Technical Memorandum

Date	March 1, 2021
Project:	Chehalis River Basin Flood Damage Reduction Project
To:	Chehalis Basin Flood Control Zone District
From:	Rachel Ainslie and Mike Garello, HDR
Subject:	Existing All Species Fish Passage Facilities Research

1.0 Introduction

The Chehalis River Basin Flood Control Zone District is proposing to construct a new flood retention facility and temporary reservoir near the town of Pe Ell, Washington to reduce damages during a major flood. Throughout construction of the flood retention facility, which is anticipated to last between 3 and 5 years, the Chehalis River will be unavailable for fish passage use. As a result, a temporary fish passage solution is needed for use during construction. As part of this effort, HDR Engineering, Inc. has been retained to research and identify potential temporary fish passage solutions to be used during the construction of the flood retention facility. The temporary fish passage facility would accommodate all aquatic species and life stages for upstream passage.

1.1 Purpose and Scope of Document

This Technical Memorandum (TM) presents example fish passage facilities constructed to accommodate all aquatic species and life stages or that incidentally accommodated a wider range of species and life stages based on existing documentation or observation by others that could be used throughout construction of the flood retention facility for temporary fish passage. The available technologies and their potential application (or viability for consideration) at the Chehalis project site are summarized herein.

Efforts to achieve the objectives of this activity include:

- Investigate the use of fish passage technologies for temporary bypass of construction projects
- Discuss the potential viability associated with implementation of fish passage strategies considered for the proposed project
- Research Washington Department of Fish and Wildlife WDFW Hydraulic Project Approvals (HPAs) to assess recent fish passage expectation requirements
- Summarize conclusions and outline next steps for continued investigation and assessment of potential temporary fish passage technology

2.0 Existing Facilities and Technology

This investigation was performed through a mixture of desktop research, review of salient background information available in the literature, and phone conversations with facility owners, agency representatives, and individuals experienced in implementing fish passage technologies at construction projects. The research includes both volitional and directional fish passage technologies and is focused on three methods that are commonly employed successfully: nature-like fishways, fish ladders, and upstream trap and transport facilities. Though additional fish passage technologies exist, these three were identified as most likely to address the temporary fish passage objectives considering site constraints and the all fish species, all life stages design criteria. Table 1 (attached at the end of this TM) displays all researched facilities.

2.1 Nature-Like Fishways

The Eel Weir project on the Oswegatchie River is located in New York. In 2015, construction was completed on a permanent bypass nature-like fishway approximately 26 feet wide that operates year round. The nature-like fishway was constructed through a rock-gap weir baffling strategy with approximately 0.5 feet of head loss per weir, characteristic of the fish needs in the New England area (Brookfield Renewable et. al. 2019).

This facility was designed to pass all species and all life stages (Brookfield Renewable et. al. 2019). In the rock ramp, velocities vary from 0 to 6 feet per second, allowing small fish and juveniles to pass easily. In fall 2017 and spring 2018, the weir was monitored to observe its effectiveness. In the fall, all manner of resident fish were documented through both electrofishing and video monitoring including fallfish, black crappie, bluegill, catfish, smallmouth bass, white sucker, and minnows, among others. In the spring, documented fish included the blacknose dace, bass, walleye, yellow perch, and lamprey, among others, including turtles (Brookfield Renewable et. al. 2019).

The San Clemente Dam Removal and Carmel River Restoration Project in California is another good example of a large-scale nature-like fishway. The fishway, made up of engineered rock step pools, was initially constructed as a temporary bypass measure during multi-year construction, similar to the investigations and purpose of this TM. Project were to improve conditions for all life stages of both resident and anadromous forms of steelhead. Counts at an upstream fish ladder showed the bypass to be effective at passing adult steelhead; resident and juvenile fish passage was not recorded in the post-project monitoring reports found during this research (CAWC 2021).

Research into other nature-like fishways (Table 1) report observational findings that support the documented findings highlighted at Eel Weir. The observation data verify passage of a broad range of fish taxonomy, body types, hydrodynamics, and body sizes, supporting the effectiveness of nature-like fishways at passing all species, all life stages – though this is not the case with all nature-like fishways (Brookfield Renewable et. al. 2019; Brookfield Renewable and HDR Engineering, Inc. 2020).

2.2 Fish Ladders

This TM focuses on examples of fish ladders located in the Pacific Northwest because a fish passage facility installed at the Chehalis River project site would likely focus on similar fish species with similar swimming abilities. Fish ladders located both in Washington and Oregon were investigated for their ability to pass all species, all life stages of fish. This TM highlights the North Fork Dam fish ladder on the Clackamas River, located in Oregon. The ladder is a permanent weir and orifice (half, ice-harbor baffle configuration) fishway that operates year-round with a standard 1.0-foot drop between pools. The design species and life stage for passage are adult winter steelhead, summer steelhead, spring Chinook, fall Chinook, early- and late-run Coho, and lamprey.

The North Fork Dam fish ladder was originally constructed in 1958 and has been modified since to incorporate lamprey passage. The ladder is 1.7 miles long extending from the Faraday Diversion Dam to the North Fork Fish Sorting facility owned by Portland General Electric. Resident fish passage is not quantified in the ladder, but from an observational perspective, incidental species observed in the ladder include whitefish, large scale suckers, bull trout, cutthroat, and resident rainbow trout (Shibahara 2020a). There is no data on passage or fallback. Juvenile fish have also been observed to treat the ladder as a long tributary and perform rearing activities. Though the ladder is not designed for passage of juveniles or residents, it does not exclude their presence.

Several other local fish ladders were researched including the River Mill fish ladder and the vertical slot ladders found on the Columbia River (Table 1). These projects focus on adult anadromous salmonids and were not designed to pass resident fish. Observational data and fish counts show that in addition to salmonid species, other species that are able to pass or may occasionally pass the ladders are shad, lamprey, and sturgeon, along with rare and occasional minnows, eulachon, and bull trout (U.S. Army Corps of Engineers [USACE] 2021; Shibahara 2020b).

Intermittently, resident and juvenile fish are observed ascending and descending local fish ladders; however, during the brief desktop research performed for this study, passage success rates were not identified at these facilities.

There are other technical fish ladders in the world that are designed for catadromous fish species, reflecting smaller fish with weaker swimming capabilities and different swimming modes. One example includes the Geesthacht fish ladder, on the Elbe River in Germany. It is a 1,800-foot-long double vertical slot ladder that accommodates approximately 13 feet (4 meters) of differential, which lends to about 3.5 inches of hydraulic differential per pool (KED Ingenieure 2016). Due to the lower velocities and lower hydraulic differential between pools in this ladder, smaller and weaker swimmers have been observed successfully passing the ladder in addition to larger fish. Monitoring reports have reported stickleback, smelt, pike, and larger fish such as salmon, sea trout, and lamprey. In all, 45 species of fish have passed through the facility, though failure and success rate details and life stages are unknown (The Local 2013).

Though there are no local examples with data regarding passage rates of non-migratory fish, the worldwide vertical slot fish ladders passing a variety of species fish show that a facility in the

Pacific Northwest could be constructed that would likely accommodate all species and life stages at the Chehalis project site.

2.3 Upstream Trap and Transport

Upstream trap and transport strategies involve the collection of fish, transfer to a tank or vessel, and transport to a designated release location. Many example upstream trap and transport systems collect fish at the top of a technical fish ladder and transfer fish to temporary holding tanks using hoppers, brails, or gravity flume technologies. In some cases, fish can be transferred directly to transport vessels. In each case, the type of upstream trap and transport strategy is configured based on the fish species collected, physical site characteristics, fish health concerns, and potential travel conditions fish may experience to the release point. Select facilities located in Washington and Oregon were investigated for their ability to pass all species, all life stages of fish. This TM highlights the Merwin Dam Adult Collection Facility on the Lewis River, located in Washington. Constructed in 2014, a short vertical slot ladder accommodates a head differential of about 12 feet with hydraulic drops ranging from 0.25 foot to 1.0 foot. A fish lift located at the upstream terminus of the ladder raises fish and temporary holding water to an elevation 30 feet above the ground surface. At the top of the lift position, water and fish are conveyed via gravity conduit to a holding gallery. Fish are crowded from the holding gallery to a sorting facility where they are routed into holding tanks ultimately for truck transport.

The design species and life stage for passage at this facility are adult steelhead, Chinook, Coho, and cutthroat. The traps are monitored closely and document a 99 percent survival rate of the design species. Incidental species and life stages are not recorded during monitoring at the dam, but are occasionally observed in the ladder and sorting ponds. Observed incidental species include resident rainbow trout, pikeminnow, tiger muskie, kokanee, bluegill, and sculpin (PacifiCorps and PUD No. 1 of Cowlitz County 2020). Small, juvenile and resident fish are capable of ascending the ladder and have done so, but the adult-sized fish crowders are unable to release the smaller fish from the sorting pond. Maintenance must be performed periodically at the sorting ponds to release any juveniles and smaller-sized fish that enter the ponds.

Several other upstream trap and transport facilities were researched including the North Fork Dam (previously discussed) and the Sunset Falls facility. The Sunset Falls escapement reports indicate there are high numbers of sub-adult salmon able to pass through the facility (WDFW 2016).

A fish lift located in Australia at Paradise Dam was also researched to determine if there are any examples worldwide of trap and transport systems that accommodate a range of species and life stages migration. At this particular facility, fish enter a hopper and are lifted up and over the 120-foot-high dam. Though the facility was designed only for catadromous migratory fish, the fishway monitoring program shows that safe passage is provided for most species of fish and a wide variety of size ranges. Passage included size ranges of a 0.4-inch western carp gudgeon to a 3-foot Queensland lungfish. Of 29 species observed at the base of the dam, 25 were able to ascend and pass (Burnett Water Pty Ltd 2011).

Upstream trap and transport facilities are typically designed to pass adult life stages of anadromous salmonids in the Pacific Northwest. Through this brief review of existing facilities,

no examples were identified where the focus was on resident, sub-adult, or juvenile life stages (except lamprey). Resident and juvenile fish are observed, but their presence and subsequent transport is incidental, and no documentation was found during this review to support passage success rates. There are efforts to improve collection and transport of lamprey. Given their unique swimming and locomotion methods, they are known to require different technologies than other fish species, including separate collection and transport mechanisms. Because upstream trap and transport technology has been used successfully elsewhere for the safe passage of a wide variety of fish species and sizes, it is likely that an upstream trap and transport facility could be designed to accommodate all fish species and life stages.

3.0 Applicability of Technology at Site

For the information presented above and that attached, each highlighted fish passage technology was assessed for feasibility and compatibility with site conditions.

3.1 Nature-Like Fishways

Nature-like fishways are implemented at low angles and provide multiple hydraulic pathways for weaker swimming fish. They have been documented and proven to pass all species and all life stages of fish in numerous applications around the world. At the Chehalis project site, an implemented nature-like fishway would be a bypass channel that avoids construction impacts of the flood retention structure. This bypass channel could be located on either the eastern or western bank of the river. The application would be similar to the San Clemente Dam Removal project outlined above, where the nature-like fishway was constructed as a bypass route for temporary construction.

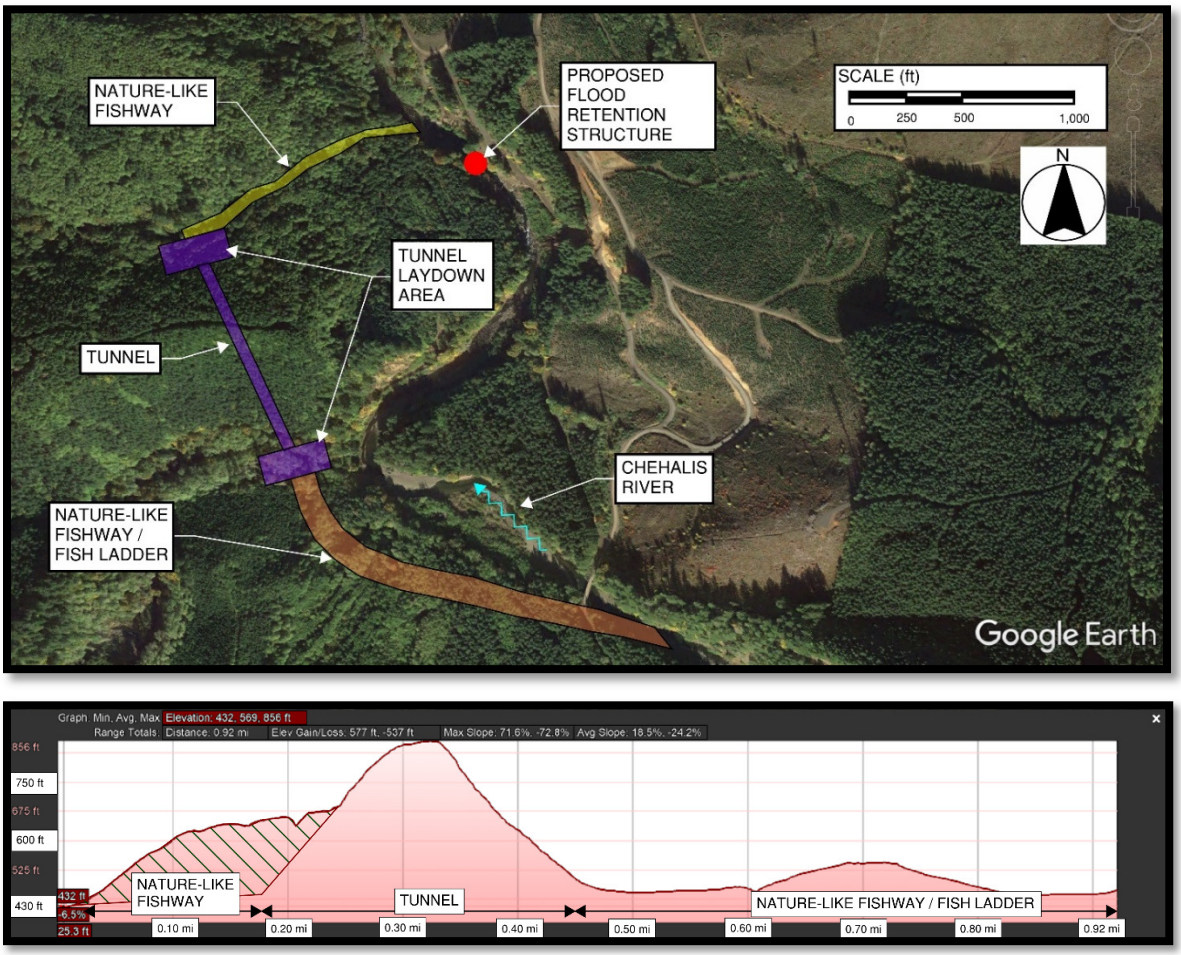
Figure 1 shows the approximate construction footprint and elevation profile required to provide a nature-like fishway as temporary fish passage on the western side of the Chehalis River, Scenario 1. The river is at approximate elevation 430 feet at the location where temporary passage construction would begin. A nature-like fishway could be oriented along the existing alignment of Mahaffey Creek. After 1,500 feet, the alignment would turn south to parallel the Chehalis River upstream. This potential alignment would need to be configured through the hillside via open cut or tunnel. Open cut could require excavation to a depth of 400 feet at its tallest point. An approximately 1,100-foot-long tunnel would be required through the hillside to extend the temporary fish passage channel past the flood retention structure construction. After the tunnel, the elevation profile flattens out. Open-cut construction could then be continued to create a nature-like fishway approximately 2,400 feet long, where the fishway would rejoin the Chehalis River.

Figure 2 shows the approximate construction footprint required to provide a nature-like fishway as temporary fish passage on the eastern side of the Chehalis River, Scenario 2. The Chehalis River is at approximate elevation 430 feet at the location where temporary passage construction would begin. The elevation profile provided shows that 3,000 feet of either open cut construction or a tunnel would be required through the hillside, at depths between 100 and 200 feet, to

extend the temporary fish passage channel past the flood retention structure construction where the nature-like fishway would rejoin the Chehalis River.

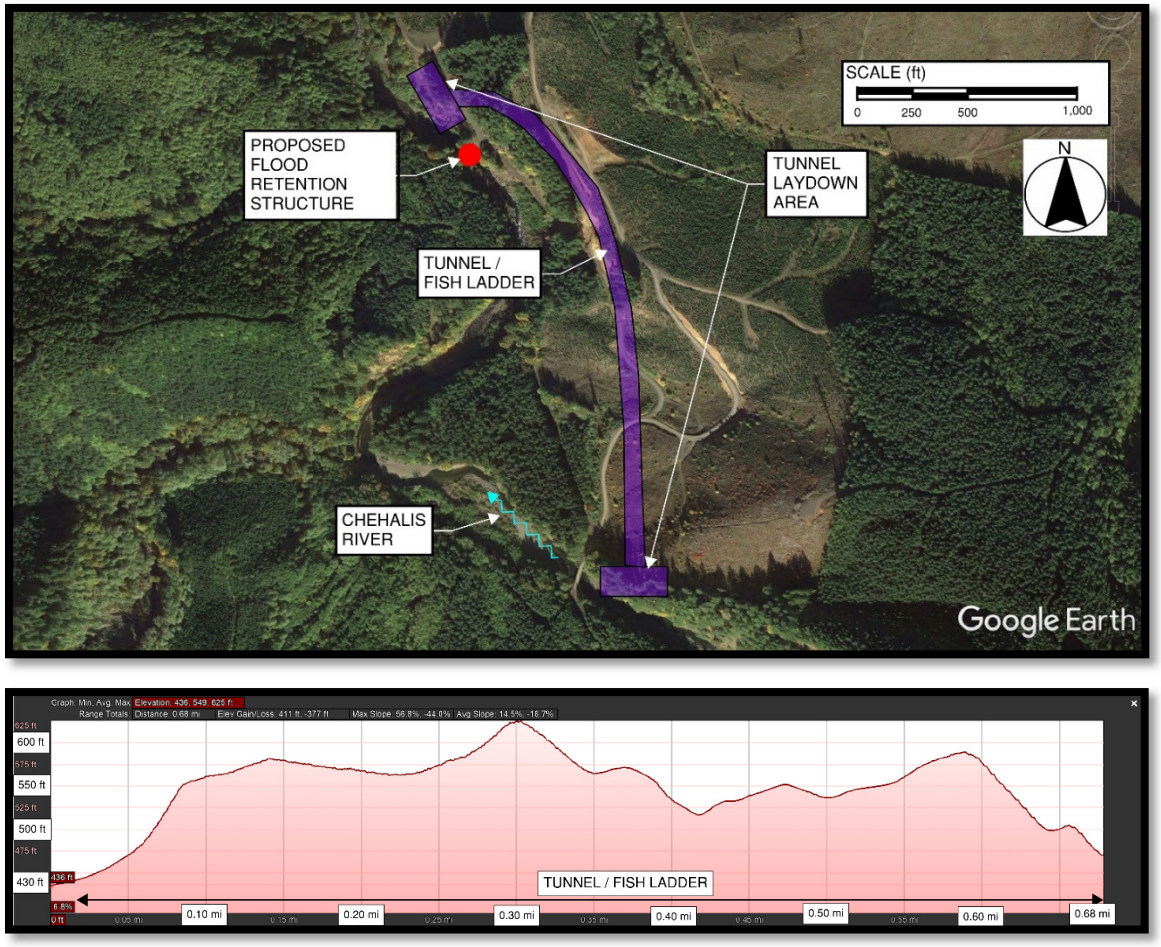
As displayed in Figure 1 and Figure 2, these potential bypass routes for a temporary passage facility are both lengthy and expensive. The nature-like fishway could be constructed only through use of a tunnel, or by performing open-cut construction several hundred feet deep, which may be economically impractical for a temporary fish passage facility. In addition, nature-like fishways may require additional measures to prevent severe flooding of the fishway and provide site safety at the bypass channel.

Figure 1: Nature-like Fishway/Fish Ladder Potential Construction Footprint Scenario 1[1]



[1] The elevation profile along Mahaffey Creek has been manually assumed as shown. Google Earth data lacks the detail to estimate the elevation profile within the small tributary.

Figure 2: Nature-Like Fishway/Fish Ladder Potential Construction Footprint Scenario 2



3.2 Fish Ladders

Research of Pacific Northwest fish ladders resulted in no documented evidence of passage rates for resident and juvenile fish, though several references identified visual observations of these fish in the ladders. Low bottom swimmers such as resident fish find it difficult to pass through longer fish ladders because of the higher velocities found inside requiring different criteria to accommodate the wide variety of fish that may be expected. A temporary fish ladder would also need to bypass the construction site, using the same routes as outlined above for the nature-like fishway option.

Under established design guidelines for anadromous fish, fish ladders use standard 1.0-foot hydraulic drops. The temporary fish passage must accommodate 40 feet of hydraulic differential, which based on standard design practices would require a ladder approximately 700 feet long. The bypass routes outlined above are approximately 3,000 and 5,000 feet long, depending on the side of the river on which the channel is located.

If the ladder was designed for a broader range of species and life stages, identification of appropriate design criteria would require additional research. For example, one limiting factor requiring vertical slot ladder design analysis is the maximum slot velocity. If the slot velocity is

reduced to accommodate weaker swimmers and the hydraulic differential per pool is reduced to 0.4 feet (~5 inches), this same concept ladder would be 1,100 to 1,200 feet long.

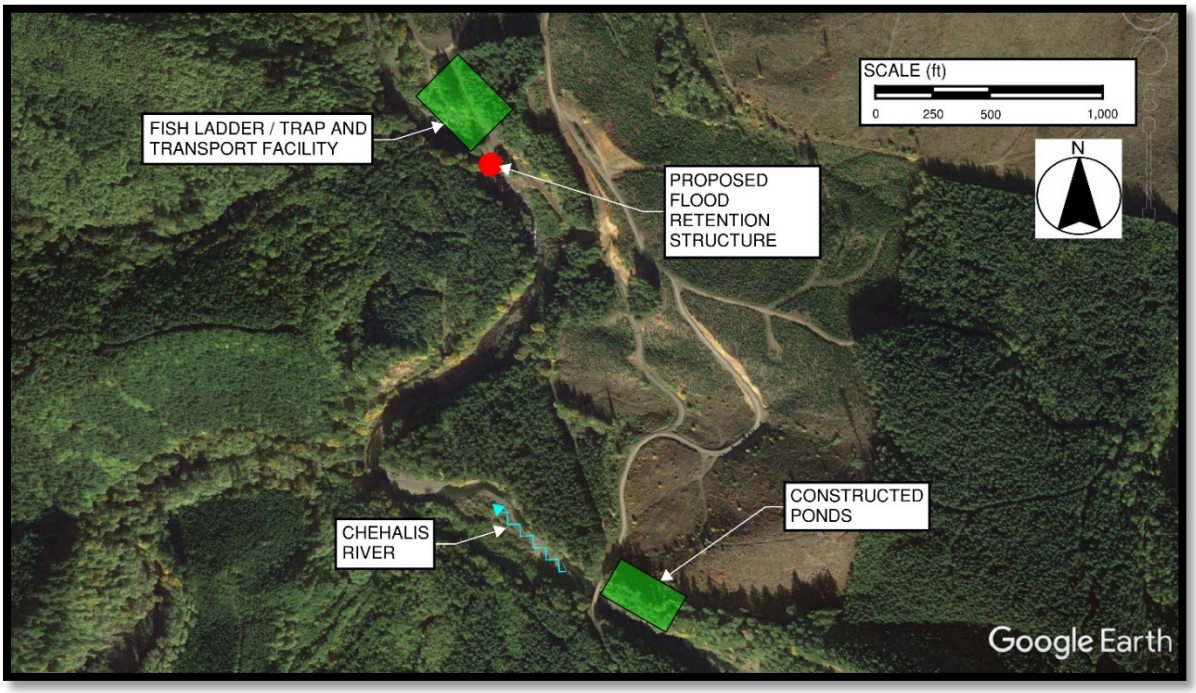
Both conceptual fish ladders, under standard design criteria or using researched design criteria, would require navigational channel sections linking the ladder segments, entrance, and exit together, and extending the fish passage far enough upstream to bypass the flood retention structure construction site. Those navigational channel sections could be sloped, nature-like fishway sections or simple channels.

Figure 1 shows an example configuration of a fish ladder with a nature-like fishway and tunnel, using the route outlined in Scenario 1 on the western bank of the Chehalis River. Figure 2 shows an example configuration of the temporary fish passage alignment on the eastern bank, where a fish ladder could be incorporated in conjunction with a tunnel.

3.3 Upstream Trap and Transport

Similar to fish ladders, documented fish passage rates for resident and juvenile fish using upstream trap and transport technology were not identified in the brief data research conducted for this TM, though there are many observations of these fish at facilities that use this technology. Figure 3 shows the approximate construction footprint that may be required to provide temporary fish passage using an upstream trap and transport facility. The system could begin with the construction of a short fish ladder downstream of the flood retention structure, which would bring all fish to a sorting facility. A short road would also be constructed to connect the facility to the nearby existing road to the north. Trucks would transport the fish upstream of the construction zone into several constructed ponds and release them to continue upstream.

Figure 3: Trap and Transport Facility Potential Construction Footprint



As displayed in Figure 3, the upstream trap and transport option would likely exhibit the smallest and most economically attractive construction footprint. However, upstream trap and transport facilities in the Pacific Northwest have historically been designed for adult-sized fish. Designing the facility for smaller, resident and juvenile fish would be an experimental undertaking.

4.0 Recent Washington State Project Approvals

Desktop research was performed to understand recent project history in Washington State and the trends in accommodation of various fish species and life stages at the projects. The research was performed using the Aquatic Protection Permitting System, which tracks all applications for HPAs within Washington, to search for all projects denoted as a Fishway project type (WDFW 2020). The database showed 30 projects were applicable to the intent of the investigation, from 2014 until 2020, though only 3 were designed for temporary passage – the rest were designed for permanent passage. Of the 30 projects investigated, only 23 project descriptions identified the fish species and life stages considered during design.

- Three were designed for all species, all life stages through the use of a nature-like fishway
- Six were designed for salmonids or trout, but that resident fish were also considered during passage design through the use of nature-like fishways or fish ladders; all species, all life stages was not mentioned
- Fourteen were designed for salmonids or trout using nature-like fishways, fish ladders, or trap and transport technology, with no mention of resident fish species

A summary of the collected information is found in Table 2 (attached).

5.0 Conclusions

For this TM, investigations into examples of each technology show that nature-like fishways, fish ladders, and upstream trap and transport facilities in the Pacific Northwest have been employed successfully according to their design species and life stages (typically anadromous adult fish). These local examples lack applicability to the all species, all life stages criteria for this project. To develop design criteria, examples of nature-like fishways, fish ladders, and upstream trap and transport facilities from elsewhere in the United States and even throughout the world must be further researched and applied at this site.

Terrain challenges at the project site show some technologies would be more costly than others. Open-cut construction or tunneling through a hillside to construct either a nature-like fishway or a fish ladder on the eastern or western banks to depths of typically 100 to 200 feet would require substantial economic funding. An upstream trap and transport facility would have a more reasonable cost, as fish would be hauled most of the way upstream using existing roadways. The construction footprint would only involve building sorting ponds upstream and a trapping facility downstream, without construction required through the hillside.

Another perceived challenge includes the lack of research regarding passage rates for all species and all life stages within fish ladders and upstream trap and transport facilities. Though

resident and juvenile fish have often been observed in these facilities, during this exercise no evidence was found showing passage success rates, which would cause these facilities to be an experimental undertaking. Nature-like fishways are documented to pass all species and life stages of fish, though not all have been designed according to this criteria.

WDFW HPAs research indicated few projects requiring passage of all species, all life stages of fish. Commonly, both temporary and permanent fish passage projects have been designed for salmonids or trout, with some projects including select resident fish. As a result, it would be unlikely that existing research of Washington State could inform passage of all species, all life stages at the project site. Each individual type of project would need to consider the biologic and ecohydraulic criteria for each fish species. Given that criteria for resident species does not exist, additional research would be required to develop the design criteria. Future steps would require research, establishing minimum design criteria, alternative formulation, feasibility evaluation, and selection of potentially viable alternatives.

6.0 References

Brookfield Renewable, Erie Boulevard Hydro, LLC, and HDR Engineering, Inc.

2019 Construction and Monitoring of Nature-Like Fishways for Lake Sturgeon and American Eel of the Oswegatchie River. NHA Regional Meeting: Innovative Fish Passage Designs, Part 1.

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2020 *Design and Construction of the Springs Dam Nature-like Fishway on the Saco River*. Presented January 16, 2020 to the Maine Section of the American Society of Civil Engineers.

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2020b Personal Communication regarding River Mill Dam. 503-630-8234.

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2021 *COE Year-to-Date Adult Dam Count Report, Bonneville Dam*. Columbia Basin Fishery Agencies and Tribes Fish Passage Center. https://www.fpc.org/adults/R_adultcoequeries_annualsums_results_lamprey.php

WDFW

2016 Sunset Falls Escapement Reports, 1958-2016.

2020 Aquatic Protection Permitting System (APPS). https://www.govonlinesaas.com/WA/WDFW/Public/Client/WA_WDFW/Shared/Pages/Main/Login.aspx

Attachments

Table 1. All Species, All Life Stages Existing Facilities Research

Table 2. Recent Fishway HPAs in Washington State

Table 1: All Species, All Life Stages Existing Facilities Research

Project Name	Location	Citation	Year of Construction	Technology Type and Description	Operation Period	Hydraulic Differential	Design Species and Life Stage for Passage	Incidental Species and Life Stage that Pass
Eel Weir	Oswegatchie River, New York	Brookfield et. al. 2019	2015	Permanent, nature-like bypass fishway created through rock arch weirs (rock ramp design); 0.5'-0.6' of head loss per weir. It's about 26 feet wide and has a bedrock bench. About 800 feet long at an average slope of 2.5%.	All year	13.5'	All species, all life stages including black crappie, bluegill, burbot, fallfish, golden shiner, pumpkinseed, logperch, smallmouth bass, rock bass, white sucker, minnows, yellow perch, among a few others. Juveniles are passed too.	NA
Heuvelton Dam	Oswegatchie River, New York	Brookfield et. al. 2019	2018	Permanent, nature-like bypass fishway created through rock arch weirs (rock ramp design). Approximately 575 feet long at average 2.5% slope.	All year	14.0'	All species, all life stages.	NA
Springs Island Dam	Saco River, Maine	Brookfield Renewable and HDR 2020	2019	Permanent, nature-like in-river fishway created through rock arch weirs (rock ramp design). About 100 feet of the dam width was taken, rock wall created, and fishway placed here. 10 weirs. Approximately 250 feet long at average 2.5% slope.	All year	8.0'	Herring, alewife, shad, salmon.	All species, all life stages. Striped bass, lamprey, minnows, turtles, resident species have been observed as well.
River Mill Dam	Clackamas River, Oregon	Shibahara 2020b	Orig 1910; rebuilt 2006	Permanent weir and orifice ladder about 1,300' in length with a 1.0' standard drop between pools.	All year	85.0'	Adult winter steelhead, summer steelhead, spring Chinook, fall Chinook, early / late run Coho, lamprey	Resident fish passage is not evaluated. Bull trout and juveniles have been observed in the ladder.
North Fork Dam	Clackamas River, Oregon	Shibahara 2020a	1958; has been modified since	Permanent weir and orifice ladder for 1.7 miles with a 1.0' standard drop between pools, and then becomes trap and transport. Entrance has been modified for lamprey in the 1970s.	All year	240.0'	Adult winter steelhead, summer steelhead, spring Chinook, fall Chinook, early / late run Coho, lamprey	Resident fish passage is not evaluated. Whitefish, large scale suckers, bull trout, brown trout, cutthroat, resident rainbow have been observed in the ladder. Juveniles treat it like a tributary, so there is rearing occurring in the ladder.
Weber Reservoir	Walker River, NV	Hassebrock 2020	2011	Permanent roughened channel fishway about 1,900 feet long with boulder weirs and vertical slot fishway	All year	40.0'	Cui-ui and Lahontan cutthroat	None observed or present
San Clemente Dam Removal	Carmel River, CA	CAWC 2021	2013 - 2015	Permanent step-pool bypass fishway; 450 feet long	All year	Unknown	Adult steelhead	None were recorded in the monitoring reports
Bonneville Dam	Columbia River	COE 2021	1937	Permanent vertical slot ladders; modified so that lamprey could pass, with wall corners.	All year		Anadromous adult salmonids; migratory fish	Shad, lamprey, and sturgeon are able to pass. Occasionally, minnows, elachon, and bull trout are recorded; none of the Columbia projects (also including John Day, Dalles, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams) are designed to pass resident fish.
Merwin Dam	Lewis River, WA	PacifiCorp and PUD No. 1 of Cowlitz County 2020	2014	Trap and transport system; part of it is a permanent vertical slot fish ladder with head loss drops ranging from 0.25' to 1.0'. Fish are loaded into the hopper of a lift and conveyance system which transports fish to the sorting building. After sorting, fish are routed into holding tanks for truck transport.	All year	10.0' for vertical slot ladder, and 30.0' for lift system	Adult steelhead, Chinook, coho, cutthroat	Resident fish passage is not evaluated. Resident rainbow trout, pikeminnow, chum, Kokanee, tiger muskie, bluegill, sculpin, and juveniles observed in the ladder and in the sorting pools.
Sunset Falls	South Fork Skykomish River	WDFW 2016	1958	Trap and transport system; fish ladder with a lift and conveyance system.	July to Dec		Anadromous adult salmonids and steelhead	Resident fish passage is not evaluated for all species. Bull trout and cutthroat are occasionally counted in escapement reports, while steelhead is common. Native char and whitefish have been observed in the trap and transport facility.
Geesthacht	Elbe River	KED Ingenieure 2016	2010	Permanent double vertical slot ladder; 1,800 feet long. Each slot is about 9 cm, or 3.5 inches, higher in hydraulic differential than the one before.	300 days per year	13'	Largest species - Atlantic sturgeon; there is also an eel pass	Weak swimmers such as stickleback and smelt, sander, pike, catfish, up to large fish like salmon. Eels, sea trout, lamprey. In all 45 species have passed.
Paradise Dam	Burnett River	Burnett Water Pty Ltd. 2011	2005	A fish lift; fish enter an outlet release channel which leads to a vertical slot, allowing fish to move to the fishlift entrance (hopper). The submerged fish hopper is hoisted over the dam wall and lowered into the water, where fish are released.	All year	120'	Migratory fish community	The fishway provides safe passage of most species of fish and a wide variety of size ranges including olive perchlet, eel, catfish, perch, hardyhead, carp, bass, herring, lungfish, cod, gudgeon, smelt. As small as western carp gudgeon at 11mm, and Queensland lungfish at 969mm, were able to pass. There are physical impediments that affect access for all species during high flows.

Table 2: Recent WDFW Approvals Research

Application ID	Temporary or Permanent?	Project Title	Facility Description	Owner	Species and life stages passage designed for
19405	Permanent	Cooke Creek Fish Screening and Passage Project	Roughened channel grade control structure and concrete fishway for diversion dam	Kittitas County Conservation District	ESA-listed steelhead, Chinook and coho salmon, and a suite of resident fishes
19424	Permanent	Cle Elum Fish Passage Splitter Wall and Adult Facility	Installation of concrete splitter wall within Cle Elum Dam basin, excavation for adult fish facility, and connection of juvenile / adult fish passage facility. Will also include temporary bypass system	Bureau of Reclamation	ESA-listed anadromous fish and other native fish species
18863	Permanent	Native Salmonid Conservation Facility	Construct NSCF related structure including intake with associated natural channel fishway, pipeline and discharge structure, water collection system	Seattle City Light	Native trout species (West Slope cutthroat; not accessible to Bull Trout or anadromous fish) all life stages
17671	Permanent	McDonald Creek Fish Passage and Infrastructure Improvement Project	New fish ladder and rock step weirs in creek channel.	Clallam County Department of Community Development	Adult and juvenile salmonids
18058	Permanent	Pilchuck Dam Removal Restoration Project	Demo of existing dam, intake, fish ladder followed by natural channel formation	Tulalip Tribes	Listed fish species
16699	Permanent	Steigerwald Floodplain Restoration Project	Levee material will be excavated to create a natural channel connection with the Columbia	Lower Columbia Estuary Partnership	Adult migrating fish; will provide habitat to benefit steelhead and cutthroat trout; Chinook, coho, and chum salmon; and lamprey
16496	Unknown	Gorst Creek Fish Barrier Seasonal Correction	Building of weirs to provide emergency fish passage for salmon to access the fish ladder at the City of Bremerton's Gorst Creek intake	City of Bremerton	Salmonids
10233	Permanent	Jordan Creek Intake Replacement	Construct new intake and fish ladder in first summer. Construct a channel spanning roughened channel to allow fish passage and medium and high flows, while keeping intake operational. The new fish ladder will allow passage at lower flows. As a result of this project, fish passage for all life stages will be improved	WDFW	Upstream passage of adult and juvenile salmon; residents were incidental
9844	Permanent	Naches-Cowiche Siphon Fish Passage	Construct roughened channel to replace the Naches Cowiche Canal Association siphon, which creates a 1.3 ft. barrier to anadromous and resident fish during periods of low flow in Cowiche Creek	Naches Cowiche Canal Company	All species and life stages under nearly all flows
8279	Permanent	City of Cosmopolis Mill Creek Park Dam Improvements Project	Construct new fish passage around the dam structurethrough the use of in-stream weirs and a fish ladder	City of Cosmopolis	Upstream passage of adult salmonids
7696	Permanent	Reed and Hatfield Diversion Removal and Restoration Project	Construct a 350-foot roughened channel to provide fish passage for all life stages of fish and other aquatic organisms	Kittitas County Conservation District	All life stages of fishes and other aquatic organisms
12061	Permanent	USBOR Reservoir Bed Passage	Establish safe fish passage conditions for upstream and downstream moving adult bull trout in tributaries that flow into Reclamation reservoirs	WDFW	Adult bull trout

Application ID	Temporary or Permanent?	Project Title	Facility Description	Owner	Species and life stages passage designed for
10403	Temporary	Cle Elum Fish Transportation System Field Test	A temporary fish passage system using Whooshh Inovations transport system would be installed on the left bank of the Cle Elum River	USBR	Upstream passage for adult salmonids
1157	Permanent	Hancock Creek Hydroelectric Project	Construct a fishway which provides volitional upstream passage consistent with State requirements; pool and weir structure	PUD No. 1 of Snohomish County	Trout and resident fish (Falls are a natural barrier to migratory fish)
6842	Permanent	Mill Creek Fish Passage	Change the hydarulic conditions in the channel to provide depths and velocities that are pasable to steelhead, chinook, and bull trout	Tri-State Steelheaders	Steelhead, Chinook, bull trout
4978	Permanent	HPA #133254 Duncan Dam Fish Passage Retrofit	Retrofits will extend the fishway by constructing a series of sheet pile weirs. The purpose of the proposed project is to enhance fish passage conditions for resident and migratory fish	Lower Columbia Fish Enhancement Group	Resident and migratory fish
2706	Permanent	Antoine Creek Roughened Channel 1	Construct a two boulder inverted vortex weir and a boulder inverted vortex sill to create a series of step pools	Colville Confederated Tribes Fish &Wildlife	Adult steelhead
3519	Permanent	Lower Clover Creek Fish Passage Project	Construct a roughened channel downstream of the existing privately owned bridge. The project will primarily be filling voids in the channel to raise the elevation	City of Lakewood	Lower Clover Creek contains coastal cutthroat trout, Puget Sound coho salmon and ESA listed winter steelhead.
2837	Permanent	HPA 133275-1 Headgate Dam Fish Passage Restoration	Construct a roughened channel to minimize stream channel head cutting or channel grade adjustment	Asotin County Conservation District	ESA listed steelhead and bull trout
1345	Permanent	Harris Creek Fish Passage Restoration	Construct a roughened channel to allow access to salmon and steelhead spawning and rearing habitat, and migration	King County Department of Natural Resources and Parks	Coho, steelhead, rainbow trout, cutthroat trout
902	Permanent	Big Creek Fish Passage Project	Construct a roughened channel to provide unrestricted upstream fish passage for all native species and all fish life-stages, to at least 15miles of stream habitat currently inaccessible to most fish	Yakama Nation	All native species. All fish life stages
981	Permanent	Little Falls Channel Modifications	Modify the falls to provide upstream passage for adult salmon and steelhead so they can reach the newly-constructed adult fish collection facility at the base of No. 2 Dam (RM 17.3)	Tacoma Power	Adult salmon and steelhead
247	Permanent	Beaver Creek Weirs Renovation Project – Fort Thurlow Diversion Redesign	Construct a rock ramp at the Fort Thurlow Rock Weir Complex	Methow Salmon Recovery Foundation	Listed fish species