

Technical Memorandum

Date: August 24, 2021

Project: Chehalis River Basin Flood Damage Reduction Project

To: Chehalis Basin Flood Control Zone District

From: HDR

Subject: FRE Site Selection

1.0 Introduction and Purpose

The Draft Environmental Impact Statements (EISs) prepared by the Washington Department of Ecology (Ecology; pursuant to the State Environmental Policy Act) and the U.S. Army Corps of Engineers (USACE; pursuant to the National Environmental Policy Act) evaluate anticipated impacts associated with construction and operation of a proposed Flood Retention Only - Expandable (FRE) facility (i.e., the Chehalis River Basin Flood Damage Reduction Project [proposed project]) in the Chehalis River basin, Washington State. As part of the ongoing review of the proposed project, USACE is evaluating feasible project modifications and mitigation measures that could avoid, minimize, or reduce project impacts, and would result in a project that still meets the identified purpose and need.

Previous geotechnical work during the early planning phases for the proposed project had considered the feasibility of a site for the flood retention facility (considering an embankment structure) upriver of the current proposed location (Shannon & Wilson [S&W] 2009a, 2009b). The current FRE site is at river mile (RM) 108. This memo provides historical information regarding site selection for the flood retention structure and the feasibility of siting the FRE facility at the location identified in the early planning phases, and any engineering or other rationale that supports siting the FRE at the current proposed location.

2.0 Project History

USACE reports completed in 1931, 1935, and 1944 evaluated flood control improvements in the Chehalis Basin, ultimately determining that such improvements were not economically justified. However, in 1944, Congress authorized a levee system to protect Aberdeen, Hoquiam, and Cosmopolis. From the 1950s through the 1970s, USACE provided several reports, including analysis of constructing a levee system in the lower Chehalis Basin, modifications to existing levees, reports detailing floodplain information, and hydraulic floodway studies. In 1972, a comprehensive framework study of water and related land needs of the Columbia River-North Pacific region was completed under the direction of the Pacific Northwest Rivers Basin Commission. This study identified the Chehalis-Centralia area as an area where flood control measures should be constructed for urban flood damage reduction.

A thorough study of flood damage reduction measures was done by USACE in 1982 (USACE 1982) and updated in 2003 (USACE 2003). USACE investigated five potential locations for multipurpose storage dams in the Upper Chehalis River Basin, including two sites on the Newaukum River, one site on the South Fork Chehalis River, and two sites on the mainstem of the Chehalis River, upstream of the Newaukum River. The first site on the mainstem Chehalis River was located at approximately RM 86.6, and the second site was located at RM 93.4 (downstream of the current site for the FRE facility at approximately RM 108). Dams at all five locations were determined to be economically infeasible at the time of the earlier investigations. Included in USACE's evaluation were alternatives for levee construction and increasing capacity of water retention at Skookumchuck Dam. In the 1982 report, USACE recommended a design modification at Skookumchuck Dam that would have provided 17,000–28,500 acre-feet of flood storage; however, further analysis and engineering was not carried forward, as USACE subsequently determined the modifications to be economically unjustifiable (USACE 2003).

2.1 Basin-wide Approach

There have been four major floods in past years (1990, 1996, 2007, and again in 2009) that have resulted in closure of Interstate 5 and severe damage to private and public property. According to the U.S. Geological Survey (USGS), the 1990 and 1996 floods were considered 100-year flood events, and 2007 was likely a 500-year flood event.

In response to the 1996 flood event, local jurisdictions and USACE conducted extensive studies of potential options. Lewis County contracted with Pacific International Engineering (PIE) to evaluate options for upstream storage in addition to other structural and non-structural alternatives. PIE evaluated options for upstream storage, including the two sites previously identified by USACE (RM 86.6, RM 93.4) and included a fourth site named Charlie's Hump located south of Pe Ell and a fifth site west of the town of Doty at RM 2.8 of Elk Creek. However, no further analysis was advanced, as the proposal for an upstream flood-retention facility was not supported by USACE or the public.

In 2003, a study by Tetra Tech (2003) looked at a variety of options in the basin, including new or modified water-retention facilities. Tetra Tech (2003) evaluated eight potential locations for a multi-purpose reservoir in the Upper Chehalis Basin. The eight sites were selected based on the previous USACE (1982) and PIE (1998) analysis, in addition to the U.S. Soil Conservation Service (SCS 1974) publication *Southwestern Washington River Basins Type IV Survey*, which identified 53 potential reservoir sites in the basin. The selection process considered the location, existing land use, estimated potential storage, and presence of priority fish species habitat. The site known as Charlie's Hump, located approximately 2 miles south of Pe Ell, was described further based on the SCS (1974) report, which indicated that the reservoir would cover more than 400 acres and could provide approximately 95,000 acre-feet of storage. New dams were not recommended for further investigation based on the project scoring, though the Charlie's Hump site had the greatest storage volume of new reservoir options.

Following the 2007 flood event, the Washington State Legislature, through House Bills 3374 and 3375, appropriated \$50 million in State general obligation bonds to the Office of Financial Management for the Flood Authority and other local governments to participate in flood hazard mitigation projects for the Chehalis River Basin. The Flood Authority was established in April

2008, with Lewis County acting as the lead agency. In 2011, the Chehalis Basin Floor Control Zone District (District) was officially formed to address the continuing flooding problem associated with the Chehalis River.

In November 2012, a work group of Chehalis Basin leaders convened by Governor Gregoire recommended a series of actions to reduce flood damages in the short term, enhance natural floodplain function and fisheries, and provide a framework for decision-making about large-scale projects, including a flood-retention facility in the basin. This work was subsequently evaluated in a Programmatic Environmental Impact Statement (EIS; Ecology 2017). Since the Programmatic EIS, the District has assumed the role of Project proponent, proposing plans for a flood-retention facility on the mainstem Chehalis River south of Pe Ell at approximately RM 108, which is the site farthest downstream that has adequate abutments for a flood control structure (the river valley has lower abutments farther downstream), located to capture significant tributaries (Crim Creek), and has sufficient flood retention storage capacity to be an attractive option.

3.0 Phase I Site Selection

Following the severe flood in 2007, EES Consulting, Inc. (EESC), was contracted by Lewis County to analyze whether flood retention structures in the Chehalis River Basin are a feasible alternative to address basin-wide flooding. In the initial scope (Phase I), EESC reviewed the possible benefits of developing water retention facilities, or flood storage structures, in the Upper Chehalis River Basin.

After reviewing several sites, EESC identified and reviewed two locations at a level of detail consistent with an initial study. One site was located south of Pe Ell on the mainstem Chehalis River (approximately RM 108), and the other site was on the South Fork of the Chehalis River. Total flood storage assumed for both sites was approximately 100,000 acre-feet. Flood water retention was the primary purpose, with instream flow augmentation secondary, and hydropower an ancillary benefit.

Phase I of the analysis considered flood-storage structure locations on the Newaukum River as well as the Upper Chehalis and South Fork Chehalis rivers. The Newaukum River locations did not provide significant storage opportunities. The proposed sites at the Upper Chehalis (approximately RM 108) and South Fork Chehalis river locations were selected based on favorable topography as well as maximum drainage area. The Phase I report mentions that five potential site locations were examined, although no detailed information on the locations of the considered sites is provided. Alternatives in facility location and size, for example, can demonstrate how to derive the greatest benefit with the least environmental impact and economic cost. Alternatives related to location and/or size can demonstrate differences in effects such as facility footprint in relation to effectiveness in flood reduction, loss of habitat, and most efficient reservoir configuration to provide low temperature and high oxygenated water, among other comparisons.

The Phase I study (EESC 2009) showed a benefit-to-cost ratio for Chehalis River water retention facilities direct benefits of 2.0. Adding the indirect benefits from the Washington State

input-output model increased the estimated benefit cost ratio to 3.6. Both the Upper Chehalis River site (referred to as Charlie's Hump) and the South Fork Chehalis River site appeared to be cost-effective and viable options to advance into a Phase II evaluation.

4.0 Phase II Site Selection

Phase II of the work was split into Phase IIA and Phase IIB. Phase IIA work by EESC included development of subsurface information prepared by a subcontractor, including geology (S&W 2009a) and geotechnical (S&W 2009b) studies of the potential sites (Upper Chehalis and South Fork Chehalis). The geotechnical study included the embankment flood retention structure at the Upper Chehalis River location (Figure 1). The studies concluded that no major impediments exist to construct flood-storage structures at the site. Phase IIA also included the development of an environmental scoping document describing future environmental studies related to the potential structures.

EESC engineers used digital mapping with 2-foot contour intervals provided by Lewis County to identify structure locations and alignments. The site was chosen based on the topography to maximize the drainage area while providing sufficient abutment height for water storage. The Phase IIA alignment location was revised due to a more detailed review and analysis regarding site topography and surface geology.

The Flood Authority, with Lewis County as the lead agency, then approved moving forward with Phase IIB to refine the basic engineering estimates developed during Phase I and update the economic information using the USACE methodology. During the Phase IIB process, the Flood Authority asked what a single-purpose, flood water retention structure might look like and whether it might be cost-effective. The results of the Phase IIB study (EESC 2011) were that the benefit-cost analysis completed using the USACE methodology indicated that the Upper Chehalis project (Charlie's Hump site, approximately RM 108) may be cost-effective as a flood reduction project or multi-purpose project. The South Fork Chehalis benefit-cost ratios were not considered favorable.

In Phase IIB, the embankment structure was moved downstream and its axis rotated (shown on Figure 4). This adjustment resulted in a slightly shorter crest length and a much more desirable alignment for a diversion tunnel through the abutment located on the lower left side of the structure (looking downstream) that allows for water diversion past the structure. The outline of the embankment flood retention structure, the location of the outlet/diversion, and the spillway are shown on Figure 2. The Phase IIB study concluded that an embankment structure axis farther downstream is better suited to construction than the originally selected location.

5.0 Flood Retention Structure Refinement (2014–2018)

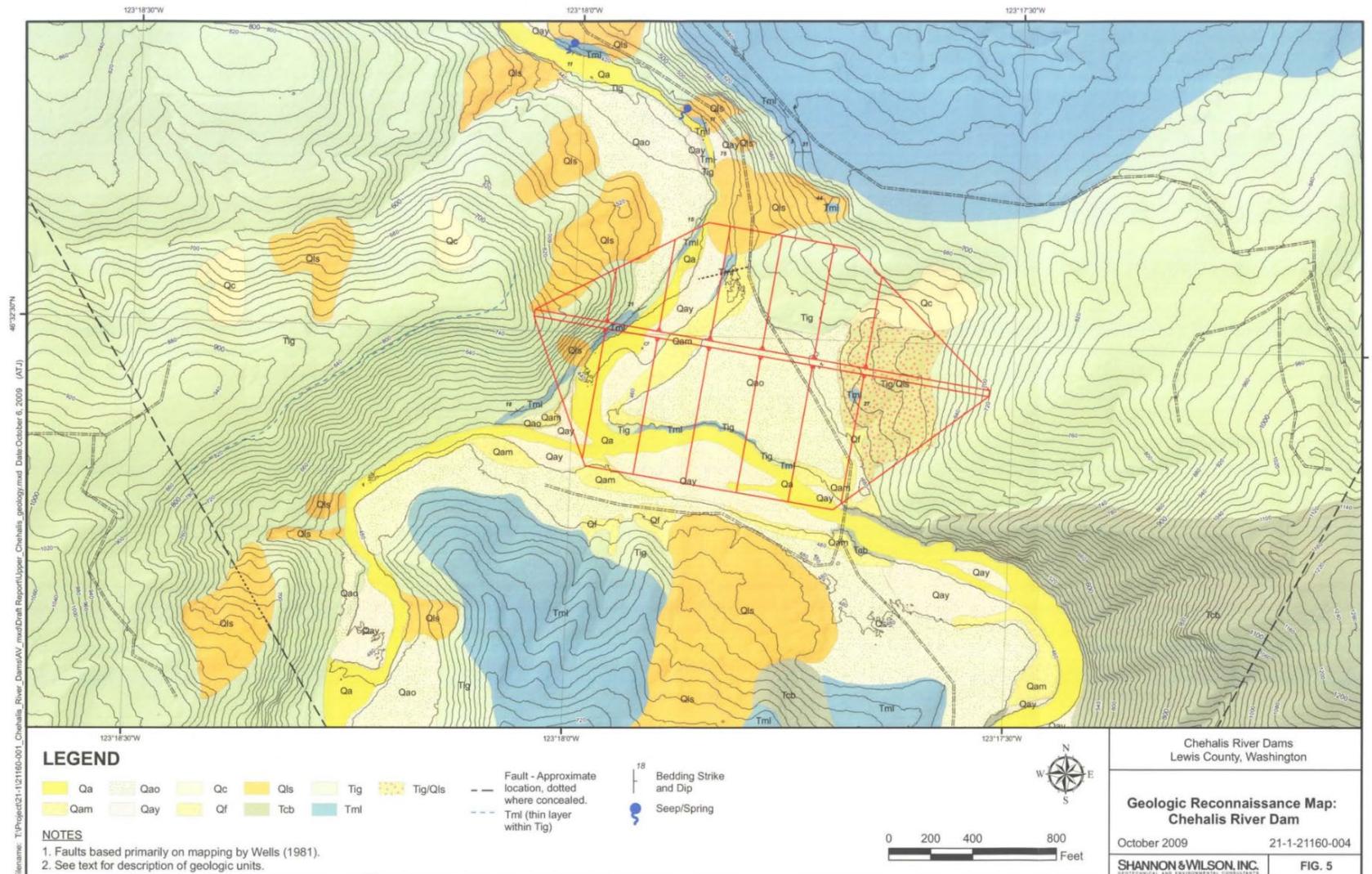
Following the Phase I and II assessments, additional interest in pursuing a flood-retention facility in the basin was pursued by the Governor's work group and the Flood Authority, which resulted in additional refinements and studies. In 2014, HDR identified a revised flood retention structure axis alignment and alternative dam type in an area where there was competent bedrock exposed in the river channel (HDR 2014). Additional geologic and geotechnical

investigations characterized foundation conditions (HDR 2017a, 2017b, 2018) and indicated that the revised flood retention structure axis location was suitable for a roller-compacted concrete (RCC) flood retention structure, which would provide significant beneficial attributes over the previously proposed embankment flood retention structure. These benefits included:

1. A smaller overall structure footprint that minimizes impacts on adjacent landscape features
2. Significantly less fill material, which minimizes the amount of quarry material needed
3. A concrete structure that facilitates the ability to build water passages through the structure to pass a range of normal and lower flood flows
4. A shorter and more effective fish passage tunnel system
5. Reduced changes to the existing hydrology and sediment transport concerns as well as fish and aquatic resource impacts during times when the FRE is not operating

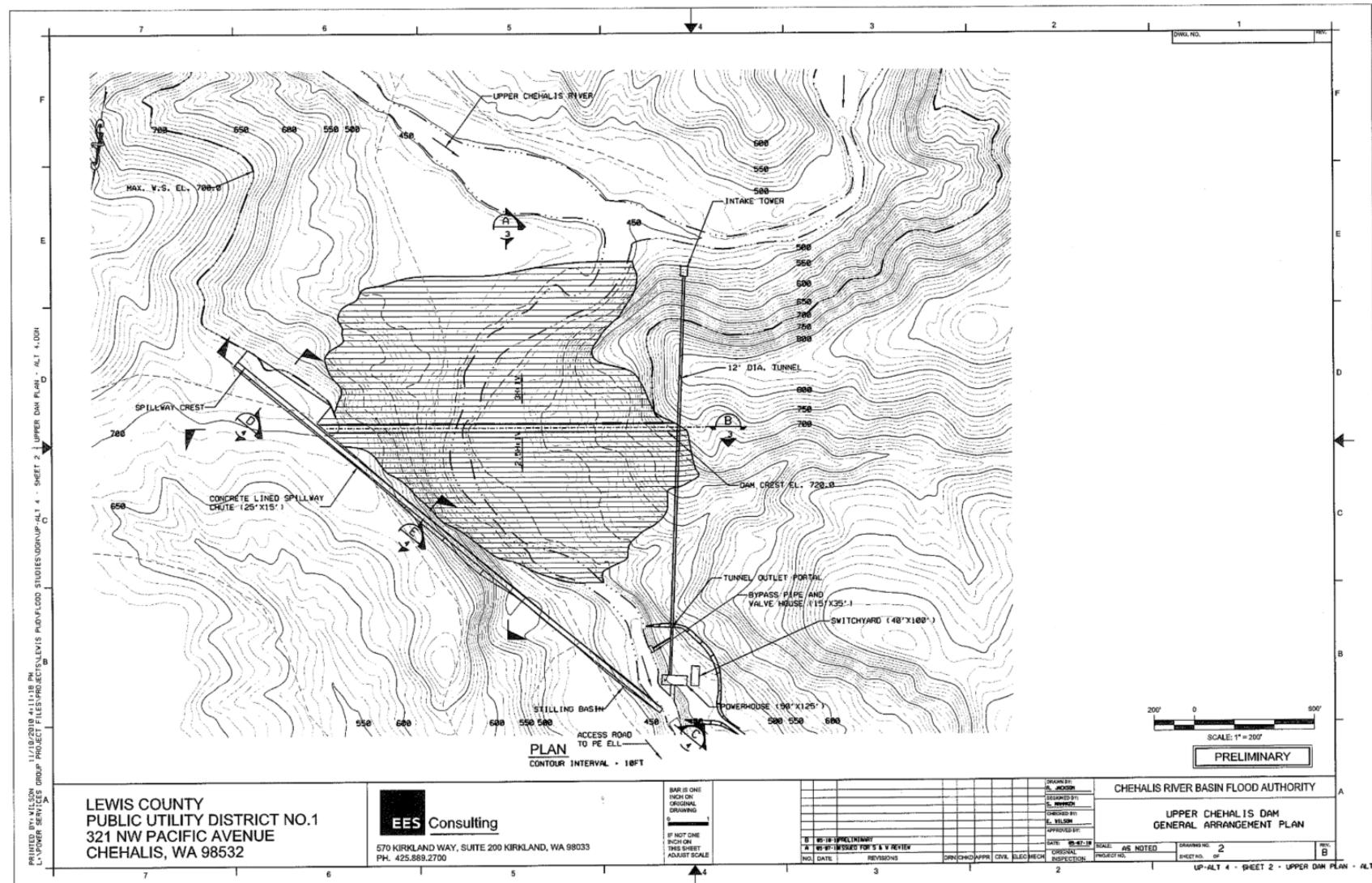
A feasibility study of the revised Upper Chehalis flood retention structure (at the Charlie's Hump site, approximately RM 108) is documented in the *Combined Dam and Fish Passage Conceptual Design Report* (HDR 2017a). The feasibility study examined both single-purpose flood retention only (FRO) and multi-purpose (flood, stream augmentation) structures called flood retention flow augmentation. The 2017 report includes the more efficient and safer RCC concepts, flood retention structure including supporting foundation characterizations (HDR 2017b) and engineering analyses, and feasibility of alternative fish passage systems and opinions of construction costs. Figure 3 shows the FRE facility configuration (with similar size and operational properties as the previously described FRO).

Figure 1. Embankment Flood Retention Structure at Charlie's Hump (see 2009 alignment on Figure 4)



Source: S&W 2009a

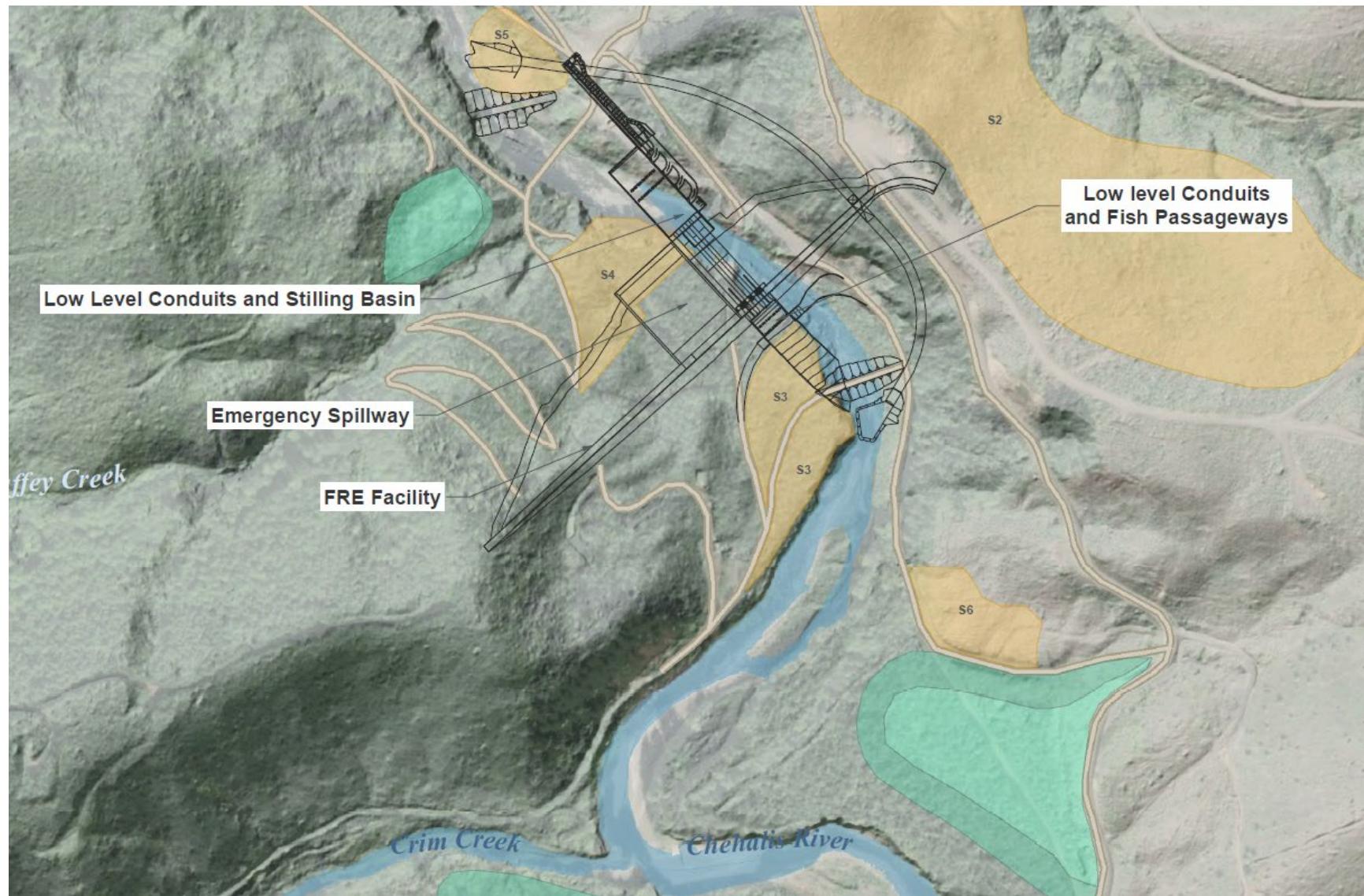
Figure 2. Revised Embankment Flood Retention Structure Site



Source: S&W 2010

Note: North arrow points down to follow the convention of having the river flow towards the bottom of the page.

Figure 3. FRE Facility Site Plan Showing In-Water Construction Elements



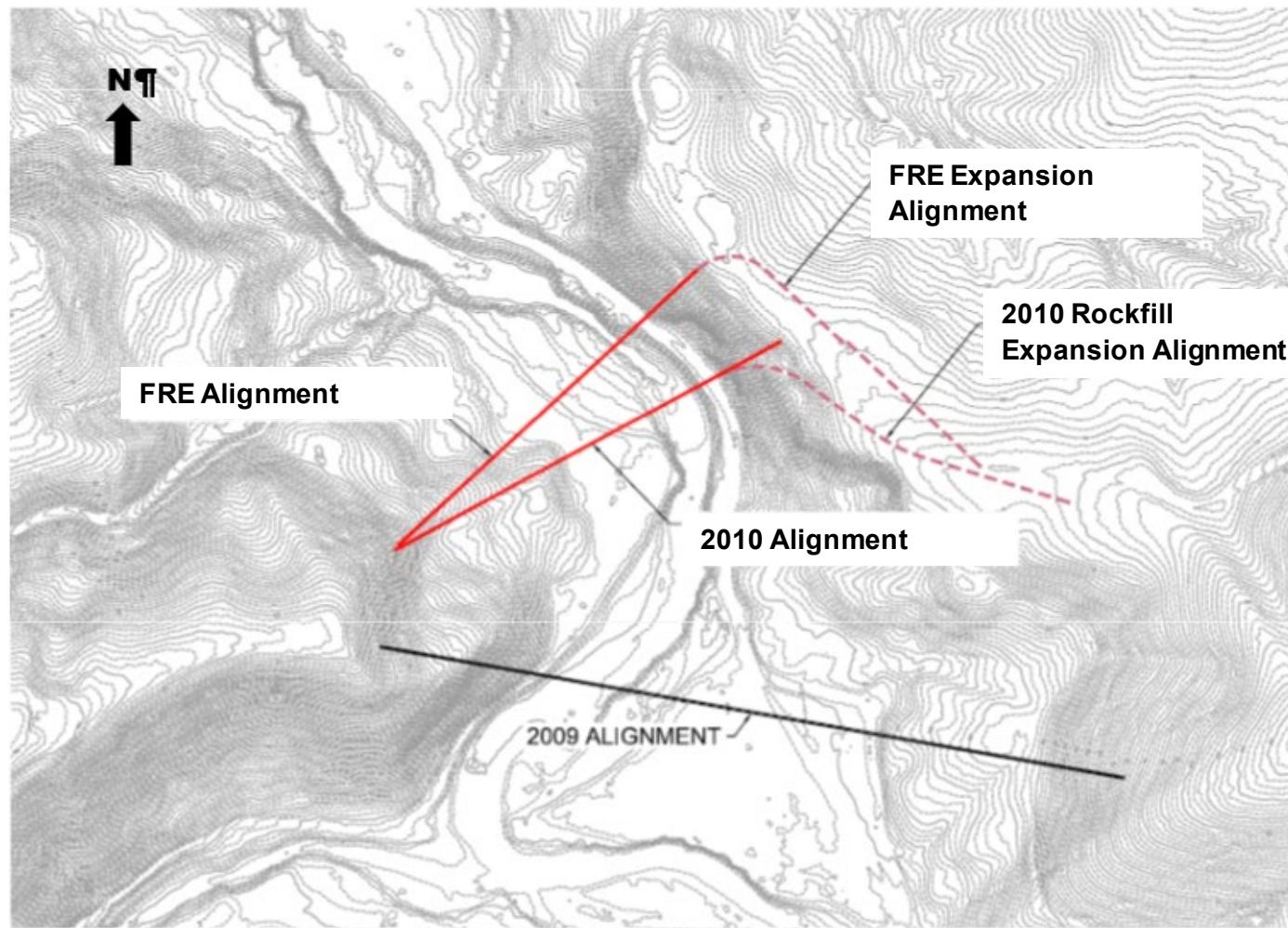
Source: USACE 2020

6.0 Summary of Siting Activities

Refinements in the alignment and dam type configuration have continued as information on subsurface conditions at the Charlies Hump site (approximately RM 108) has been obtained (see Figure 4):

- PIE 1998 and Tetra Tech 2003 identified a potential site for an earth embankment dam in the Upper Chehalis Basin at a location known as Charlies Hump (approximately RM 108).
- Phase I (EESC 2009) further assessed the potential viability of the site known as Charlies Hump (approximately RM 108) for the siting of a flood retention structure.
- Phase IIA led by EESC included development of subsurface information prepared by a subcontractor including geology (S&W 2009a) and geotechnical (S&W 2009b) studies of the potential sites (Upper Chehalis and South Fork Chehalis) and proposed an embankment dam at a location where a straight access could provide a large storage area.
- Phase IIB – based on the findings of the Phase IA (S&W 2009a, 2009b) and further construction evaluation (S&W 2010), the embankment structure axis was shifted downstream and rotated and its axis rotated to better geologic characteristics on the right abutment (looking downstream) and more favorable construction characteristics.
- HDR 2017, 2018. Alignment rotated farther about left abutment to be better suited to a concrete dam, and to provide better opportunities for hydraulic structures that provide for fish passage and sediment transport when the FRE is not in use for flood retention.

Figure 4. Comparison of Flood Retention Structure Alignments



Source: HDR 2014

7.0 Conclusions

A historical review of the siting of potential flood retention structures in the Chehalis Basin shows that considerable analysis of potential sites has occurred, and the site known as Charlies Hump in the Upper Chehalis Basin has long been identified as the most probable location to successfully reduce the impacts of flooding in the Chehalis Basin, including the cities of Centralia and Chehalis. The current FRE facility site (approximately RM 108) meets the purpose and need as defined in USACE's Draft EIS of a flood retention structure that would substantially reduce flood impacts within the Chehalis River basin and minimize project impacts over other alternatives historically considered. Moving the planned FRE facility upstream or downstream of the currently planned location, or to an alternative location within the basin, could require significant changes to the facility configuration, increased costs, reduced flood control effectiveness of the structure, and increased environmental impacts of the facility where feasibility of the structure could be in question.

The Upper Chehalis Basin site known as Charlies Hump (approximately RM 108) is located in a semi-confined section of the Chehalis River that provides appropriate abutment opportunity for the construction of a large RCC-type flood retention facility. The embankment heights downstream of the current FRE site location are not conducive to constructing a large flood retention facility capable of storing the needed volume of water to reduce flooding in the Chehalis basin. Farther downstream, the general topography of the Boisfort Valley near the town of Pe Ell does not provide any significant water storage opportunities.

Moving the facility upstream of the confluence of the Chehalis River and Crim Creek would also reduce the flood storage capacity and increase the challenges of managing river water during construction and as part of normal operations. Moving the alignment upstream could result in foundation conditions unsuitable for the RCC-type structures and negate the significant benefits relative to sediment management and fish passage of the current site location. The location farther upstream (approximately 1,500 feet from RM 108) was previously rejected following geotechnical and geologic investigations (S&W 2009a, 2009b; EECS 2011). The site characterization, engineering, and environmental studies (HDR 2017a, 2017b, 2018) represent a significant investment. A different FRE location would need to be investigated to a similar level of detail in order to characterize foundation conditions and flood retention structure type and layout requirements. Similar investments would be needed if other alternative sites or alignments are identified for further evaluation.

8.0 Literature Cited

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