Yakima River Basin Integrated Water Resource Management Plan

Technical Memorandum:

Keechelus and Kachess Dams

Fish Passage Concepts Review

U.S. Bureau of Reclamation
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Prepared by

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Contents

List of Tables

List of Figures

Appendices

Glossary and List of Acronyms

Integrated Plan	Yakima Basin Integrated Water Resource Management Plan
cfs	cubic feet per second
El.	elevation
FSC	Floating Surface Collector (system)
ft/sec	feet per second
I-90	Interstate 90
KKC	Keechelus-to-Kachess Conveyance
KDRPP	Kachess Drought Relief Pumping Plant
NMFS	National Marine Fisheries Service

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1.0 Introduction and Background

Background

In 2001, Reclamation committed to study the feasibility of fish passage at all five storage dams of the Yakima Project and to seek funding to implement passage where determined feasible. Reclamation's commitment is documented in mitigation and settlement agreements and permits associated with the Keechelus Dam Safety of Dams (SOD) Modification. As a result of these agreements and permits, Reclamation completed a *Phase I Assessment Report* of all five dams in 2003, updated in 2005. This report highlighted Cle Elum and Bumping Lake Dams as high-priority sites for continued investigation.

Future evaluation of passage at the remaining four dams, including Bumping Lake Dam, would require additional study funds, including firm cost-share commitments from other agencies. The intent, to the extent possible, is to meet all of the essential Keechelus Dam SOD requirements outlined in the Record of Decision, the Washington State Hydraulic Project Approval (HPA) permit, the Mitigation Agreement between the Washington Department of Fish and Wildlife (WDFW) and Reclamation, and the Settlement Agreement between Reclamation and Yakama Nation (see Appendix A).

This technical memorandum summarizes design concepts for future fish passage facilities at Keechelus Dam and Kachess Dam in the Yakima River Basin of central Washington State. The U.S. Department of the Interior Bureau of Reclamation and the Washington State Department of Ecology are currently conducting feasibility studies of two projects located adjacent to these dams. In cooperation with the Yakima Storage Dam Fish Passage Core Team and the Habitat Subcommittee of the Integrated Plan, Reclamation has undertaken this concept review so that the projects currently being studied account for the possible footprints and associated land requirements of future fish passage facilities at Keechelus Dam and Kachess Dam.

The Storage Dam Fish Passage Core Team includes members from the Washington State Department of Fish and Wildlife, U.S. Fish & Wildlife Service, National Marine Fisheries Service, Yakima Joint Board Irrigation Districts, Yakama Nation, and Reclamation.

The projects being studied are the Keechelus-to-Kachess Conveyance (KKC) and the Kachess Drought Relief Pumping Plant (KDRPP). The feasibility studies are authorized under the Yakima River Basin Water Enhancement Project (YRBWEP) Feasibility Study 1979 PL 96-162 Feasibility Study, December 28, 1979.

The KKC is part of the Structural and Operational Changes element, and the KDRPP is part of the Surface Water Storage element of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan). The goals of the Integrated Plan are as follows: to protect, mitigate, and enhance fish and wildlife habitat; to provide increased operational flexibility to manage instream flows to meet ecological objectives; and to improve the reliability of the water supply for irrigation, municipal supply, and domestic uses.

The Habitat Subcommittee of the YRBWEP Workgroup in coordination with Reclamation has identified other fish passage facilities as higher priority. Reclamation anticipates that it will construct fish passage facilities at Cle Elum Dam first, Tieton Dam second and Bumping, Keechelus and Kachess Dams following in that order. Reclamation requested that the KKC and KDRPP design teams provide concept designs of fish passage facilities at Keechelus and

Kachess dams in coordination with the KKC and KDRPP feasibility studies to not preclude installation of future fish passage facilities. It is prudent to ensure that adequate space remains available for future upstream and downstream fish passage facilities at each facility is available. This technical memorandum addresses this request and has two objectives:

1. Update previously reported fish passage options, criteria, and considerations for each dam site (Reclamation, 2005), and
2. Show how future fish passage facilities at the two dam sites can be accommodated in addition to the KKC and KDRPP designs.

KKC and KDRPP are located east of Snoqualmie Pass near Interstate-90 (I-90) approximately 10 to 20 miles northwest of the City of Cle Elum, Washington (Figure 1).

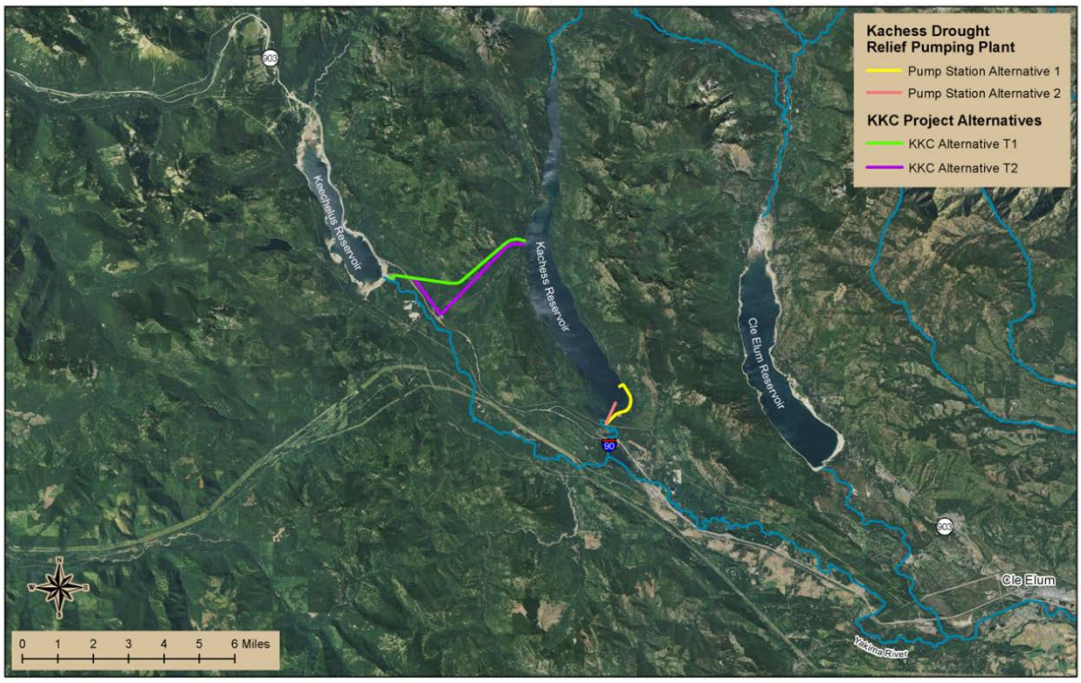


Figure 1. Project Location

The KKC would include a tunnel enabling transfer of water from Keechelus Reservoir to Kachess Reservoir. The project would have an intake on the Yakima River just downstream from Keechelus Dam outlet. The KDRPP would include a pumping plant adjacent to Kachess Reservoir. One of the alternatives under consideration would site the pumping plant immediately downstream from Kachess Dam. The other alternative would include a discharge structure on the Kachess River immediately downstream from Kachess Dam. For further information on the two projects, see Reclamation and Ecology 2014b and 2014c. Schematics showing KKC and KDRPP are shown in Figures 2 and 3. Just one alternative is displayed from each project. For KKC, the two alternatives under consideration both would have an identical footprint in the vicinity of Keechelus Dam. For KDRPP, the alternative displayed is the one that would have the more extensive footprint in the vicinity of Kachess Dam.

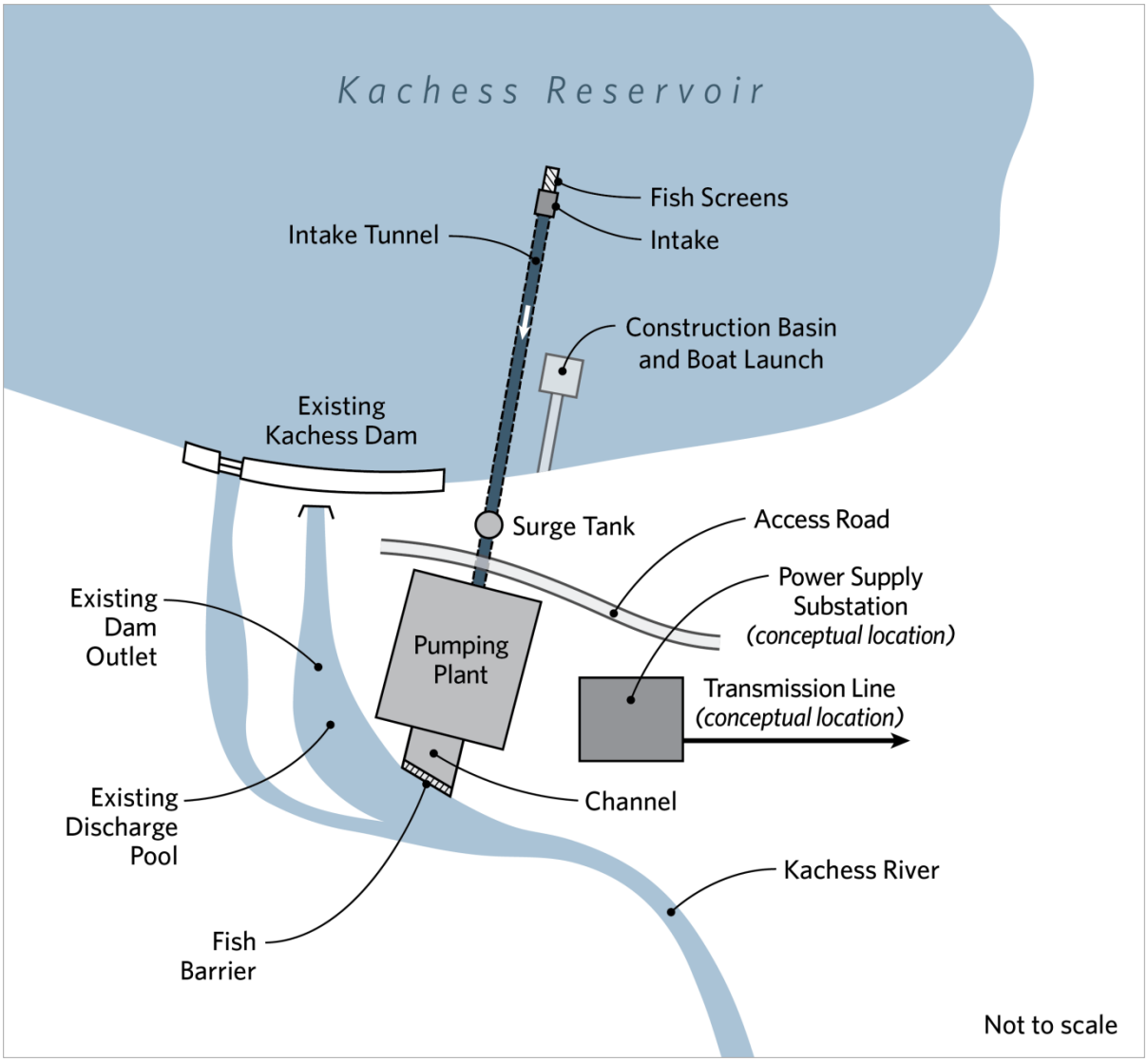


Figure 2. KDRPP South Pumping Plant Conceptual Site Plan

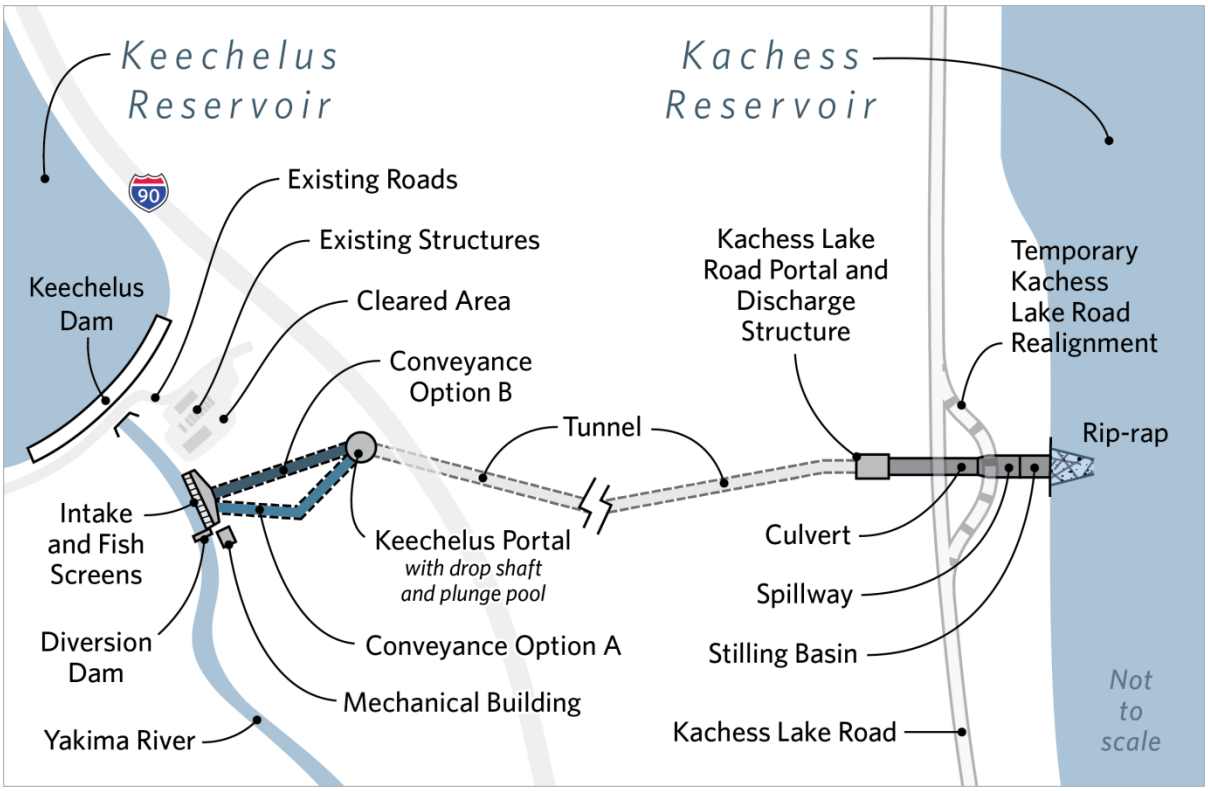


Figure 3. KKC North Tunnel Alignment Conceptual Site Plan

Reclamation performed a Phase I fish passage assessment (Reclamation, 2005) that reviewed fish passage options for all five large storage dams of the Yakima Project − Keechelus, Kachess, Cle Elum, Bumping Lake, and Tieton. The Mitigation Agreement between WDFW and Reclamation and WDFW's HPA for Keechelus Dam modifications (see Appendix A) proved the foundation for elements presented in the Phase 1 fish passage assessment. Subsequent planning documents have investigated feasibility in more detail for Cle Elum and Bumping Lake dams. Lack of fish passage at the dams has blocked access to the reservoirs and upstream habitats for several anadromous salmonid species, including Chinook, sockeye, coho, and steelhead. In addition, some of the dams also block bull trout. This technical memorandum relies upon the previous work in the Phase 1 Assessment for development and study of fish passage concepts at Keechelus and Kachess dams.

Reclamation has considered two categories of fish passage concepts for each of the dams: 1) upstream and 2) downstream passage. Upstream passage is primarily for adult fish returning to spawn, and downstream passage is primarily for juvenile fish that are migrating to the Pacific Ocean. Note that adult steelhead that have spawned (kelts) and adult bull trout may also be included in downstream passage requirements.

2.0 Previously Studied Fish Passage Concepts

2.1 Phase I Assessment and Cle Elum Dam Fish Passage Facilities

As previously mentioned, the Phase I Assessment (Reclamation, 2005) reviewed fish passage options for all five large storage dams of the Yakima Project and subsequent planning documents have investigated feasibility in more detail for Cle Elum and Bumping Lake dams(Reclamation, 2008, Reclamation, 2009 and Reclamation, 2011). Reclamation is currently designing fish passage facilities at Cle Elum Dam. The Phase I Assessment determined that there is a range of technically possible options for providing fish passage at the five Yakima Project storage dams. For purposes of the Phase I Assessment, Reclamation considered each project separately, based on existing operational considerations and constraints. The general concepts considered by Reclamation for providing upstream passage were trap-and-haul, a fish ladder with pumped flow, and a traditional fish ladder. The concepts for providing downstream fish passage included surface spill with modification to the existing spillway, construction of new spillways, use of a fish collection barge, and construction of new outlet works.

Each of the different dams and reservoirs require site-specific considerations to address site-specific constraints. Through further research and study, Reclamation selected the preferred fish passage concepts of trap-and-haul for adult fish passage and a multi-level fixed surface collector with bypass conduit for downstream fish passage for both Bumping Lake and Cle Elum dams (Reclamation, 2008). The multi-level surface collector offers the improved potential for juvenile fish passage through operation over a wider range of reservoir elevations and variability of reservoir conditions from year-to-year when compared to other downstream passage concepts.

Reclamation determined that further study was required to minimize operations and maintenance costs for downstream fish passage concepts, and performed hydraulic investigation of different concepts. The primary intent of the hydraulic investigation was to develop an intake structure and bypass conduit system that would allow fish to self guide into the intake structure, provide for a smooth transition from the reservoir for an appropriate range of reservoir elevations, and enable them to reach the downstream river channel without injury.

Based on testing of a physical model at Reclamation's hydraulics lab in Denver, CO and discussion with the Yakama Nation and state and federal fish and wildlife agencies, Reclamation selected a helix design for the downstream fish passage facility at Cle Elum Dam. This concept accommodates downstream fish passage at a range of reservoir pool elevations, while controlling the velocity and turbulence of flow for outmigrating fish. The helix structure will be housed in a concrete structure near the right abutment of Cle Elum Dam. Fish will enter through one of six inlet structures situated within Cle Elum Reservoir at different elevations. From the inlet structures, fish will pass through pipes that connect to the helix. From there, fish will then pass down the sloped, curving conduit within the helix, leading them to a tunnel that goes to the Cle Elum River on the downstream side of the dam.

The upstream adult fish passage concept for Cle Elum Dam remains a trap-and-haul facility. Final design of this facility is nearly complete as of July 2015.

2.2 Phase I Assessment Fish Passage Facilities for Keechelus and Kachess Dams

2.2.1 Keechelus Dam Upstream Fish Passage Options

For Keechelus Dam, the concepts identified and preliminary costs developed in the Phase I Assessment for upstream fish passage included an adult passage collection facility for trap-and-haul and a Fish Ladder with Pumped Flow.

2.2.1.1 Trap-and-Haul Option

The trap-and-haul option included a barrier dam and fish collection facility located in the river downstream from the point where the spillway channel enters the river. This is to prevent upstream migrants from swimming up the spillway channel and missing the fish trap facility. However, this option would eliminate a reach, about one mile long, between the barrier and the dam. As an alternative, the design could place the barrier closer to the dam and place a second barrier in the spillway channel. The design would include a haul route built along the left bank of the river, extending to the left abutment of the dam, and the construction of a ramp from the crest of the dam down to the reservoir. The fish transportation trucks would back down the ramp to release fish into the reservoir. Reclamation recognized that adjustment of the final alignment of the haul route to minimize potential impacts on wetlands and material source areas for a dam safety project was possible. The estimated construction cost for this option was $7 million at the time of the Phase 1 Assessment (issued in April 2005).

2.2.1.2 Fish Ladder with Pumped Flow Option

The Fish Ladder with Pumped Flow option included a barrier dam constructed in the river at the ladder entrance to guide fish toward the ladder entrance and prevent them from swimming past. The ladder would extend to the crest of the dam on the left abutment. Fish would swim up the ladder to the false weir at the crest of the dam and then jump over the false weir into a chute that flows to the reservoir. Excavation of a channel at the end of the chute would be required for periods of low-reservoir elevation. The design would include a pump structure for the ladder flow, located in the river just downstream from the end of the outlet works conduit, and align the ladder discharge pipe from the pump station to the false weir next to the ladder. The estimated construction cost for this option was $8.5 million at the time of the Phase 1 Assessment.

2.2.2 Keechelus Dam Downstream Passage Options

For downstream passage at Keechelus Dam, the concepts identified in the Phase I Assessment included spillway modifications, a new fish spillway, a fish collection barge, and new outlet works.

2.2.2.1 Modify Spillway with Single Level Gates Option

The Modify Spillway with Single Level Gates option included spillway modifications and channel excavations. This option consisted of four slide gates (vertically traveling overflow gates) that would allow a surface spill from the reservoir above elevation (El.) 2507. After flow passed over the gates, it would enter a pool excavated in the spillway channel, and continue to a low-flow channel excavated downstream from the pool. The estimated construction cost for this option was $3.5 million at the time of the Phase 1 Assessment.

2.2.2.2 Modify Spillway with Multiple Level Gates Option

The Modify Spillway with Multiple Level Gates option would be essentially the same as Modify Spillway with Single Level Gates option, except that Reclamation would place gates at multiple levels to permit a surface spill release from the reservoir at a lower elevation. The concept drawings in the Phase 1 Assessment report show five 10-feet high by 10-feet wide downward opening roller gates at staggered levels. This option would allow a release from the reservoir to El. 2497 and above. The spillway modifications required would be similar to the Modify Spillway with Single Level Gates option. The estimated construction cost for this option was $4.5 million at the time of the Phase 1 Assessment.

2.2.2.3 New Spillway Option

The New Spillway option included a new spillway adjacent to the existing spillway. The spillway would include multiple-level gates to provide a surface spill discharge out of the reservoir from El. 2480 and above. Emigrating fish would enter the spillway through one of the downward operating slide gates and spill into a pool. The gate and pool in use depends on the water surface elevation in the reservoir. Water would flow out of the pool and into a chute. The chutes would merge into one chute at the downstream end that would convey fish to the existing spillway channel and back into the Yakima River. The estimated construction cost for this option was $8 million at the time of the Phase 1 Assessment.

2.2.2.4 Fish Collection Barge Option

The Fish Collection Barge system consisted of a barrier net (to guide fish), a collection (or "gulper") barge with pumps, an underwater bypass pipe, and a holding barge. The concept was modeled after existing facilities at Upper Baker Dam (on the Baker River in western Washington and owned by Puget Sound Energy). A small-mesh guide-net would extend across the reservoir and direct fish toward a collection barge positioned to use outlet works flow for additional attraction. A log boom on the upstream side of the net would help protect it from floating debris. The net at the Upper Baker Dam has been used without major debris problems; however, it was reported that the orientation of the reservoir is such that debris does not drift toward the dam. This may not be the case at Keechelus Reservoir since significant debris drifts onto the dam.

The collection barge would be similar in function to a fish screen. The barge's main pumps would be located at its downstream end and would draw an attraction flow into the upstream end (front) of the barge and through a sloping screen. The project team would size the main pumps to draw 20 percent of the 10 percent exceedance flow released from the reservoir. The sloping screen would meet current screen criteria for juvenile fry-sized fish. The design would divert a portion of the attraction flow containing the fish over the screen into a flume. Smaller pumps would then draw the flow through a second screen, further reducing the flow containing the fish. The design would divert the fish into a collection hopper. A bypass pipe at the base of the hopper would convey the fish to a holding barge, equipped with a crowder and hopper. The holding barge would be located in the low-reservoir channel in front of the outlet works. A bridge to the barge would be required from the crest of the dam to a point near the outlet works. A jib crane at the end of this bridge would lift the fish hopper to a truck on the bridge. A truck would haul the fish from the bridge to a release point downstream from the dam. This system could be used for downstream passage of fish through the entire range of reservoir water surface

elevations. The estimated construction cost for this option was $11 million at the time of the Phase 1 Assessment.

2.2.2.5 New Outlet Works Option

The New Outlet Works option would be a stationary collection structure that provides an attraction flow to draw downstream migrants to the structure. A screen would separate fish from the attraction flow. The fish would then be transferred to a bypass flow that moves them into a collection chamber. From there, they are moved below the dam by one of two methods: either in a pipe extending through the outlet works conduit, or a trap-and-haul system with a trap and fish-transfer hopper that could be lifted out and hauled downstream from the dam by truck. The model of the concept was a fish passage facility designed by the U.S. Army Corps of Engineers for Howard Hanson Dam on the Green River in western Washington. This system could be used for downstream fish passage over the entire range of reservoir water surface elevations. The existing outlet works would remain in place and operational. No additional water release would be required. Normal operational releases would provide the attraction flow used in the new outlet works. The outlet works conduit at Keechelus Dam consists of an open-channel flow conduit with room at the top of the conduit for a fish bypass pipe. The estimated construction cost for this option was $25 million at the time of the Phase 1 Assessment.

2.2.3 Kachess Dam Upstream Fish Passage Options

For Kachess Dam, the concepts identified and preliminary costs developed in the Phase I Assessment for upstream fish passage included an adult passage collection facility for trap-and-haul and a Fish Ladder with Pumped Flow.

2.2.3.1 Adult Passage Collection Facility Option

Reclamation assumed the trap-and-haul concept would be the same as the one for Keechelus Dam. Reclamation estimated the construction cost for this option was about the same as for Keechelus Dam, $7 million at the time of the Phase 1 Assessment.

2.2.3.2 Fish Ladder with Pumped Flow Option

Reclamation also assumed the Fish Ladder with Pumped Flow option would be the same as the Keechelus Dam option. Reclamation assumed the estimated construction cost for this option was about the same as for Keechelus Dam, $8.5 million at the time of the Phase 1 Assessment.

2.2.4 Kachess Dam Downstream Fish Passage Options

For downstream passage at Kachess Dam, the concepts identified included spillway modifications, a new fish spillway, a fish collection barge, and new outlet works.

2.2.4.1 Modify Spillway Gate Option

The Modify Spillway Gate option included a simple modification to the existing spillway at Kachess Dam that would allow a surface spill release from the reservoir from El. 2254 and above. The spillway at the dam would contain a single 8-foot-high by 50-foot-wide radial gate. This option assumed replacing the radial gate with a “Rodney Hunt” crest gate that would discharge water over its top. Water would then flow down the existing spillway. A modification to the spillway invert by constructing a V-shaped channel would provide increased flow depth at

minimum flow. The estimated construction cost of this option was about $5 million at the time of the Phase 1 Assessment.

2.2.4.2 New Spillway Option

The New Spillway option would include construction of a new spillway in an abandoned spillway channel. It would allow a surface spill from El. 2240 and above. The abandoned spillway is approximately 3,000 feet to the left of the dam. The spillway crest is 250 feet long. This option would require excavation of a channel upstream from the spillway down to El. 2240. Excavation of the dike in the abandoned spillway would allow the placement of an Obermeyer weir gate (or any overshot gate). Flow would pass over the weir and into a plunge pool. Water would then flow down the abandoned spillway channel that Reclamation assumed has a lining of geomembrane fabric and riprap. Information on the abandoned channel was not available at the time; such data would be required to investigate this option further. The estimated construction cost of this option was about $10 million at the time of the Phase 1 Assessment.

2.2.4.3 Fish Collection Barge Option

Reclamation assumed that the Fish Collection Barge option would be the same as the one for Keechelus Dam. The estimated construction cost of this option was about the same as for Keechelus Dam, $11 million at the time of the Phase 1 Assessment.

2.2.4.4 New Outlet Works Option

Reclamation also assumed the New Outlet Works option would be similar to the one for Keechelus Dam. The estimated construction cost of this option was about the same as for Keechelus Dam, $25 million at the time of the Phase 1 Assessment.

2.3 Basis of Assumptions Review for Fish Passage Projects Cost Estimating

A technical memorandum titled *Basis of Assumptions Review for Fish Passage Projects Cost Estimating* (Reclamation, 2012) summarized a cursory review of proposed fish passage facilities at the Yakima Project storage dams, their estimated costs, and whether the basis of assumptions for the continued budgeting of the projects were still valid. HDR determined that construction of fish passage facilities would be more expensive at some dams, like Cle Elum, due to the differences among the dams relative to site conditions, the dam configurations, and reservoir operations. HDR compared the Cle Elum fish passage concept with site conditions of other dams. The Cle Elum downstream fish passage concept included the multi-level gated concrete intake structure with a helix bypass structure connected to a bypass conduit through the dam. The Cle Elum upstream fish passage concept included an adult passage collection facility at the base of the dam (without a fish barrier dam) for trap-and-haul. As adult trap-and-haul facilities are readily adaptable to most dam sites, the more critical fish passage consideration for comparison was for the downstream fish passage concepts.

2.3.1 Keechelus Dam Basis of Assumptions

As noted above, Reclamation considered that an adult passage collection facility for trap-and-haul, as planned for Cle Elum, would be applicable and generally transferable for Keechelus Dam except that a fish barrier dam is needed for this site given the distance (approximately 1

mile downstream) between the outlet works, spillway channel, and the preliminarily selected location of the trapping facility at the time. Reclamation expected costs would be similar to Cle Elum for planning and budgeting purposes, but also needed to consider a fish barrier dam as noted. Reclamation would consider locating the collection facility closer to the outlet works for advantage of adjacent facilities after further study of flow discharge conditions and locations during the adult migration period.

There were two reasonably feasible downstream fish passage options for this site assumed for the Basis of Assumptions Review: (1) new outlet works that include a floating collection inlet (a horn), and (2) a substantial modification of the spillway inlet with a multi-level gated concrete intake structure and a new channel in the reservoir leading to the spillway intake structure for operation at lower reservoir elevations. HDR also examined a floating collection barge but this is very similar in concept to the new outlet works for the purposes of comparison of cost basis assumptions. HDR found a reservoir inlet channel leading to a multi-level gated concrete intake structure with new bypass conduit through the dam as planned for Cle Elum is applicable and generally transferable for this site as is the modified spillway option described above. However, the expected reservoir elevation capture range for the modified spillway option (a multi-level gated concrete intake structure and reservoir inlet channel leading to the modified spillway inlet) is approximately 30 feet. The expected reservoir elevation capture range for the new outlet works option was estimated much higher at approximately 85 feet. This latter option is much more flexible for the ability to collect and pass juvenile fish for a large portion of, and potentially critical, downstream passage periods that could require a range of 70 feet or more. However, the amount of bypass flows discharged downstream through the system over the planned range of reservoir elevations limits the ability of the new outlet works collector intake to attract juvenile fish and HDR considered that it might not achieve desired fish passage efficiencies.

If Reclamation selects the downstream fish passage option of new outlet works as preferred (including a floating collection inlet with new bypass conduit through the dam), then the costs would not be similar to Cle Elum. In this case, the project team recommends appraisal level investigations to better plan and budget for this site.

2.3.2 Kachess Dam Basis of Assumptions

For Kachess Dam, HDR considered an adult passage collection facility for trap-and-haul, as planned for Cle Elum, applicable and generally transferable for this site, and expected costs to be similar to Cle Elum for planning and budgeting purposes.

There were two reasonably viable downstream fish passage options identified for this site, new outlet works and a substantial modification of the primary spillway. HDR considered a reservoir inlet channel leading to a multi-level gated concrete intake structure with new bypass conduit through the dam, as planned for Cle Elum, applicable and generally transferable for this site. However, the expected reservoir elevation capture range for new outlet works (a multi-level gated concrete intake structure) is only approximately 20 feet and even less for the modified spillway option, thereby limiting the ability to collect and pass juvenile fish for a large portion of, and potentially critical, downstream passage periods that could require a range of up to 60 feet or more. HDR considered another downstream fish passage facility concept to accommodate a larger range of reservoir elevations, a movable floating surface collector. A movable floating surface collector provides more flexibility to locate it in the reservoir to handle the expected reservoir elevation range compared to a fixed collector concept. Additionally, the

amount of bypass flows discharged downstream through the system over the planned range of reservoir elevations limits the ability of the fixed collector intake to attract juvenile fish and HDR considered that it might not achieve desired fish passage efficiencies.

The Basis of Assumptions Review technical memorandum identified that if Reclamation selected the preferred downstream fish passage option for this site as a multi-level gated concrete intake structure with new bypass conduit through the dam, as planned for Cle Elum, then the costs are expected to be similar to Cle Elum or even less since the bypass conduit through the dam might not be as long or require larger excavations. However, given the consideration for other potentially improved downstream fish passage options mentioned above, the costs were not likely to be similar to Cle Elum costs if other options become more preferred. The technical memorandum recommended appraisal level investigations to better plan and budget for this site.

The technical memorandum also mentioned that, for Kachess Dam fish passage, Reclamation could consider the effects of fish passage through Lake Easton just one mile downstream of Kachess Dam. Reclamation could consider management options for collection, sorting, and segregation of Kachess River fish from Yakima River fish and transport them around Lake Easton and Kachess Reservoir for improving overall fish passage efficiency.

3.0 Fish Passage Criteria and Considerations

The following sections provide recommendations for primary design considerations, criteria, and guidelines for the project and for fish passage facilities in the future. Reclamation may use many of these design considerations in the evaluation of different fish passage options. Reclamation must meet specific criteria relative to facility hydraulics to assure compliance with regulatory requirements; typically, designers apply these criteria during detailed design. Detailed design of fish passage facilities should use the best available guidelines and criteria, including but not limited to the National Marine Fisheries Service (NMFS) Northwest Region's (now Western Region) (NMFS, 2011) Anadromous Salmonid Passage Facility Design manual, taking into account site-specific conditions, biological information specific to the target species, and other relevant information.

This technical memorandum only considers these criteria generally for the basic identification and development of potential fish passage options. Fisheries criteria are typically guidelines providing a range of values or, in some instances, a specific value for design. Although Reclamation should adhere to these fisheries criteria, it can also adjust them in combination with other criteria for site-specific conditions. Site-specific biological and physical rationale for not meeting criteria exactly may be required and different values that should support better performance or solve site-specific issues may be necessary during the development of the design. The list of criteria provided below is not an all-inclusive list of criteria for design but Reclamation can use it to guide option identification and formulation.

Note that the terms "entrance" and "exit" used for notation of fish passage features are in reference to the direction that a fish is travelling. In the case of fish ladders, typically designed for adult upstream passage, the fish ladder entrance refers to the downstream end or hydraulic

outlet, and the fish ladder exit refers to the upstream end or hydraulic inlet. In the case of fish bypass features, typically designed for juvenile (and sometimes post-spawn adults) downstream passage, the bypass entrance refers to the upstream end or hydraulic inlet, and the bypass exit refers to the downstream end or hydraulic outlet. Terminology in the following subsections follows standard terminology for fish ladders (upstream passage) and fish bypasses (downstream passage), depending upon which type of passage facility is being addressed.

3.1 Selected Fish Species for Fish Passage

It is important to identify the fish species targeted for fish passage as this sets the selection of design criteria and considerations applied to fish passage concepts. Table 1 lists the fish species selected to establish fish passage requirements and design criteria for the projects.

Table 1. Species and Life-Stages Selected for Fish Passage Requirements and Design

SPECIES	UPSTREAM	DOWNSTREAM
Chinook Salmon (spring run)	Adult	Juvenile (smolts)
Coho Salmon	Adult	Juvenile (smolts)
Steelhead	Adult	Adult (kelts) Juvenile (smolts)
Pacific Lamprey	*Adult	*Ammocoetes *Macropthalmia
Western Brook Lamprey	*Adult	*Ammocoetes *Macropthalmia
Bull Trout	Adult	Adult (kelts) Juvenile
Sockeye Salmon	Adult	Juvenile

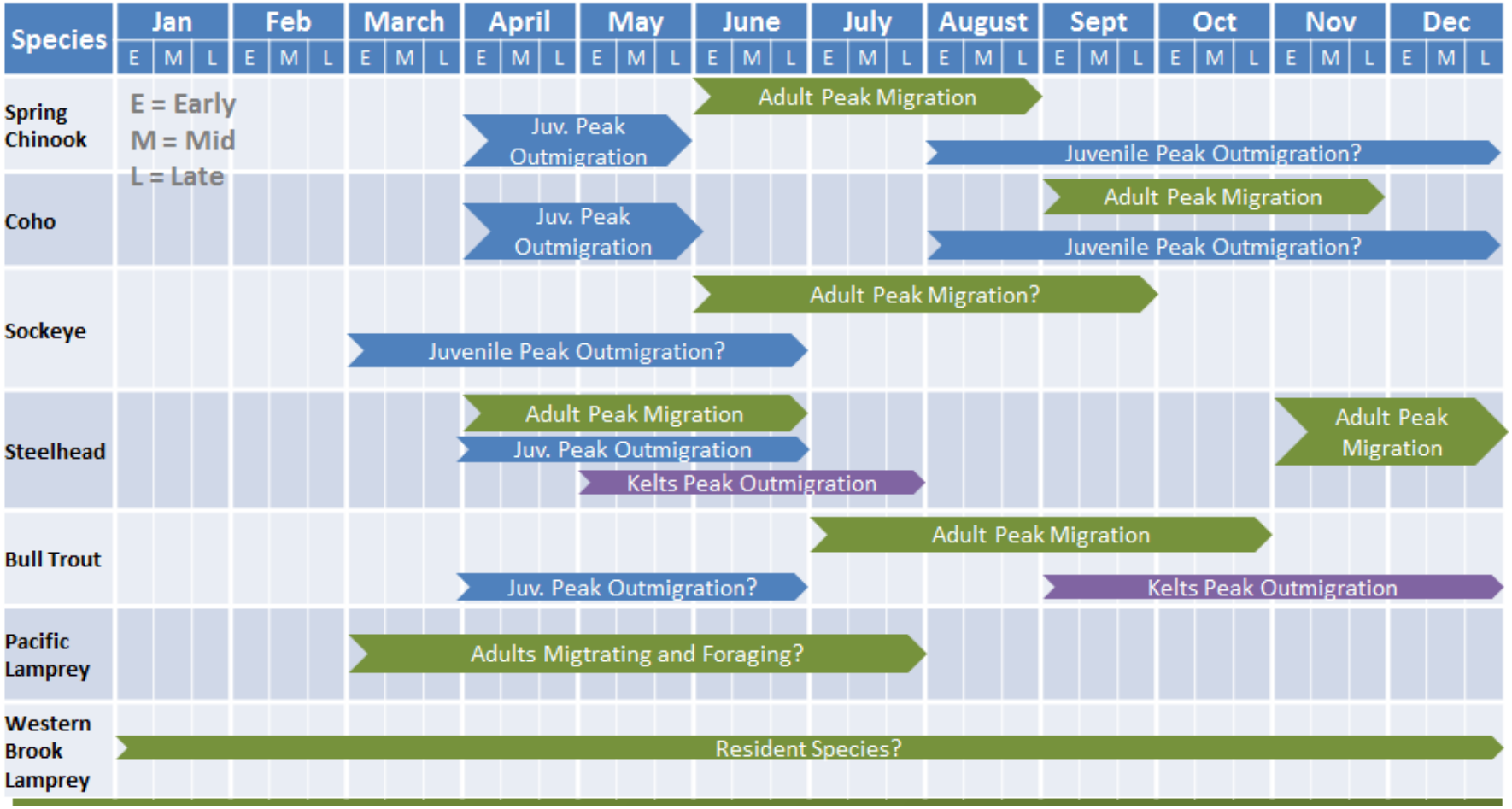
Source: Reclamation Technical Committee Meeting Notes, 2005 and July 16, 2014

Species in Bold are considered no longer present.

*Indicates those more constraining life stages and species that would require special consideration during alternative development and design

Migration periods of the different fish species and their life stages are also important in the selection and application of design criteria for fish passage and considerations of different fish passage options. Table 2 lists the anticipated periods of migration for each selected fish species.

Table 2. Anticipated Migration Periods of Targeted Species and Life Stages



Data compiled from Reclamation Technical Committee Meeting Notes, 2005 and July 16, 2014.

In identifying target fish species and life stages, the State of Washington encourages consideration of its regulatory authority (RCW 77.57.030, Fishways required in dams, obstructions – penalties, remedies for failure) and relevant guidance (WDFW, 2000b). These policies guide study requests and design recommendations at the later phases in project development, so clarity at an early stage of concept identification is important. Practitioners using the State's fish passage policies generally construe them to require provision for passage of all fish in the system. This would include designing for upstream juvenile passage, with acknowledgement that robust design criteria for such passage at barriers of a scale are less available. For species of fish in any system, where data and understanding of life history, behavior, and ecologic importance in the area of a proposed barrier is lacking, it may not be reasonable to design passage specifically for those fish.

The approach for identifying potential fish passage design options for this project, and the associated considerations and criteria, assume a traditional species and life stages approach. The design for traditional fish species and life stages include adult salmonids moving upstream and juvenile salmonids moving downstream. This has been the traditional approach used elsewhere in the Pacific Northwest and for which there is an abundance of precedence and information. However, where possible, the project team would include design considerations and criteria for various fish passage options for other, more constraining species and life stages for upstream and downstream fish passage. This includes other species of concern like lamprey, where some establishment of criteria and design features for passage have more recently been developed or are emerging.

3.2 Fish Passage Effectiveness Considerations and Criteria

A primary consideration for identification and design of fish passage options is the anticipated effectiveness of an option. Potential options for fish passage at the dams are typically evaluated using anticipated effectiveness evaluations and other factors listed below. Concurrence with regard to effectiveness and these other factors is important early in the planning process to facilitate efficient and effective identification of concepts while meeting the objectives of the permitting agencies and other project stakeholders. Fish passage effectiveness can include the following considerations and criteria:

- Attraction of target fish to a fish passage facility under a range of probable flows and reservoir conditions
- Certainty of fish collection and passage through a fish passage facility
- Fish ability to safely exit a fish passage facility or be safely transported
- Passage of fish through an impoundment or reservoir in consideration of potential predation, water quality impairments, and availability of habitat
- Potential for migration delay
- Attraction and passage of non-target species and life stages

Reclamation should consider the following other factors during a concept identification, development, and evaluation process and in the design process for selected options:

- Selection of targeted fish species and life stages for design
- Ability to meet fish passage design criteria
- Site constraints
- Construction complexity and methods (constructability)

- Anticipated construction cost
- Operations and maintenance requirements
- Relationship to dam operations and facilities
- Durability and adaptability
- Ability to acquire permits
- Potential for ancillary impacts
- Potential for fish passage evaluation or biological monitoring

3.3 Operational Considerations and Criteria

As mentioned above, an important consideration for fish passage effectiveness and a factor for identification and design of fish passage options include the ability to attract and collect fish at a fish passage facility under a range of probable flows and reservoir conditions and during the appropriate anticipated migration period. This section outlines the site-specific operational considerations and criteria for the range of probable flows and reservoir conditions. Understanding the occurrence and magnitude of streamflows and associated reservoir conditions is a key component in providing for the successful migration of fish. A design objective is to provide suitable hydraulic conditions over a range of reasonable streamflows and associated reservoir conditions that the selected fish species and life stages are expected to migrate, either upstream or downstream. The project team examined hydrology data, and performed preliminary analyses to help define the anticipated range of target fish passage flow rates and associated reservoir conditions. The team anticipated that the criteria to be used would be the range of at least 90 percent exceedance elevations for the reservoir and a range of 5 percent to 95 percent annual exceedance flows for upstream migration hydrology (per NMFS, 2011).

Using RiverWare® hydrologic modeling of the rainfall and runoff in the drainage basins, operation of the Yakima River basin irrigation systems, and evaluation of environmental benefits (Reclamation and Ecology, 2014a), the team evaluated certain scenarios and examined statistics used in specifying fish passage operations and applicable design criteria of fish passage facilities. The exceedance flows or reservoir elevations statistically represent the mean daily flow or reservoir stage equaled or exceeded certain percentages of the time. The following sections describe site-specific results for each dam site establishing or informing the fish passage criteria. The list below is the key to the different scenarios.

- IP0 – a baseline scenario that includes water conservation projects also included in other scenarios
- IP1A – KKC implemented and operating alone
- IP2A – KDRPP implemented and operating alone
- IP2 – Both KKC and KDRPP implemented and operating

3.3.1 Keechelus Dam and Reservoir Hydrology

Table 3 lists the exceedance values for Keechelus Dam outflow that may be used in sizing upstream fish passage facility components.

Table 3. Keechelus Dam Mean Daily Outflow Exceedance (Water Years 1925 – 2009)

PERCENT EXCEEDED	KEECHELUS OUTFLOW (CFS) IP0	KEECHELUS OUTFLOW (CFS) IP1A	KEECHELUS OUTFLOW (CFS) IP2A	KEECHELUS OUTFLOW (CFS) IP2
0	3,490	3,010	3,630	2,990
1	990	510	910	560
5	860	480	780	500
10	770	410	700	430
25	450	245	470	240
50	102	100	120	100
75	100	100	100	100
80	100	88	100	100
90	80	80	80	80
95	80	80	80	80
99	57	80	66	66

Table 4 lists the exceedance values for Keechelus Reservoir that may be used in locating and determining the necessary reservoir elevation range for downstream fish passage facility options. Note that the normal full pool elevation is 2,517 feet and the low "inactive" (reservoir storage at an elevation below the existing outlet) pool elevation is 2,425 feet. The spillway crest elevation is 2,522 feet. These statistics are based on data from water years (October through September) 1925 through 2009.

Table 4. Keechelus Reservoir Stage Exceedance (Water Years 1925 – 2009)

PERCENT EXCEEDED	KEECHELUS RESERVOIR ELEVATION (FEET) IP0	KEECHELUS RESERVOIR ELEVATION (FEET) IP1A	KEECHELUS RESERVOIR ELEVATION (FEET) IP2A	KEECHELUS RESERVOIR ELEVATION (FEET) IP2
0	2,517.0	2,517.6	2,517.0	2,517.6
1	2,517.0	2,517.0	2,517.0	2,517.0
5	2,516.3	2,516.2	2,516.6	2,516.0
10	2,512.4	2,511.4	2,514.3	2,510.3
25	2,502.3	2,500.8	2,504.5	2,498.9
50	2,490.5	2,484.6	2,497.1	2,483.0
75	2,472.2	2,478.9	2,480.9	2,475.6
80	2,467.6	2,475.5	2,476.4	2,471.1
90	2,453.0	2,464.3	2,459.3	2,455.7
95	2,438.4	2,452.9	2,442.0	2,442.0
99	2,431.5	2,441.7	2,431.8	2,431.5

As mentioned above it can be important for the identification and design of fish passage options to include the ability to attract and collect fish at a fish passage facility under a range of probable flows and reservoir conditions and during the appropriate anticipated migration period. In subsequent communications with the Core Team it was determined that the most important common period of the year for downstream outmigration of juvenile fish is April and May (see Table 2). Therefore the hydrologic modeling output data for the scenarios (IP0, IP1A, IP2A, and IP2) were isolated to April and May to develop the reservoir elevation exceedance statistics. Table 5 provides the reservoir stage equaled or exceeded certain percentages of the time for the April and May period at Keechelus Dam.

Table 5. Keechelus Reservoir Stage Exceedance for April and May Only (Water Years 1925 – 2009)

PERCENT EXCEEDED	KEECHELUS RESERVOIR ELEVATION (FEET) IP0	KEECHELUS RESERVOIR ELEVATION (FEET) IP1A	KEECHELUS RESERVOIR ELEVATION (FEET) IP2A	KEECHELUS RESERVOIR ELEVATION (FEET) IP2
0	2,517.0	2,516.9	2,517.0	2,516.9
1	2,516.9	2,516.8	2,516.9	2,516.8
5	2,516.2	2,515.4	2,516.5	2,514.8
10	2,514.4	2,512.3	2,515.3	2,511.6
25	2,508.0	2,505.1	2,510.1	2,503.9
50	2,502.8	2,498.7	2,503.5	2,496.4
75	2,492.5	2,485.9	2,493.8	2,483.7
80	2,489.2	2,483.9	2,491.6	2,482.3
90	2,481.0	2,481.6	2,481.2	2,479.6
95	2,475.2	2,479.1	2,474.2	2,474.4
99	2,464.0	2,472.6	2,461.0	2,460.5

When comparing the 90% exceedance statistic between Tables 4 and 5 all scenarios substantially increase in pool elevations when using only the April and May data. For example, for the IP0 scenario the 90% exceedance statistic increased from elevation 2,453 feet considering all year data to elevation 2,481 feet when considering just the April and May period data. This is an increase of 28 feet, which is expected since early spring is a wetter period of the year. This difference can be considered significant for certain downstream fish passage concept options. This information will be used later in the document for describing the fish passage concepts being considered and their operability relative to these reservoir exceedances.

3.3.2 Kachess Dam and Reservoir Hydrology

Table 6 lists the exceedance values for Kachess Dam outflow that may be used in sizing upstream fish passage facility components.

Table 6. Kachess Dam Mean Daily Outflow Exceedance (Water Years 1925 – 2009)

PERCENT EXCEEDED	KACHESS OUTFLOW (CFS) IP0	KACHESS OUTFLOW (CFS) IP1A	KACHESS OUTFLOW (CFS) IP2A	KACHESS OUTFLOW (CFS) IP2
0	3,590	4,000	2,040	4,000
1	1,150	1,220	1,150	1,220
5	920	1,150	1,000	1,150
10	680	1,080	810	1,060
25	410	660	450	650
50	36	90	21	80
75	15	15	15	15
80	15	15	15	15
90	15	15	15	15
95	15	15	15	15
99	15	15	0	0

Table 7 lists the exceedance values for Kachess Reservoir that may be used in locating and determining the necessary reservoir elevation range for downstream fish passage facility options. Note that the normal full pool elevation is 2,262 feet and the low inactive pool elevation is approximately 2,200 feet (without the KDRPP project). These statistics are based on data from water years 1925 through 2009.

Table 7. Kachess Reservoir Stage Exceedance (Water Years 1925 – 2009)

PERCENT EXCEEDED	KACHESS RESERVOIR ELEVATION (FEET) IP0	KACHESS RESERVOIR ELEVATION (FEET) IP1A	KACHESS RESERVOIR ELEVATION (FEET) IP2A	KACHESS RESERVOIR ELEVATION (FEET) IP2
0	2,262.0	2,262.0	2,262.0	2,262.0
1	2,262.0	2,262.0	2,262.0	2,262.0
5	2,261.7	2,261.6	2,259.4	2,261.5
10	2,259.6	2,259.5	2,254.2	2,259.1
25	2,253.9	2,254.2	2,243.7	2,253.9
50	2,243.2	2,245.5	2,226.5	2,241.5
75	2,231.0	2,227.5	2,198.4	2,217.7
80	2,228.5	2,223.9	2,185.0	2,208.3
90	2,218.2	2,212.9	2,155.2	2,171.2
95	2,209.5	2,204.1	2,136.1	2,145.3
99	2,199.9	2,196.6	2,113.2	2,116.4

As was done with Keechelus Reservoir the hydrologic modeling output data for the scenarios (IP0, IP1A, IP2A, and IP2) were isolated to just April and May to develop the reservoir elevations exceedance statistics. Table 8 provides the reservoir stage equaled or exceeded certain percentages of the time for the April and May period at Kachess Dam.

Table 8. Kachess Reservoir Stage Exceedance for April and May Only (Water Years 1925 – 2009)

PERCENT EXCEEDED	KACHESS RESERVOIR ELEVATION (FEET) IP0	KACHESS RESERVOIR ELEVATION (FEET) IP1A	KACHESS RESERVOIR ELEVATION (FEET) IP2A	KACHESS RESERVOIR ELEVATION (FEET) IP2
0	2,262.0	2,262.0	2,262.0	2,262.0
1	2,261.9	2,261.9	2,261.8	2,261.9
5	2,261.3	2,261.6	2,259.6	2,261.5
10	2,259.8	2,260.4	2,255.5	2,260.2
25	2,255.5	2,256.5	2,249.4	2,256.0
50	2,251.0	2,252.9	2,239.2	2,251.5
75	2,242.8	2,246.1	2,215.1	2,238.6
80	2,239.9	2,243.0	2,204.4	2,230.5
90	2,231.9	2,232.1	2,172.7	2,187.1
95	2,227.5	2,225.7	2,154.3	2,165.7
99	2,220.1	2,216.2	2,140.0	2,141.8

When comparing the 90% exceedance statistic between Tables 7 and 8 all scenarios substantially increase in exceedance elevations when using only the April and May data. For example, for the IP0 scenario the 90% exceedance statistic increased from elevation 2,218 feet considering all year data to elevation 2,232 feet when considering just the April and May period data. This is an increase of 14 feet. This difference may be considered significant for certain downstream fish passage concept options and controlling features of Kachess Reservoir. This information will be used later in the document for describing the fish passage concepts being considered and their operability relative to these reservoir exceedances.

3.4 Upstream Fish Passage Facility Design Criteria

For upstream fish passage past Keechelus and Kachess Dams, Reclamation has determined that both locations would use a trap-and-haul system. The primary considerations for designing and configuring a trap-and-haul system include trapping, holding, sorting, and handling of fish. The following design criteria apply:

- Holding Pool Volume – Size fish holding pools to provide a minimum volume of 0.25 cubic feet per pound of fish. For holding durations greater than 72 hours, increase holding pool volumes by a factor of three. Determine the required trap capacity by the maximum daily fish return, or number of fish expected to be trapped before fish are removed (NMFS, 2011).

- Temperature – Maintain water temperatures less than 50° F. If temperatures exceed this threshold, reduce the poundage of fish held 5 percent for each degree above 50° F (NMFS, 2011).
- Dissolved Oxygen – Maintain dissolved oxygen between 6 and 7 parts per million (NMFS, 2011).
- Water Supply – Supply a minimum of 0.67 gallons per minute per adult fish to the holding pool (NMFS, 2011).
- Handling – Handle fish with extreme care, and minimize or eliminate use of nets. Anesthetize fish before handling and only use individuals trained to handle fish safely (NMFS, 2011).
- Frequency of Removal – Do not retain fish in traps for more than a day. Clear traps more often, if necessary to prevent crowding or adverse water quality (NMFS, 2011).
- Adult Jumping Provisions –Jumping may injure fish. Include provisions such as the following in the holding pool design to minimize adult jumping: freeboard of 5 feet or more; covering of the holding pool to create a darkened environment; use of netting over the pool; or sprinklers above the holding pool (NMFS, 2011).
- Segregation of Fish – Establish specific criteria for segregating different species and life stages of fish on a site-specific basis. Include picket panels, screens, and other materials to limit certain sizes of fish holding in pools.

Additionally, a trap-and-haul facility typically includes fishway and auxiliary water system components that guide fish from a tailwater condition at a dam up to the actual trap-and-haul facility. Fish ladder designs at dams, traditionally for the adult fish life stage, use widely recognized fishway design guidelines and references. There are two major components to a fishway leading to a trap-and-haul facility: the fishway entrance and fish ladder. The fishway exit, in this case for a trap-and-haul facility, is simply the end of the fish ladder where it transitions into a holding pool or channel for crowding and trapping fish. A fyke trap, finger weir, or false weir closes the holding pool to prevent fish falling back down into the ladder. The fishway entrance's primary objective is to maximize fish attraction. The fish ladder's primary objective is to provide hydraulic conditions that promote fish passage up to the trap-and-haul facility.

Designers most often base fish passage design flow criteria on exceedance calculations of daily mean flows. The exceedance flows statistically represent the flow equaled or exceeded certain percentages of the time. NMFS (2011) requires the high fish passage design flow to be the mean daily average streamflow that is exceeded 5 percent of the time during periods when migrating fish are typically present, while WDFW (2000a) suggests 10 percent exceedance flow. NMFS (2011) requires a low fish passage design flow equal to the mean daily average streamflow that is exceeded 95 percent of the time during periods when migrating fish are typically present.

The design criteria for the fishway entrance component, which includes an auxiliary water supply system for good fish attraction to the entrance is presented below:

- Entrance Location – Base the entrance location on site-specific operations and streamflow characteristics. Place entrances in locations where fish can easily locate the

attraction flow. Multiple entrances may be required if the site has multiple locations where fish hold (NMFS, 2011 and WDFW, 2000a).

- Entrance Geometry – Size the entrance with a minimum width of 4 feet and depth of 6 feet (NMFS, 2011).
- Entrance Head Differential – Maintain the head differential at the entrance between 1.0 and 1.5 feet (NMFS, 2011 and WDFW, 2000a).
- Attraction Flow – Maintain a minimum of 5 percent to 10 percent of the high fish passage design flow, which is the 5 percent exceedance flow during the period of migration (NMFS, 2011). WDFW has no specific fishway attraction flow criteria but states that flow must be adequate to compete with spillway or powerhouse flows for attraction of fish. Use auxiliary water systems, if necessary to increase the fishway entrance attraction flow.

The following lists design criteria for the fish ladder component:

- Head Differential – Use a maximum of 1-foot hydraulic drop between each pool within the fish ladder (NMFS, 2011 and WDFW, 2000a).
- Minimum Pool Dimensions – Use a minimum of 8 feet long, 6 feet wide, and 5 feet deep (NMFS, 2011).
- Energy Dissipation Factor – Size each pool volume to have a maximum energy dissipation factor of 4 ft-lb/sec/ft^3. Only the volume of the pool having active flow and contributing to energy dissipation should be included in the energy dissipation calculation (NMFS, 2011 and WDFW, 2000a).
- Minimum Depth Over Weirs – Use a 1-foot minimum flow depth over weirs in fishways (NMFS, 2011 and WDFW, 2000a).
- Turning pools – Turning pools are required at each location where the fishway bends more than 90 degrees. Turning pools should be at least double the length of the designed standard pool measured along the centerline (NMFS, 2011). The design of bends should eliminate upwelling in the corners (WDFW, 2000a).
- Orifice Dimensions – Use a minimum of 15 inches high and 12 inches wide (NMFS, 2011). WDFW criteria recommend a minimum size of 18 inches high and 15 inches wide (WDFW, 2000a).
- Freeboard –Use a minimum of 3 feet within the fish ladder at the high design flow (NMFS, 2011 and WDFW, 2000a).
- Lighting – The use of ambient lighting throughout the entire fishway is preferred. Neither NMFS nor WDFW allows abrupt lighting changes within the fishway (NMFS, 2011 and WDFW, 2000a).

Fish ladders designed for salmonids can be impediments to lamprey passage. Older fish ladders typically have inadequate surfaces for attachment, velocities that are too high and inadequate resting locations for lamprey passage. Lamprey require conditions with generally lower velocities than salmonids, rounded corners, resting areas, natural stream channels, or wetted ramps, or a combination of these features. Anecdotal information indicates that reduced velocities in a fishway during nighttime hours may improve lamprey passage since lamprey typically pass through dams at night. This may not significantly reduce the effectiveness of salmonid passage as salmonids pass fishways primarily during daylight hours. Specific

information is not available on how the operation of collection, handling, and transport facilities affect lamprey. Reclamation would need to obtain information from similar types of fish passage projects and consider it for this type of facility relative to lamprey.

3.5 Downstream Fish Passage Facility Design Criteria

For downstream fish passage, the most applicable design criteria include that of guidance devices, fish screens, and bypasses. Fish screens and bypasses are designed using the WDFW's Draft Fish Protection Screen Guidelines for Washington State (WDFW 2000b), and the NMFS Northwest Region's Anadromous Salmonid Passage Facility Design (NMFS, 2011). The intent of the fish screening criteria is to provide design guidelines and criteria that protect juvenile fish from entrainment or impingement and to guide them to a bypass system. For some downstream fish passage options, such as collectors, designers may use screens as a component or feature for guiding fish to a bypass or a collection system. In this case, the applicable design criteria could include the following:

- Structure Orientation – In a river, the screen must be oriented parallel to river flow. Upstream and downstream transitions must minimize eddies. In a reservoir, the design of the screening and bypass system must withdraw water from the appropriate elevation for best fish attraction and provide appropriate water temperature control downstream. The design must accommodate the entire range of forebay fluctuations (NMFS, 2011 and WDFW, 2000b).
- Screen Size – The minimum screen area required is determined by dividing the maximum-screened flow by the allowable approach velocity (NMFS, 2011).
- Approach Velocity – The design must provide uniform approach velocity across the face of the screen. Approach velocity for the listed target species must be less than 0.4 feet per second (ft/sec) for actively cleaned systems and provide measures to adjust flow patterns across the face of the screen to assure maintaining uniformity (NMFS, 2011 and WDFW, 2000b). For passively cleaned screens, approach velocity must not exceed 0.2 ft/sec (NMFS, 2011).
- Sweeping Velocity – The sweeping velocity should be greater than the approach velocity. Sweeping velocity must be maintained or gradually increase for the entire length of screen (NMFS, 2011 and WDFW, 2000b).
- Travel Time – The fishery agencies state the maximum time fish can be exposed to a screen face is 60 seconds, assuming fish are moving at rate equal to the sweeping velocity (NMFS, 2011 and WDFW, 2000b).
- Screen Openings – For salmonid fry, screen-opening size must not exceed 1.75 millimeters (0.069 inch), with a minimum open area of 27 percent. Wire mesh or perforated plate screens must not exceed 3/32 inches, with a minimum open area of 27 percent (NMFS, 2011 and WDFW, 2000b).
- Screen Materials – NMFS recommends screens constructed of rigid, corrosion-resistant material with no sharp edges or projections (e.g., stainless steel, plastic) (NMFS, 2011).
- Screen Cleaning – Cleaning systems should provide complete debris removal at least every 5 minutes and operate as required to prevent debris accumulation. The cleaning

system should use automatically triggered screen cleaning if the head differential across the screen exceeds 0.1 feet or as agreed to by NMFS (NMFS, 2011).

- Redundancy – Although not required by fishery agencies, it is common design practice to oversize the screen area for maximum diversion by a factor of 1.2 to 1.3.

The design of bypass systems facilitate both juvenile and adult fish downstream passage back to the river system, typically around a diversion or fish screen system, in a manner that minimizes risk of injury and delay. Fish bypass systems typically contain three major components: the bypass entrance, conduit, and exit.

Fish bypass entrance criteria include the following:

- Flow Control – Provide independent flow control at each bypass entrance (NMFS, 2011).
- Travel Time – Fish are to enter a bypass within 60 seconds of exposure to any length of screen (NMFS, 2011 and WDFW, 2000b).
- Velocity – Bypass entrance velocity must be greater than 110 percent of the maximum screen-sweeping velocity. Velocity should not decrease between the screen terminus and bypass entrance and should accelerate gradually (NMFS 2011 and WDFW, 2000b).
- Acceleration – The flow should not decelerate and should not exceed an acceleration rate of 0.2 ft/sec per foot of travel (NMFS, 2011).
- Lighting – Ambient lighting is required at the entrance to the bypass flow control (NMFS, 2011).
- Dimensions – Bypass entrance should be a minimum of 18 inches wide, and its height must extend from floor of the screen to the water surface (NMFS, 2011 and WDFW, 2000b). For weirs used in bypass systems that have diversions greater than 25 cfs, maintain a minimum weir depth of 1 foot throughout the smolt out-migration period (NMFS, 2011).
- Juvenile Capture Velocity – A minimum velocity of 8 ft/sec is a common design threshold used in situations that require the capture of juvenile salmonids. Reclamation would consider experience with current projects if a bypass system becomes part of the facility design.

Criteria for fish bypass conduits include the following:

- Materials and fittings – The design should include smooth pipes, joints, and other interior surfaces to minimize turbulence and the potential for fish injury. Closure valves should not be used within the bypass pipe (NMFS, 2011 and WDFW, 2000b).
- Flow Transitions – No pumping is allowed if fish are within the bypass system. If site conditions permit, bypass flows should be open channel (NMFS, 2011 and WDFW, 2000b). Where site conditions do not permit open channel bypass flows, a bypass pipe may be used. WDFW criteria states that bypass pipes should not be pressurized, while NMFS criteria state that pressures within bypass pipes must be equal to or above atmospheric pressure. NMFS criteria also state that transitions from pressurized to non-pressurized (or vice-versa) should be avoided within the pipe. The criteria do not allow free fall of fish in a pipe or enclosed conduit within the bypass system (NMFS, 2011).

- Bypass Flow – Bypass flow should be at least 5 percent of the total screened flow (NMFS, 2011). Reclamation would consider higher bypass flow if a bypass is included in the design.
- Velocity – NMFS criteria state the bypass pipe should be designed to have velocities between 6 and 12 ft/sec; however, higher velocities can be approved with special attention to pipe and joint smoothness (NMFS, 2011). WDFW limits maximum bypass pipe velocity to 30 ft/sec (WDFW, 2000b).
- Geometry – NMFS only requires that the design of open channel or pipe diameter size include bypass flow and slope to meet other bypass conduit criteria. WDFW states the bypass diameter should be a minimum of 2 feet (WDFW, 2000b).
- Bends – The ratio of bypass centerline to pipe diameter must be 5 or greater, and larger ratios may be required for super-critical velocities (NMFS, 2011 and WDFW, 2000b).
- Depth – NMFS criteria requires a minimum depth of at least 40 percent of the bypass pipe diameter, unless otherwise approved (NMFS, 2011). WDFW requires a depth of 9 inches or greater (WDFW, 2000b).
- Hydraulic Jump – Hydraulic jumps should not occur within the pipe (NMFS, 2011 and WDFW 2000b).

Fish bypass exit criteria include the following:

- Velocity – The outfall impact velocity, the velocity of the bypass flow entering the river, should not exceed 25 ft/sec (NMFS, 2011 and WDFW, 2000b).
- Location – The outfall should be located in an area with strong downstream currents, at least 4 ft/sec, free of eddies, reverse flow, or likely predator habitat. The outfall should also be located in an area with sufficient depth to avoid fish injuries (NMFS, 2011 and WDFW, 2000b).
- Adult Attraction – Design of the bypass outfall must avoid the attraction of upstream migrants. Upstream migrants might leap at the outfall; therefore, provisions for minimizing risk to injury or stranding on the bank must be included in the outfall design (NMFS, 2011, and WDFW, 2000b). These criteria are only applicable where upstream and downstream passage facilities are separate.

3.6 Other General Criteria and Considerations

The common use of debris racks is to exclude large debris from entering fish passage facilities. Debris rack openings should be a minimum of 8 inches clear, or 12 inches clear if adult Chinook are present. NMFS criteria state that approach velocity should be less than 1.5 ft/sec, while WDFW criteria states the maximum should be 2.0 ft/sec. Debris racks should be sloped at 1:5 or flatter to assist with manual cleaning. In systems with coarse floating debris, the fishery agencies require debris booms or other provisions incorporated into the debris rack design (NMFS, 2011 and WDFW, 2000a).

Reclamation should consider the following items for operations and maintenance of fish passage facilities:

- Debris management:
    - Fish ladders and fish protection screens are vulnerable to debris. Debris can impair operations and hydraulic performance if allowed to accumulate, thus compromising passage effectiveness. Screens for facility or auxiliary water should be used to exclude debris.
- Durability of structure:
    - There is risk of damage to fish passage facilities due to high flows, debris, and sediment, or changes in the channel alignment. The project design life and replacement cost of the fish passage facility should be considered.
- Effect on project operations:
    - Various options may have differing impacts on a project's ability to meet its water supply and other objectives. Reclamation should consider dam operation requirements for each type of passage facility.
- General operation of constructed facilities.
- General maintenance requirements.
- Operations and maintenance costs.

Some other general considerations include the following:

- Constructability, including site constraints, access, power requirements, periods and duration of construction, dewatering requirements, interruption of project operations, materials availability, specialty construction, and permitting constraints or conditions.
- Public safety.
- Aesthetics and education.
- Permitting.
- Research and monitoring.
- Presence of other natural or human influenced or constructed features that cause fish passage impediments during flow events within the range of anticipated migration periods.
- Hatchery supplementation program — Hatcheries are commonly used in lieu of passage or in tandem for large fish passage projects.

4.0 Current Fish Passage Options under Consideration

This section describes the current fish passage options for each dam under consideration for future implementation. The organization is by dam first and by direction of fish migration, upstream and then downstream passage. Figure 4 and Figure 5 provide overviews of the

different options that are further described for each dam. Appendix B provides the concept drawings and schematic figures for the different options.

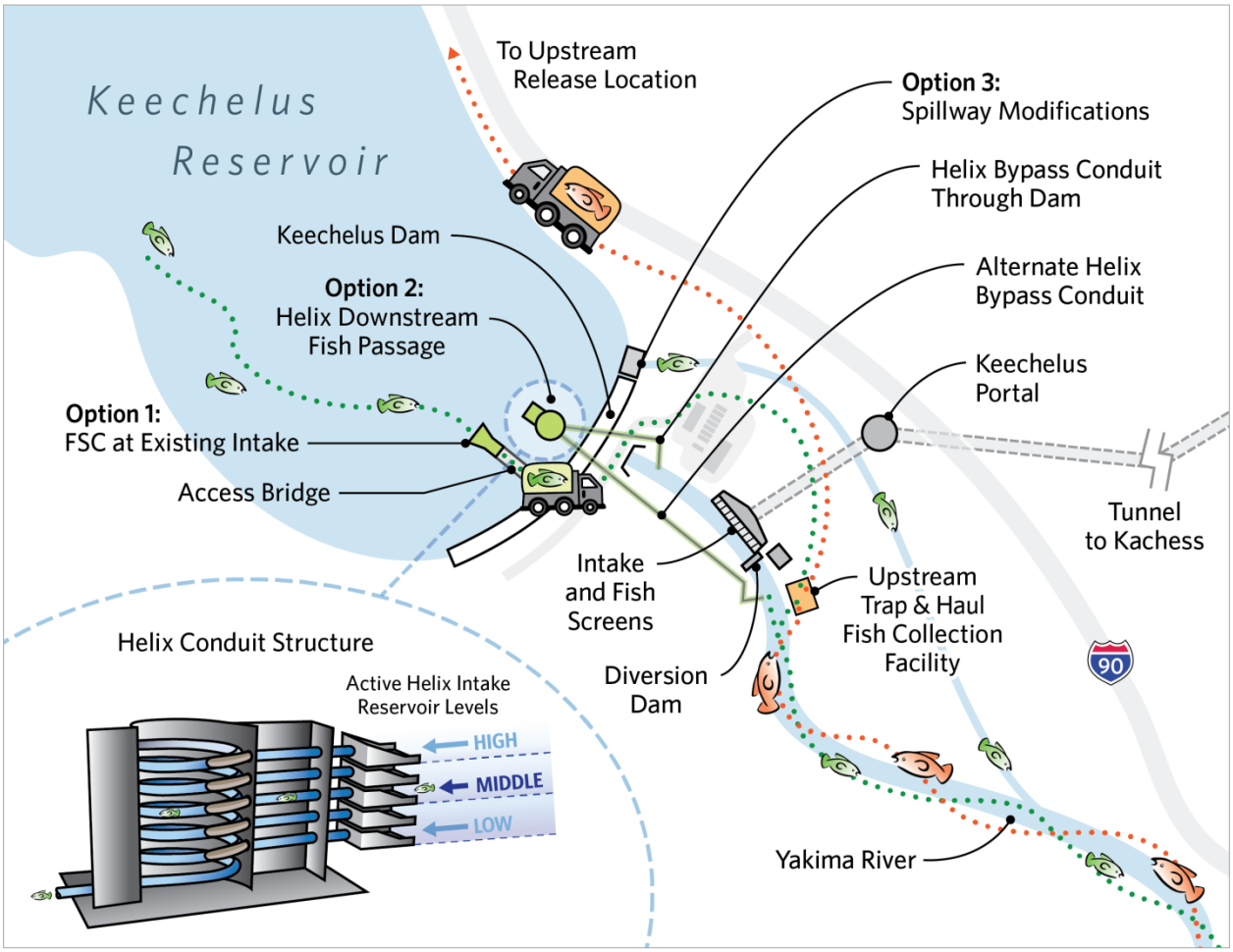


Figure 4. Current Keechelus Fish Passage Options

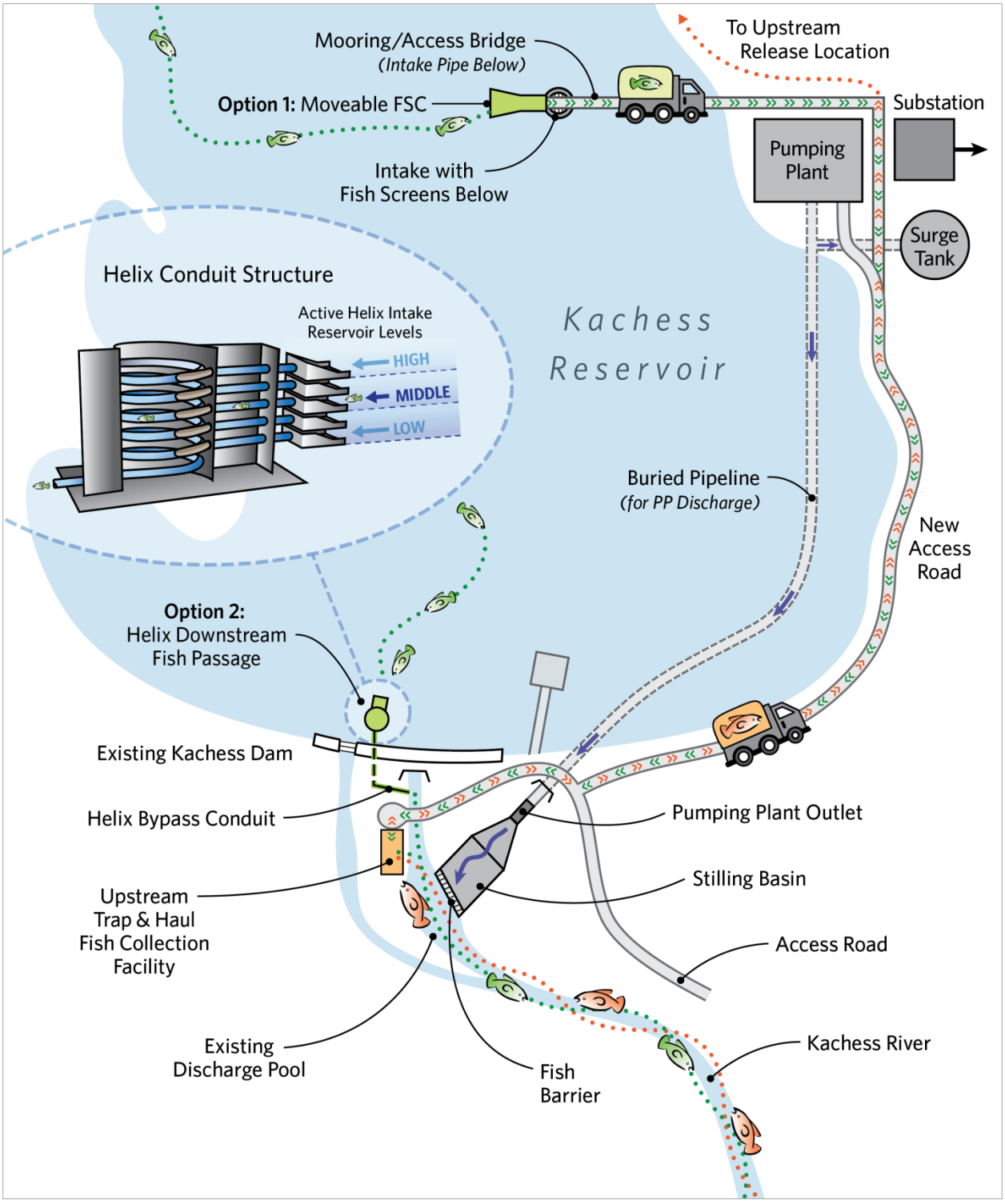


Figure 5. Current Kachess Fish Passage Options

4.1 Current Keechelus Dam Upstream Fish Passage Option

The current concept identified for Keechelus Dam upstream fish passage includes an adult passage collection facility for trap-and-haul as depicted in the associated drawings in Appendix B. The design would integrate the trap-and-haul facilities with the KKC river intake downstream of the dam. The facility includes a small water level control dam that can serve as a barrier to fish and guide them to a fish ladder entrance. The fish ladder would allow fish to ascend to holding and collection pools for sorting and trapping for transfer. The haul route for the fish transportation trucks would utilize existing and newly created access roads at the dam and the construction of a ramp from near the dam crest down to the reservoir. Reclamation could extend or improve an existing ramp at the north end of the dam to access the spillway floating debris boom and to clear debris from that area for the fish transport release location. A haul route for transferring fish above the reservoir may also be determined in the future.

One of the previous locations considered for a trap-and-haul facility was in the river downstream from the point where the spillway channel enters the river. Reclamation considered this option to prevent upstream migrants from swimming up the spillway channel and missing the fish trap facility. However, this location would eliminate a reach of river, about one mile long, between the barrier and the dam. Additionally, this location would be difficult to access through forested habitat on U.S. Forest Service land. Furthermore, the reservoir elevation on an average daily basis is always at least 4 feet below the spillway crest (El. 2522) in all hydrological operational scenarios presented (Table 4) so the spillway channel would not flow except during flooding conditions. To help with a final decision for location of facilities, it is important to determine the forecast frequency, duration, and timing of Keechelus Dam spill events, especially if the KKC transfer tunnel is in place.

The anticipated operation of the facility would occur during adult fish migration periods determined with the fishery agencies for run management of the different fish species. Table 2 provides a preliminary estimate of operational periods. Peak adult migration periods begin in April for steelhead, and continue through the summer and fall for sockeye, Chinook, and coho. Operation of the facility for winter steelhead may be necessary during the months of November and December. Adult migration for bull trout occurs in the summer and early fall overlapping with the seasons for salmonids. Adult migration for lamprey may occur in the spring and summer with partial overlap of the seasons for salmonids.

The primary design flow consideration includes providing a base flow for operation of the fish ladder, trap, and holding and sorting pools. This flow, provided from the dam outlet works, would range from a low of 2 cfs up to 10 cfs. An additional design flow consideration is providing more flow for fish attraction to the fish ladder entrance through an auxiliary water system. As outlined previously, fish passage design criteria require a minimum of 5 percent to 10 percent of the high fish passage design flow, which is the 5 percent exceedance flow during the period of migration (NMFS, 2011). Per Table 3, the 5 percent annual exceedance flow ranges from 480 cfs to 860 cfs, depending on the hydrological operational scenario. To maintain a minimum of 5 to 10 percent of this flow for attraction would require a range of approximately 25 to 90 cfs. The auxiliary water system would operate to maintain at least 5 percent of the total Keechelus Dam outflow. The conceptual design of facilities would handle up to 100 cfs of combined auxiliary water system and fish ladder flow. The existing outlet works at Keechelus Dam consists of an open-channel flow conduit with room at the top of it for a water supply pipe to serve the fish passage facilities via gravity flow.

Reclamation would determine the exact sizing and configuration of the upstream fish passage facilities during final design and implementation of such facilities.

4.2 Current Keechelus Dam Downstream Passage Options

For downstream passage at Keechelus Dam, the concepts currently identified for possible future implementation include spillway modifications, a fish collection barge, and new outlet works in a Helix configuration. Reclamation does not consider a new spillway option adjacent to the existing spillway, identified in the Phase I Assessment, viable at this time.

4.2.1 Spillway Modifications

Spillway modifications could include those identified in the Phase I Assessment for single level or multiple level gates options. Channel excavations in the reservoir to connect the gate levels hydraulically would also be included along with spillway channel modifications, such as a receiving pool and an inset low-flow channel for concentrating spillway flows that may contain fish. The Phase I Assessment outlined that the single level gate option would allow a surface spill from the reservoir above El. 2507. Modifying the spillway crest with multiple level gates would be essentially the same as the single level gates option, except that Reclamation would place gates at multiple levels to permit a surface spill release from the reservoir at multiple and lower elevations. That particular option would allow a release from the reservoir to El. 2497 and above.

The primary consideration of setting any gates for this option at lower elevations than the normal full reservoir elevation is the need to excavate a channel through the reservoir bottom to connect to the gates hydraulically at the spillway. The lower the elevation, the larger and deeper this channel would need to be because of the location of the existing spillway in a shallow part of the reservoir (relative to the main dam where the deeper parts of the reservoir are located). Additionally, the lower that gates are set for this option, along with more gates spaced out at multiple levels over a wider range of elevations, would provide downstream passage over a greater range of the reservoir operational conditions. Another important consideration for lower gate elevations in the spillway crest is the need to lower portions of the spillway channel. The Phase 1 assessment drawings for this concept show a spillway lowering of up to 9 feet. As stated previously from Table 4, the reservoir elevation on an average daily basis is always at least 4 feet below the spillway crest (El. 2522) in all hydrological operational scenarios presented and the spillway channel in its current configuration would not normally flow except during flooding conditions. Also from Table 4, the reservoir elevation on an average daily basis is at El. 2453 or above 90 percent of the time. From Table 5, the reservoir elevation on an average daily basis is at El. 2481 above 90 percent of the time during April and May. This parameter (90 percent) is a target reservoir operation range for providing downstream fish passage and the associated hydraulic connectivity to fish passage options. Providing gates at a low reservoir level such as El. 2453 may not be feasible due to the height requirements (up to 80 feet) for a spillway structure containing all of the gates and connecting the different gate elevations through channels in the existing spillway to the corresponding elevations. Additionally, the substantial channel excavation in the reservoir leading to the spillway area would be needed to connect to the structure at the lower reservoir elevation.

In the case of the specific single level and multiple level gates options identified in the Phase I Assessment, a lower operating reservoir level of El. 2507 (single level gates option) corresponds

to an approximate 15 to 30 percent exceedance level for the April and May period; and a lower operating reservoir level of El. 2497 (multiple level gates option) corresponds to an approximate 40 to 70 percent exceedance level for the April and May period, depending on the hydrological operational scenario considered. In other words, the reservoir only exceeds (is higher than) El. 2507 on average 15 to 30 percent of the time for the April and May period and the reservoir only exceeds El. 2497 on average 40 to 70 percent of the time for the April and May period to allow for the respective options to be engaged and provide opportunities for downstream passage. To illustrate this information, Figure 6 presents the reservoir exceedance curves for the April and May period with some different indicated elevations.

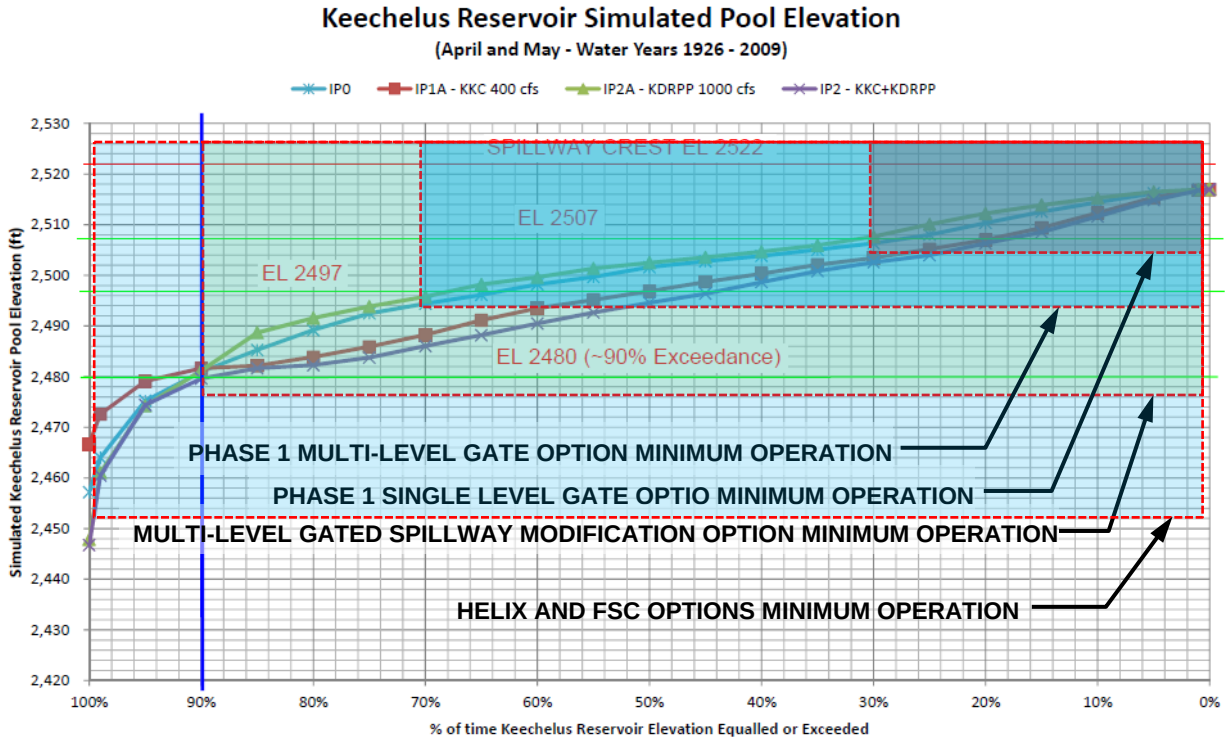


Figure 6. Keechelus Reservoir Elevation Exceedance Curves

Appendix B drawings illustrate an example of a multiple level gates option that would operate down to El. 2480 with an approach channel excavated to El. 2480 and corresponding spillway channel modifications. This elevation corresponds to an approximate 90 percent exceedance level for the April and May period. The drawings illustrate this example elevation because the Phase I Assessment considered it the elevation for the new spillway option. The example is a variation of the Phase I Assessment multiple level gates option. It would require at least two additional gates for that concept design to operate down to a reservoir elevation of 2480 feet along with a deeper approach channel and increased lowering of the spillway channel.

HDR recommends that Reclamation consult with the technical teams and fishery agencies to determine if the amount of time that this option could operate (relative to the anticipated range of

reservoir elevations) is acceptable, while comparing it to other downstream fish passage options. Selecting this option for downstream fish passage would also require a careful review of the forecast frequency, duration, and timing of Keechelus Dam spill events, especially if the KKC transfer tunnel is in place. Reclamation would need to make these determinations as part of future tasks if the agency selects this option for further evaluation.

4.2.2 Fish Collection Barge Option (Floating Surface Collector)

As described above for the Phase I Assessment, the Fish Collection Barge system consists of a barrier net (to guide fish), a collection barge with pumps, an underwater bypass pipe, and a holding barge. The concept was modeled after existing facilities at Upper Baker Dam. The Fish Collection Barge system concept, known today as a Floating Surface Collector (FSC) system, and its associated technology has evolved since implementation of the Upper Baker and other FSC projects. The basic concept is still very similar to that described for the Fish Collection Barge system. The technological refinements for more recent FSC systems include sizing and optimizing the collection, handling, and transport components of the system as adapted for the site-specific reservoir conditions anticipated.

A FSC system is a viable option for Keechelus Dam. Specific components of the system may vary from that described for the Fish Collection Barge system. The design phase would detail this option if it is selected. The Appendix B drawings illustrate this option with a modified intake tower. The intake tower would take advantage of the higher range of reservoir elevations that the FSC system could operate, since it is located in the deepest part of the reservoir adjacent to the dam. With this option, the existing outlet works would remain in place but with modifications for truck access and to enable the vertical range of FSC travel as the reservoir elevation fluctuates. Operational water releases from the existing outlet works could combine with the FSC system to supplement attraction to it in addition to the recirculating attraction flow pumps in the FSC. It is anticipated that this system could be used for downstream passage of fish through the entire range of reservoir water surface elevations (for example, 100 percent of the time depicted in Figure 6).

Some primary considerations for this option include locating the system where it may best capture downstream migrating fish, while also providing for the best access to the facility. Other considerations include the possible use of guide nets, debris management schemes, outlet works flow for additional attraction, and other operational and maintenance requirements. The primary operational requirements include physical access to the FSC system trap for truck transport of fish and power for attraction flow pumps and other electrical systems on the FSC.

To aid in making a decision for this option, it is recommended that Reclamation consult with the technical teams and fishery agencies to determine if the anticipated costs and operational requirements are acceptable, while comparing it to other downstream fish passage options.

4.2.3 New Outlet Works Option (Helix System)

As stated previously, Reclamation is currently designing downstream fish passage facilities at Cle Elum Dam (the Helix). The basis of the New Outlet Works option for Keechelus Dam would be the Cle Elum Dam Helix design. Reclamation expects completion of the Helix design at Cle Elum Dam in 2015. The Helix system includes a multiple level intake structure with adjustable weir gates at each level. The weir gates create an attraction flow to draw downstream migrating fish to the surface water flow spill over the weir gates. The multiple level intake and

weir gates allow the Helix system to draw from the reservoir water surface over a range of reservoir elevations, depending on the number of intake levels and the range of operation for each weir gate. Once spilled over the weir gates, the fish would enter the helix-shaped bypass conduit that is connected to the intake structure at different levels and flow downstream through a bottom conduit that may extend through the base of the dam. A drawing in Appendix B illustrates this layout.

The design of this system could allow for downstream fish passage for almost 100 percent of reservoir water surface elevations with the location depicted in the drawing. Preliminarily, this would include seven 10-foot interval levels to operate down to El. 2455. Another advantage of this option is that it is a passive fish passage operation in that fish pass downstream when captured in the intake structure and the system does not include collection and transporting of fish. It also requires much less operational and maintenance requirements compared to the FSC option where trucks transport trapped fish downstream. With this option, the existing outlet works would remain in place and operational, but water releases could be combined or operated separately with the Helix system. Normal operational releases would provide the attraction flow used in the Helix system but Reclamation would determine the capacity and other limitations of the system through ongoing study on the Helix system for Cle Elum and other project dams.

4.3 Current Kachess Dam Upstream Fish Passage Option

For Kachess Dam, the current concept identified for upstream fish passage includes an adult passage collection facility for trap-and-haul, as depicted in the associated drawing in Appendix B. The trap-and-haul facilities would be on the opposite side (western side) of the dam outlet channel from the KDRPP outlet. A new access bridge crossing the outlet channel would access the trap-and-haul facility from the eastern side. The trap-and-haul facility includes a fish ladder strategically placed to attract fish to its entrance, although Reclamation would determine the precise location and configuration through hydraulic study and detailed design considering the range of future dam and KDRPP operations. The ladder would allow fish to ascend to holding and collection pools for sorting and staging for transfer. The haul route for the fish transportation trucks would utilize existing and newly created access roads at the dam and the possible construction of a ramp from near the dam crest down to the reservoir, at a location Reclamation would determine in the future. Reclamation might also determine a haul route for transferring fish above the reservoir in the future.

A consideration for locating a trap-and-haul facility is minimizing the potential of upstream migrating fish to ascend a channel away from the trap-and-haul facility. The Kachess Dam spillway channel is separate from the outlet works channel with the spillway channel joining the outlet works channel approximately 450 feet downstream of the current proposed location of the future trap-and-haul facility. The spillway outlet channel is approximately 1,200 feet long from the toe of the spillway to where it joins the outlet works channel. Additional facilities to prevent upstream migrants from swimming up the spillway channel and missing the route to the trap-and-haul facility is not considered necessary due to the infrequent spillway flow events. The reservoir elevation on an average daily basis is always at least 2 feet below the spillway crest (El. 2264) in all hydrological operational scenarios presented (Table 7), so the spillway channel would not flow except during flooding conditions. To help with a final decision for location of facilities, it would be important to determine the forecast frequency, duration, and timing of Kachess Dam spill events, especially with the KDRPP project in place.

The anticipated operation of the facility would occur during adult fish migration periods determined with the fishery agencies for run management of the different fish species. A preliminary estimate of operational periods can be determined from Table 2. Peak adult fish migration periods begin in April for steelhead, and continue through the summer and fall for sockeye, Chinook, and coho. Operation of the facility for winter steelhead may be necessary during the months of November and December. Adult migration for bull trout occurs in the summer and early fall, overlapping the seasons for salmonids. Adult migration for lamprey occurs in the spring and summer with partial overlap of the seasons for salmonids.

The primary design flow consideration includes providing a base flow for operation of the fish ladder, trap, and holding and sorting pools. This base flow would range from as low of 2 cfs up to 10 cfs provided from the dam outlet works by gravity when the reservoir is above the inactive storage level. This base flow will be provided from the KDRPP project when the reservoir is below the inactive storage level. When there are higher flow releases from the dam, additional flow for fish attraction to the fish ladder entrance, through an auxiliary water system up to 100 cfs, will be supplied from either the dam outlet works by gravity when the reservoir is above the inactive storage level or the KDRRP when the reservoir is below the inactive storage level. As outlined previously, fish passage design criteria require a minimum of 5 percent to 10 percent of the high fish passage design flow, which is the 5 percent exceedance flow during the period of migration (NMFS, 2011). Per Table 5, the 5 percent annual exceedance flow ranges from 920 cfs to 1,150 cfs, depending on the hydrological operational scenario. To maintain a minimum of 5 to 10 percent of this flow for attraction would require a range of approximately 45 to 115 cfs. The auxiliary water system would operate to maintain at least 5 percent of the total Kachess Dam outflow. Conceptually, the facilities would handle up to 110 cfs of combined auxiliary water system and fish ladder flow from either the existing dam outlet works or the KDRPP, depending on the reservoir conditions and operations.

Reclamation would determine the exact sizing and configuration of the upstream fish passage facilities during final design and implementation of such facilities.

4.4 Current Kachess Dam Downstream Passage Options

For downstream passage at Kachess Dam, the concepts currently identified for possible future implementation include a fish collection barge and new outlet works in a Helix configuration. Reclamation does not consider the modified spillway or new spillway options, identified in the Phase I Assessment, viable at this time pending further study of the other options. The primary consideration for selection and potential implementation of a downstream fish passage option at Kachess Dam is the range of reservoir elevations in relation to the reservoir bathymetry and other controlling elevations. To illustrate this information, Figure 7 presents reservoir exceedance curves for the April and May period with different indicated elevations.

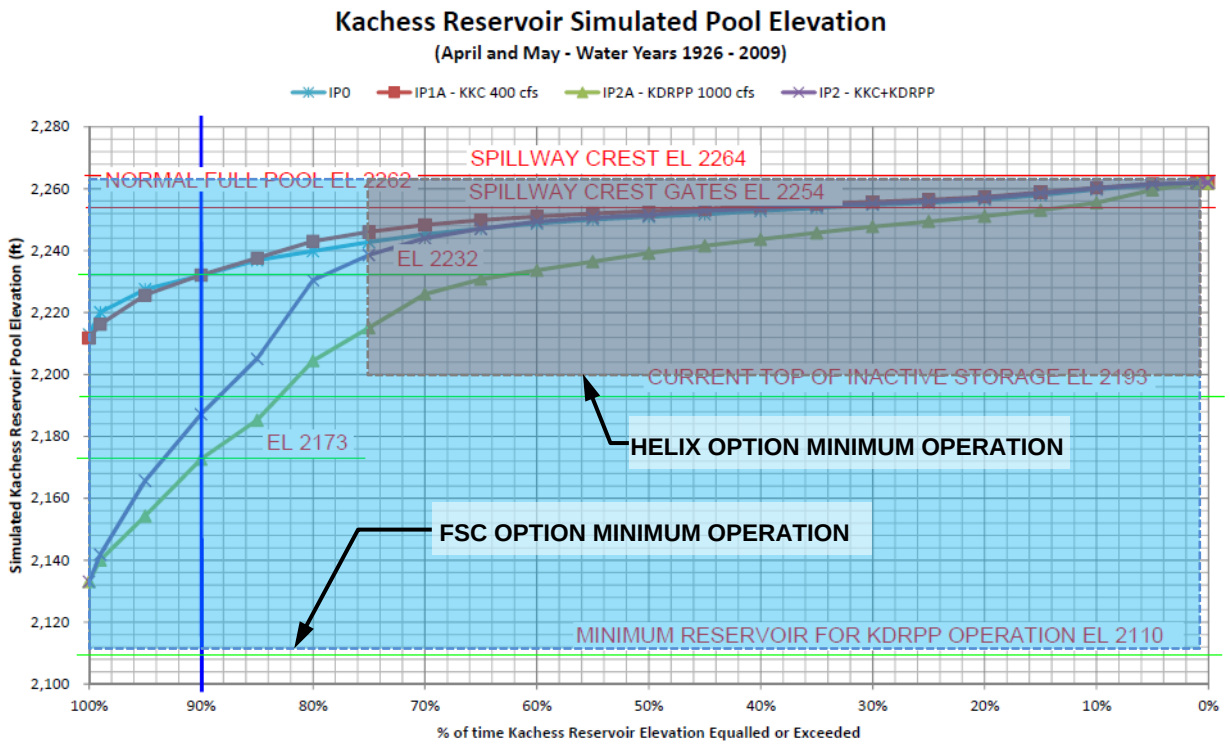


Figure 7. Kachess Reservoir Elevation Exceedance Curves

The range of reservoir elevations in relation to the reservoir bathymetry and other controlling elevations determines the location and lowest elevation for operation of downstream fish passage options. The spillway crest is at El. 2264 with crest gates inverts at El. 2254, and the normal full pool is at El. 2262. Due to the location of the dam relative to the naturally deepest parts of the reservoir, there is a shallower part of the reservoir directly adjacent to the dam and existing outlet works. The channel that leads from the deeper part of the reservoir to the existing outlet works is at approximate El. 2200. Elevation 2200 is approximately the elevation at which the KDRPP design begins drought relief water- pumping operations. The current (without KDRPP) top of inactive storage in the reservoir and for the existing outlet works is at El. 2193. The design of the KDRPP operation is for a minimum reservoir water surface elevation of El. 2110.

As stated previously, the reservoir elevation on an average daily basis is always at least 2 feet below the spillway crest in all hydrological operational scenarios presented and the spillway gates operated to maintain the normal full pool at El. 2262 (Table 7). The reservoir elevation on an average daily basis is at El. 2173 or above 90 percent of the time for the April and May period depending on the hydrological operational scenario (Table 8). This parameter (90 percent) is a target reservoir operation range for providing downstream fish passage and the associated hydraulic connectivity to fish passage options. Providing downstream fish passage options that operate down to this reservoir elevation or lower would provide more certainty of fish passage. However, fish passage options like a modified spillway with multiple level gates or a new spillway option may not be feasible to operate to these reservoir levels without requiring substantial channel excavations through the reservoir bottom to connect the fish passage system hydraulically at lower reservoir elevations. From Figure 7, the top of inactive storage (current)

in the reservoir (El. 2193) that can connect to the existing outlet works is exceeded between approximately 80 and 100 percent of the time on an average daily basis for the April and May period, depending on the hydrological operational scenario. The minimum reservoir water surface elevation for which the KDRPP operation is designed (El. 2110) is exceeded 100 percent of the time on an average daily basis for all hydrological operational scenarios presented, and considering either the whole year data or just the Arpil and May period. It would represent the full range of reservoir elevations from which the design could provide complete certainty of downstream fish passage operations and options. The next section describes how these constraints interact with the different options.

4.4.1 Fish Collection Barge Option (Floating Surface Collector)

Reclamation may consider a FSC system as a viable option for Kachess Dam. Specific components of the system may vary from that described for the Fish Collection Barge system. The design phase would detail the components if this option is selected. An Appendix B drawing shows this option located adjacent to the KDRPP headworks intake (KDRPP Alternative 1). This location takes advantage of a higher range of reservoir elevations that the FSC system could operate since the KDRPP headworks and intake tower are in a deeper part of the reservoir that is not adjacent to the dam.

This FSC concept would be "movable" to provide flexibility in locating the FSC depending on reservoir levels and flow release operations, and to adapt to changing patterns or locations of out-migrating fish movement. The movable FSC would have a self-anchoring and mooring system to anchor it in the open reservoir or moor it to a tower structure. This could allow it to accommodate a larger range of reservoir elevations for collecting fish during potentially critical downstream passage periods. This movable FSC option would be instead of a fixed location FSC that would limit reservoir elevation ranges for fish collection, such as next to the existing intake tower. However, the movable FSC could be moored to the intake tower for fish collection operation to take advantage of intake tower flow releases and supplement attraction flows to the FSC. The existing intake tower and outlet works would remain in place and operate normally to the lower level (top of inactive storage) limitations. However, the design would be modified the option for truck access and to enable mooring of the FSC for the vertical range of FSC travel as the reservoir elevation fluctuates. When reservoir levels begin to fall below the top of inactive storage, Reclamation could move the FSC to deeper parts of the reservoir or moor it to a new tower near the KDRPP headworks intake. Reclamation could use this system for downstream passage of fish through the entire range of reservoir water surface elevations.

Primary considerations for this option include providing power and suitable access to the facility. When anchored in the open, reservoir generators from a power barge would provide electrical power for the attraction flow pumps. Additionally, a transfer boat or barge would transport fish to shore. This transfer boat or another utility boat would seasonally position the FSC in the open reservoir. When moored to the existing intake tower, an access bridge capable of accommodating a utility truck would transfer fish from the FSC and transport them downstream. As depicted in the Appendix B drawing, a pier is located between the KDRPP headworks and the intake location for transferring fish to a truck from the FSC and transporting them downstream. Other considerations include the possible use of guide nets, debris management schemes, intake flow (existing or the KDRPP intake) for additional attraction, and other operational and maintenance requirements. The primary operational requirements include physical access to the

FSC system trap for transport of fish and power for the attraction flow pumps and other electrical systems on the FSC.

To aid in making a decision for this option, HDR recommends that Reclamation consult with the technical teams and fishery agencies to determine if the anticipated costs and operational requirements are acceptable while comparing it to other downstream fish passage options.

4.4.2 New Outlet Works Option (Helix System)

The basis of a New Outlet Works option for Kachess Dam would be the Cle Elum Dam Helix design. As with this option described for Keechelus Dam, the system for Kachess Dam would include a multiple level intake structure with adjustable weir gates at each level, a helix-shaped bypass conduit, and a bottom conduit that may extend through the base of the dam. An Appendix B drawing illustrates this layout. This system could be used for downstream fish passage over a limited range of reservoir water surface elevations with the location depicted in the drawing. Preliminarily, the system would include six 10-foot interval levels to operate down to El. 2200 for an approximate reservoir range of 60 feet. The advantage of this option is that it is a passive fish passage operation in that fish pass downstream when captured in the intake structure and the system does not include collection and transport of the fish. It also requires much less operational and maintenance as compared with the FSC option where trucks transport the trapped fish downstream. However, with the location of the system adjacent to the dam, this option would be limited to the reservoir operational range above El. 2200 and would not be able to collect fish when reservoir levels fall below that level. As described previously, this corresponds to a reservoir exceedance between approximately 75 and 100 percent depending on the hydrological operational scenario.

With this option, the existing outlet works would remain in place and operational, but water releases could be combined or operated separately with the Helix system. Normal operational releases would provide the attraction flow, and Reclamation would determine the capacity and other limitations of the system through ongoing study of the Helix system for Cle Elum and other project dams. To aid in making a decision for this option, HDR recommends Reclamation consult with the technical teams and fishery agencies to determine if the anticipated costs and operational requirements are acceptable, while comparing it to other downstream fish passage options.

5.0 Conclusion

The feasibility designs for the KKC and KDRPP appear to be compatible with the fish passage concepts at Keechelus Dam and Kachess Dams reviewed in this technical memorandum.

There are many considerations for future selection and implementation of fish passage alternatives at both Keechelus Dam and Kachess Dam. A list of primary considerations is provided here.

- Final design and implementation of KKC project elements which may influence the effectiveness of selected fish passage options.
- Final design and implementation of KDRPP project elements which may influence the effectiveness of selected fish passage options.

- Implementation of other fish passage projects in the Yakima River Basin according to prioritization and planning efforts.
- Ongoing development of fisheries biology information that could affect consideration of habitat suitability, population viability, migration timing and run sizes.
- Fish passage performance information that will become available after fish passage is installed at Cle Elum, Tieton and/or Bumping Lake Dams.
- Ongoing availability of new and updated information about various fisheries facility technologies, such as floating surface collectors, fixed multi-inlet collectors, transport tube systems and helical bypass systems.

These considerations should be taken into account at the time Reclamation moves forward with appraisal and/or feasibility designs at the two sites.

6.0 References

HDR, 2012	Bureau of Reclamation. 2012. *Basis of Assumptions Review for Fish Passage Projects Cost Estimating Technical Memorandum (Draft).* Prepared by HDR Engineering, for the U.S. Department of the Interior, Bureau of Reclamation.
Reclamation, 2005	Bureau of Reclamation. 2005. *Phase I Assessment Report Storage Dam Fish Passage Study Yakima Project*. U.S. Department of the Interior, Bureau of Reclamation. September 2003, Revised April 2005. Washington.
Reclamation, 2008	Bureau of Reclamation. 2008. *Cle Elum and Bumping Lake Dams Fish Passage Facilities Planning Report – Draft*. U.S. Department of the Interior, Bureau of Reclamation.
Reclamation, 2009	Bureau of Reclamation. 2009. *Value Planning – Final Report Cle Elum Dam Fish Passage Facility*. U.S. Department of the Interior, Bureau of Reclamation.
Reclamation, 2011	Bureau of Reclamation. 2011. *Final Planning Report Cle Elum Dam Fish Passage Facilities*. U.S. Department of the Interior, Bureau of Reclamation.
Reclamation and Ecology, 2014a	Bureau of Reclamation and Washington State Department of Ecology. 2014. *Yakima River Basin Integrated Water Resource Management Plan Technical Memorandum: Hydrologic Modeling of System Improvements Phase 1 Report*. Unpublished Draft prepared by HDR Engineering, Inc. July 2014.
Reclamation and Ecology, 2014b	Bureau of Reclamation and Washington State Department of Ecology. 2014. *Yakima River Basin Integrated Water Resource Management Plan Technical Memorandum: Kachess Drought Relief Pumping Plant Draft Feasibility Design Report*. Unpublished Draft prepared by HDR Engineering, Inc. November 2014.
Reclamation and Ecology, 2014c	Bureau of Reclamation and Washington State Department of Ecology. 2014. *Yakima River Basin Integrated Water Resource Management Plan Technical Memorandum: Keechelus-to-Kachess Conveyance Draft Feasibility Design Report*. Unpublished Draft prepared by HDR Engineering, Inc. September 2014.
WDFW, 2000a	Washington Department of Fish and Wildlife. 2000. *Draft Fishway Guidelines for Washington State.*
WDFW, 2000b	Washington State Department of Fish and Wildlife. 2000. *Draft Fish Protection Screen Guidelines for Washington State*.

7.0 List of Preparers

NAME	BACKGROUND	RESPONSIBILITY
HDR ENGINEERING, INC.		
Jon Mann	Fish Passage Engineering	Lead Author
John Nelson	Engineering	Fish Screening and Passage
Jim Peterson	Engineering	Task Manager – KKC Feasibility Study
Bob King	Engineering	Task Manager – KDRPP Feasibility Study
Mike Garello	Engineering	Quality Control Review
Andrew Graham	Water Resources Policy and Planning	Project Manager. Document Review.

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Appendix A
Related Agreements

Hydraulic Project Approval E1998-01 2002

WDFW BOR SOD Agreement 2002

Yakima Nation Settlement Agreement 2006

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HYDRAULIC PROJECT APPROVAL

RCW 77.55.100 - appeal pursuant to Chapter 34.05 RCW

State of Washington
Department of Fish and Wildlife
Region 3 Office
1701 South 24th Avenue
Yakima, Washington 98902-5720

DATE OF ISSUE: April 17, 2002

LOG NUMBER: 00-E1998-01

PERMITTEE

USDI Bureau of Reclamation
Upper Columbia Area Office
ATTENTION: David Kaumheimer
1917 Marsh Road
Yakima, Washington 98901
(509) 575-5848 ext. 232
Fax: (509) 454-5650

AUTHORIZED AGENT OR CONTRACTOR

USDI Bureau of Reclamation
Pacific Northwest Construction Office
ATTENTION: Bernie Meskimen
P.O. Box 2967
Yakima, Washington 98902
(509) 575-5946
Fax: (509) 454-5622

PROJECT DESCRIPTION: **Dam Reconstruction** -Safety of Dams reconstruction of Keechelus Dam. Work includes reconstructing the earthen dam, construction of access roads, handling and stockpiling of materials, excavating and placing fill and drain in wetlands, constructing new bridges, and installing bank protection materials.

PROJECT LOCATION: **Lake Keechelus Dam - Yakima River -** Keechelus Dam adjacent to I-90, east of Snoqualmie Pass.

#	WRIA	WATER BODY	TRIBUTARY TO	1/4 SEC.	SEC.	TOWNSHIP	RANGE	COUNTY
1	39.0002	Yakima River	Columbia River	SE	27	20 North	15 East	Kittitas

PROVISIONS

1. **TIMING LIMITATIONS:** The project may begin **May 1, 2002** and shall be completed by **November 30, 2004.**

GENERAL PROJECT PROVISIONS APPLICABLE TO ALL ELEMENTS

GENERAL

2. Work shall be accomplished per plans and specifications entitled, Keechelus Dam Modification, Solicitation Number 02SP101485, dated September 21, 2001 and information submitted by USDI Bureau of Reclamation (Reclamation) to Washington Department of Fish and Wildlife (WDFW) with the Hydraulic Project application, except as modified by this Approval. A copy of these plans shall be available on-site during construction. Plan changes must be specifically approved by the WDFW field representative.

3. Temporary run-off and erosion control measures shall be employed as necessary throughout the project area to prevent discharge of sediment-laden water, earth or sediment to watercourses or wetlands. Unless specifically approved in the plan of work, there shall be no discharge of sediment, turbid water or water containing materials harmful to fish or aquatic life to water bodies or wetlands.

4. Concrete structures shall be sufficiently cured to prevent leaching of chemicals harmful to fish or aquatic life prior to removal of containment measures and allowing contact with surface water.

5. Aggregate, sand, gravel, clay or earth needed to construct the project shall be obtained from the Bureau of Reclamation designated borrow areas referred to as DSL Borrow Area, DSLE Borrow Area, Iron Horse Trail Quarry and the Crystal Springs SnoPark site, or obtained from public or commercial sources which are not in the geomorphic flood plain of the Yakima River, except that gravel may be obtained from floodplain sources where it can be clearly shown that removal of these materials is not likely to adversely affect Middle Columbia River steelhead or bull trout.

REQUIRED SALVAGE OF TREES AND SHRUBS

6. Select trees and riparian shrubs which must be removed to construct this project shall be salvaged for use on site (see restoration plans) or stockpiled at an approved stockpile site for use elsewhere in creating fish habitat and restoring shoreline vegetation. Trees and shrubs for salvage shall be identified and clearly marked on site in collaboration with WDFW. The total number of trees with intact rootwads to be salvaged shall be determined by WDFW and Reclamation at the time of marking based on the needs for restoration work, the ability to stockpile trees and the size of the trees actually salvaged for these purposes. .

7. Removal of each tree designated for salvage shall be done by excavating around the rootwad to loosen soil and then pushing the tree over so as to keep a large rootwad attached to the tree for use as in-channel Large Woody Debris (LWD). Where practical, select trees shall be removed and placed or stockpiled as whole trees (no cutting, limbing or removal of rootwads).

8. Trees and shrubs of a size suitable for machine transplanting as part of construction site or wetland restoration shall be marked in advance, removed with a trackhoe with rootballs intact, protected from dessication and replanted as soon as possible.

STAKING AND MARKING

9. The project boundary and clearing limits shall be clearly marked/staked prior to any clearing or ground disturbing activity. Sensitive areas and trees to be protected from disturbance or salvaged shall be delineated/marked so as to be clearly visible to equipment operators.

ENVIRONMENTAL COMPLIANCE INSPECTION AND REPORTING

10. The Bureau of Reclamation shall monitor and ensure contractor compliance with HPA provisions. If work occurs in violation of permit provisions, Reclamation shall immediately stop work on the particular task or project section until the problem is corrected. Reclamation shall promptly notify WDFW of any non-compliance with provisions and the actions taken to address the problem.

11. The permittee shall provide a qualified "Environmental Compliance Inspector", knowledgeable about fishes, wetlands and the environment of the upper Yakima River Basin. This inspector shall have the authority to assure compliance with plans, permit provisions and mitigation measures. This inspector shall be on site on a sufficiently regular basis to monitor work and ensure compliance with HPA provisions. The inspector shall be present during all activities of special concern identified in the approved Plan of Work and pre-construction meeting.

EQUIPMENT LIMITATIONS

12. Except for work to install containment/coffer dams, all work shall be done in isolation from surface water (i.e. wetlands, streams, Lake Keechelus, and the Yakima River). Equipment shall work from the access

roads, constructed work platforms, the bank, from the dry shoreline or dry lake bed, or from inside of containment or coffer dams.

13. Equipment operating in the shoreline zone, wetlands or associated buffers, or operating within the ordinary high water line shall be maintained in good working conditions such that petroleum products or other harmful chemicals are not leaked or spilled to these areas.

14. Equipment entering the wetted perimeter of the river, lake or tributary streams in accordance with the approved plan of work (i.e. to install containment structures, etc.) shall be cleaned prior to entering the water so as to be free of accumulations of earth, petroleum products and other materials harmful to fish life.

REQUIRED NOTIFICATIONS, MEETINGS AND SUBMITTALS

NOTIFICATION REQUIREMENT

15. The permittee or contractor shall notify the Department field office by phone (509) 925-1013 or FAX (509) 925-4702 at least 72 hours prior to starting work on those portions of this project within the ordinary high water line. Leave message for Habitat Biologist Brent Renfrow. The notification shall include the permittee's name, project location, starting date for work, and the log number for this Hydraulic Project Approval.

PRE-CONSTRUCTION MEETINGS AND SUBMITTALS

16. **Water Control Plan**. Prior to commencement of work within the ordinary high water marks, the permittee shall submit for approval a detailed water control plan showing the proposed methods for isolation of work areas from water, methods for care of the release of water from Keechelus Lake during construction, and measures to be taken to meet river flow and water quality requirements. This plan shall include back-up pump(s) installed and ready for immediate service or other satisfactory contingency measures to maintain instream flow without interruption. No work shall begin within the ordinary high water marks until a satisfactory plan is approved.

17. **Spill Prevention and Containment Plan**. Prior to commencement of work within the ordinary high water marks, the permittee shall submit for approval a detailed Spill Prevention and Containment Plan. No work shall begin within the ordinary high water marks until a satisfactory plan is approved.

18. **Plan of Work**. Prior to commencement of work, the permittee shall arrange a preconstruction meeting with WDFW, the project superintendent and key personnel to discuss and develop a detailed Plan of Work, and highlight areas of special concern. The Plan of Work shall address all elements of work related to or affecting the lake, watercourses, and wetlands. The plan shall include the timing and sequence of work, installation and removal of the temporary containment structures needed to isolate the work areas, water management in the work area, dewatering of work areas, location of settling ponds, access roads, borrow and stockpile areas, etc.. The plan of work shall describe in detail how the permittee shall ensure protection of water quality, fish and fish habitat during clearing, grubbing, and construction of the downstream drain,

outlet tunnel section, bridges, cutoff wall and embankment. No work shall begin within the ordinary high water marks until a satisfactory plan is approved and staked in the field as appropriate.

19. **Wetland Restoration and Monitoring Plan**. By August 15, 2002, the permitee shall submit to WDFW for approval a detailed wetland restoration and monitoring plan for restoring the large wetland complex immediately downstream of Keechelus Dam and monitoring the success of the restoration measures. The plan shall include the time table for restoration and the schedule for monitoring and reporting. This plan shall include landscaping and cultural measures for restoring vegetation, and structural measures to restore pre-project (i.e. 1998) hydrology to the wetland complex and stream channels. The plan shall also include a ten-year monitoring program and contingency measures to ensure that vegetation is successfully restored and that the hydrology is not adversely affected by the toe drain or other project features.

CARE AND MANAGEMENT OF WATER DURING CONSTRUCTION

TEMPORARY CONTAINMENT STRUCTURES

20. Temporary containment structures shall be in place prior to initiation of in-water work or ground-disturbing work within or adjacent to the ordinary high water line of Lake Keechelus, water courses or wetlands. Containment structures must effectively isolate the work area and prevent discharge of sediment or harmful materials to water or wetlands.

21. Containment structures placed or worked in water shall be installed using only clean materials (e.g. sand bags, "ecology blocks", plastic sheeting, washed gravels, etc.) until the structure is closed and the work area fully contained. Only clean materials shall be allowed on the outboard side of structures. After the work area is contained, materials containing fines may be used within the contained area if necessary.

22. Removal of containment structures and cofferdams shall be done in the reverse of the sequence in which they are installed. Removal shall be done in a manner which minimizes the release of fine sediment to water or wetlands. Materials used in the temporary containment structures shall be removed from the site and disposed of in approved locations.

DEWATERING OF WORK AREAS

23. During initial dewatering of work areas, turbid water shall be pumped to an upland area to allow fines to settle out before the water re-enters the river. Subsequent pumping to remove clean water infiltrating through sands and gravels may be discharged directly to water courses and wetlands provided that: a) a perforated sump chamber is installed away from the main work area to intercept the inflow, b) waste water containing raw concrete or other harmful materials is NOT reaching the sump chamber, c) water being pumped from the sump is clear (no suspended solids or turbidity), and d) state water quality standards are satisfied. Lines discharging water shall be equipped with a diffusing device which shall prevent the scouring and dislodging of fine sediments from the bank or bed of the watercourse or wetlands.

24. Wastewater containing earth, silt or contaminants (e.g. bentonite, raw concrete, etc.) shall be pumped to an upland area where these contaminants shall be treated and removed from the water. Care shall be taken to ensure no harmful material (e.g. fresh cement, petroleum products, wood preservatives, toxic chemicals, etc.)

are allowed to enter the water of the river, lake, streams or wetlands. (Note that raw concrete is toxic to fish and other aquatic life.)

SETTLING PONDS

25. Settling ponds shall be located in upland sites away from watercourses and wetlands, or at specifically approved locations. Water and erosion control measures shall be taken at all sites so as to prevent transport of sediment or harmful materials (e.g. fresh cement, petroleum products, bentonite, chemicals, etc.) to waters or wetlands.

MAINTENANCE OF INSTREAM FLOW BELOW DAM

26. Flows released from the dam to the river shall be set at approximately 100 cfs by September 10th. Once spawning of chinook and bull trout occurs downstream from the dam, there shall be no reduction in flow released from the dam except as follows: a) flow below the dam may be reduced to 70 cfs for a period of time not to exceed 24 hours to allow installation and removal of low flow bypass facilities as per the approved water control plan; and b) flow below the dam may be reduced to less than 100 cfs IF, based upon the location and distribution of redds, Reclamation's ability to operate, and recommendations of SOAC, WDFW and Reclamation concur that a lower instream flow is acceptable.

27. After September 10th, WDFW shall be notified prior to altering flows. Leave message for John Easterbrooks (509) 457-9330 and Brent Renfrow (509) 925-1013. Except for emergency actions, notification shall be at least 72 hours in advance of the anticipated change.

28. During the period when the dam's outlet works are blocked to replace the outlet conduit section, river flow shall be monitored continuously to ensure that the bypass system is functioning adequately and that there is no disruption of water flow to the river.

29. Sufficient measures shall be taken to prevent sediment from entering the river from the bypass operations or from construction-related discharges from the work area. If pumps are used to bypass flow to the river, the pump intake shall be located where only clean water will be drawn into the pump. If necessary to obtain proper submergence of the intake, a pool sufficient to accommodate the pump intake and pump screen may be excavated in the lake bed at the location of the intake. The pump outlet shall be equipped with a diffusing device or located where the discharge will not mobilize fine materials nor scour the river bank or bed. There shall be no increase of turbidity (over background) permitted in the river below the project.

30. If pumps are used to bypass flow to the river, the pump system shall be equipped with a fish guard (screen) to prevent passage of fish into the pumps. The screen shall be consistent with the current WDFW screening criteria (copy attached). Screen maintenance shall be adequate to maintain screen criteria and to prevent injury or entrapment to juvenile fish. The screen shall remain in place whenever water is withdrawn through the pump intake.

State of Washington
Department of Fish and Wildlife
Region 3 Office
1701 South 24th Avenue
Yakima, Washington 98902-5720

DATE OF ISSUE: April 17, 2002 **LOG NUMBER:** 00-E1998-01

CLEARING AND GRUBBING OF CONSTRUCTION AREA

TREE AND STUMP REMOVAL

31. All work within wetlands or watercourses shall be done in isolation from the wetted perimeter, or performed during a period when the site is dry.

32. The work area shall be protected from erosion. Water and sediment control measures shall be installed and maintained to prevent discharge of earth or silty water to wetlands or watercourses.

EMBANKMENT REMOVAL AND RECONSTRUCTION

REMOVAL AND RECONSTRUCTION OF EXISTING EMBANKMENT

33. Work shall be performed per the plans and specifications and as detailed in the approved Plan of Work (refer to provision #18 above).

34. Any surplus or waste embankment material shall be disposed of at approved location(s) outside of the Yakima River floodplain.

OUTLET WORKS AND OUTLET CHANNEL

REPLACEMENT OF PORTION OF OUTLET CONDUIT

35. Work shall be done in the dry.

36. Any concrete or grout shall be sufficiently cured prior to contact with water to avoid leaching of materials harmful to fish. (Note that raw concrete is toxic to fish and other aquatic life.)

RIPRAP

37. Grouted riprap installation in the outlet channel shall be placed in the dry.

CLEARING AND MODIFICATION OF OUTLET CHANNEL BANKS

38. To prevent sloughing of earth into the outlet channel and the Yakima River, the outlet channel shall be isolated from the excavation area during bank sloping by a temporary containment barrier of ecology blocks or equivalent, durable and sturdy containment barrier.

SPILLWAY AND OUTLET CHANNEL BRIDGES

GENERAL

39. The work areas at each bridge site shall be separated from the channel by a secure barrier that shall prevent sloughing or erosion of earth and fine material from the work area into the water course.

REMOVAL OF EXISTING BRIDGES

40. Prior to bridge removal, any accumulation of earth or traction material on the bridges shall be carefully removed in a manner which does not discharge this material to the watercourse. Waste material shall be disposed of in approved locations.

41. The existing steel bridges shall be removed in a manner which does not damage the beds or banks of the watercourses. Bridge members shall be fully suspended while being removed from across the channel. There shall be no dragging of the bridge members through the riverbed or across the face of the bank.

BRIDGE CONSTRUCTION

42. During preparation of abutments, adequate containment shall be provided to prevent discharge of earth, raw concrete, grout, chemicals or other harmful material to the channel.

43. The new bridges shall be installed in a manner as to not damage the beds or banks of the watercourses. Bridge members shall be suspended while being placed across each channel. There shall be no dragging of bridge members through the channel or across the face of the bank.

44. During grouting or pouring of concrete, the bridges shall be draped or sealed to prevent leakage of raw cement or other harmful materials, or leakage of water contaminated with such materials to the watercourses.

45. Bridge approach material shall be structurally stable and protected from erosion. Adequate drainage facilities shall be incorporated in the roadway and bridge approach material to direct road runoff away from the bridge and into biofiltration swale or other suitable stormwater treatment area.

46. Curbs or wheel guards shall be installed on each bridge.

GATEHOUSE BRIDGE

BRIDGE REPLACEMENT

47. Removal of the existing bridge and installation of the new gate house bridge shall be done in a manner which does not allow earth, debris or waste materials to be entrained in to the outlet of the reservoir and discharged to the Yakima River.

DOWNSTREAM DRAIN CONSTRUCTION

WORKSITE LIMITATIONS

48. All work shall be done in isolation from surface water. All sediment shall be contained within the work area boundary.

49. The equipment travel routes, clearing limits, and excavation limits shall be clearly staked in the field prior to beginning work within the wetland complex. The wetland outside of the construction area shall be clearly marked in the field and separated from the construction area with silt fence or equivalent barrier.

50. During construction, water in the drain trench shall be pumped to suitable location for treatment. Following treatment, this water shall be directed back to the wetland complex to help maintain the natural soil water table. Clean water infiltrating into the drain trench may be discharged directly to the wetland area in a manner consistent with provision #23 above.

TRENCH EXCAVATION AND INSTALLATION OF DRAIN IN WETLAND

51. Equipment operating within the delineated areas of the wetlands shall be maintained in good working condition such that petroleum products and other harmful materials are not leaked to wetlands.

52. All wetland soils removed during trench excavation shall be transported to the borrow pit or other approved site for temporary stockpiling for use in final restoration of the borrow pit.

DOWNSTREAM DRAIN OUTFALLS

53. Outfall to the Yakima River shall be constructed in isolation from the flowing water of the river.

54. The outfall shall be protected from erosion.

FISH PASSAGE IN LAKE KEECHELUS TRIBUTARY STREAMS DURING DAM CONSTRUCTION

TEMPORARY FISH PASSAGE DURING RESERVOIR DRAWDOWN

55. During the time period that Keechelus Reservoir is drawn down below the average low pool elevation (approximately elevation 2456), Reclamation shall monitor fish passage from Lake Keechelus into the major tributary streams to Lake Keechelus (i.e. Gold Creek, Meadow Creek and Coal Creek) at least two times per week. If passage is impaired, permittee shall immediately report this information to WDFW and consult with WDFW to determine what corrective measures shall be taken to provide passage (e.g. temporary flume, minor channel modification, permanent channel modification, etc.). Reclamation shall construct corrective measures as soon as possible but not later than seven days after determining that passage is impaired.

FISH PASSAGE AT KEECHELUS DAM OR ALTERNATIVE

56. Permittee shall immediately conduct a project-wide assessment of fish passage at all Yakima Project reservoirs. This assessment shall be done in collaboration with WDFW and the first phase of the assessment shall be completed and distributed by January 31, 2003. The first facility to be considered in this project-wide assessment shall be Keechelus Dam. The assessment shall include investigations as to the engineering, constructability and biological considerations of fish passage at each facility. The assessment shall include consideration of the potential fish production and likelihood of sustainability above each dam using a mutually acceptable assessment tool. Phase II of the assessment shall prioritize where fish passage is

determined to be desirable and practicable, based upon the results of the phase I assessment. Phase II shall focus on engineering feasibility, cost, water management implications, and biological parameters for restoring specific stocks. Phase II of the assessment shall be completed by January, 2004. Where fish passage is determined to be both desirable and feasible, the permittee shall seek funding and complete design and construction of fish passage facilities in a timely manner. A separate HPA or HPA amendment is required for construction of these facilities. Where fish passage is determined to be undesirable or impractical, based upon the results of this assessment, Reclamation shall negotiate with WDFW an alternative to providing fish passage consistent with state law. The net benefit of this alternative shall provide equal or greater productivity and ecological function than that predicted for fish passage facilities if constructed at the dam(s).

57. **The Permittee shall immediately begin the assessment of Keechelus Dam as per provision #56 above, and determine whether the proposed design and construction of the Safety of Dams Project will adversely affect the feasibility, cost or efficacy of fish passage facilities at this dam. Reclamation shall modify the Safety of Dams work as necessary to ensure that the proposed Safety of Dams reconstruction-related actions at Keechelus Dam will not result in significant additional costs for retrofitting fish passage facilities at Keechelus Dam nor require future modification of the portions of the dam being reconstructed as part of the SOD work.**

58. **The Permittee shall provide interim fish passage (e.g. trap and haul program) in collaboration with WDFW at facilities where fish passage is desirable based upon the results of the project-wide passage assessment.** Interim passage shall be provided at locations agreed upon by the fish management entities as soon as possible but not later than one year from completion of Phase II of the passage study.

SITE RESTORATION

GENERAL SITE RESTORATION

59. Settling ponds and other earthworks within the ordinary high water mark of Lake Keechelus shall be recontoured to original grade, unless an alternate restoration/grading plan is specifically approved by WDFW.

60. All earth areas adjacent to the watercourse which have been exposed or disturbed by this project are to be graded to a stable grade, seeded with a suitable erosion control seed mix which includes native grasses and forbs, and protected from erosion with a straw mulch or equivalent.

61. Riparian and wetland plantings shall be cared for and maintained as per the monitoring plan, so as to ensure survival and rapid establishment of a robust plant community.

LONG-TERM WETLAND RESTORATION

62. Permittee shall complete the implementation of the approved wetland restoration plan by **November 30, 2004.**

State of Washington
Department of Fish and Wildlife
Region 3 Office
1701 South 24th Avenue
Yakima, Washington 98902-5720

DATE OF ISSUE: April 17, 2002 **LOG NUMBER:** 00-E1998-01

63. The wetland channels shall be restored to include complex large woody debris such as rootwads or small debris jams, etc.. The banks of the channel, where not fully vegetated, shall be planted with appropriate native plants adapted to streamsides and wetlands.

POST-CONSTRUCTION MONITORING

WETLAND COMPLEX RESTORATION MONITORING

64. The permittee shall monitor the performance and function of the wetland complex, the impacts of the new toe drain on the wetland and flow within the wetland channels, the success in restoration of pre-1998 wetlands hydrology and the success of revegetation of the areas disturbed during construction. Monitoring shall also assess whether mitigation objectives described in the EIS are achieved. Project monitoring shall be as per the approved submitted monitoring plan, and shall include a detailed inspection with sampling and photo documentation and written report submitted to WDFW for approval for one, three, five and ten years post construction. Copies of the monitoring results shall be sent to WDFW following each periodic site review. Any failures of features or revegetation and any deficiencies in performance shall be corrected in a timely fashion. Any corrective action which requires work within the lake, river, wetland or stream channels shall require specific approval from WDFW.

65. If monitoring results indicate that the restoration plan is not successful (i.e. wetland hydrology is not fully restored or that areas remain where native vegetation has not been successfully established) by year five the permittee shall develop a contingency plan to address the restoration deficiencies. The permittee shall submit this plan to WDFW for review and approval, and implement the approved corrective measures in a timely fashion.

SEPA: DS, Adoption of Existing Environmental Document and addendum - Washington Department of Ecology, April 8, 2002

APPLICATION ACCEPTED: April 17, 2002 **ENFORCEMENT OFFICER:** Rogers 125 [P1]

Brent Renfrow
Area Habitat Biologist **(509) 925-1013**

For Director
WDFW

Enclosures: Location map, site plan, construction boundary map, and project narrative

State of Washington
Department of Fish and Wildlife
Region 3 Office
1701 South 24th Avenue
Yakima, Washington 98902-5720

DATE OF ISSUE: April 17, 2002 **LOG NUMBER:** 00-E1998-01

GENERAL PROVISIONS

This Hydraulic Project Approval (HPA) pertains only to the provisions of the Fisheries Code (RCW 77.55 - formerly RCW 75.20). Additional authorization from other public agencies may be necessary for this project.

This HPA shall be available on the job site at all times and all its provisions followed by the permittee and operator(s) performing the work.

This HPA does not authorize trespass.

The person(s) to whom this HPA is issued may be held liable for any loss or damage to fish life or fish habitat which results from failure to comply with the provisions of this HPA.

Failure to comply with the provisions of this Hydraulic Project Approval could result in a civil penalty of up to one hundred dollars per day or a gross misdemeanor charge, possibly punishable by fine and/or imprisonment.

All HPAs issued pursuant to RCW 77.55.100 or 77.55.200 are subject to additional restrictions, conditions or revocation if the Department of Fish and Wildlife determines that new biological or physical information indicates the need for such action. The permittee has the right pursuant to Chapter 34.04 RCW to appeal such decisions. All HPAs issued pursuant to RCW 77.55.110 may be modified by the Department of Fish and Wildlife due to changed conditions after consultation with the permittee: PROVIDED HOWEVER, that such modifications shall be subject to appeal to the Hydraulic Appeals Board established in RCW 77.55.170.

APPEALS - GENERAL INFORMATION

IF YOU WISH TO APPEAL A DENIAL OF OR CONDITIONS PROVIDED IN A HYDRAULIC PROJECT APPROVAL, THERE ARE INFORMAL AND FORMAL APPEAL PROCESSES AVAILABLE.

A. INFORMAL APPEALS (WAC 220-110-340) OF DEPARTMENT ACTIONS TAKEN PURSUANT TO RCW 77.55.100, 77.55.110, 77.55.140, 77.55.190, 77.55.200, and 77.55.290:
A person who is aggrieved or adversely affected by the following Department actions may request an informal review of:
   (A) The denial or issuance of a HPA, or the conditions or provisions made part of a HPA; or
   (B) An order imposing civil penalties.
It is recommended that an aggrieved party contact the Area Habitat Biologist and discuss the concerns. Most problems are resolved at this level, but if not, you may elevate your concerns to his/her supervisor. A request for an INFORMAL REVIEW shall be in WRITING to the Department of Fish and Wildlife, 600 Capitol Way North, Olympia, Washington 98501-1091 and shall be RECEIVED by the Department within 30-days of the denial or issuance of a HPA or receipt of an order imposing civil penalties. The 30-day time requirement may be stayed by the Department if negotiations are occurring between the aggrieved party and the Area Habitat Biologist and/or his/her supervisor. The Habitat Protection Services Division Manager or his/her designee shall conduct a review and recommend a decision to the Director or its designee. If you are not satisfied with the results of this informal appeal, a formal appeal may be filed.

B. FORMAL APPEALS (WAC 220-110-350) OF DEPARTMENT ACTIONS TAKEN PURSUANT TO RCW 77.55.100 OR 77.55.140:

State of Washington
Department of Fish and Wildlife
Region 3 Office
1701 South 24th Avenue
Yakima, Washington 98902-5720

DATE OF ISSUE: April 17, 2002 **LOG NUMBER:** 00-E1998-01

A person who is aggrieved or adversely affected by the following Department actions may request an formal review of:

(A) The denial or issuance of a HPA, or the conditions or provisions made part of a HPA;
(B) An order imposing civil penalties; or
(C) Any other "agency action" for which an adjudicative proceeding is required under the Administrative Procedure Act, Chapter 34.05 RCW.

A request for a FORMAL APPEAL shall be in WRITING to the Department of Fish and Wildlife, 600 Capitol Way North, Olympia, Washington 98501-1091, shall be plainly labeled as "REQUEST FOR FORMAL APPEAL" and shall be RECEIVED DURING OFFICE HOURS by the Department within 30-days of the Department action that is being challenged. The time period for requesting a formal appeal is suspended during consideration of a timely informal appeal. If there has been an informal appeal, the deadline for requesting a formal appeal shall be within 30-days of the date of the Department's written decision in response to the informal appeal.

C. FORMAL APPEALS OF DEPARTMENT ACTIONS TAKEN PURSUANT TO RCW 77.55.110, 77.55.200, 77.55.230, or 77.55.290:
A person who is aggrieved or adversely affected by the denial or issuance of a HPA, or the conditions or provisions made part of a HPA may request a formal appeal. The request for FORMAL APPEAL shall be in WRITING to the Hydraulic Appeals Board per WAC 259-04 at Environmental Hearings Office, 4224 Sixth Avenue SE, Building Two - Rowe Six, Lacey, Washington 98504; telephone 360/459-6327.

D. FAILURE TO APPEAL WITHIN THE REQUIRED TIME PERIODS RESULTS IN FORFEITURE OF ALL APPEAL RIGHTS. IF THERE IS NO TIMELY REQUEST FOR AN APPEAL, THE DEPARTMENT ACTION SHALL BE FINAL AND UNAPPEALABLE.

MITIGATION AGREEMENT BETWEEN THE USDI BUREAU OF RECLAMATION AND WASHINGTON DEPARTMENT OF FISH AND WILDLIFE REGARDING KEECHELUS DAM CONSTRUCTION ISSUES INCLUDING FISH PASSAGE.

This Mitigation Agreement ("Agreement") is made between the Washington State Department of Fish and Wildlife, hereinafter referred to as WDFW, and the USDOI Bureau of Reclamation, hereinafter referred to as Reclamation. For purposes of this Agreement, the above entities are referred to collectively as "the Parties." The terms of this Agreement shall be binding upon the respective successors or assigns of each Party.

WHEREAS the U.S. Department of Interior Bureau of Reclamation ("Reclamation") and the Washington Department of Fish and Wildlife ("WDFW") share a common objective to protect, maintain and enhance water, fish and wildlife resources, and they recognize their mutual desire to continue a long-standing working relationship;

WHEREAS Congress established that the purposes of the Federal Yakima Project include fish, wildlife and recreation and that the existing storage rights of the project include storage for the purposes of fish, wildlife and recreation (Public Law 103-434, Title XII Yakima River Basin Water Enhancement Project - Sec 1205(e) Operation of Yakima Project);

WHEREAS Congress established that said storage for the purposes of fish, wildlife and recreation shall not impair the operation of the Yakima Project to provide water for irrigation purposes nor impact existing contracts (Public Law 103-434, Title XII Yakima River Basin Water Enhancement Project - Sec 1205(e) Operation of Yakima Project);

WHEREAS The Washington State law requires that a dam or other obstruction shall be provided with a durable and efficient fishway approved by the director of WDFW and that the fishway shall be maintained in an effective condition and continuously supplied with sufficient water to freely pass fish (RCW 77.55.060);

WHEREAS Reclamation and WDFW agree that Reclamation's authorities in the Yakima Basin provide for a broad range of fish enhancement activities including such things as barrier removal, screening of diversions and restoration of instream flows on both the mainstem river and tributaries, within proscribed limits;

WHEREAS Reclamation and WDFW agree that restoring fish passage at man-made barriers is, in nearly all cases, biologically preferable for conserving, restoring and enhancing indigenous fish species; and

WHEREAS the parties agree that moving forward expeditiously with repairs to Keechelus Dam is in the public interest to protect public safety and provide necessary

water for project purposes.

THEREFORE the parties agree to work collaboratively to carry out their respective responsibilities and agree as follows:

I. Commitments of WDFW:

WDFW Agrees:

1) To issue a Hydraulic Project Approval (HPA) for the proposed Safety of Dams reconstruction of Keechelus Dam as soon as possible. The HPA shall incorporate the provisions of this agreement.

2) To provide technical support to Reclamation so that the fisheries objectives of this agreement may be met.

II. Commitments by the United States of America

Reclamation Agrees:

1) To abide by the provisions of the HPA.

2) To immediately conduct an assessment of fish passage at all Yakima Project storage reservoirs in the Yakima River Basin as outlined in the HPA for the Keechelus Safety of Dams Modification Project. The assessment shall include consideration of the potential fish production and likelihood of sustainability above each dam using a mutually acceptable assessment tool. Where fish passage is determined to be desirable and practicable, based upon the results of this assessment, Reclamation shall examine engineering feasibility. Where fish passage is determined to be impracticable or infeasible, Reclamation shall negotiate with WDFW to provide an alternative to fish passage, consistent with state law.

3) To seek appropriate funding to ensure timely implementation of: a) fish passage facilities, where passage is determined to be desirable and practicable by the project-wide passage assessment (item 2 above), and b) alternative fish restoration measures for locations where fish passage is determined by the project-wide assessment to be biologically beneficial but impractical or infeasible.

4) Until construction of fish passage facilities at each of the Yakima Project storage reservoirs where fish passage has been determined as necessary as per item 2 above, and such fish passage facilities are in operation, to provide interim fish passage (e.g. trap and haul program) in collaboration with WDFW at each of those reservoirs.

5) To restore fish passage for salmonids from Lake Keechelus into Cold Creek, in collaboration with WDFW, as an interim measure to address fish passage concerns at Keechelus Dam and construction-related impacts of the Safety of Dams project. Reclamation shall do this in concert with the reconstruction of Keechelus Dam and ensure that conditions suitable for adult passage into Cold Creek from the reservoir are restored.

6) To develop a formal process involving regularly scheduled meetings to occur no less than biannually to ensure that there is ample opportunity for input by the fish management agencies (WDFW, National Marine Fisheries Service, US Fish and Wildlife Service and the Yakama Nation) into decisions concerning fish enhancement measures implemented by Reclamation under its various authorities in the Yakima River basin.

7) To ensure that construction materials for major Reclamation projects (including Safety of Dams projects) are sourced from sites not in the geomorphic flood plain of the Yakima River, or tributaries, whenever practicable.

8) To ensure that the proposed Safety of Dams reconstruction-related actions at Keechelus Dam will not result in significant additional costs for retrofitting fish passage facilities at Keechelus Dam nor require future significant modification of the portions of the dam being reconstructed as part of the SOD work.

9) To ensure that the functions of the large (approximately 300 acres) wetland complex below the toe of Keechelus Dam are not impaired. This wetland is the source of water for three different water courses, at least two of which are fish-bearing streams, which flow into a river side channel complex below Keechelus Dam. Reclamation shall mitigate for unavoidable impacts to this wetland as outlined in the Final Environmental Impact Statement (FEIS) for the Keechelus Dam Safety of Dams Modification (September 2001). If for some reason the land acquisition outlined in the FEIS cannot be accomplished, alternative mitigation strategies shall be developed in cooperation with the WDFW and others.

III. DISPUTE RESOLUTION

1) In the event that a dispute between the parties should arise, the parties shall make every effort to informally resolve the matter. Should a dispute arise, the aggrieved party shall send the other parties written notice of the issue in dispute, which shall state the aggrieved party's preferred resolution to the matter. Nothing shall prevent the parties from using any other remedy otherwise available to them if informal dispute resolution does not work; provided, however, that no party shall engage in self-help without first notifying the other parties of its intended act(s) and providing reasonable time for the other parties to respond.

2) Each Party shall have all remedies otherwise available in equity or at law to enforce the terms of this agreement, including specific performance and injunctive relief. No party shall be liable in damages to any other Party or other person for any breach of this agreement, any performance or failure to perform a mandatory or discretionary obligation imposed by this agreement, or any other cause of action arising from this agreement.

IV. MODIFICATION OF AGREEMENT

This agreement may only be modified upon written agreement of the parties.

V. SAVINGS CLAUSE

Nothing herein shall prevent, waive or diminish the right or authority of WDFW to use any statutory or other remedy available to enforce the provisions of this agreement. Nothing herein shall prevent, waive or diminish the right or authority of WDFW to protect populations of fish, or any other aquatic life in Lake Keechelus, theYakima River or tributaries to the fullest extent allowed by law, nor shall this preclude the WDFW from using any statutory or other remedy available concerning or relating to these fish. Nothing contained in this agreement is intended to unlawfully limit the authority or responsibility of the Department of Fish and Wildlife to invoke penalties or otherwise fulfill its responsibilities as a public agency.

VI. GENERAL PROVISIONS

1) Nothing herein shall or shall be construed to obligate Reclamation to expend or involve the United States of America in any contract or other obligation for the future payment of money in excess of appropriations authorized by law and administratively allocated for the purposes and projects contemplated hereunder.

2) No member of, or delegate to Congress or resident Commissioner, shall be admitted to any share or part of this Agreement or to any benefit that may arise out of it.

3) The parties agree to comply with all federal statues relating to nondiscrimination, including but not limited to: Title VII of the Civil Rights Act of 1964, as amended which prohibits discrimination on the basis of race, color, religion, sex or national origin; Title IX of the Education amendments of 1972, as amended, which prohibits discrimination on the basis of sex; the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act of 1990, as amended, which prohibit discrimination on the basis of disability: the Age Discrimination in Employment Act of 1976, as amended, which prohibits discrimination based on age against those who are at least 40 years of age; and the Equal Pay Act of 1963.

4) The Agreement shall become effective on the date of last signature hereto and

extended until terminated. Either party may formally request modification of the agreement.

5) Nothing in this Agreement shall, or shall be construed to alter or affect the authorities, rights or obligations of the parties under existing law or regulations.

THE UNITED STATES OF AMERICA

By: Eric Glover
Dated: 4/8, 2002

Eric Glover
Area Manager
Bureau of Reclamation

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

By: Jeff Tayer
Dated: 4-08-, 2002

Jeff Tayer, Regional Director
Department of Fish and Wildlife

SETTLEMENT AGREEMENT

Confederated Tribes and Bands of the Yakama Nation v. J. William McDonald, et al.,
9th Cir. Docket No. 03-35229,
District Court No. CY-02-3079-AAM (E.D. Wash.)

WHEREAS, the parties consent to execution of this Settlement Agreement (Agreement) in full settlement of all issues arising in *Confederated Tribes and Bands of the Yakama Nation v. J. William McDonald, et. al.*, 9th Cir. Docket No. 03-35229, District Court No. CY-02-3079-AAM (E.D. Wash.),

WHEREAS, the parties have conferred and engaged in negotiations pursuant to the Mediation Program of the U.S. Court of Appeals for the Ninth Circuit,

WHEREAS, this Settlement Agreement is the result of each party's good faith effort to resolve this case,

WHEREAS, each government party to this Settlement Agreement desires to work within the framework of a government-to-government relationship,

WHEREAS, the parties agree that this Settlement Agreement constitutes a fair resolution and compromise of this matter and its underlying competing contentions,

WHEREAS, the parties intend that this Settlement Agreement completely resolve, as among them, all issues raised in this case, or that could properly have been raised in this case, and that this Settlement Agreement is binding upon the parties, and

WHEREAS, though intended to resolve all issues in this case, this Settlement Agreement primarily addresses the establishment of a cooperative framework among the parties for achieving the ultimate goal of passage of anadromous fish at all U.S. Bureau of Reclamation (BOR) irrigation water storage facilities within the Yakima Basin where feasible, as well as anadromous fish reintroduction and habitat restoration efforts,

THE PARTIES AGREE AS FOLLOWS:

1. The Yakama Nation agrees to voluntarily dismiss its appeal in this action before the U.S. Court of Appeals for the Ninth Circuit, with prejudice.

2. BOR agrees to use its existing congressional authority and funding under § 1206 of the Yakima River Basin Water Enhancement Project (YRBWEP), Pub. L. No. 103-434, 108 Stat. 4550, 4560 (1994), to implement interim juvenile (downstream) fish passage measures at Cle Elum Dam, as developed by the Technical Yakima Basin Storage Fish Passage Work Group described in ¶ 6(a). BOR has implemented interim juvenile (downstream) fish passage at Cle Elum Dam and shall continue to do so per this paragraph.

3. "Interim" is defined throughout this Settlement Agreement as the period of time from the execution date of this document to the time at which permanent adult (upstream) and/or

juvenile (downstream) fish passage is implemented, or to the time at which the Regional Director, Pacific Northwest Region, BOR, concludes that permanent adult (upstream) and/or juvenile (downstream) fish passage is infeasible, for Cle Elum and Bumping Lake Dams as described in ¶ 7.

4. The parties agree to study and develop feasible measures, if any, for inclusion in a Cooperative Technical Plan for permanent juvenile (downstream) and adult (upstream) fish passage implementation at Cle Elum and Bumping Lake Dams.

5. BOR agrees to provide up to $65,000.00 in annual funding to the Yakama Nation for cooperative planning activities by the Yakama Nation Fisheries Resource Management Program, beginning in FY 2005 and continuing until submission of the planning report to the Office of the Secretary as described in ¶ 7. To receive this funding, the Yakama Nation must enter into an appropriate financial agreement with BOR, and thereafter comply with the terms of that financial agreement, or any future agreement executed to provide additional funding to the Yakama Nation. After the planning report is submitted to the Office of the Secretary as described in ¶ 7, BOR's funding obligations to the Yakama Nation shall cease.

6. BOR will develop the Cooperative Technical Plan in accordance with the following principles:

a. The Technical Yakima Basin Storage Fish Passage Work Group shall provide technical assistance in the development of biological and engineering measures for anadromous fish passage and reintroduction of anadromous fish above the Yakima Project storage dams. The Work Group shall provide technical assistance in the evaluation and monitoring of such measures upon implementation. This Work Group may consist of biologists and engineers from BOR, the Yakama Nation, irrigation interests, NOAA Fisheries, the U.S. Fish and Wildlife Service, the U.S. Forest Service, and the Washington Department of Fish and Wildlife.

b. To the extent that interim fish passage measures are implemented, the Cooperative Technical Plan shall include a proposed program to monitor and evaluate the performance of the fish passage measures at Cle Elum and Bumping Lake Dams and a proposal for authorization of participation by, and funding for, the Yakama Nation in the monitoring and evaluation activities.

c. The Cooperative Technical Plan will include a section discussing whether existing data from Cle Elum and Bumping Lake Dams and from the monitoring programs discussed in ¶ 6(b) can be used in the development of additional plans for fish passage measures at other BOR dams in the Yakima Basin, including Keechelus, Kachess, and Tieton Dams. The section shall also identify uncertainties and additional data necessary to determine the feasibility of fish passage at these three dams.

7. Consistent with federal law and applicable planning principles and standards, the Regional Director, Pacific Northwest Region, BOR, shall prepare a planning report with regard to the feasibility of implementing permanent fish passage at Cle Elum and Bumping Lake Dams. BOR shall include the Cooperative Technical Plan in BOR's administrative record for this

planning report and in the report itself as an appendix. The planning report shall include the Regional Director's recommendations and conclusions with respect to the feasiblity of implementing permanent juvenile (downstream) and adult (upstream) fish passage implementation at Cle Elum and Bumping Lake Dams. BOR shall submit, through appropriate Departmental channels, the Regional Director's planning report and any other required documentation to the Office of the Secretary, U.S. Department of the Interior, for consideration.

8. Within six months of the completion of the planning report for Cle Elum and Bumping Lake Dams outlined in ¶ 7, the parties shall meet to discuss whether the Technical Yakima Basin Storage Fish Passage Work Group should study and develop additional plans (consistent with federal law and applicable planning principles and standards) with regard to the feasibility of implementing permanent adult (upstream) and juvenile (downstream) fish passage at Kachess, Keechelus and Tieton Dams within the Yakima River Basin. If the parties agree that additional plans are warranted, they shall attempt to negotiate a memorandum of agreement outlining the process and establishing deadlines for the completion of additional plans addressing passage at Kachess, Keechelus, and Tieton Dams.

9. Designated representatives of the parties shall meet on a semiannual basis to discuss the progress of the implementation of the Settlement Agreement.

10. Nothing in this Agreement shall be deemed to waive, abrogate, diminish, define or interpret the rights of the Yakama Nation under the Treaty of June 9, 1855. The parties do not construe this Settlement Agreement to waive, abrogate, diminish, define or interpret the Treaty rights of the Yakama Nation.

11. Nothing in this Agreement shall be construed to limit or modify the discretion accorded to the Federal Defendants, by the Endangered Species Act, 16 U.S.C § 1531 et seq., the Administrative Procedures Act, 5 U.S.C. §§ 551-559, 701-706, or other federal laws.

12. This Agreement shall not be construed as an admission or agreement by any party, whether plaintiff, defendant or intervenor, as to the validity or legitimacy of any or all of any party's factual or legal contentions made in this case, including but not limited to any party's contentions regarding Yakama Nation Treaty rights.

13. Except as set forth in this Agreement, all parties reserve and do not waive any and all other legal rights and remedies.

14. Nothing in this Agreement shall be construed to obligate the United States to pay any attorney's fees or costs associated with this case.

15. The parties agree that the United States shall not be liable for costs or attorney's fees under the Equal Access to Justice Act, 28 U.S.C. § 2412 or the Endangered Species Act, 16 U.S.C. 1540(g).

16. No provision of this Agreement shall be interpreted to constitute a commitment or requirement obligating the United States to pay funds in violation of the Anti-Deficiency Act, 31 U.S.C. § 1341, and nothing herein shall be construed to obligate the United States to expend or

involve the United States in any contract or other obligation for future payment of money in excess of appropriations authorized by law and administratively allocated for the purposes and projects contemplated hereunder.

17. No member of or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this Agreement or to receive any benefit that may arise out of it other than as a water user or landowner in the same manner as other water users or landowners.

18. Nothing in this Agreement shall be deemed to waive, abrogate, diminish, define, interpret or impair the rights of the landowners/water users, irrigation districts, water companies or municipalities which receive their water from or through BOR operated reservoirs, dams or other facilities.

19. Nothing in this Agreement shall be deemed to waive, abrogate, diminish, define, interpret or impair the obligation or ability of BOR to deliver water in accordance with its contracts and obligations provided by the 1945 Judgment in *KRD, et al. v. SVID et al.*, Civil 21, US. District Court (ED Wash.), and the water rights adjudicated in *Washington State Dept. of Ecology v. Acquavella*, Yakima County No. 77-2-01484-5.

20. The parties disagree as to whether reintroduced fish stocks or species, if any, and restoration of habitat for such reintroduced stocks or species constitute "enhancement" of fish life as defined in *Washington State Dept. of Ecology v. Acquavella*, Yakima County No. 77-2-01484-5. Nothing in this Agreement shall be deemed to waive, abrogate, diminish, define, or interpret the rights of any parties with regard to this issue. The parties expressly reserve their rights, as well as any arguments, on this issue.

21. This Agreement constitutes the final, complete and exclusive agreement and understanding among the parties hereto with respect to the matters addressed herein. There are no representations, agreements or understandings relating to this Agreement other than those expressly contained herein. All prior communications, discussions, drafts, meetings or writings of any kind are superseded by this Agreement and shall not be used by any party to vary, contest or otherwise interpret the terms of this Agreement.

22. In the event of a disagreement among the parties concerning the interpretation or performance of any aspect of this Agreement, the dissatisfied party shall provide the other parties with written notice of the dispute and a request for negotiations. Within 30 days of the date of the written notice, or such time thereafter as the parties may mutually agree upon, the parties shall meet and confer in an effort to resolve their differences. If the parties are unable to reach agreement within 30 days of such meeting, the dissatisfied party may seek appropriate resolution by filing the appropriate complaint based on applicable law.

23. Any notice required or made with respect to this Agreement shall be in writing and shall be effective upon receipt. For any matter relating to this Agreement, the contact persons are:

For Plaintiff

Tom Zeilman
15 North 15th Avenue
Yakima, Washington 98902

For Defendant

Area Manager
Upper Columbia Area Office
U.S. Bureau of Reclamation
1917 Marsh Road
Yakima, WA 98901

24. The parties may agree in writing to modify any provision of this Agreement.

25. The undersigned representatives of each party certify that they are fully authorized by the party or parties they represent to agree to the terms and conditions of this Agreement and do hereby agree to the terms herein.

For the Bureau of Reclamation:

J. William McDonald

J. WILLIAM MCDONALD
Regional Director
Pacific Northwest Region
Bureau of Reclamation
U.S. Department of the Interior

Sept. 1, 2006
Date

For the Yakama Nation:

Lavina Washines

Chairman
Yakama Tribal Council

Dec 6-06
Date

Appendix B
Fish Passage Concepts Drawings

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B-1: Keechelus Dam Fish Passage Concepts

FC-201 Keechelus Dam Downstream Fish Passage Options

1C-202 KKC Yakima River Diversion & Intake Site Plan including future Keechelus Dam fish passage facilities

1C-203 KKC Yakima River Diversion Dam Plan and Sections including future Keechelus Dam fish passage facilities

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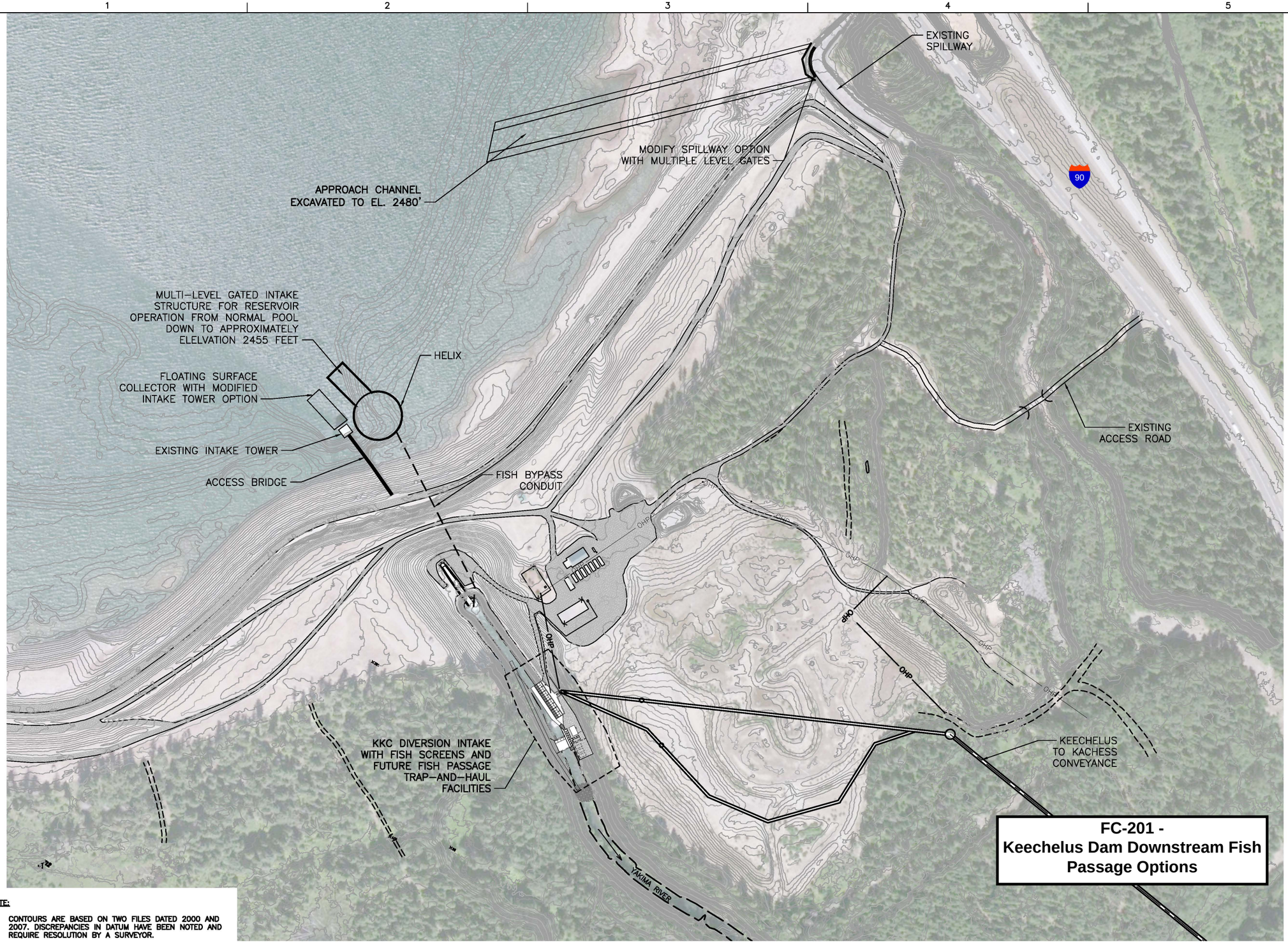

FC-201 - Keechelus Dam Downstream Fish Passage Options

NOTE:

1. CONTOURS ARE BASED ON TWO FILES DATED 2000 AND 2007. DISCREPANCIES IN DATUM HAVE BEEN NOTED AND REQUIRE RESOLUTION BY A SURVEYOR.

SITE PLAN

0 75 150 300

SCALE IN FEET

N

0 1" 2"

FEASIBILITY DRAWING

ELEVATIONS AND DIMENSIONS ARE APPROXIMATE

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BUREAU OF RECLAMATION
YAKIMA PROJECT - WA
KITTITAS DIVISION

KEECHELUS RESERVOIR TO KACHESS RESERVOIR

J. MANN
DESIGNED

REVIEWED

YAKIMA, WA 2014-09-__

KEECHELUS DAM DOWNSTREAM FISH PASSAGE

FC-201

Preliminary Design Only
Not For Construction

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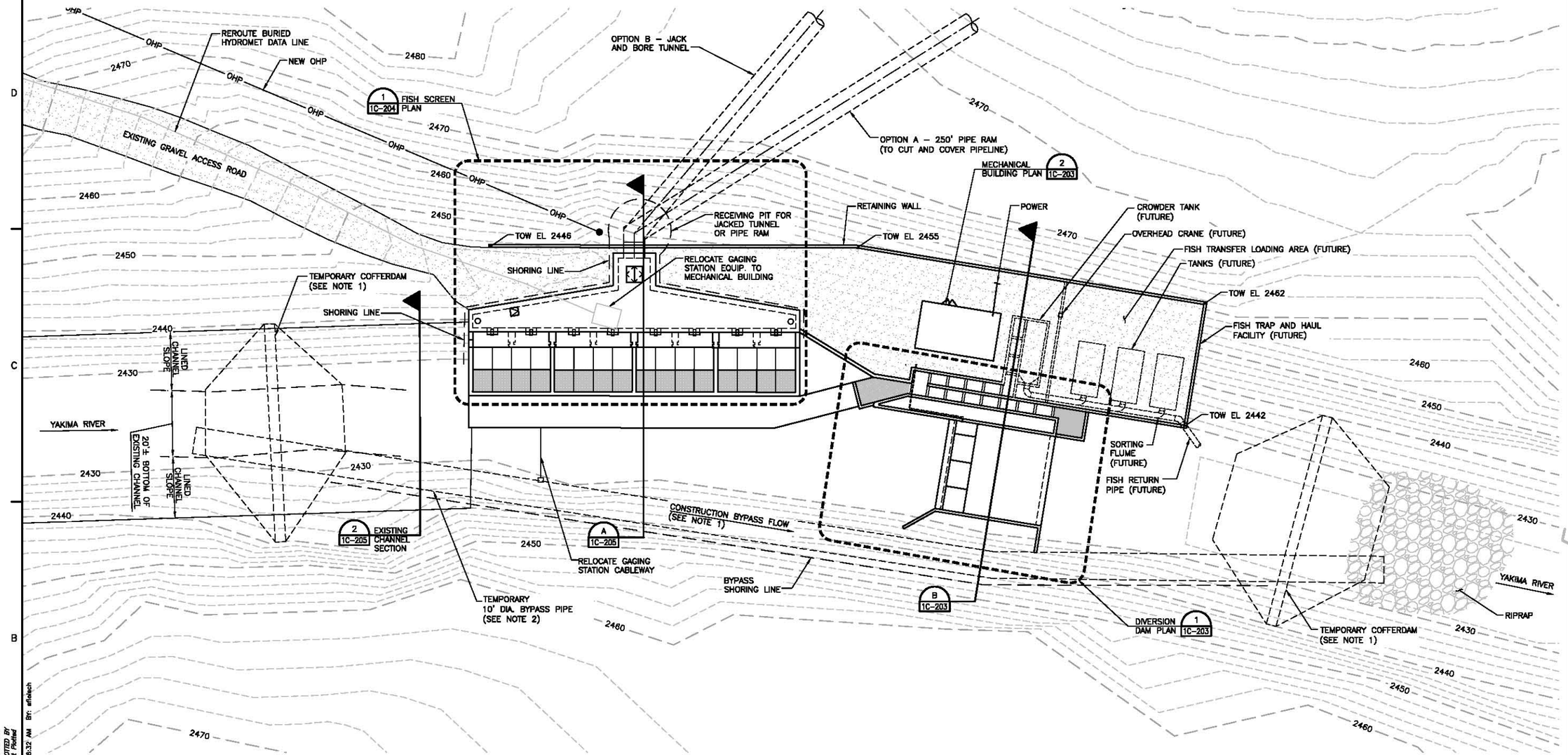

DESIGN CRITERIA

- MAXIMUM DIVERSION: 400 CFS
- MINIMUM POOL DEPTH: 7.0 FT
- SCREEN AREA: 1,150 SQ FT (4 BAYS, 29.25 FT LONG x 9.92 FT WIDE EACH)
- MAXIMUM APPROACH VELOCITY: 0.40 FPS
- MINIMUM 0.8 FPS SWEEPING FLOW
- ATTRACTION FLOW: 50 CFS
- TRAP AND HAUL WATER SUPPLY: 10 CFS (FUTURE)
- MINIMUM FISH LADDER FLOW: 20 CFS
- FISH LADDER MINIMUM POOL SIZE: 8 FT LONG x 6 FT WIDE x 5 FT DEEP
- AUTOMATED AIR BURST CLEANING

DIVERSION & INTAKE SITE PLAN 1 — 1

0 10 20 40
SCALE IN FEET

N

NOTES:

1. COFFERDAM AND RIVER BYPASS TO BE IMPLEMENTED BY CONTRACTOR. PIPE BYPASS IS ONE ALTERNATIVE. RELOCATION WILL BE REQUIRED DURING CONSTRUCTION TO ACCOMMODATE COMPLETION OF ADJUSTABLE CREST DIVERSION DAM AND SCREEN STRUCTURE.
2. BYPASS PIPE ALIGNMENT IS APPROXIMATE.

1C-202
KKC Yakima River Diversion & Intake Site Plan including future Keechelus Dam fish passage

0 1" 2"

FEASIBILITY DRAWING
ELEVATIONS AND DIMENSIONS ARE APPROXIMATE

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HDR

JAMES C. PETERSON — STATE OF WASHINGTON — 27574 — REGISTERED PROFESSIONAL ENGINEER

JOHN D. NELSON — STATE OF WASHINGTON — 39603 — REGISTERED PROFESSIONAL ENGINEER

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YAKIMA PROJECT – WA
KITTITAS DIVISION

KEECHELUS RESERVOIR TO KACHESS RESERVOIR

J. NELSON
DESIGNED

J. PETERSON
REVIEWED

YAKIMA, WA 2014-08-20

YAKIMA RIVER DIVERSION AND INTAKE SITE PLAN

NORTH TUNNEL ALIGNMENT

1C-202
SHEET 6 OF 17

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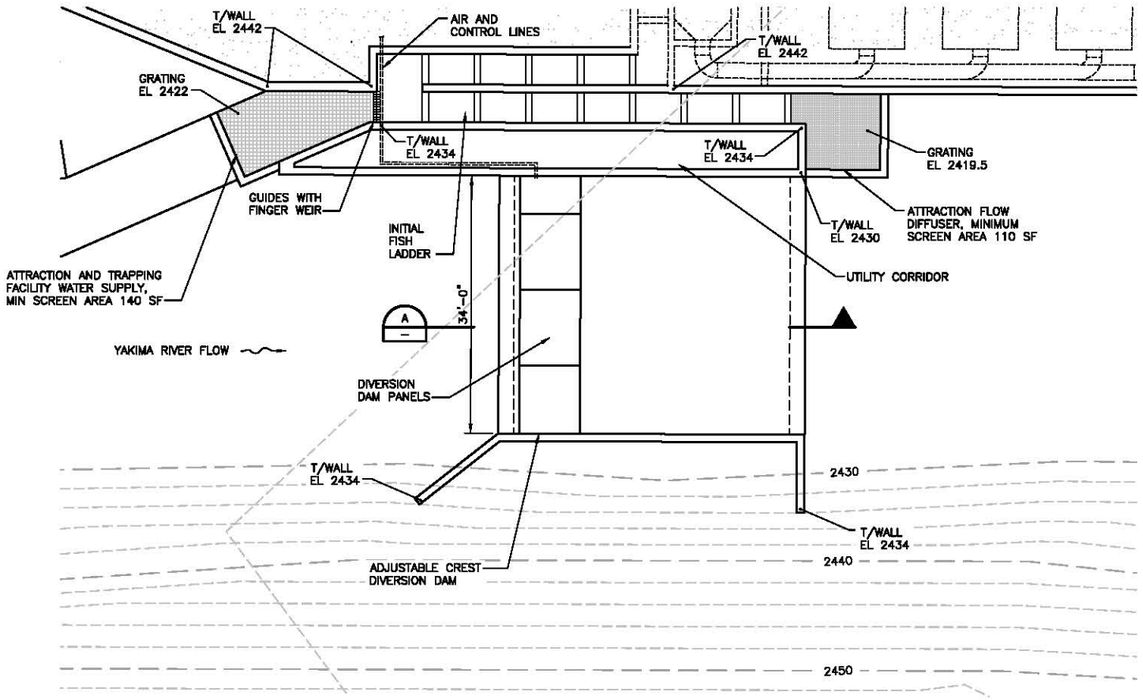
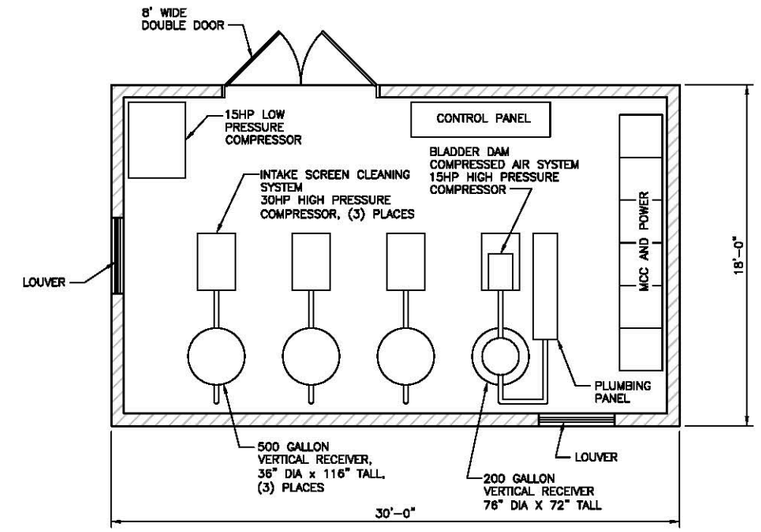
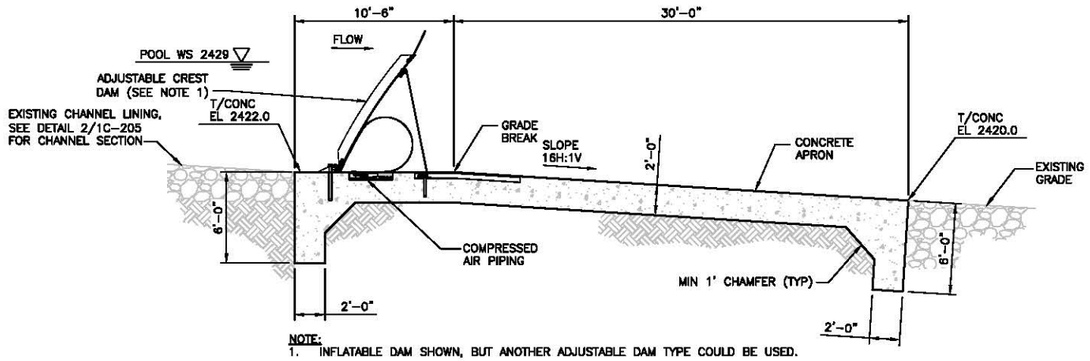


DIVERSION DAM PLAN
SCALE: 1"=10'
1 / 1C-202

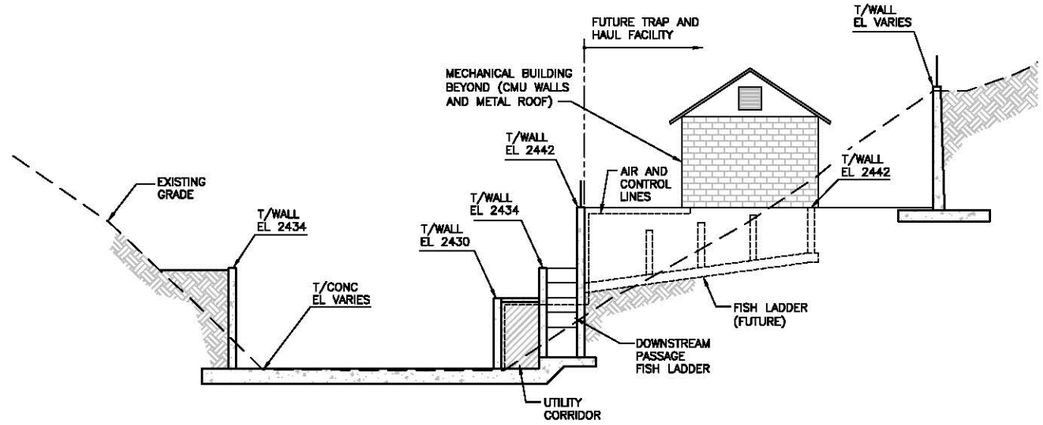


MECHANICAL BUILDING PLAN
SCALE: 1/4"=1'-0"
2 / 1C-202



NOTE:
1. INFLATABLE DAM SHOWN, BUT ANOTHER ADJUSTABLE DAM TYPE COULD BE USED.

DIVERSION DAM SECTION
SCALE: 1"=5'
A / –



DAM SECTION
SCALE: 1"=10'
B / 1C-202

1C-203
KKC Yakima River Diversion Dam Plan and Sections including future Keechelus Dam fish passage facilities

0 1" 2"

FEASIBILITY DRAWING
ELEVATIONS AND DIMENSIONS ARE APPROXIMATE

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JAMES C. PETERSON — STATE OF WASHINGTON — 27574 — REGISTERED PROFESSIONAL ENGINEER

JOHN D. NELSON — STATE OF WASHINGTON — 39603 — REGISTERED PROFESSIONAL ENGINEER

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KITTITAS DIVISION

KEECHELUS RESERVOIR TO KACHESS RESERVOIR

J. NELSON
DESIGNED

J. PETERSON
REVIEWED

YAKIMA, WA 2014-08-20

YAKIMA RIVER DIVERSION DAM PLAN AND SECTION

NORTH TUNNEL ALIGNMENT

1C-203
SHEET 7 OF 17

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B-2: Kachess Dam Fish Passage Concepts

FC-102 Kachess Dam Downstream Fish Passage Options

FC-101 Kachess Dam Upstream Fish Passage Trap and Haul Facility Concept with KDRPP Alternative 1

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NOTE:

1. ABBREVIATIONS INCLUDE:
   - DOA – DEPARTMENT OF AGRICULTURE
   - DOT – DEPARTMENT OF TRANSPORTATION
   - BPA – BONNEVILLE POWER ADMINISTRATION
   - WNF – WASHINGTON NATIONAL FOREST

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KACHESS DROUGHT RELIEF
PUMPING PLANT
KDRPP

FC-102
Kachess Dam Downstream Fish Passage Options

FEASIBILITY DRAWING
ELEVATIONS AND DIMENSIONS ARE APPROXIMATE

J. MANN
DESIGNED

M. BORELLO
REVIEWED

YAKIMA, WA 2014-08-20

DOWNSTREAM FISH PASSAGE OPTIONS

KDRPP

ALTERNATIVE 1
EAST SHORE
PUMPING PLANT

FC-102
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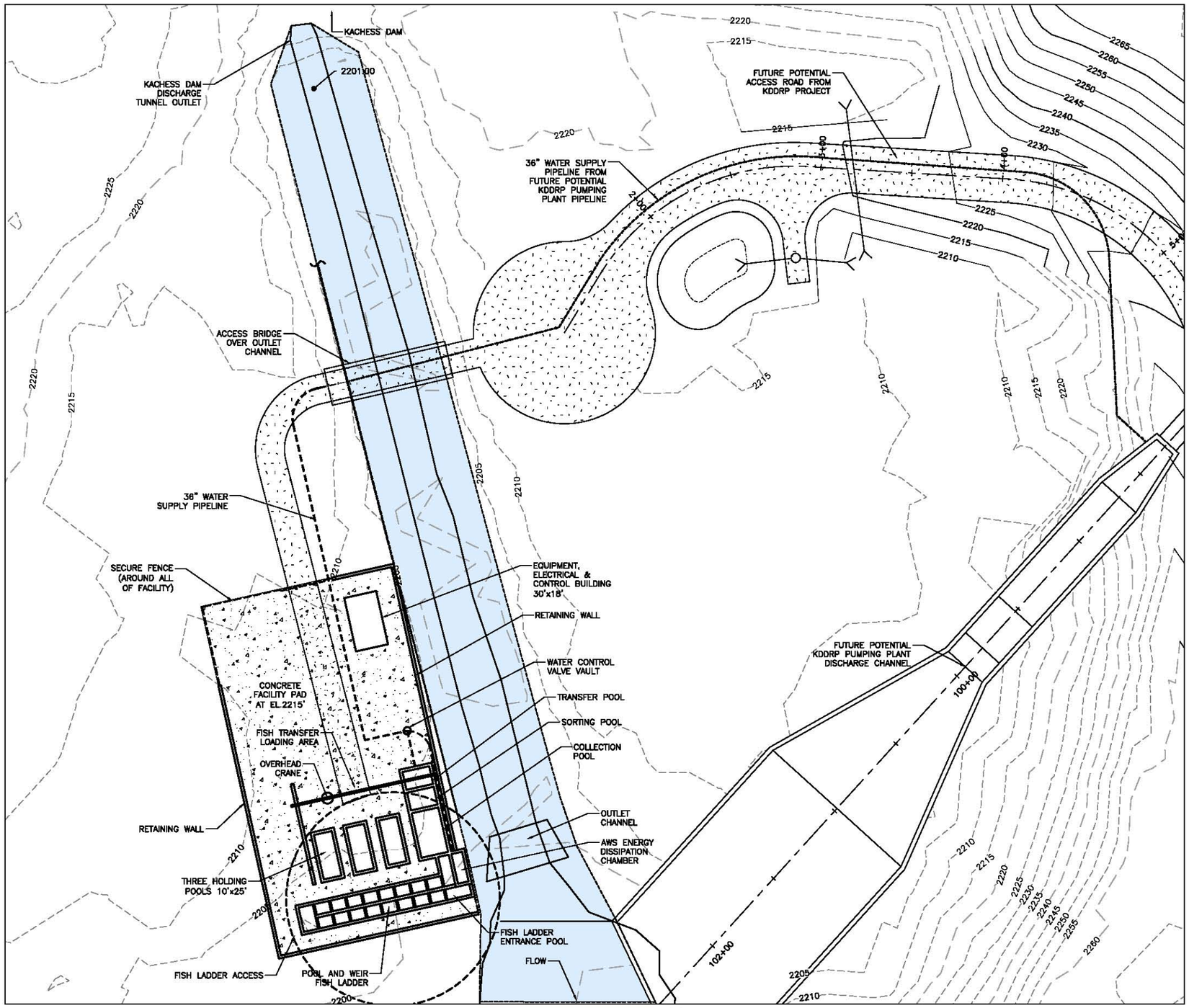

PLAN

FEASIBILITY DRAWING
ELEVATIONS AND DIMENSIONS ARE APPROXIMATE

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YAKIMA PROJECT – WA
KITTITAS DIVISION

KACHESS DROUGHT RELIEF
PUMPING PLANT

J. WARNER
DESIGNED

B. SHAHA
REVIEWED

YAKIMA, WA 2014-08-20

FC-101
Kachess Dam Upstream Fish Passage Trap and Haul Facility Concept with KDRPP Alternative 1

US FISH PASSAGE
CONCEPT DESIGN
PLAN
TRAP AND HAUL FACILITY

ALTERNATE 1

FC-101
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NOTE:

1. ABBREVIATIONS INCLUDE:
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YAKIMA PROJECT - WA
KITTITAS DIVISION

KACHESS DROUGHT RELIEF
PUMPING PLANT
KDRPP

FC-102
Kachess Dam Downstream Fish Passage Options

FEASIBILITY DRAWING
ELEVATIONS AND DIMENSIONS ARE APPROXIMATE

J. MANN
DESIGNED

M. BORELLO
REVIEWED

YAKIMA, WA 2014-08-20

DOWNSTREAM FISH PASSAGE OPTIONS

KDRPP

ALTERNATIVE 1
EAST SHORE
PUMPING PLANT

FC-102
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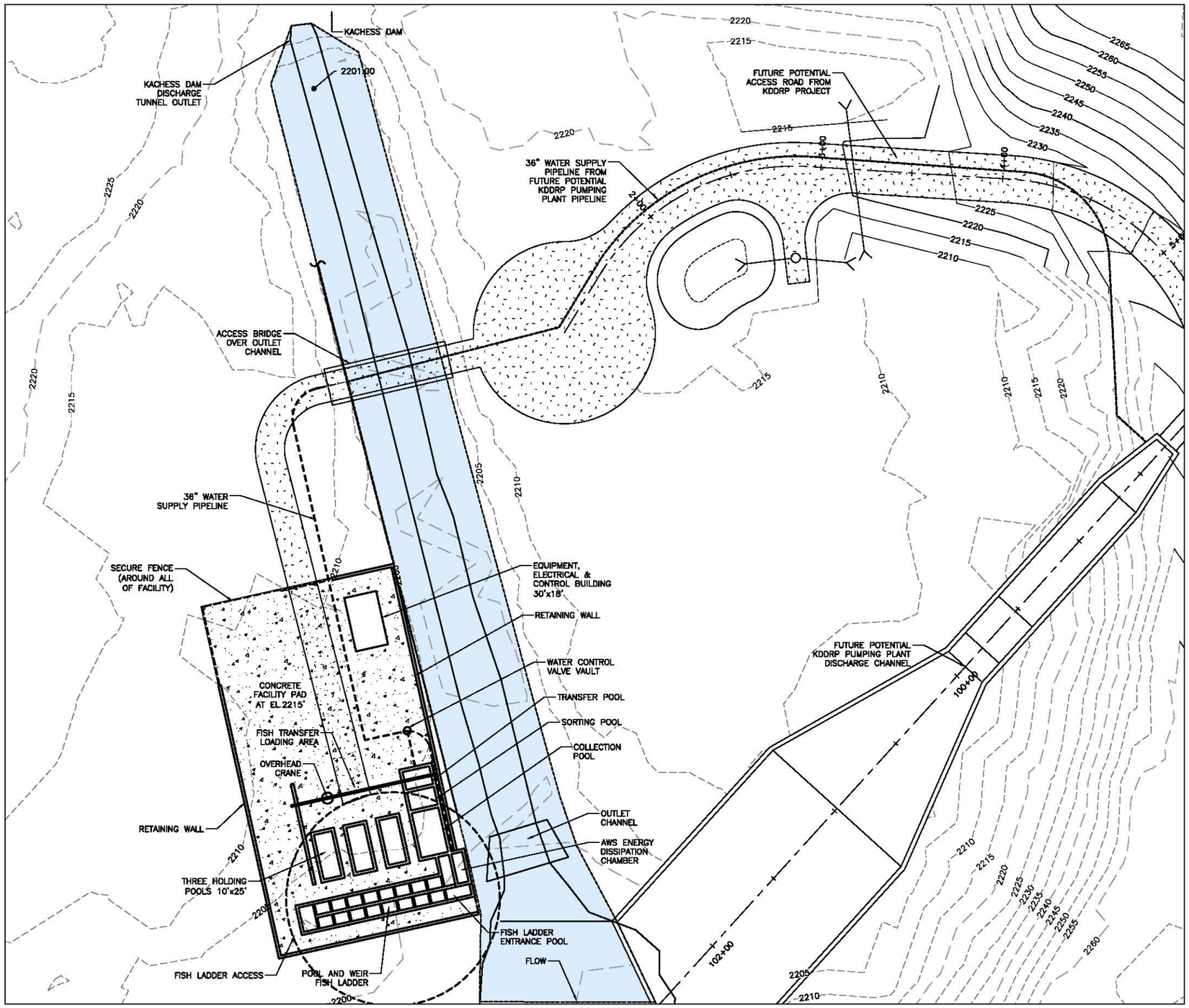

PLAN

FEASIBILITY DRAWING
ELEVATIONS AND DIMENSIONS ARE APPROXIMATE

RECLAMATION
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YAKIMA PROJECT – WA
KITTITAS DIVISION

KACHESS DROUGHT RELIEF
PUMPING PLANT

J. WARNER
DESIGNED

B. SHAHA
REVIEWED

YAKIMA, WA 2014-08-20

FC-101
Kachess Dam Upstream Fish Passage Trap and Haul Facility Concept with KDRPP Alternative 1

US FISH PASSAGE
CONCEPT DESIGN
PLAN
TRAP AND HAUL FACILITY

ALTERNATE 1

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