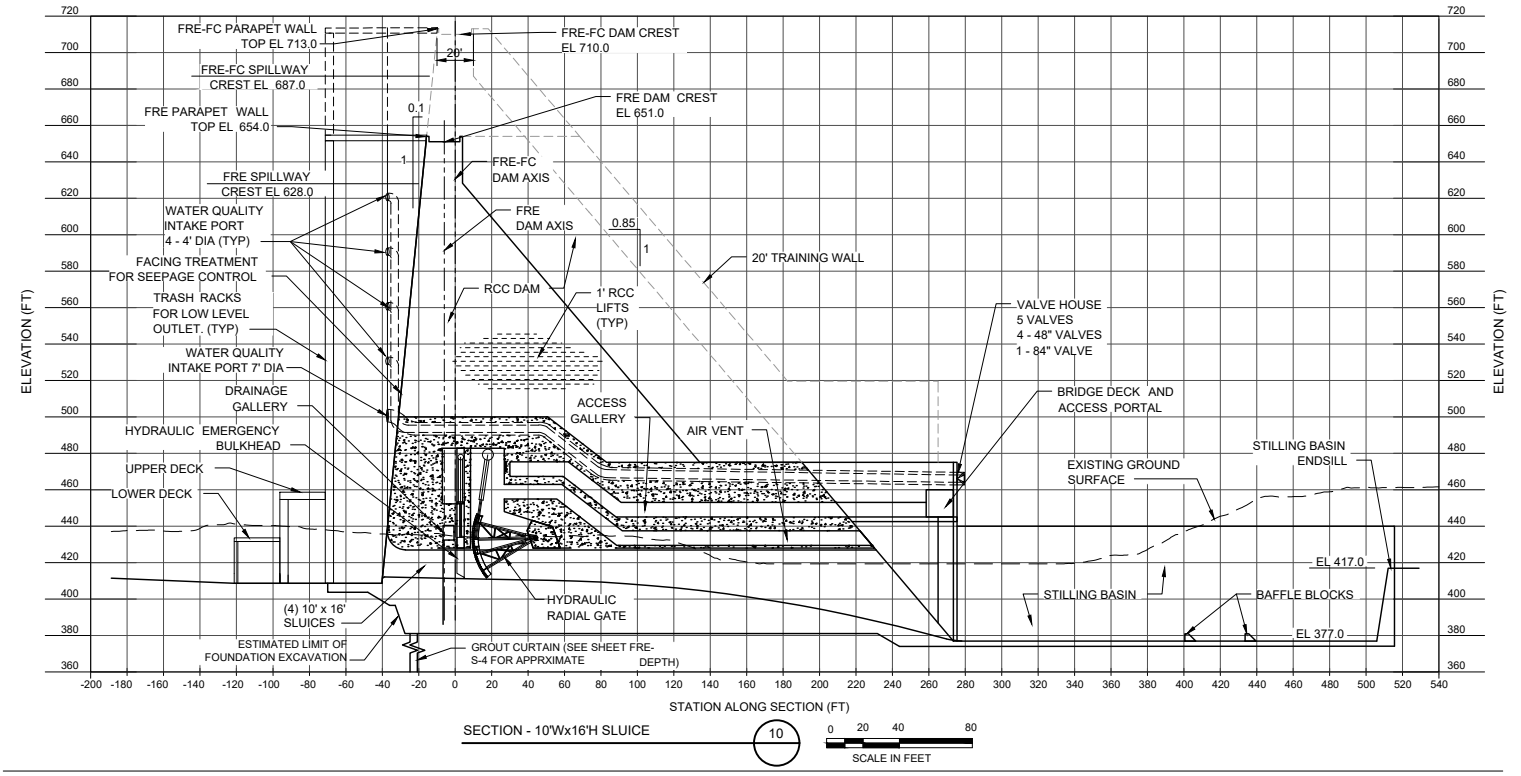
SHEET: 16 of 22 DATE: 7/29/2020



SECTION - 12'W x 20'H SLUICE 9



SECTION - 10'Wx16'H SLUICE 10

Attachment A
Figure A-3

FRE Dam
Low Levels Sluices
Longitudinal Sections

APPLICANT:
Chehalis River Basin Flood Control Zone District

DATUM: North American Datum 1983

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N

0 125 250 500

Feet

DEBRIS MANAGEMENT SORTING YARD

TEMPORARY WETLAND IMPACT

DELINEATED OHWM (ANCHOR QEA 2018)

DELINEATED WETLAND (ANCHOR QEA 2018)

FRE Debris Management Sorting Yard

Attachment A Figure A-4

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