Howard A. Hanson Dam
Additional Water Storage Project

Section 902 Post Authorization Change Validation Study – Fish Passage
King County, Washington

APPENDIX C

COST ENGINEERING

Final Integrated Validation Report and

Supplemental Environmental Impact Statement

US Army Corps of Engineers®
Seattle District

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Cost Appendix

This appendix provides supplemental and background information on the development of the project cost estimates for the Howard A Hanson Dam Fish Passage Facility Project.

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1 Introduction

The Cost Engineering Section at the USACE Seattle District has prepared this cost estimate to determine the probable engineering and construction costs for the downstream Fish Passage Facility at Howard A Hanson Dam, Ravensdale, Washington. The point of contact for this estimate is Ray Koong, Cost Engineering, 206-316-3899.

2 Summary of Project Features

This project includes construction of a Multiport Collector, Full Flow Bypass Structure, Deceleration Tunnel and Outlet Structure. The Multiport Collector consists of 5 horns stacked vertically to allow for collection of fish over the typical fluctuations in the reservoir water surface. Connected to the collector is the Full Flow Bypass Structure which consists of a Steep Slope Bypass and Full Flow Bypass. At the Steep Slope Bypass five primary bypasses – one for each collector horn – convey fish from the collector through the dam and to the bottom of the steep slope bypass before merging into a U-shaped steel conduit at the deceleration tunnel. The Full Flow Bypass conveys the water that is screened off at each of the 5 horns down to the deceleration tunnel. The Deceleration Tunnel is a 15' horseshoe tunnel that runs approximately 1,225' through the left abutment of the dam and exits downstream to the Outlet Structure. The Outlet Structure includes a stilling basin and scour pool for reintroducing the water from the Full Flow Bypass into the river. The Primary Bypass with the fish is diverted another ~200' downstream of the full flow stilling basin (~400' downstream of the end of the Deceleration Tunnel) through an elevated conduit to an exit into a plunge pool in the river.

3 Recommended Plan Cost

The Recommended Plan is the construction of a downstream Fish Passage Facility consisting of a Multiport Collector, Full Flow Bypass Structure, Deceleration Tunnel and Outlet Structure. The cost of the Recommended Plan is summarized below and detailed in the attached TPCS.

Table 1 – TSP Cost Estimate ($K)

Feature	First Cost (FY22)	Fully Funded (FY Varies)
Phase 1 Sunk Cost*	111,440	111,440
06 – HAHD Fish Passage Facility	602,310	719,325
06 – Adaptive Management	11,458	15,457
01 – Lands and Damages	296	340
30 – PED	76,046	85,324
31 – Construction Mgmt.	17,684	20,767
Total Phase 1	819,234	952,653
Phase 2		
06 – Additional Water Storage	22,859	57,489
01 – Lands and Damages	399	616
30 – PED	10,408	16,093
31 – Construction Mgmt.	2,285	3,864
Total Phase 2	35,951	78,062
Total	**855,185**	**1,030,715**

*Spent through consists of $98,959K in construction, $1,901K in lands & damages and $10,580K in GI PED provided by the NWS Planning Branch

4 Cost Estimate Development

The estimates were prepared in accordance with ER 1110-2-1150 E&D Civil Works Projects, and ER 1110-2-1302 E&D Civil Works Cost Engineering.

The basis for the cost estimates was conceptual design, post authorization change validation study engineering appendix and quantities prepared by the Project Delivery Team (PDT). The cost engineer verified the provided quantities were reasonable and calculated additional supporting quantities as necessary (e.g. tunnel walls, stilling basin, bypass flumes). Additional information provided by the PDT via e-mails, phone calls, and in-person discussions was incorporated into the estimate.

The cost estimates were prepared using the Corps of Engineers Micro-Computer Aided Cost Estimating System II (MII). The estimates were developed at a Class 3 level in order to support Section 902 post authorization change. Per ER 1110-2-1302, a Class 3 estimate is supported by a technical information (scope, design, acquisition and construction methods, etc.) discussion within the estimate and the uncertainties associated with each major cost item in the estimate.. Uncertainties were documented in the Cost and Schedule Risk Analysis (CSRA) risk register, and a risk-based contingency was developed using a Monte Carlo simulation done with Crystal Ball.

4.1 Price Level

The estimated cost is communicated at three price levels: "Estimated Cost," "Project First Cost," and "Total Project Cost." The Estimated Cost is the construction cost calculated in MII based on the actual price level on the preparation date. The Project First Cost includes escalation from the estimate date to the anticipated date of Authorization, and the Total Project Cost includes escalation to the anticipated midpoint of construction.

The estimate price level is April 2022 (reported as FY22 Q1). The project first cost is presented at the October 2021 price level (FY22) for programming. The midpoints of construction vary by feature.

4.2 Estimate Structure and Feature Cost Development

The estimate is organized at a high level by feature to match the Civil Works Work Breakdown Structure (WBS) accounts. This ensures the MII estimate is consistent with the risk analysis and the TPCS. The pertinent WBS accounts and their usage are summarized below.

Phase 1 Sunk Cost

Phase 1 sunk costs include both construction and GI PED (General Investigation Planning, Engineering & Design) spent since the Additional Water Storage Project (AWSP) was initially authorized in Water Resources Development Act (WRDA) of 1999

06 HAHD Fish Passage Facility

Multiport Collector

This feature is based on the Aug 2008, 95% level of design which has been mostly adopted for this current Feasibility Phase Design. The current Multiport Collector estimate likewise is based on the estimate originally created by USACE NWW on 19 July 2007. Certain cost elements have been removed and or added per current design. For example, fish holding and sorting structure was removed while an intake crane and stoplogs were added. Material, labor and equipment costs were also updated. The team reviewed the 95% designs and prepared a complete quantity take off for all the structural, mechanical, electrical, and plumbing work. Quantities for architectural work and other miscellaneous features were reused where appropriate with adjustments made by the team as necessary based on engineering judgment.

Full Flow Bypass Structure

Volume for this new concrete structure were developed based on draft elevation drawings provided by the PDT — these sections were pulled from the 3D model prepared in Inventor. The earthwork quantities came from Inroads. Excavation will be completed by drilling and blasting in 10 feet lifts. Rock stabilization will be installed as necessary after completion of each excavated lift. The Full Bypass Structure is primary bypass and full flow bypass. The primary bypass is a series of custom fabricated stainless steel conduits that are embedded in concrete which serve to transport fish from the collector horn downstream to the outfall location. The full flow bypass is two concrete channels constructed side by side. Each channel is 4’ wide and 8’ high. Three ports will feed one conduit and two ports will feed the other. Each conduit will also be constructed with custom fabricated stainless steel plates upstream and downstream from service gate slot. Concrete will require a class A surface finish and 6 inches of cover over embedded rebar.

Full Flow Tunnel

The tunnel is cast in place concrete with a class A finish comprised of a primary bypass and two side by side full flow bypasses. The tunnel length is approximately 1,225 ft long which connects the Full Flow Bypass Structure and Outlet Structure. Tunneling is expected to encounter rock and will be performed by blasting. Tunneling stabilization will require wall anchoring and shotcrete fiber reinforced liner.

Outlet Structure

The Outlet Structure consists of a bridge, tunnel outlet, stilling basin, downstream access road and outfall pipe. The bridge is composed of precast concrete post tensioned slabs with a concrete topping slab will be provided with approach ramps. The tunnel outlet contains exterior excavation and sidewall stabilization to enable the transition to the stilling basin. The stilling basin is a concrete structure that is approximately 130 ft in length and incorporate a parabolic transition from the deceleration tunnel exit to basin apron. The downstream access road is an improvement of the existing gravel road. The fish outfall location will be reached by providing a 4-foot diameter outfall pipe from the end of the deceleration tunnel to the location approximately 200 feet downstream from the end of the stilling basin. The outfall pipe is supported on piers every 55 feet for 210 feet and then cantilevers beyond the last pier 15 feet before releasing the primary bypass flow.

06 Adaptive Management

Adaptive Management consists of a list of features that may be implemented post construction if needed. Some of the notable features are tunnel relining or refinish, replace/change porosity plates behind the MIS screens, installation of fish guidance nets and additional log boom. Each feature is evaluated based on the likelihood of implementation with likely features applied at 100%, possible features at 50% and unlikely features not applied.

01 Land and Damages

Land and Damages is the cost of land provided by the Non-Federal Sponsor (NFS) and its value is based on the cost table provided by NWS Real Estate.

30 Planning, Engineering, and Design

The Planning, Engineering and Design (PED) costs are the design costs from authorization until project completion. This work includes detailed surveys, soil investigations, preparation of the plans and specifications to guide the contractor to construct the project, and designer support during construction. All values are based on the work plan developed by the design lead with input from the PDT.

31 Construction Management

Construction Management (CM) – sometimes called Supervision and Administration, or S&A – includes the cost of project managers, project engineers, and other field staff supervising the project construction. All values are based on the work plan developed by the design lead with input from the PDT.

Phase 2 Additional Water Storage

Phase 2 Additional Water Storage consists of restoration costs that would be required to make up for stream habitat, elk forage, upland forest, and wetland riparian zone inundated by the pool raise.

01 Land and Damages

Land and Damages is the cost of non-federal land required for Phase 2 as provided by NWS Real Estate.

30 Planning, Engineering, and Design

Phase 2 (PED) consists of additional monitoring, dam safety study and design effort relating to habitat restoration due to pool raise.

31 Construction Management

Phase 2 (CM) includes the cost of project managers, project engineers, and other field staff supervising the habitat restoration due to pool raise.

4.3 Key Assumptions

Several key assumptions were made to estimate the construction costs:

- Mob and demob is assumed to be 5% of direct cost.
- Multiport Collector is somewhat based on the previous NWW CWE, with new features added or omitted if no longer needed. New takeoff quantities have been developed

based on the 95% 2008 design drawings for the Multiport Collector concrete structure and MEP items.

- Two tower cranes for the full duration to support the project.
- Excavation is performed by blasting with sidewall stabilization based on Engineering Appendix.
- Earthwork quantities and structural volumes are provided by the PDT.
- Unused excavated material can be hauled and disposed at the 6-mile disposal site, located about 2.2 miles from the dam.
- On site concrete batch plant is assumed.
- Tunneling will start from the downstream side concurrent with excavation work on the upstream.
- Two crews working 5 days a week, 10 hours a day.

5 Risk-Based Contingency Development

A Construction Schedule Risk Analysis (CSRA) was conducted with the PDT in order to identify, assess, and mitigate all potential risks to the project. The risks identified are documented in the CSRA document included as an attachment. Analysis of these risks contributed to the determination of how much contingency should be added to the total cost of the project. The CSRA has been updated to reflect the base case estimate and risks inherent in the Recommended Plan. Key risks identified include:

- Proper escalation value
- Delay in funding – Construction phase
- Design criteria changes
- Modifications
- Delays in funding – Design phase
- Completeness of scope of work
- High quality finishes in confined spaces
- Blasting near existing structures
- Incomplete structural design
- Weather impacts

6 Construction and Implementation Schedules

The implementation schedule is established by the work plan developed by the design lead. The construction schedule is developed in Primavera P6 and is informed by construction durations from the cost estimate.

The implementation schedule is summarized in the table below:

Table 2 – Implementation Schedule of the TSP

Event	Duration (mo)	Start	Finish	Midpoint	Notes
Feasibility	10	Aug 2021	June 2022	Jan 2022	Feasibility finalized with the Chief's report in June 2022.
Authorization & Approval	12	June 2022	June 2023	Dec 2022	Awaiting authorization and approval
Investigations, Design, Acquisition	42	Oct 2022	April 2026	July 2024	Start when IIJA funding is received
Construction	52	April 2026	Aug 2030	May 2028	Reference attached P6 schedule
Post Construction Monitoring	48	Aug 2030	Aug 2034	Aug 2032	

7 Enclosures

The following attachments supplement this appendix.

1. TPCS
2. CSRA Risk Register and Outputs
3. P6 Construction Schedule

Enclosures 1: TPCS

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Howard A. Hanson Dam Additional Water Storage Project**
PROJECT NO: P2 488932
LOCATION: Ravendale, WA

DISTRICT: Seattle District **PREPARED: 4/4/2022**
POC: CHIEF, COST ENGINEERING, Ian Pumo

This Estimate reflects the scope and schedule in report; HAHD FPF Engineering Appendix and 15% Design Drawings

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2022 Effective Price Level Date: 1 OCT 21									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: **1-Oct-21** ($K)	**TOTAL FIRST COST** ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*K*	*L*	*M*	*N*	*O*
06	Phase 1 - Fish Passage Facility	$409,178	$204,589	50.0%	$613,768	0.0%	$409,178	$204,589	$613,768	$98,959	$712,726	19.7%	$489,855	$244,927	$833,741
06	Phase 2 - Additional Water Storage	$15,239	$7,620	50.0%	$22,859	0.0%	$15,239	$7,620	$22,859	$0	$22,859	151.5%	$38,326	$19,163	$57,489
	CONSTRUCTION ESTIMATE TOTALS	$424,417	$212,209		$636,626	0.0%	$424,417	$212,209	$636,626	$98,959	$735,585	24.4%	$528,181	$264,090	$891,230
01	LANDS AND DAMAGES	$556	$139	25.0%	$695	0.0%	$556	$139	$695	$1,901	$2,596	37 5%	$765	$191	$2,857
30	PLANN NG, ENGINEER NG & DESIGN	$72,046	$14,409	20.0%	$86,455	0.0%	$72,046	$14,409	$86,455	$10,580	$97,035	17.3%	$84,514	$16,903	$111,997
31	CONSTRUCTION MANAGEMENT	$16,641	$3,328	20.0%	$19,969	0.0%	$16,641	$3,328	$19,969	$0	$19,969	23.3%	$20,526	$4,105	$24,632
	PROJECT COST TOTALS	$513,660	$230,085	44.8%	$743,746		$513,660	$230,085	**$743,746**	$111,440	**$855,185**	23.6%	$633,986	$285,290	$1,030,715

______________________ **CHIEF, COST ENGINEERING,**

______________________ **PROJECT MANAGER,**

______________________ **CHIEF, REAL ESTATE,**

______________________ **CHIEF, PLANNING,**

______________________ **CHIEF, ENGINEERING,**

______________________ **CHIEF, OPERATIONS,**

______________________ **CHIEF, CONSTRUCTION,**

______________________ **CHIEF, CONTRACTING,**

______________________ **CHIEF, PM-PB**

______________________ **CHIEF, DPM,**

ESTIMATED TOTAL PROJECT COST: $1,030,715

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Howard A. Hanson Dam Additional Water Storage Project
LOCATION: Ravendale, WA
This Estimate reflects the scope and schedule in report; HAHD FPF Engineering Appendix and 15% Design Drawings

DISTRICT: Seattle District
POC: CHIEF, COST ENGINEERING, Ian Pumo
PREPARED: 4/26/2022

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			28-Apr-22	Program Year (Budget EC):			2022					
		Effective Price Level:			1-Oct-21	Effective Price Level Date:			1 OCT 21					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 - FPF CONSTRUCTION & MONITORING													
06	Fish Passage Facility	$401,540	$200,770	50.0%	$602,310	0.0%	$401,540	$200,770	$602,310	2028Q3	19.4%	$479,550	$239,775	$719,325
06	Adaptive Management	$7,638	$3,819	50.0%	$11,458	0.0%	$7,638	$3,819	$11,458	2033Q2	34.9%	$10,304	$5,152	$15,457
06			$0	50.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06			$0	50.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06			$0	50.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$409,178	$204,589	50.0%	**$613,768**		$409,178	$204,589	$613,768			$489,855	$244,927	$734,782
01	LANDS AND DAMAGES	$237	$59	25.0%	$296	0.0%	$237	$59	$296	2027Q1	14.9%	$272	$68	$340
30	PLANNING, ENGINEERING & DESIGN													
0.4%	Project Management	$1,530	$306	20.0%	$1,836	0.0%	$1,530	$306	$1,836	2024Q3	6.4%	$1,627	$325	$1,953
0.5%	Planning & Environmental Compliance	$1,863	$373	20.0%	$2,236	0.0%	$1,863	$373	$2,236	2024Q3	6.4%	$1,982	$396	$2,378
8.8%	Engineering & Design	$35,824	$7,165	20.0%	$42,989	0.0%	$35,824	$7,165	$42,989	2024Q3	6.4%	$38,105	$7,621	$45,726
0.4%	Reviews, ATRs, IEPRs, VE	$1,752	$350	20.0%	$2,102	0.0%	$1,752	$350	$2,102	2024Q3	6.4%	$1,864	$373	$2,236
0.3%	Life Cycle Updates (cost, schedule, risks)	$1,100	$220	20.0%	$1,320	0.0%	$1,100	$220	$1,320	2024Q3	6.4%	$1,170	$234	$1,404
0.3%	Contracting & Reprographics	$1,040	$208	20.0%	$1,248	0.0%	$1,040	$208	$1,248	2024Q3	6.4%	$1,106	$221	$1,327
2.4%	Engineering During Construction	$9,648	$1,930	20.0%	$11,577	0.0%	$9,648	$1,930	$11,577	2028Q3	17.4%	$11,330	$2,266	$13,596
0.0%	Planning During Construction	$0	$0	20.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.4%	Monitoring	$9,897	$1,979	20.0%	$11,876	0.0%	$9,897	$1,979	$11,876	2033Q2	32.9%	$13,155	$2,631	$15,786
0.2%	Project Operations	$718	$144	20.0%	$862	0.0%	$718	$144	$862	2024Q3	6.4%	$764	$153	$916
31	CONSTRUCTION MANAGEMENT													
2.9%	Construction Management	$11,855	$2,371	20.0%	$14,226	0.0%	$11,855	$2,371	$14,226	2028Q3	17.4%	$13,923	$2,785	$16,707
0.3%	Project Operation:	$1,176	$235	20.0%	$1,411	0.0%	$1,176	$235	$1,411	2028Q3	17.4%	$1,381	$276	$1,657
0.4%	Project Management	$1,705	$341	20.0%	$2,046	0.0%	$1,705	$341	$2,046	2028Q3	17.4%	$2,003	$401	$2,403
	CONTRACT COST TOTALS:	$487,524	$220,270		$707,794		$487,524	$220,270	**$707,794**			$578,536	$262,677	**$841,214**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Howard A. Hanson Dam Additional Water Storage Project
LOCATION: Ravendale, WA
This Estimate reflects the scope and schedule in report; HAHD FPF Engineering Appendix and 15% Design Drawings

DISTRICT: Seattle District
POC: CHIEF, COST ENGINEERING, Ian Pumo

PREPARED: 4/26/2022

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: Effective Price Level:			28-Apr-22 1-Oct-21	Program Year (Budget EC): Effective Price Level Date:			2022 1 OCT 21					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 2 – ADDITIONAL WATER STORAGE													
06	Streambank Habitat	$4,179	$2,090	50.0%	$6,269	0.0%	$4,179	$2,090	$6,269	2042Q1	68.9%	$7,056	$3,528	$10,584
06	Streambank Habitat - AM at 10 years	$840	$420	50.0%	$1,260	0.0%	$840	$420	$1,260	2053Q3	126.9%	$1,906	$953	$2,859
06	Elk Forage Habitat	$264	$132	50.0%	$396	0.0%	$264	$132	$396	2042Q1	68.9%	$446	$223	$669
06	Elk Forage Habitat - 50 yr maintenance	$7,500	$3,750	50.0%	$11,250	0.0%	$7,500	$3,750	$11,250	2068Q1	229.1%	$24,683	$12,341	$37,024
06	Upland Forest Habitat	$252	$126	50.0%	$378	0.0%	$252	$126	$378	2042Q1	68.9%	$426	$213	$638
06	Upland Forest Habitat - AM at 10 years	$96	$48	50.0%	$144	0.0%	$96	$48	$144	2053Q3	126.9%	$218	$109	$327
06	Riparian Zone Habitat	$1,741	$871	50.0%	$2,612	0.0%	$1,741	$871	$2,612	2042Q1	68.9%	$2,940	$1,470	$4,410
06	Riparian Zone Habitat - 2 yr maintenance	$367	$184	50.0%	$551	0.0%	$367	$184	$551	2044Q1	77.7%	$652	$326	$978
	CONSTRUCTION ESTIMATE TOTALS:	$15,239	$7,620	50.0%	**$22,859**		$15,239	$7,620	$22,859			$38,326	$19,163	$57,489
01	LANDS AND DAMAGES	$319	$80	25.0%	$399	0.0%	$319	$80	$399	2038q3	54.4%	$492	$123	$616
30	PLANNING, ENGINEERING & DESIGN													
n/a	Phase 2 Monitoring	$4,066	$813	20.0%	$813	0.0%	$4,066	$813	$4,879	2038Q3	53.2%	$6,229	$1,246	$7,475
n/a	Dam Safety Study	$570	$114	20.0%	$4,180	0.0%	$570	$114	$684	2038Q3	53.2%	$873	$175	$1,048
2.5%	Project Management	$381	$76	20.0%	$646	0.0%	$381	$76	$457	2038Q3	53.2%	$584	$117	$700
1.0%	Planning & Environmental Compliance	$152	$30	20.0%	$411	0.0%	$152	$30	$183	2038Q3	53.2%	$233	$47	$280
15.0%	Engineering & Design	$2,286	$457	20.0%	$610	0.0%	$2,286	$457	$2,743	2038Q3	53.2%	$3,502	$700	$4,203
1.0%	Reviews, ATRs, IEPRs, VE	$152	$30	20.0%	$183	0.0%	$152	$30	$183	2038Q3	53.2%	$233	$47	$280
1.0%	Life Cycle Updates (cost, schedule, risks)	$152	$30	20.0%	$183	0.0%	$152	$30	$183	2038Q3	53.2%	$233	$47	$280
1.0%	Contracting & Reprographics	$152	$30	20.0%	$183	0.0%	$152	$30	$183	2038Q3	53.2%	$233	$47	$280
3.0%	Engineering During Construction	$457	$91	20.0%	$549	0.0%	$457	$91	$549	2042Q1	69.1%	$773	$155	$927
2.0%	Planning During Construction	$305	$61	20.0%	$366	0.0%	$305	$61	$366	2042Q1	69.1%	$515	$103	$618
0.0%	Adaptive Management & Monitoring	$0	$0	20.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Operations	$0	$0	20.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$1,524	$305	20.0%	$1,829	0.0%	$1,524	$305	$1,829	2042Q1	69.1%	$2,576	$515	$3,091
0.0%	Project Operations	$0	$0	20.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$381	$76	20.0%	$457	0.0%	$381	$76	$457	2042Q1	69.1%	$644	$129	$773
	CONTRACT COST TOTALS:	$26,137	$9,815		$33,666		$26,137	$9,815	**$35,952**			$55,449	$22,612	**$78,062**

Enclosures 2: CSRA Risk Register and Outputs

					Project Cost			Project Schedule		
REF	**Risk Type**	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Likelihood (C)**	**Impact (C)**	**Risk Level (C)**	**Likelihood (S)**	**Impact (S)**	**Risk Level (S)**
1	1 - Project & Program Management (PM)	WRDA 22	If the PDT miss WRDA 22. This is likely. If that happens, USACE won't receive funding until 2025 which reduces the design, acquisition, and construction windows to meet the 2030 deadline.	Assume this could cause a two year delay to the project. This risk is intentionally excluded because the current goal and cost estimate is setup for making WRDA 22. This risk has a potential impact of 2 year delay. If PDT failed to meet this goal then leadership would have to re-assess/plan this project and cost will update the number if WRDA 22 is missed. **UPDATE: Seattle will receive $200m in IIJA funding in October 2022, so even if WRDA window is missded, PDT will have enough funding to get through PED and (potentially begin acquisition).** **Do not model!**	Likely	Critical	**High**	Likely	Critical	**High**
2	1 - Project & Program Management (PM)	Delay in funding - Design phase	If there is a funding delay then PDT may be required to take additional measures to accelerate the schedule.	Design Funding is delays by 6 months and the design team is required to accelerate design work by 6 months. Modeled at a possible (<30%) and up to a 10% increase to design costs due to potential for inefficiencies and rework. As shown by MMD, when work is ran concurrently there is often changes that cause lost work and inefficiency due to the team having to make assumptions to keep moving.	Possible	Moderate	**Medium**	Unrated	Critical	**#N/A**
3	1 - Project & Program Management (PM)	Delay in funding - Construction phase	If there is a funding delay then PDT may be required to take additional measures to accelerate the schedule.	Construction Funding is delays by 6 months and we are required to shorten the construction duration by 6 months. Modeled at a possible (<30%) and up to a 5% increase in construction cost due to acceleration of the contract.	Possible	Critical	**High**	Unrated	Critical	**#N/A**
4	5 - Contract Acquisition Risks (CA)	Undefined acquisition strategy	Is there a defined acquisition strategy?	While PDT don't have one set currently but it's most likely going to be best value tradeoff and most likely full and open. This is a strategy that we have plenty of experience with. Not a risk.	Unrated	Negligible	**#N/A**	Unrated	Significant	**#N/A**
5	5 - Contract Acquisition Risks (CA)	Risk of Protest	Receive a protest at the end of acquisition	Assume it will take up to 3 months to resolves protest	Possible	Negligible	**Low**	Possible	Critical	**High**
6	5 - Contract Acquisition Risks (CA)	Year end acquisition timeline	During year end acquisition timeline could increase	1 to 2 months	Possible	Negligible	**Low**	Possible	Significant	**Medium**
7	5 - Contract Acquisition Risks (CA)	Offers above IGE	Risk of offers exceeding our IGE by +/-25%	1 to 2 months	Possible	Negligible	**Low**	Possible	Significant	**Medium**
8	5 - Contract Acquisition Risks (CA)	Early completion	If timely completion of this project is critical, would PDT consider offering a early completion incentive?	Assume 2% of the construction contract to reduce the contract duration by a significant timeframe. For example on McChord Bridge project the offer was $50k per day up to 30 days. MMD have a specific amount but it was 6 month intervals	Likely	Moderate	**Medium**	Likely	Negligible	**Low**
9	5 - Contract Acquisition Risks (CA)	Attract competition/qualified contractors	Is there a risk of not attracting enough competition or qualified contractors for a project of this complexity and magnitude?	Shouldn't be an issue based on MMD FPF, McChord Bridge and other projects in the region. This is not a risk.	Unrated	Negligible	**#N/A**	Unrated	Significant	**#N/A**
10	7 - General Technical Risk (TR)	Change in the length of the steep slope bypass	The length of the Steep slope bypass could change due to refined hydraulic modeling resulting in an increase or decrease in the length of the open excavation and outlet tunnel stabilization. The proposed additional excavation and tunnel are within 13' of the existing tunnel which requires stabilization of the rock between the structures prior to excavation. Additional stabilization could be required either due to additional excavation requirements or less stable rock than anticipated.	If the excavation scope grows, length of the reinforcement would need to increase to match the excavation as required. Due to the length of the steep slope increasing. Assume 5% chance of this happening. 20% length increase/decrease resulting in increase/decrease in the tunnel length, open excavation requirements, and rock stabilization for the existing outlet tunnel	Possible	Significant	**Medium**	Possible	Negligible	**Low**
11	7 - General Technical Risk (TR)	Tunnel Alignment adjacent to Railway	The structure and tunnel are currently placed between the existing outlet tunnel and the railroad alignment. If the tunnel has to shift under the railroad alignment, additional real estate would be required to construct the project. This could also potentially delay the project schedule.	Very low probability that we will align the tunnel anywhere close to Railway, possible one year delay plus, confirm with real estate current alignment not impacting railway. Risk not assessed, probabaility is too low.	Unrated	Critical	**#N/A**	Unrated	Critical	**#N/A**
12	7 - General Technical Risk (TR)	Stilling Basin alignment adjustments	The proposed stilling basin comes in at an approximately 30 degree angle to the river, due to hydraulics it may be required to adjust this to be more parallel to the river, increasing the overall length of the tunnel.	The tunnel will most likely change as we are only in feasibility. It could be up to 100' longer and probability is likely.	Likely	Marginal	**Medium**	Likely	Marginal	**Medium**
13	7 - General Technical Risk (TR)	Modify Existing Stilling Basin	To improve fish survivability	Extend excavation by add additional 30 yd, grouting surface 2' thick slab and wall and riprap. Cost is negligible so not assessed.	Possible	Negligible	**Low**	Possible	Negligible	**Low**
14	7 - General Technical Risk (TR)	MIS pivot point changes	The Modular Incline Screen has remained the same as the previous design, the screen may need to be redesigned to sit flush in the floor either with a changing the pivot point or moving to a system that provides a more mobile screen significantly increasing the complexity of the system.	This is unlikely. The most likely change is the MIS screen shifting to the floor which would be a negligible cost. The cost is probably $50k per screen and $250K total. Cost too negligible so not assessed.	Unlikely	Negligible	**Low**	Unlikely	Marginal	**Low**
15	7 - General Technical Risk (TR)	Conduits not designed to be pressurized	The primary bypass and full flow bypass structures are not designed to be pressurized, there is a potential that during design the conduits will need to be upsized or further reinforced to avoid/design for pressurization.	Not a risk, facility is designed for pressure and H&H is confident that the conduit will not increase in size.	Unrated	Negligible	**#N/A**	Unrated	Negligible	**#N/A**
16	7 - General Technical Risk (TR)	Design Criteria Changes	There is a potential that the design criteria we have developed will change during design and therefore requiring modifications to the design.	Steep slope is an experimental technology which does not have defined criteria, which means there is not a define criteria from NMFS and experience says the criteria will change during design. This could push the design back to a Helix structure. Considering the Cle Elum design for the Helix was $100M.	Unlikely	Critical	**Medium**	Unlikely	Negligible	**Low**
17	7 - General Technical Risk (TR)	Stoplog Slot Conditions unknown	Due to the tight tolerances of the existing stoplogs and unknown condition of the slots after pounding the stoplogs in place, the slots may need to be modified or rehabbed at the end of construction. This would either require extensive dive work or an additional cofferdam.	Base case estimate includes the effort to inspect stoplog slots and to have a dive team rehab them (ground concrete and mill smooth). Base case also includes full replacement of stoplogs. Team will include stoplog inspection in initial investigations so that a stoplog issue will not delay construction.	Unrated	Negligible	**#N/A**	Unrated	Negligible	**#N/A**
18	7 - General Technical Risk (TR)	Placement of Trash rack on existing Structure	The trash rack is intended to be attached to the existing track rack, there is a potential that it will need to be move upstream 6' to allow racking of the trash rack. This work would either require an additional cofferdam or need to be done at low pool.	Can use existing slots, no longer a risk	Unrated	Negligible	**#N/A**	Unrated	Negligible	**#N/A**
19	7 - General Technical Risk (TR)	Additional Geotechnical Explorations	The cost for geotechnical explorations is based on a percentage of the construction for certain features, once a plan is developed the expected cost could be exceeded either due to an increase in needed data or due to escalating costs for explorations.	Additional $1M in exploration costs due to increases in the labor costs or additional borings	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
20	7 - General Technical Risk (TR)	Geological conditions better or worse than expected	The bedrock through the left abutment has some known poor quality areas, this could lead to a need for more structural reinforcement in the excavation or tunnel efforts.	Running into really bad quality rock, flowing ground water could require using steel sets (additional stabilization) or additional grouting of faults. 10-20% more stabilization for the tunnel. Stabilization for sidewall is sufficient	Possible	Negligible	**Low**	Possible	Negligible	**Low**
21	7 - General Technical Risk (TR)	Modifications to the physical model	The current estimate for Physical Modeling does not include any modification to the structure. There is always a potential that modifications will be required as more is learned about the design.	Assume up to $1M in modifications to the physical model	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
22	7 - General Technical Risk (TR)	Alignment Changes	Until everything is modeled into real space and PDT knows it all fits, there is a chance full realignment could be needed	Covered in other risks, not modeled	Unrated	Negligible	**#N/A**	Unrated	Negligible	**#N/A**
23	7 - General Technical Risk (TR)	MIS Porosity plate changes	Airburst system in the screen could obscure the flow through the screen, could result in changes to the porosity of the perf plate system.	While there would likely be changes, the porosity plates are already included in the estimate. Changes would have negligible costs.	Likely	Negligible	**Low**	Likely	Negligible	**Low**

HOWARD A. HANSON DAM FISH PASSAGE - SECTION 902 VALIDATION STUDY - Feasibility Milestone #4 - CWRB

April 2022

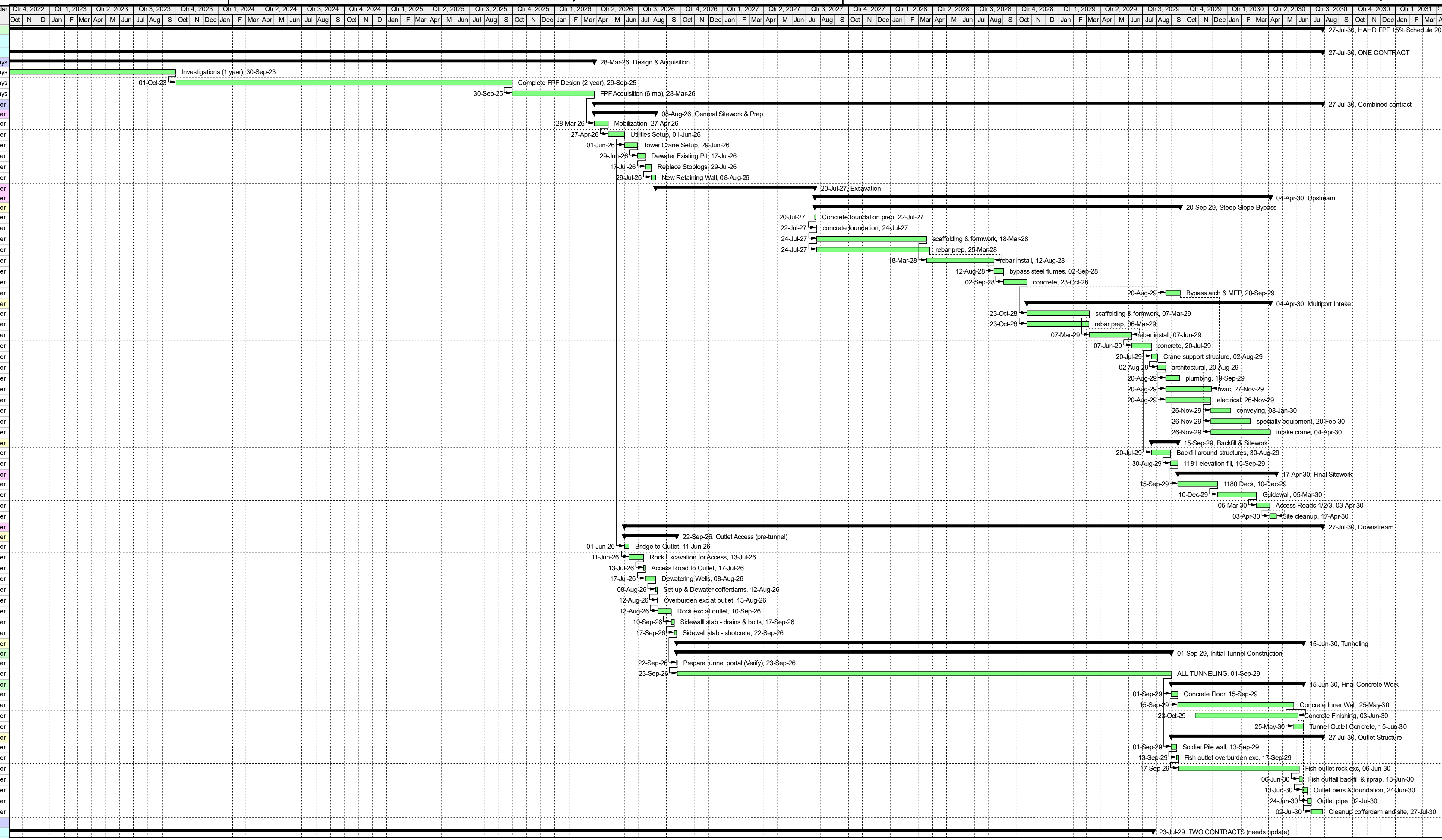
					Project Cost			Project Schedule		
REF	**Risk Type**	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Likelihood (C)**	**Impact (C)**	**Risk Level (C)**	**Likelihood (S)**	**Impact (S)**	**Risk Level (S)**
24	7 - General Technical Risk (TR)	Stilling Basin Scour pool modifications	The proposed scour pool excavates across the entire river channel, it may require additional stabilization or require multiple phases of work to complete	The current design is conservative for the stilling basin. So this is no longer a risk	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
25	7 - General Technical Risk (TR)	Plunge Pool Modifications	The plunge pool concept as designed would be very challenging to construct and maintained, additional excavation or stabilization of the river channel maybe required to complete the work.	The current design is conservative, any modifications will likely result in a decrease in cost so this is no longer a risk.	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
26	7 - General Technical Risk (TR)	High Quality Finishes required in confined spaces	The Full flow bypass structure and the deceleration tunnel require high quality concrete finishes to not injure fish. Getting high quality concrete finishes in a confined space can be extremely difficult and may even require epoxy coating the concrete. The project assumes using high quality concrete finishes and this could be much more labor intensive that estimated.	The risk is that a contractor can't get the concrete smooth enough and the design would have to switch to fully lining of the steep slope bypass and first 50' of deceleration tunnel with stainless steel plates.	Unlikely	Significant	Medium	Unlikely	Negligible	Low
27	7 - General Technical Risk (TR)	Stilling Basin Rock Excavation	The proposed stilling basin does not anticipate significant rock excavation, however rock in this location is not well defined. If we run into more rock than anticipated, it will increase construction costs, have to mechanically excavate or blast the rock out. If we encounter rock this could also eliminate the need for a retaining structure for construction.	Assume 10% increase in rock excavation for the stilling basin. Ensure that stabilization of the excavation is incorporated into the estimate.	Possible	Negligible	Low	Possible	Negligible	Low
28	7 - General Technical Risk (TR)	Scour Pool Increase	As the hydraulic modeling is refined it may be necessary to increase the size of the scour pool.	The design is conservative, so this is no longer a risk	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
29	7 - General Technical Risk (TR)	Geometry Changes in the Bypass Structure	The bypass structure has a lot of tight tolerances with equipment and site constraints, if we find conflicts as the design progresses this could lead to changes in the hydraulics and require the bypass structure to increase in length or require additional excavation	Covered in other risks, not modeled	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
30	7 - General Technical Risk (TR)	Tower Excavation	The tower design is conceptual and may require additional excavation to get all the required equipment routed through the facility to the bottom of the tower.	Additional excavation for the pass through to the existing tower. Additional 0-5% excavation for the elevator and tower needs. Need to add the sump excavation into the estimate (25'x12'x 12'D), additional 130 CY x 2 for the pass through to the existing tower	Unlikely	Negligible	Low	Unlikely	Negligible	Low
31	7 - General Technical Risk (TR)	Tower size used from the 95% design	The 95% design used a pretty large tower size with a lot of open space, it is possible that the tower size could be reduced, reducing the amount of concrete required for the structure.	Not modeling opportunities for feasibility.	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
32	7 - General Technical Risk (TR)	Primary Bypass complexity	The primary bypass has become more complex to construct with multiple pipes merging in the steep slope, this could lead to increase construction costs or a need to redesign due to the complexity of the design	Covered in other risks, not modeled	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
33	7 - General Technical Risk (TR)	Tunnel Exit requiring open excavation	The rock quality at the end of the tunnel is known to be poor and will require an open excavation for the last 100' or more. This would likely increase costs due to the additional stabilization and additional material excavation to daylight the work.	Covered in the earthwork spreadsheet, not modeled	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
34	7 - General Technical Risk (TR)	Primary Bypass outfall access	The design does not include driving access to the outfall location, an access road would be extremely challenging and costly to construct	Include 200' of access road along the left bank (steep embankment).	Likely	Negligible	Low	Likely	Negligible	Low
35	7 - General Technical Risk (TR)	Steep Slope access at the downstream end	The design currently does not have access to the bottom of the steep slope bypass, the design may need to incorporate access to the bottom of the bypass or require an inspection crawler/pipe pig. Incorporating an access would require additional excavation	Crawler Cams are $55K, install a couple vertical access into the primary steep slope bypass. Forming in an access point to the bottom of the steep slope bypass. $250K to $500K	Likely	Negligible	Low	Likely	Negligible	Low
36	7 - General Technical Risk (TR)	Facility Inspection Requirements	Inspection access has not been fully developed for the facility and will likely require additional infrastructure to facility the required inspections.	Covered in other risks, not modeled	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
37	7 - General Technical Risk (TR)	Geotechnical	Assumed 50% of the excavation material could be reused	This could be anywhere from 25%-75% for material reused	Likely	Negligible	Low	Likely	Negligible	Low
38	7 - General Technical Risk (TR)	Acclimation Pond	The design may need to include an acclimation pond at the end of the deceleration tunnel	Assume 5' wide by 8' deep 50' long concrete box with a dewatering screen, bird netting and earthwork.	Possible	Negligible	Low	Possible	Negligible	Low
39	7 - General Technical Risk (TR)	More monitoring during construction	Additional monitoring may be need during construction	Could be an additional cost of up to $1M	Possible	Negligible	Low	Possible	Negligible	Low
40	7 - General Technical Risk (TR)	Additional Dewatering	More groundwater issues that previously experienced	Assume a 20% increase in the volume of water that needs to be handled for dewatering	Possible	Negligible	Low	Possible	Negligible	Low
41	7 - General Technical Risk (TR)	Scaling of the facility	Interior systems are not designed and currently cost is based on factored scaling of the previous estimate of 10% to 15%.	Assume we double the scaling factor for the general facility (10-15% doubled to 20-30%)	Possible	Negligible	Low	Possible	Negligible	Low
42	7 - General Technical Risk (TR)	Phase II additional water storage	If phase II does happen, what adjustment is needed to the design to account for the additional water storage?	Won't add additional horns, may adjust the spacing of the horns but the cost should be minimal. Not modeled Completed phase II cost is now included..	Possible	Negligible	Low	Possible	Negligible	Low
43	13 - Construction (CO)	Scour Pool Construction	Is additional cofferdam needed for the scour pool?	Cofferdam may be needed. Added to estimate.	Likely	Negligible	Low	Likely	Negligible	Low
44	13 - Construction (CO)	Plunge Pool Construction	Is additional cofferdam needed for the plunge pool?	Cofferdam is likely to be needed. Added to estimate.	Very Likely	Negligible	Low	Very Likely	Negligible	Low
45	13 - Construction (CO)	Modifications to the existing stilling basin	The existing tunnel has not been evaluated for survivability at low pool elevations, this will be done during design, there is a chance that modifications to the stilling basin will be required to improve safe passage of fish.	Extend the excavation downstream to create a more mild slope. Extend the stilling basin additional 30 yards and 2' thick concrete floor and walls. Cost is negligible so not modeled.	Possible	Negligible	Low	Possible	Negligible	Low
46	13 - Construction (CO)	Blasting near critical structures	Rock Excavation could be more difficult than expected requiring additional effort for blasting, additionally there are a number of sensitive structures directly adjacent to where we are doing the blasting	Assume 25% of rock excavation will be controlled (near critical structures) so half the space or double the amount of blast holes. Assume 100' of the tunnel upstream is also affected and will experience this slow down.	Very Likely	Moderate	High	Very Likely	Significant	High
47	13 - Construction (CO)	Flooding of the cofferdam	Usual flood season is 10/15 to 2/15. What is the risk of flood outside of the typical flood season	Cofferdam is above 10-year flood elevation; 10-year flood (10% chance exceedance per year) would trigger emergency demobilization. If the cofferdam is overtopped then the contractor would incur costs to re-drain the cofferdam and potentially repair some work. Minimum impact is a false alarm with emergency demob but no damages. Most likely is overtopping with emergency demob and some cleanup. Worst case is overtopping with emergency demob and significant cleanup and delays. Four seasons --> four chances for risk to occur.	Unlikely	Significant	Medium	Unlikely	Significant	Medium
48	13 - Construction (CO)	Unknown condition of existing bulkhead	Risk of significant leakage of the bulkheads beyond what is tolerable to manage with pumping.	The impact of this risk would likely be a couple week delay in schedule and guessing a weeks worth of time for divers to seal the bulkheads.	Likely	Negligible	Low	Likely	Negligible	Low
49	13 - Construction (CO)	Unknown condition of existing bulkhead	Stoplogs have been in place for many years without inspection, PDT is assuming they are still in a functional state and do not leak significantly. The risk would be that replacement of the bulkheads is required due to loss of structural integrity	This would result in at least a 12 month delay to fabricated new bulkheads. This risk can be mitigated through an inspection of the bulkheads early during design and an early contract to fabricate new bulkheads if necessary that can be provided to the contractor at the start of construction. Because this risk can be mitigated and we already have assumed that the bulkheads will be replaced during construction We should not model this risk.	Likely	Negligible	Low	Likely	Negligible	Low
50	13 - Construction (CO)	Unusual concrete forms/shape	Cost increases due to irregular concrete shapes	Assume a +10% markup on the concrete formwork, 50% of the surfaces are unique within the facility	Likely	Negligible	Low	Likely	Negligible	Low
51	13 - Construction (CO)	Interruption to Tacoma water supply	Monitoring and treatment of water at TPU diversion downstream (80-90 MGD summer winter -50 mgd)	Additional turbidity or chemicals in the water due to construction activities that impact the water quality at TPUs facility. Cost is negligible so risk not modeled.	Likely	Negligible	Low	Likely	Negligible	Low

REF	Risk Type	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Project Cost: Likelihood (C)	Project Cost: Impact (C)	Project Cost: Risk Level (C)	Project Schedule: Likelihood (S)	Project Schedule: Impact (S)	Project Schedule: Risk Level (S)
52	13 - Construction (CO)	Construction activities damage existing dam infrastructure	Blasting activities damage the bridge piers or impact the existing control tower due to a design flaws	Assume $1M to $2M in damages and repair	Unlikely	Negligible	Low	Unlikely	Negligible	Low
53	13 - Construction (CO)	Site access	Limited staging areas, remote construction site, long distance to any concrete plants, constrained construction site with limited access,	This is addressed in the base case estimate with two productivity reductions: 87.5% to cover time in transit between TPU headworks and worksite, and 95% for overall inefficiencies associated with a complex site. Equipment/material access is not a concern because the project has a very active logging road already. Team feels these productivity reductions in the base case. will address all the impacts onsite.	Likely	Negligible	Low	Likely	Negligible	Low
54	13 - Construction (CO)	Modifications	How much modifications might there be on this project?	Assume 10% to 15% based on MMD FPF and 6 months in schedule delay. Other schedule delays due to specific risks are covered in those other risks!	Likely	Critical	High	Likely	Critical	High
55	13 - Construction (CO)	Critical component placement	Construction delays due to sensitive placement of gates. Installation of gates may delay other work, concrete placement and forms	Assume 2 months in schedule delay.	Likely	Negligible	Low	Likely	Significant	High
56	13 - Construction (CO)	Lock out Tag out	Lacking the staff to hold clearance	Acct 31 of the TPCS should have enough cost and operations should have sufficient operations staff to support this priority project. Not a risk.	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
57	33 - Regulatory And Environmental (ENV)	Water Certification	Dept of Ecology's review will take 60 days. Based on their review could there be additional or more stringent requirements?	It is possible but unlikely. The list of environmental requirements are added into the estimate should be pretty extensive. However assume increase in additional requirement of 10-20%.	Unlikely	Marginal	Low	Unrated	Negligible	#N/A
58	33 - Regulatory And Environmental (ENV)	In Water Work	There is a risk of slower excavation work due to turbidity requirements. For example driving the piles for the outfall pipe.	Risk could be adding additional silt booms, work slow down or stopping work to make sure turbidity standards are met. The delay could be 1-2 weeks.	Unlikely	Negligible	Low	Unlikely	Negligible	Low
59	33 - Regulatory And Environmental (ENV)	Additional unforeseen risks or related schedule delays	Would there be other risks and requirements?	The team has already engaged multiple outside regulators regarding this project and Environmental Compliance Documents are completed so additional unforeseen risk is minimized	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
60	33 - Regulatory And Environmental (ENV)	Working in a drinking water reservoir	Would there be additional precautions required due to the site being a drinking water reservoir?	Extra care or requirements due to working near a drinking water supply is already accounted for. But assume there is an unlikely chance of 10-20% increase in environmental requirements	Unlikely	Marginal	Low	Unrated	Negligible	#N/A
61	33 - Regulatory And Environmental (ENV)	Fish monitoring	Could additional fish monitoring be needed?	Additional studies may be needed. One study for design phase and another for post construction. Cost is negligible so risk not modeled.	Possible	Negligible	Low	Possible	Negligible	Low
62	9 - Lands and Damages Risk (RE)	Railroad easement	What would it take real estate wise if the tunnel went under the railroad?	Already addressed in risk 10.	Unlikely	Negligible	Low	Unlikely	Negligible	Low
63	9 - Lands and Damages Risk (RE)	Land use charges	Would USACE be charged for land use, for example staging area?	HAHD have not be charged in past projects. So not a risk.	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
64	4 - External Risks (EX)	External stakeholders	Don't foresee any delays from other partners/stakeholders due to the critical nature of this project.	Not a risk.	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
65	14 - Estimate and Schedule Risks (ES)	Completeness of scope of work	Did the estimate capture all SOW?	Estimate is based on the previous multicollector estimate and adjusted for removed/new features based on the engineering appendix. The PDT had 2-3 months to prepare the SOW and should be fairly complete. The estimate and schedule were significantly revised in April with a lot of quick rework and reviews. It is possible the estimators overlooked some details in their assumptions about site access, means and methods, or miscellaneous requirements. Allow some cost growth to cover this.	Possible	Moderate	Medium	Possible	Moderate	Medium
66	14 - Estimate and Schedule Risks (ES)	Confidence in quantities used	Estimate confidence in large and critical quantities?	Large and critical quantities are provided by the PDT which are based on models/softwares and are already conservative. PDT has indicated all quantities should stay the same or drop as design progresses. Do not model.	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
67	14 - Estimate and Schedule Risks (ES)	Adequate source of labor and equipment	Is there adequate source/supply of labor and equipment to complete this project.	Based on previous projects, there is no risk of inadequate skilled labor, equipment or contractors willing to bid on the project. There are large civil works contractors whose business is based on this kind of work. They are unlikely to shy away from a difficult and complex project like this to take on an residential or office building construction because this is their line of work. Risk not modeled.	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
68	14 - Estimate and Schedule Risks (ES)	Conservativeness of markups	Are the markups conservative and sufficiently applied?	Productivity reduction, site access, overtime, costbook escalation markups are all applied. All work are assumed to be subbed out with the Prime acting as a construction manager only. Contractor markups are on the high end of our typical range. Blasting contractor markups are 10% higher than that. So the markups should be sufficiently conservative. Risk not modeled.	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
69	14 - Estimate and Schedule Risks (ES)	Proper escalation value	Could escalation of key materials or construction costs outpace average values recommended by USACE and OMB? This could be due to material volatility or add'l requirements for materials, e.g., USA steel or low-E concrete.	Approximately 50% of the estimate is materials. Most of the material cost is in steel, wood formwork, and concrete, all of which have increased on cost much more quickly than average inflation over the last few years. (It's worth noting that steel price was quite low for a while; it is now just a bit more expensive than it was 5 years ago. But the main concern is volatility.) Current estimates from ENR show all these materials experiencing corrections over the next one or two years and then returning to typical inflation rates of 1 to 3% per year in the near future. However, it is possible they could continue to fluctuate. Allow some increase beyond typical inflation. Cost could increase due to new requirements or to fluctuations. Consider both.	Possible	Critical	High	Unrated	Negligible	#N/A
70	13 - Construction (CO)	COVID 19	Is the effect of COVID 19 accounted for?	This project is almost 10 years out in the future. Hopefully by then COVID 19 is a thing of the past. Risk not modeled.	Unrated	Negligible	#N/A	Unrated	Negligible	#N/A
71	7 - General Technical Risk (TR)	Incomplete structural design	Incomplete structural design could lead to missing scope of work	Assume there could be between 5% low, 10% likely and 20% high of missing scope of work based on the current structural cost of $50M	Possible	Marginal	Low	Possible	Negligible	Low
72	2 - Scope and Objectives (SC)	**Elk Forage Habitat Removed**	1998 report called for creation and maintenance of elk forage habitat. This would not be done as part of recent practice.	Restoration and maintenance effort is $7.5m. Should not have to do any cutting of forest or pasture maintenance fore elk habitat. This already happens indirectly as a result of TPU forestry. Assume minimum impact is no change, most likely impact is 90% reduction, max impact is 100% reduction.	Very Likely	Moderate	High	Very Likely	Negligible	Low
73	13 - Construction (CO)	Weather impacts	HAHD has 68 weather days per year. It's possible work could be done during these days, but base case schedule assumes all weather days occur.	Inclement weather calendar for HAHD allows 68 weather days per year. Chief of Construction advises that we should include all these days in our base case schedule but that he would expect a contractor to budget 0-3% of these days and that we should make our base case estimate assuming a contractor claims 5%. Ops staff and construction engineering staff confirm that contractors seldom need weather days at HAHD. It is possible we may not need all the weather days.	Unlikely	Marginal	Low	Possible	Significant	Medium

Enclosures 3: P6 Construction Schedule

HAHD FPF 15% Schedule 20220426 | Classis WBS Layout | 28-Apr-22 18:41

Activity Name	Original Duration	Total Float	Start	Finish	Calendar
HAHD FPF 15% Schedule 20220426	2040	111	01-Oct-22	27-Jul-30	
Flood Season (Potential)	0	0			
ONE CONTRACT	2040	111	01-Oct-22	27-Jul-30	
Design & Acquisition	1275	121	01-Oct-22	28-Mar-26	7x12 No Holidays
Investigations (1 year)	365	121	01-Oct-22	30-Sep-23	7x12 No Holidays
Complete FPF Design (2 year)	730	121	01-Oct-23	29-Sep-25	7x12 No Holidays
FPF Acquisition (6 mo)	180	121	30-Sep-25	28-Mar-26	7x12 No Holidays
Combined contract	1130	111	28-Mar-26	27-Jul-30	2x6x10 w holidays & weather
General Sitework & Prep	100	164	28-Mar-26	08-Aug-26	2x6x10 w holidays & weather
Mobilization	20	90	28-Mar-26	27-Apr-26	2x6x10 w holidays & weather
Utilities Setup	27	90	27-Apr-26	01-Jun-26	2x6x10 w holidays & weather
Tower Crane Setup	20	164	01-Jun-26	29-Jun-26	2x6x10 w holidays & weather
Dewater Existing Pit	15	164	29-Jun-26	17-Jul-26	2x6x10 w holidays & weather
Replace Stoplogs	10	164	17-Jul-26	29-Jul-26	2x6x10 w holidays & weather
New Retaining Wall	8	164	29-Jul-26	08-Aug-26	2x6x10 w holidays & weather
Excavation	285	238	08-Aug-26	20-Jul-27	2x6x10 w holidays & weather
Upstream	585	173	20-Jul-27	04-Apr-30	2x6x10 w holidays & weather
Steep Slope Bypass	490	268	20-Jul-27	20-Sep-29	2x6x10 w holidays & weather
Concrete foundation prep	2	164	20-Jul-27	22-Jul-27	2x6x10 w holidays & weather
concrete foundation	2	164	22-Jul-27	24-Jul-27	2x6x10 w holidays & weather
scaffolding & formwork	131	164	24-Jul-27	18-Mar-28	2x6x10 w holidays & weather
rebar prep	135	265	24-Jul-27	25-Mar-28	2x6x10 w holidays & weather
rebar install	105	164	18-Mar-28	12-Aug-28	2x6x10 w holidays & weather
bypass steel flumes	16	164	12-Aug-28	02-Sep-28	2x6x10 w holidays & weather
concrete	32	164	02-Sep-28	23-Oct-28	2x6x10 w holidays & weather
Bypass arch & MEP	23	268	20-Aug-29	20-Sep-29	2x6x10 w holidays & weather
Multiport Intake	297	173	23-Oct-28	04-Apr-30	2x6x10 w holidays & weather
scaffolding & formwork	62	164	23-Oct-28	07-Mar-29	2x6x10 w holidays & weather
rebar prep	61	226	23-Oct-28	06-Mar-29	2x6x10 w holidays & weather
rebar install	61	164	07-Mar-29	07-Jun-29	2x6x10 w holidays & weather
concrete	32	164	07-Jun-29	20-Jul-29	2x6x10 w holidays & weather
Crane support structure	10	173	20-Jul-29	02-Aug-29	2x6x10 w holidays & weather
architectural	14	173	02-Aug-29	20-Aug-29	2x6x10 w holidays & weather
plumbing	22	269	20-Aug-29	19-Sep-29	2x6x10 w holidays & weather
hvac	59	232	20-Aug-29	27-Nov-29	2x6x10 w holidays & weather
electrical	58	173	20-Aug-29	26-Nov-29	2x6x10 w holidays & weather
conveying	18	215	26-Nov-29	08-Jan-30	2x6x10 w holidays & weather
specialty equipment	38	195	26-Nov-29	20-Feb-30	2x6x10 w holidays & weather
intake crane	60	173	26-Nov-29	04-Apr-30	2x6x10 w holidays & weather
Backfill & Sitework	43	164	20-Jul-29	15-Sep-29	2x6x10 w holidays & weather
Backfill around structures	32	164	20-Jul-29	30-Aug-29	2x6x10 w holidays & weather
1181 elevation fill	11	164	30-Aug-29	15-Sep-29	2x6x10 w holidays & weather
Final Sitework	108	164	15-Sep-29	17-Apr-30	2x6x10 w holidays & weather
1180 Deck	45	164	15-Sep-29	10-Dec-29	2x6x10 w holidays & weather
Guidewall	38	164	10-Dec-29	05-Mar-30	2x6x10 w holidays & weather
Access Roads 1/2/3	15	164	05-Mar-30	03-Apr-30	2x6x10 w holidays & weather
Site cleanup	10	164	03-Apr-30	17-Apr-30	2x6x10 w holidays & weather
Downstream	927	90	01-Jun-26	27-Jul-30	2x6x10 w holidays & weather
Outlet Access (pre-tunnel)	85	90	01-Jun-26	22-Sep-26	2x6x10 w holidays & weather
Bridge to Outlet	8	90	01-Jun-26	11-Jun-26	2x6x10 w holidays & weather
Rock Excavation for Access	23	90	11-Jun-26	13-Jul-26	2x6x10 w holidays & weather
Access Road to Outlet	4	90	13-Jul-26	17-Jul-26	2x6x10 w holidays & weather
Dewatering Wells	18	90	17-Jul-26	08-Aug-26	2x6x10 w holidays & weather
Set up & Dewater cofferdam	3	90	08-Aug-26	12-Aug-26	2x6x10 w holidays & weather
Overburden exc at outlet	1	90	12-Aug-26	13-Aug-26	2x6x10 w holidays & weather
Rock exc at outlet	20	90	13-Aug-26	10-Sep-26	2x6x10 w holidays & weather
Sidewalll stab - drains & bolts	5	90	10-Sep-26	17-Sep-26	2x6x10 w holidays & weather
Sidewall stab - shotcrete	3	90	17-Sep-26	22-Sep-26	2x6x10 w holidays & weather
Tunneling	811	121	22-Sep-26	15-Jun-30	2x6x10 w holidays & weather
Initial Tunnel Construction	651	90	22-Sep-26	01-Sep-29	2x6x10 w holidays & weather
Prepare tunnel portal (Veri	1	90	22-Sep-26	23-Sep-26	2x6x10 w holidays & weather
ALL TUNNELING	650	90	23-Sep-26	01-Sep-29	2x6x10 w holidays & weather
Final Concrete Work	160	121	01-Sep-29	15-Jun-30	2x6x10 w holidays & weather
Concrete Floor	9	110	01-Sep-29	15-Sep-29	2x6x10 w holidays & weather
Concrete Inner Wall	137	110	15-Sep-29	25-May-30	2x6x10 w holidays & weather
Concrete Finishing	119	110	23-Oct-29	03-Jun-30	2x6x10 w holidays & weather
Tunnel Outlet Concrete	14	121	25-May-30	15-Jun-30	2x6x10 w holidays & weather
Outlet Structure	191	90	01-Sep-29	27-Jul-30	2x6x10 w holidays & weather
Soldier Pile wall	8	90	01-Sep-29	13-Sep-29	2x6x10 w holidays & weather
Fish outlet overburden exc	2	90	13-Sep-29	17-Sep-29	2x6x10 w holidays & weather
Fish outlet rock exc	144	90	17-Sep-29	06-Jun-30	2x6x10 w holidays & weather
Fish outfall backfill & riprap	5	90	06-Jun-30	13-Jun-30	2x6x10 w holidays & weather
Outlet piers & foundation	6	90	13-Jun-30	24-Jun-30	2x6x10 w holidays & weather
Outlet pipe	6	90	24-Jun-30	02-Jul-30	2x6x10 w holidays & weather
Cleanup cofferdam and site	20	90	02-Jul-30	27-Jul-30	2x6x10 w holidays & weather
Post-Construction	0	0			
TWO CONTRACTS (needs update)	1776	375	01-Oct-22	23-Jul-29	



Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

TASK filter: All Activities