DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, PORTLAND DISTRICT
PO BOX 2946
PORTLAND, OR 97208-2946

Dear Fish Facility Design Work Group:

The U.S. Army Corps of Engineers, Portland District (Corps) Draft Final Engineering Documentation Report, "Juvenile PIT Tag Detection Prototype for Precision Increase," is available for your review and comment.

This Engineering Documentation Report is part of the Corps' effort to increase passive integrated transponder (PIT) detection at Bonneville Dam, and thus improve the precision of juvenile fish survival estimates calculated from detections of PIT-tagged fish passing Bonneville Dam. This effort is consistent with Conservation Recommendation 9 of the National Marine Fisheries Service 2019 Columbia River System Biological Opinion.

Your review of this draft report is very important. The comment period is now open. You may send your written comments to Ida Royer at 503-808-4776 or ida.m.royer@usace.army.mil by December 02, 2019. Thank you for your continued participation in the Fish Facility Design Work Group.

Sincerely,

Chris Page
Acting Chief, Environmental Resources Branch

US Army Corps
of Engineers®
Portland District

Engineering Documentation Report

Bonneville Lock and Dam

Juvenile PIT Tag Detection
Prototype for Precision Increase

Columbia River, Oregon-Washington

October 2019

Draft Final Review

Executive Summary

This Engineering Documentation Report (EDR) documents engineering and biological investigations and provides a recommended prototype for additional juvenile fish passive integrated transponder (PIT) tag detection at the Bonneville Project. Study goals were focused on increasing the overall number of PIT-tagged fish detected passing the Bonneville Project for the purpose of improving survival estimates through the Federal Columbia River Power System.

Ten alternatives were developed by the Product Delivery Team (PDT):

(1) Flat-Plate Type Antenna on Fixed Gates (Bay 1A and 1B) for B1 ITS Entrance.
(2) Pass-Thru Type Antenna On Fixed Gates (Bay 1A and 1B) for B1 ITS Entrance (Eliminated).
(3) Flat-Plate Type Antenna On Automated Gates (Bay 3B, 6C, and 10B) for B1 ITS Entrance.
(4) Pass-Thru Type Antenna On The B1 ITS Outfall (Eliminated).
(5) Pass-Thru Type Antenna On A Newly Extended B1 ITS Outfall (Similar to B2CC) (Eliminated).
(6) Pass-Thru Type Antenna On A Newly Rerouted And Extended B1 ITS Outfall (Similar to B2CC) (Eliminated).
(7) Flat-Plate Type Antenna Array In A Spillway Bay (Bay 1 Or 18) Embedded In The Concrete Ogee.
(8) Additional pass-thru type antenna on the B2CC Channel.
(9) Undetermined Type Antenna Attached To The JBS Outfall Pier(S) (Eliminated).
(10) Barge With Fin Type Antenna Array.

A decision matrix was used to evaluate and rank the alternatives not eliminated. Alternatives 2 and 4 were eliminated due to technical issues related to performance of the antenna. Alternatives 5 and 6 were eliminated due to nonconformance with the required constraints. Alternative 9 was eliminated due to lack of interest from PIT tag detection system vendors because of installation and performance issues. The remaining alternatives were rated for the following attributes: Detection Delta, Construction Cost, Operations and Maintenance (O&M) Burden, Constructability, Reliability and Durability, and Secondary Biological Uses. The ranking resulted in the following top three alternatives:

- Alternative 3
- Alternative 1
- Alternative 8

Regional collaboration through the Fish Facilities Design and Review Work Group (FFDRWG) has been influential in the development of alternatives and criteria. Appendix C catalogs regional coordination at the 60% EDR review.

Alternative 3 is the selected alternative, however, due to comments received from the National Oceanic and Atmospheric Administration (NOAA) stating they would not support implementation of Alternative 3 or Alternative 1 alone, the PDT recommends a combination of alternatives and supports NOAA's recommendation. Alternative 3 consists of the installation of flat-plate antenna arrays on the top of the three automated B1 Ice & Trash Sluiceway (ITS) Entrance Gates. Alternative 1 consists of the installation of antenna arrays on the concrete sills directly upstream from the two fixed B1 ITS Entrance Gates. The implementation of both of these alternatives will provide complete coverage of juvenile PIT-tagged fish through the B1 ITS. Construction cost for Alternative 1 is approximately $700,000 with an estimated boost in overall project-wide detection of PIT-tagged juveniles of 2.2 percent. Construction cost for Alternative 3 is approximately $440,000 with an estimated boost in overall project-wide detection of PIT-tagged juveniles of 1.6 percent. The combined USACE direct construction cost will be approximately $1,200,000 with an estimated boost in overall project-wide detection of PIT-tagged juveniles of 3.8 percent. It is recommended that these alternatives be carried forward for further development in the Design Documentation Report phase.

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PROJECT DESCRIPTION

Stream	Columbia River (river mile 146.1)
Location	Bonneville, Oregon
Owner	U.S. Army Corps of Engineers
Project Authorization	Rivers and Harbors Act of 1935
Authorized Purposes	Power, Navigation
Other Uses	Fisheries, Recreation

LAKE/RIVER ELEVATIONS (Elevation in NGVD 29, from mean sea level)

Maximum Controlled Flood Pool	90.0
Maximum Spillway Design Operating Pool	82.5
Maximum Regulated Pool	77.0
Minimum Pool	69.5
Normal Operating Range	71.5 - 76.5
Maximum 24-Hour Fluctuation at Stevenson Gage	4.0
Maximum Flood Tailwater (spillway design flood)	51.5
Maximum Operating Tailwater	33.1
Standard Project Flood Tailwater	48.9
Minimum Tailwater	7.0
Base (100-year) Flood Elevation (at project site tailwater)	39.8

POWERHOUSES

First Powerhouse (Oregon)

Length	1,027 feet
Number of Main Units	10
Nameplate Capacity [2 @ 43 megawatts (MW), 8 @ 54 MW]	518 MW
Overload Capacity (2 @ 47 MW, 8 @ 60 MW)	574 MW
Station Service Units (1 @ 4 MW)	4 MW
Hydraulic Capacity	136,000 cfs

Second Powerhouse (Washington)

Length (including service bay and erection bay)	985.5 feet
Number of Main Units	8
Nameplate Capacity (8 @ 66.5 MW)	532 MW
Overload Capacity (8 @ 76.5 MW)	612 MW
Fish Water Units (2 @ 13.1 MW)	26.2 MW
Hydraulic Capacity	152,000 cfs

SPILLWAY

Capacity at Pool Elevation (El. 87.5)	1,600,000 cfs

FISH PASSAGE FACILITIES

Adult Fish Ladders:

- Washington Ladders (Washington Shore, Cascades Island)
- Oregon Ladders (‘A’ branch, ‘B’ branch, Bradford Island)

Ice and Trash Sluiceway – First Powerhouse
Corner Collector – Second Powerhouse
Juvenile Bypass System – Second Powerhouse

Acronyms and Abbreviations

B1	Bonneville First Powerhouse
B2	Bonneville Second Powerhouse
BPA	Bonneville Power Administration
CC	Corner Collector
cfs	cubic feet (foot) per second
CRSO	Columbia River System Operation
EDR	Engineering Documentation Report
EL	Elevation
EMI	electromagnetic interference
FFDRWG	Fish Facilities Design and Review Work Group
FGE	Fish Guidance Efficiency
FPP	Fish Passage Plan
GFE	Government-furnished equipment
HVAC	heating, ventilation and air conditioning
ITS	Ice and Trash Sluiceway
JBS	Juvenile Bypass System
MOU	Memorandum of Understanding
MW	Mega watts
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWFSC	Northwest Fisheries Science Center
O&M	Operation and Maintenance
PDT	Product Development Team
PH1	Bonneville First Powerhouse
PH2	Bonneville Second Powerhouse
PIT	passive integrated transponder
PSMFC	Pacific States Marine Fisheries Commission
R&D	Research and Development
RM	river mile(s)
ROM	Rough Order of Magnitude
SbyC	Separation by Code
SMF	Smolt Monitoring Facility
STS	submersible traveling screen
UPS	Uninterruptible Power Supply
USACE	U.S. Army Corps of Engineers

1. INTRODUCTION

1.1. Purpose and Scope

The purpose of this Engineering Documentation Report (EDR) is to document engineering investigations and provide a recommended alternative for an effective, low cost method for increasing the precision of system survival estimates through the installation of additional juvenile fish passive integrated transponder (PIT) tag detection at the Bonneville Project. This report will assess the feasibility of installing additional juvenile fish PIT tag detection at the Bonneville Project in one, or more, of the following suggested potential locations:

- First Powerhouse Ice and Trash Sluiceway (B1 ITS)
- Spillway Bays
- Second Powerhouse Corner Collector (B2CC)
- Second Powerhouse Juvenile Bypass System (JBS) Outfall Piers

1.2. Background

Juvenile fish migrating downstream past the Bonneville Project may pass through the B1 ITS, B1 turbines, spillway, B2CC, Second Powerhouse JBS, or Second Powerhouse turbines. Of these routes, only the B2CC and Second Powerhouse (B2) JBS provide PIT tag detection systems. The First Powerhouse (PH1) and the spillway have no PIT tag detection. See Plate G-001 for locations of systems.

The proportion of tagged juvenile Chinook and Steelhead passing through each passage route at the Bonneville Project was estimated in studies conducted in 2010 and 2011 using acoustic-tagged fish (Ploskey et al. 2012). Percent spill in 2010 and 2011 (52% and 47%, respectively) was representative of the percent spill occurring from 2005-2019, which ranged from 40% (2012) to 61% (2015) with a median of 48%. As voluntary (or planned) spill will increase from the 100 kcfs experienced during 2010-2011 to 150 kcfs in 2020, the current numbers of fish passing through the spillway may be slightly higher in 2020 and fish passing through other routes may be slightly lower. However, consensus among regional fisheries managers was that the 2010-2011 data was the best available information, and in spite of operational changes in the intervening years, it should still be utilized to estimate detection efficiencies at each location (01 February 2019 FFDRWG).

The 2010-2011 data indicated that roughly half of the tagged fish passed the spillway (see Appendix D). Around 5 percent passed the ice and trash sluiceway (ITS) at PH1. Of the two routes currently containing PIT tag antennas, roughly 15 percent of the fish passed through the B2CC and roughly 4.5 percent of the fish passed through the B2 JBS. The efficiency of the single B2CC antenna is 85 percent (Gordon Axel, pers. comm.). The B2 JBS contains four antennas, in succession, for 100 percent detection efficiency. The overall number of PIT-tagged fish currently detected at the Project is around 17 percent.

Advancements and innovations in PIT tag technology (antennas, tags, transceivers, etc.) are credited largely to the Bonneville Power Administration (BPA) Research and Development (R&D) project (1983-319-00) lead by National Oceanic and Atmospheric Administration (NOAA) and Northwest Fisheries Science Center (NWFSC) staff. This ongoing project directs funding to promote continual development of PIT tag detection technology, including reader development, PIT tag improvements and advancements in methods for detection. The BPA R&D project has worked closely with regional partners and vendors, including Pacific States Marine Fisheries Commission (PSMFC), Biomark, and West Fork Environmental, to advance technologies and practices involving PIT tag detection. Currently, Biomark is the only vendor capable of providing the transceivers necessary for the larger size antennas examined in this report.

1.3. Project Authorization

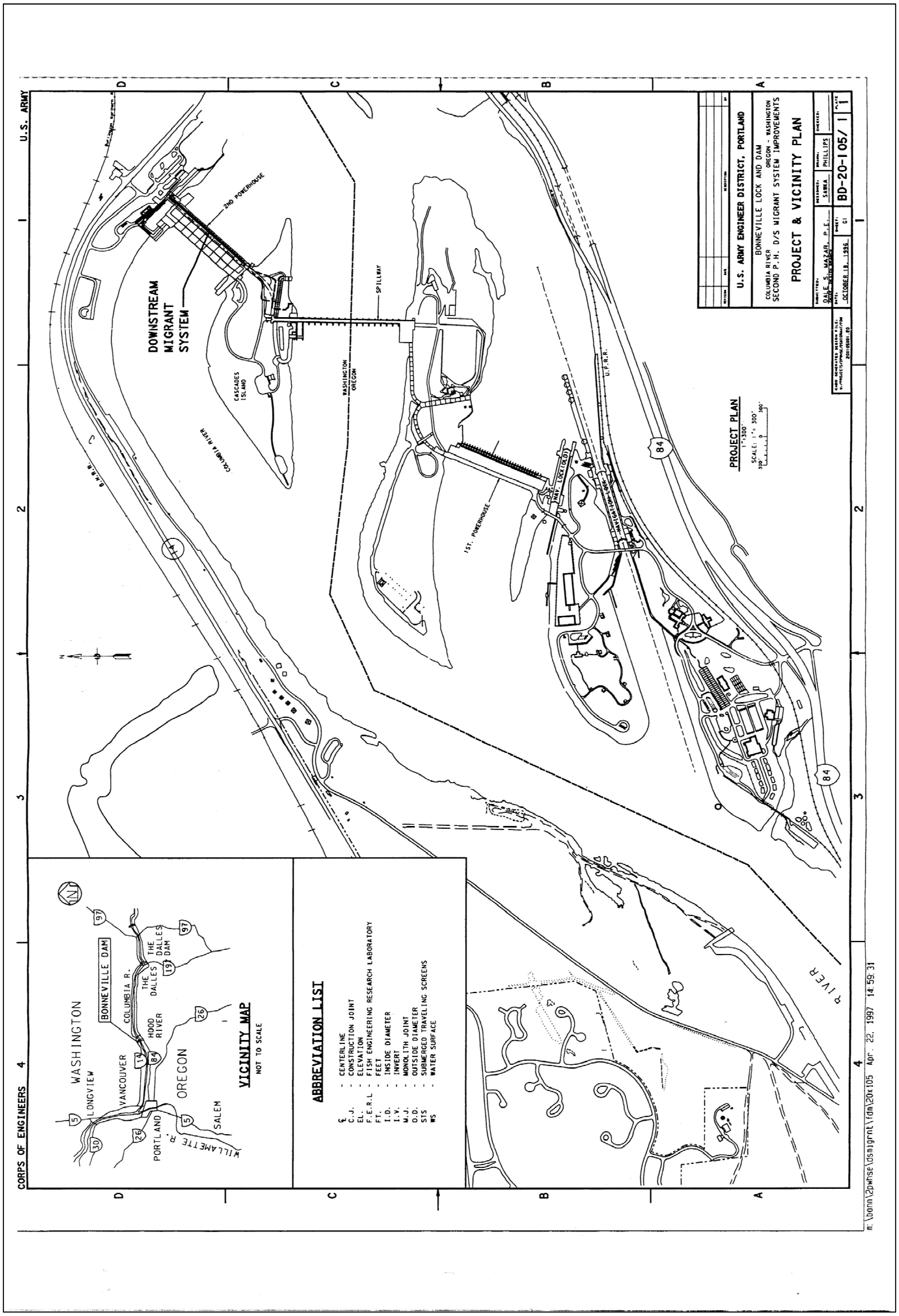
The Bonneville Project began with the National Recovery Act, 30 September 1933, and was formally authorized by Congress in the Rivers and Harbors Act of 30 August 1935. Authority for the completion, maintenance, and operations of the Bonneville Project was provided in the Bonneville Act (Public Law 329, 75th Congress, 20 August 1937). This act provided the authority for the construction of additional hydroelectric generation facilities (Bonneville Second Powerhouse) when requested by the Administrator of BPA. Letters dated 21 January 1965 and 2 February 1965 from the Administrator developed the need for the construction of Bonneville Second Powerhouse. Construction started on the Second Powerhouse in 1974, with units 11 through 18 and two fishway units, and was completed in 1982.

The Energy and Water Development Appropriation Bill of 1995, directed the U.S. Army Corps of Engineers (USACE) to use additional appropriations to aggressively improve effectiveness and efficiency of the bypass systems, reduce predator mortality, and enhance fish passage conditions.

1.4. Project Location

The Bonneville Project is located on the Columbia River approximately 42 miles east of Portland, Oregon at river mile (RM) 146 (Figure 1-1).

Figure 1-1. Bonneville Project and Vicinity



2. DESCRIPTION OF PROJECT FEATURES

Currently, juvenile fish PIT tag detection is only performed in two locations at the Bonneville Project. One is in the B2CC channel (system titled “B2CC PIT Tag Detection System”). The second is in the PH2 JBS transportation pipe (system titled “B2 JBS Full Flow PIT Tag Detection System”) downstream near the Smolt Monitoring Facility (SMF). See Plate G-001 for locations of systems.

2.1.1. B2 Corner Collector PIT Tag Detection System (B2CC)

Juvenile fish passing B2 at the surface are diverted into the B2CC and travel downstream at (low turbulence) high velocities to the outfall. PIT tag detection is provided by a single full channel pass-thru antenna. The efficiency of the existing B2CC antenna is estimated to be 85 percent for standard 12 millimeter PIT tags (Gordon Axel, pers. comm.).

2.1.2. B2 JBS Full Flow PIT Tag Detection System (B2 JBS Transportation Pipe)

Juvenile fish passing B2 at deeper elevations are diverted by submersible traveling screens into a gatewell, and from there, pass through orifices into a downstream channel. These fish then pass down a two-mile transportation pipe to the Smolt Monitoring Facility (SMF). Directly prior to the SMF, fish may either be directly passed to the river via outfalls, or bypassed to the SMF for sampling. Prior to this separation in passage route, PIT tag detection is provided by four (redundant) pass-through antennas, which have a combined efficiency of 100 percent. PIT tag detection is also performed at the SMF but this is strictly for “Separation by Code” (SbyC) purposes and data is not used to determine juvenile survival rate.

3. PROBLEM STATEMENT

Estimating survival of juvenile salmonids through the Columbia River System (from Lower Granite to Bonneville) has been a key component of the NOAA Fisheries Biological Opinions, and is included in Term and Condition #1 in the 2019 Biological Opinion. Estimation of this metric is dependent on detecting PIT-tagged fish migrating downstream at the Bonneville Project. Currently, detection of PIT-tagged fish requires passage through either the JBS or the B2CC.

In recent years, the relative proportion of water passing through the spillway has increased in order to meet ESA and Biological Opinion requirements, increasing the number of fish passing the spillway and decreasing the number passing via B1 or B2. As both the JBS and B2CC are located at B2, this has resulted in reduced numbers of fish passing these routes, thereby reducing the overall detection of PIT-tagged fish at the Bonneville Project and subsequently, the ability to precisely estimate system survival (McCann et al. 2018).

Regional stakeholders have consequently requested that the Action Agencies increase detection capability at the Bonneville Project. Conservation Recommendation #9 of the 2019 Biological Opinion also directed the Action Agencies to "…evaluate alternative means of detecting PIT tags at the Bonneville Project…".

The goal of this study is to increase the overall number of PIT-tagged fish detected passing downstream through the Bonneville Project. The relative benefits of each passage route location and PIT tag antenna type must be weighed against cost, technical complexity, and other factors.

4. CONSTRAINTS AND CRITERIA

Constraints limit which alternatives receive further consideration and evaluation. The constraints for this study are:

- The prototype must fit within the existing infrastructure.
- The existing water channel profiles must be maintained.
- The prototype cannot hinder fish passage during operation by obstructing a passage route.
- The prototype must be based on technology that either exists or could exist by the time of construction.

The following criteria will be used for analyzing the various alternatives:

- Detection Delta
- Cost
- Operations and Maintenance (O&M) Burden
- Constructability
- Reliability and Durability
- Secondary Biological Uses

See Section 7, Alternatives Evaluation, for discussion and application of constraints and criteria.

5. ALTERNATIVES DEVELOPMENT

5.1. Biological Considerations

5.1.1. Biological Criteria

The most important biological criteria is to increase the number of PIT-tagged juvenile salmonids successfully detected passing downstream through the Bonneville Project. This assumes that any detected fish is 'dedicated' to passing and could not turn and move back upstream, or later pass through another route. Additionally, if possible, an alternative may provide information on fish behavior (for adults or juveniles). This includes information on adult fallback behavior, or relative numbers of juvenile fish passing through routes that currently have no PIT tag detection.

5.1.2. Biological Considerations

The Bonneville Project is operated to minimize impacts to ESA-listed fish. These operations are outlined in the Fish Passage Plan (FPP), http://pweb.crohms.org/tmt/documents/fpp/. While juvenile salmonids pass downstream primarily in the spring and summer, some adults pass year-round. Steelhead kelts are repeat spawners and return to the ocean after spawning in late winter - early spring. Both Chinook and steelhead can overshoot their natal streams, traveling above dams and then falling back when ready to move into their spawning grounds.

The B1 ITS is operated year-round, while some passage routes, such as the spillway and B2CC, are operated only during the juvenile fish passage season (10 April - 31 August). The B2CC often opens early (early March) to aid in the downstream migration of adult steelhead kelts. Turbines are operated as power demand and water supply allows, but due to fish-related considerations, the turbine units at B2 are operated first, followed by the units at B1. Spill that occurs to aid in downstream migration of fish is 'voluntary'; excess water above turbine use, voluntary spill, and other water passage routes (e.g. B1 ITS, B2CC, B2 JBS) is then passed via the spillway as 'involuntary spill'. All of these operations contribute to how water, and fish, pass The Bonneville Project and the benefit of specific passage routes.

5.2. Hydraulic Considerations

5.2.1. Hydraulic Design Criteria

The hydraulic criteria the PDT used to evaluate the alternatives was based on how the presence of the prototype will effect dam safety.

Dam safety is unquestionably important. Jeopardizing the safe operation of the project puts downstream communities and invested entities at unnecessary risk. In addition, if the prototype requires the project to perform new operational procedures, those must be taken into account and minimized to reduce the burden on the project. Regardless of how effective the prototype is at fish detection, if it places the project into an unsafe or unstable state, the prototype is unacceptable.

5.2.2. Hydraulic Considerations

Two additional hydraulic considerations, outside of the hydraulic design criteria, must be examined for each alternative to establish advantages and disadvantages.

The first consideration is the degree of turbulence the water will have when it passes near the PIT tag detection antenna. The overall efficiency of the antennas to detect PIT tags is correlated with the degree of turbulence within the flow. True laminar flow is not achievable for any fish passage routes at the project, as velocities to achieve such flow would be considerably low. However, the degree of turbulence can vary significantly between proposed antenna location sites, allowing for favorable (low-turbulence) and unfavorable (high-turbulence) flow distinctions. Low-turbulent flow is preferred because the fish are able to retain their orientation in the water column as they pass near the antenna, providing an easy ‘target’ for the antenna to detect and record the PIT tag. Highly-turbulent flow is not preferred because the fish are less likely to retain their orientation in the water column due to the random nature of the flow regime. This in turn increases the likelihood the fish will ‘tumble’ past the antenna, thereby reducing the chance of detecting and recording the PIT tag. Note that low-turbulent flow does not mean every fish will be detected. Likewise, highly-turbulent flow does not mean every fish will pass undetected. Rather, the chance of detection is higher with low-turbulent flow.

The second consideration is how the prototype will change the geometry of the structure it is attached to within the flow. The change in geometry could have a significant impact on the hydraulics of the structure. This is where hydraulic modeling would be able to provide further insight. For example, an antenna that sits atop one of the variable B1 ITS gates will alter the weir crest shape, thus causing a greater geometric change, and possible hydraulic change, than an antenna that is mounted flush within the walls of the B2CC.

5.3. Structural Considerations

5.3.1. Structural Design Criteria

The PDT evaluated each antenna type and location within the dam and how the antenna would be installed or mounted. Due to the function and makeup of the proposed antennas, the overall impact to the dam’s structural integrity is minimal and not considered a major factor in the alternatives analysis. The constraints stated in this report confine the following alternative solutions to fitting within the existing flow surfaces of the Bonneville Project.

5.3.2. Structural Considerations

The antennas and arrays considered in the report have very little impact to the structures at the Bonneville Project. Most systems are installed with concrete anchors, metal fasteners, or simply slide into existing gate slots. Concrete demolition, if needed, will be limited to preserve the structural integrity of the affected system. Shielding, by means of ferrite tiles, may be necessary to mitigate potential electromagnetic interference (EMI) caused by embedded rebar and other ferrous metal adjacent to antennas. None of the alternatives that meet the constraints set by this report pose any great risk to the structural stability and function of the Bonneville Project.

5.4. Electrical Considerations

5.4.1. Electrical Design Criteria

Provide “clean” power source and isolated ground (where necessary) for transceiver system. Power conditioners will be provided where necessary to provide “clean” power. Backup power will be provided for each transceiver through an uninterruptible power supply (UPS). Backup power is already provided by PSMFC for their data collection equipment. Provide environmentally controlled location (room) for PSMFC data collection equipment (electronics). This can be provided by existing PIT Tag rooms where data collection capacity and logistics allow. The existing PIT Tag room at Bradford Island is under consideration. Under a Memorandum of Understanding (MOU) between USACE and BPA, USACE pays for construction and infrastructure of PIT tag detection systems and BPA provides the PIT tag antennas and O&M. BPA funds PSMFC for this effort. Certain detection system components (transceivers, antennas, antenna cables) will therefore be provided by PSMFC as Government-Furnished Equipment (GFE). Design of the detection system will be closely coordinated with PSFMC.

5.4.2. Electrical Considerations

Transceivers will most likely be installed outdoors. Sun/rain shields will be provided for outdoor transceiver panels to provide protection from heating and moisture when panels are open for maintenance. Installation of transceiver power and data transmission could be temporary (for prototype purposes) and made permanent at a later date. Transceiver panels, cabling, etc., will need to be protected from routine O&M hazards.

5.5. Mechanical Considerations

5.5.1. Mechanical Design Criteria

The mechanical design will support the data collection infrastructure through heating, ventilation and air conditioning (HVAC) design and any other mechanical requirements of the prototype design and installation.

5.5.2. Mechanical Considerations

Cooling may not be needed if alternatives use current PIT tag detection processing spaces. Mechanical changes may have to be made to the ITS intakes for some of the alternatives.

6. ALTERNATIVES

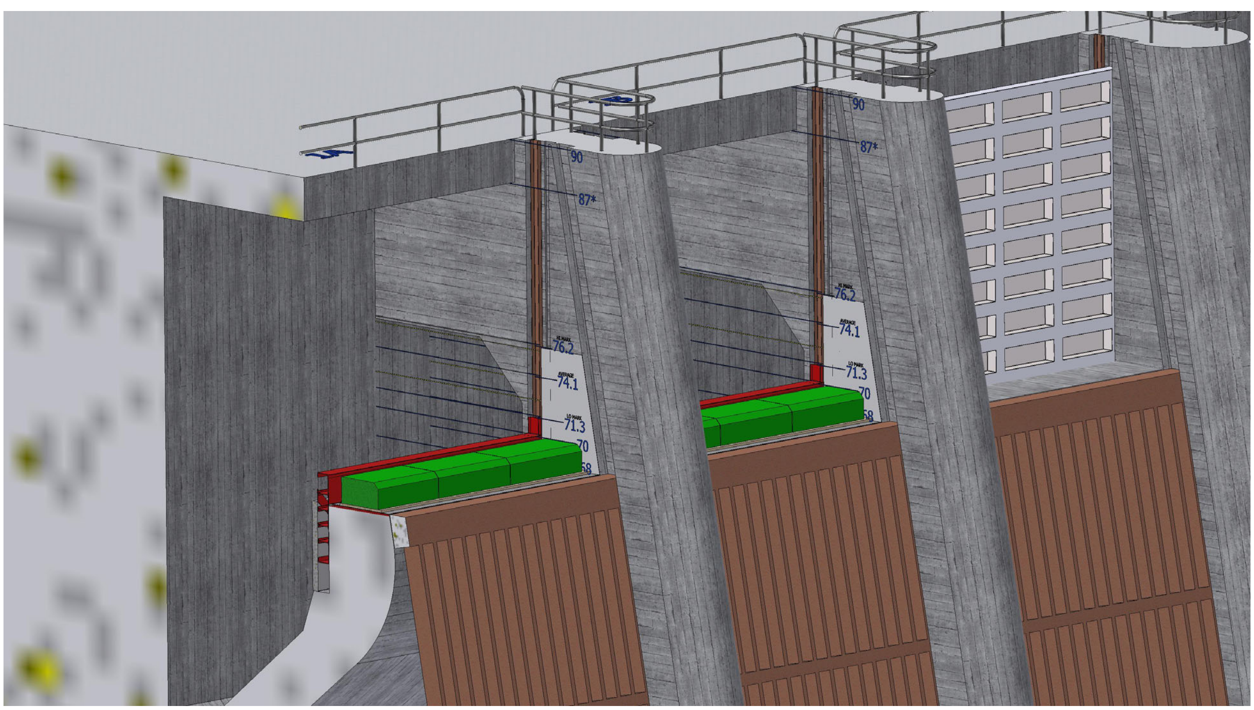
Ten alternatives were identified as potential solutions for increasing the overall number of PIT-tagged fish detected passing the Bonneville Project. A surface antenna at the ITS forebay gates was not considered due to consensus among the PDT, NOAA researchers, and PSMFC that such an antenna would not withstand the significant debris impacts with the debris load the ITS experiences. Similarly, In order to evaluate the merits of each alternative, alternatives are split out based on the antenna technology used, as well as location. The possibility of combining alternatives is examined in Section 7.

6.1. Alternative 1 – B1 ITS Fixed Entrance Gates (Flat-Plate Antenna)

6.1.1. General Description

There are two ITS bays with fixed entrance gates (Bays 1A and 1B) used to pass ice and trash as well as juvenile fish. In accordance with the FPP, both gates are to be positioned so top of gates are at EL 70.0. PSMFC is currently developing a conceptual design for a prototype flat-plate antenna that could be installed in Bays 1A and 1B so top of antennas are at EL 70.0 (Figure 6-1, antennas shown in green and fixed gates in red). This style of antenna will include a ferrite tile shield to minimize the interference of surrounding ferrous metal (concrete rebar, metal guides, etc.). See Plate G-001 for location.

Figure 6-1. B1 ITS Fixed Gate Flat-Plate Antenna



6.1.2. Structural Design Components

Installation of this style of flat-plate antenna would require a caisson or cofferdam to dewater the area. The flat-plate would likely be installed directly to the concrete immediately downstream of the turbine intake trashracks. Post-installed concrete anchors would be the feasible means of mounting the flat antenna to the concrete. A wedge immediately upstream of the antennas to redirect incoming flow up over the antennas is recommended to create a more favorable hydraulic profile. This would prevent unnecessary load on the antennas from flow striking the flat, upstream antenna face and double as a debris deflector.

6.1.3. Electrical Design Components

Transceivers, antenna cables, and associated electronics will be provided by PSMFC and installed by a USACE contractor. USACE will provide transceiver power and fiber optics for PIT tag data transmission to PSMFC data collection electronics. There is no space on the intake deck to locate transceiver panels so they will need to be located in PH1 (Pipe Gallery, EL 77.0). Conduits for cables from antennas to transceivers will be run up the pier wall and require protection.

6.1.4. Mechanical Design Components

None. It is assumed that the transmission of the PIT tag data to existing collection electronics will not require any extra cooling. There are no other mechanical impacts for this alternative.

6.1.5. Advantages

Hydraulics: The top of the flat-plate antennas will sit at the FPP top of gate (EL 70.0). The antennas will not protrude into the flow and cause constriction as flow passes over the top of gate. The wedge shape at the front of the antennas will improve the hydraulic profile. Low-turbulence flow is expected over the antennas.

6.1.6. Disadvantages

Electrical: Prototype antennas tested by NOAA and PSMFC indicate a maximum read range of 55 inches (Appendix E). Antenna read range might not capture fish at higher forebay elevations where the water depth over the top of the antenna exceeds 55 inches. Should the operating position of the gates in accordance with the FPP (EL 70.0) change, then the antennas would not function as intended. The antennas would actually interfere with flow should the required operating position fall below EL 70.0.

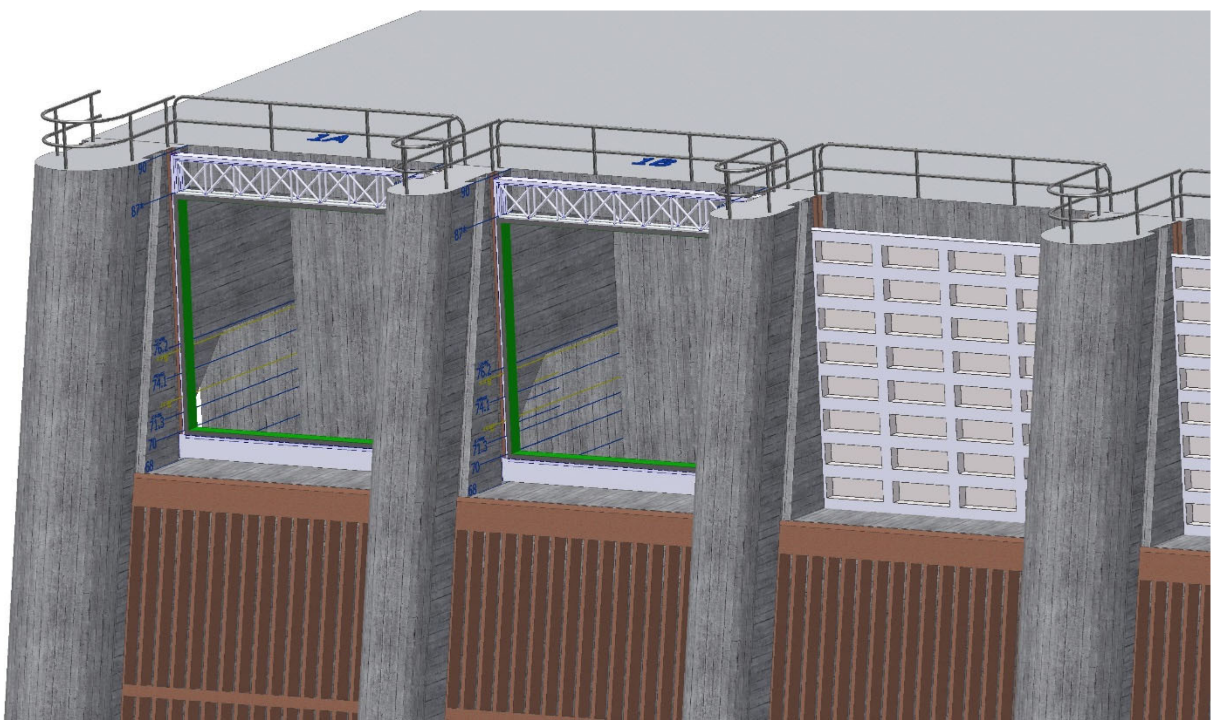
Hydraulics: The protective casing for the antenna cable conduits up the pier wall might cause a very slight constriction of flow and change in hydraulic profile.

6.2. Alternative 2 – B1 ITS Fixed Entrance Gates (Pass-Through Antenna)

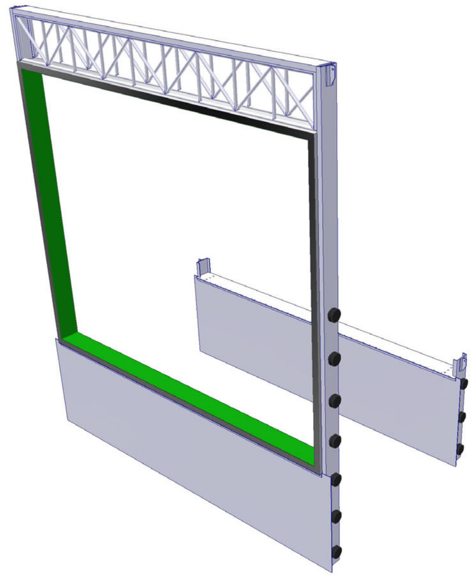
6.2.1. General Description

There are two ITS bays with fixed entrance gates (Bays 1A and 1B) used to pass ice and trash, as well as juvenile fish. An antenna for these gates would consist of a modular pass-through type antenna placed in the gate slot above the entrance gate (Figure 6-2, antennas shown in green). The antenna will affix to the top of the gates. This style of antenna would include a ferrite tile shield to minimize the interference of surrounding metal (concrete rebar, metal guides, etc.). Biomark is not interested in pursuing a pass-through type antenna concept of the required size because of anticipated poor performance due to decreased field strength, as well as susceptibility to emitted EMI from the PH1. NOAA and PSMFC share this concern. For these reasons, the PDT has chosen to eliminate this alternative. This alternative will not be scored in the Decision Matrix. See Plate G-001 for location.

Figure 6-2. B1 ITS Fixed Gate Pass-Through Antenna



INSTALLED IN SLOT



ANTENNA AND GATE ASSEMBLY

6.2.2. Structural Design Components

Since the pass-through antenna array will be delivered in a modular form, there would be a brief analysis of the added load to the top of the fixed gate and to ensure that the gate control system is rated for this higher load.

6.2.3. Electrical Design Components

Transceivers, antenna cables, and associated electronics will be provided by PSMFC and installed by a USACE contractor. USACE will provide transceiver power and fiber optics for PIT tag data transmission to PSMFC data collection electronics. There is no space on the intake deck to locate transceiver panels so they will need to be located in PH1 (Pipe Gallery, EL 77.0).

6.2.4. Mechanical Design Components

None. It is assumed that the transmission of the PIT tag data to existing collection electronics will not require any extra cooling. There are no other mechanical impacts for this alternative.

6.2.5. Advantages

Hydraulics: Pass-through antenna would be flush with gate slots. No expected change in geometry, low-turbulence flow expected.

6.2.6. Disadvantages

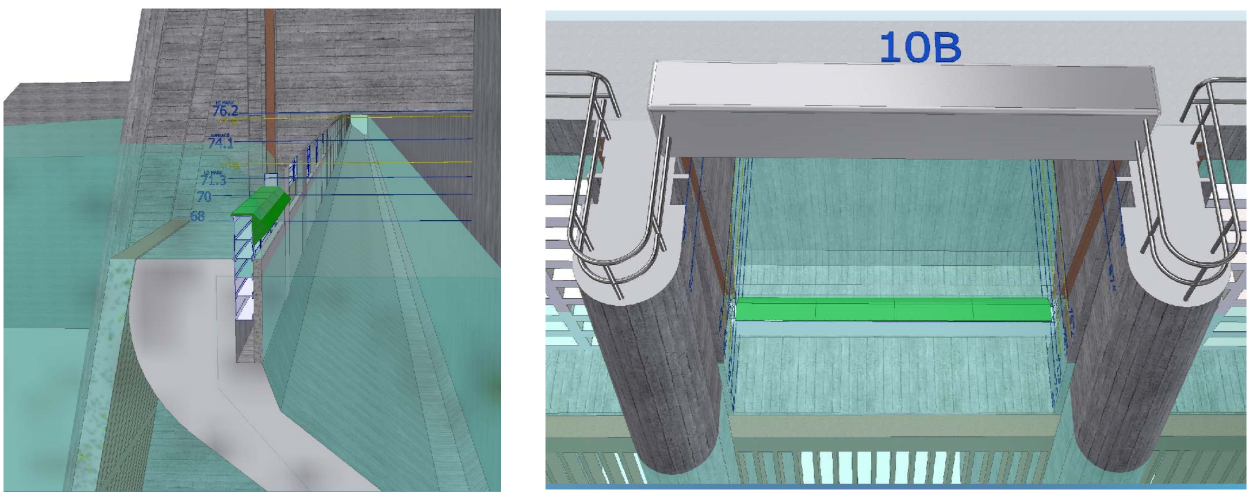
Operations: Antenna uses gate slot. Antenna would need to pulled and stored if gates were operated.

6.3. Alternative 3 – B1 ITS Automated Entrance Gates (Flat-Plate Antenna)

6.3.1. General Description

There are three ITS bays with automated entrance gates (Bays 3B, 6C and 10B) used to pass ice and trash, as well as juvenile fish. Antennas for these gates would consist of a flat-plate type antenna installed on the top of each gate (Figure 6-3, antennas shown in green). See Plate G-001 for location.

Figure 6-3. B1 ITS Automated Gate Flat Plate Antenna



Section View

Plan View

6.3.2. Structural Design Components

Installation of this antenna type will likely involve mounting the antenna directly to the automatic gate using metal fasteners. Structural impact to the system is relatively low compared to other antenna designs and placements. This alternative is perhaps the simplest to accomplish due to the antenna installation on a moveable gate, which can easily be brought out of the water for installation.

6.3.3. Electrical Design Components

Transceiver, antenna cables, and associated electronics will be provided by PSMFC and installed by a USACE contractor. USACE will provide transceiver power and fiber optics for PIT tag data transmission to PSMFC data collection electronics. There is no space on the intake deck to locate transceiver panels so they will need to be located in PH1 (Pipe Gallery, EL 77.0). Antenna cable connections will have to be capable of extending and retracting to follow the gate travel. Cable protection will be a design concern. Controls for the automated gate will most likely need some modifications to maintain the desired head over the gate, due to additional height of the gate from antenna installation.

6.3.4. Mechanical Design Components

It is assumed that the transmission of the PIT tag data to existing collection electronics will not require any extra cooling. The gate lifting machinery will have to be removed along with the gate in order to install the antennas.

6.3.5. Advantages

Hydraulics: Lower head than fixed gates, head relatively constant over range of operation levels, and low-turbulence flow expected over antennas.

6.3.6. Disadvantages

Hydraulics: Significant changes to weir (gate) crest shape could affect hydraulic profile.

6.4. Alternative 4 – B1 ITS Outfall (Pass-Through Antenna)

6.4.1. General Description

This alternative would consist of an addition of a pass-through antenna installed upstream of the outfall exit. A flush-mounted antenna array would be installed within the flume channel requiring concrete demolition in dry conditions. Biomark is not interested in pursuing a pass-through type antenna concept of the required size because of anticipated poor performance due to high flow, high turbulence, and decreased field strength, as well as susceptibility to emitted EMI from the PH1. NOAA and PSMFC share this concern. For these reasons, the PDT has chosen to eliminate this alternative. This alternative will not be scored in the Decision Matrix. See Figure 6-4 for photo of the outfall. See Plate G-001 for location.

Figure 6-4. B1 ITS Outfall Pass-Through Antenna

6.4.2. Structural Design Components

This alternative consists of the installation of a flush-mounted antenna array along the ITS channel outfall and would require concrete demolition in dry conditions. For this alternative, a 6-inch by 9-inch rectangular demolition of the concrete channel walls and floor would be required in order to properly in-set the array, so that its face is flush with the existing channel walls. The affected wall sections would then need to be reinforced with buttressing, or similar supports. This style of antenna would include a ferrite tile shield to minimize the interference of surrounding metal (concrete rebar, metal guides, etc.). It is important to note that this particular antenna has not been prototyped.

6.4.3. Electrical Design Components

Transceiver and associated electronics will be provided by PSMFC and installed by a USACE contractor. USACE will provide transceiver power and fiber optics for PIT tag data transmission to PSMFC data collection electronics. Antenna design would utilize a new NOAA flat cable design.

6.4.4. Mechanical Design Components

None. It is assumed that the transmission of the PIT tag data to existing collection electronics will not require any extra cooling. There are no other mechanical impacts for this alternative.

6.4.5. Advantages

Hydraulic: Antenna would be flush against walls and floor, with no change in geometry.

Biological: Captures entirety of fish that utilize B1 ITS for downstream passage at one location. Also provides PIT tag detection at B1, which currently has none.

6.4.6. Disadvantages

Hydraulics: Highly turbulent flow and likely high velocities. Fish might pass too quickly for antenna to read PIT tag.

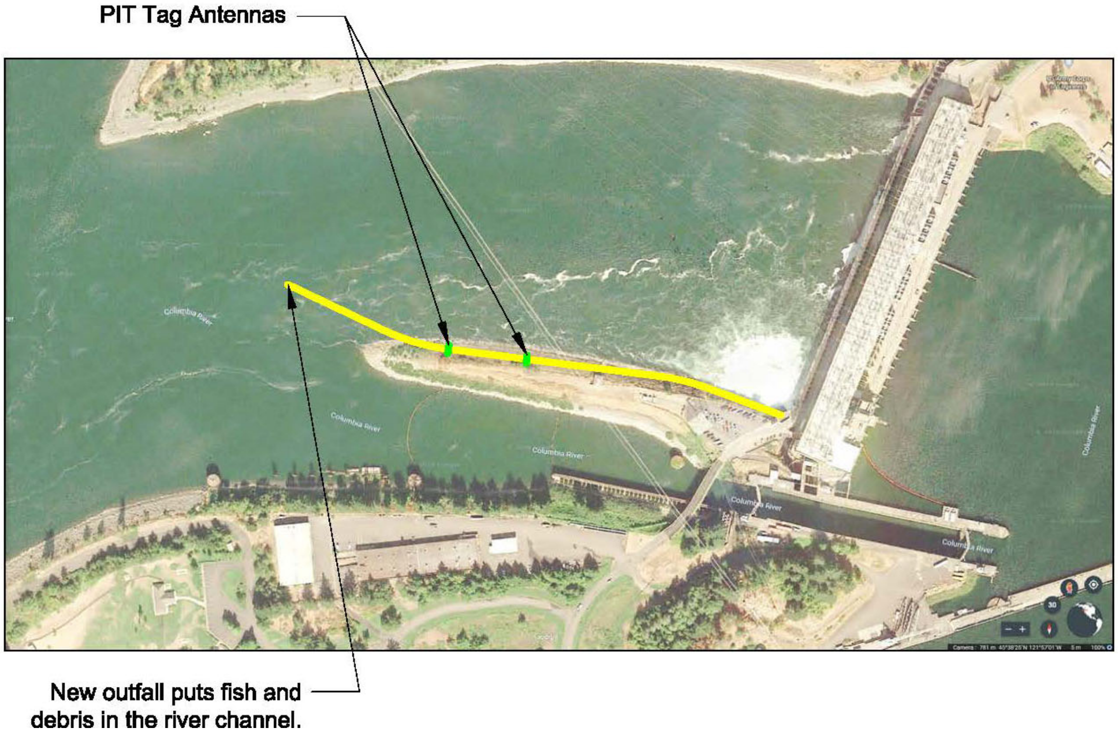
Electrical: Detection efficiency unknown; the antenna has not been prototyped. PSMFC, NOAA, and Biomark have reservations as to whether this alternative is viable, due to water speed and turbulence.

6.5. Alternative 5 – B1 ITS Outfall Extension (Pass-thru Antenna)

6.5.1. General Description

Similar to the existing B2CC, the ITS outfall extension would effectively extend the ITS channel over 1,000 feet along the north bank of Tower Island. This increase in channel length would be needed to allow the water to slow down and reach a lower-turbulence flow, improving array detection efficiency. The channel flume would likely be designed with pier and beam style foundation with equally spaced struts along its length (similar to B2CC flume). This alternative fails to meet the constraint for fitting within the existing infrastructure and is therefore eliminated (see Section 7). This alternative will not be scored in the Decision Matrix. See Figure 6-5 for conceptual layout.

Figure 6-5. B1 ITS Outfall Extension

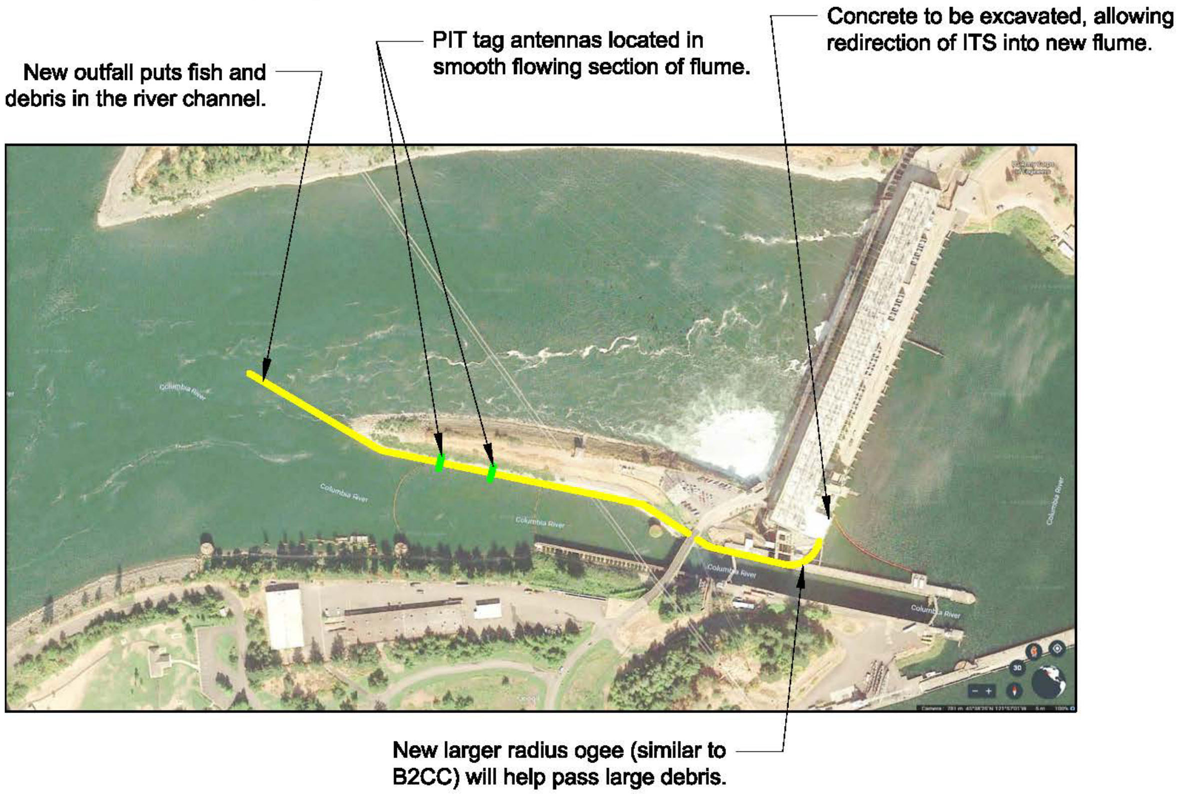


6.6. Alternative 6 – B1 ITS Outfall Reroute (Pass-thru Antenna)

6.6.1. General Description

For details of this alternative, see Alternative 5. This alternative fails to meet the constraint for fitting within the existing infrastructure and is therefore eliminated (see Section 7). This alternative will not be scored in the Decision Matrix. See Figure 6-6 for conceptual layout.

Figure 6-6. B1 ITS Outfall Reroute and Extension

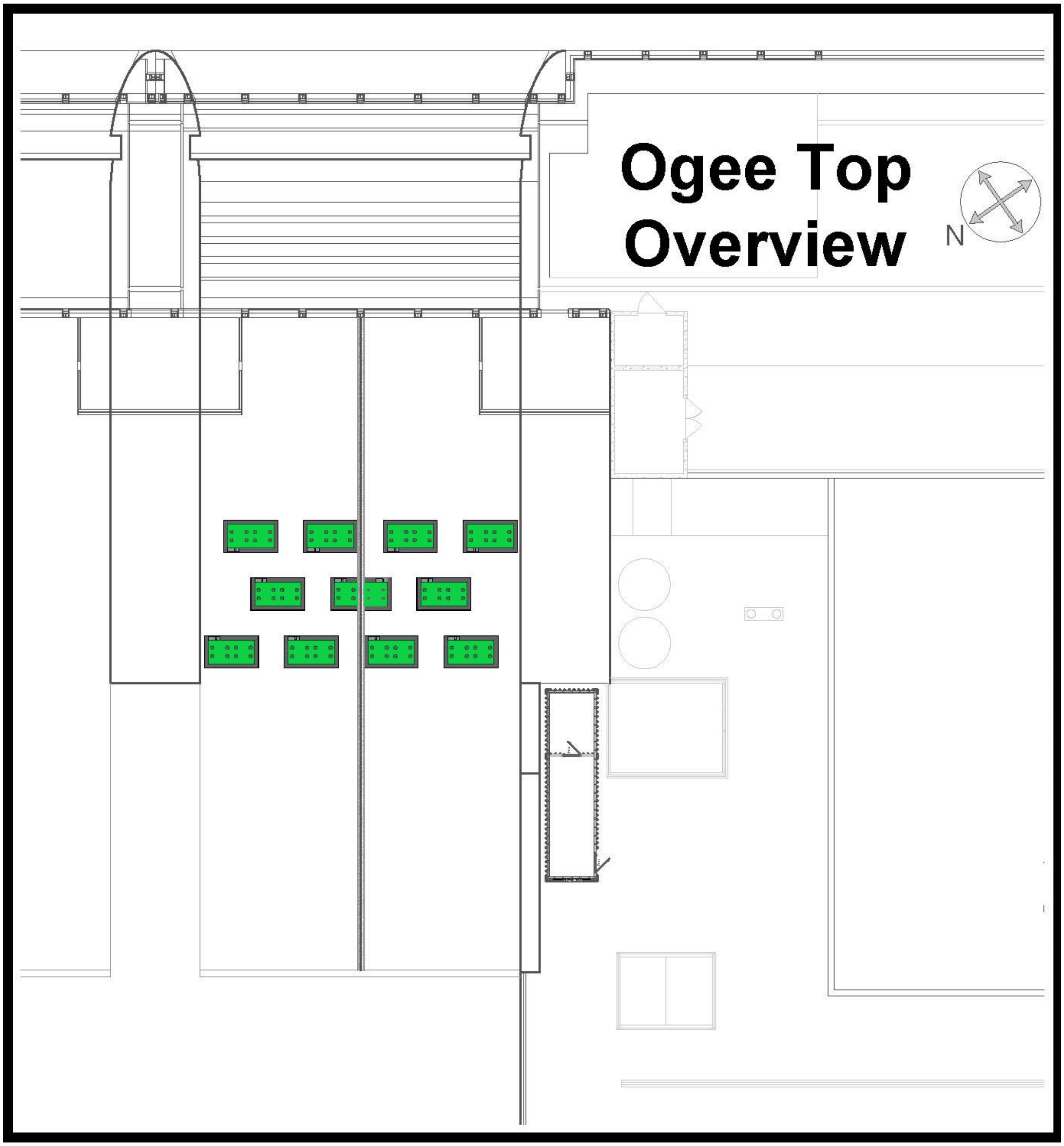


6.7. Alternative 7 – Spillway Bay (Flat-Plate Array)

6.7.1. General Description

This alternative is based on a system being installed at Lower Granite Dam. It's important to note that the spillway at Lower Granite is very different from the spillway at Bonneville Project both hydraulically and structurally, and a similar antenna at Bonneville is anticipated to perform less efficiently (see Appendix D). This design involves the excavation of the ogee surface profile approximately 2 feet in depth. The individual antennas (antenna array) are installed in the new lower demolished surface and concrete is placed back (around the antennas) to restore the original ogee profile (Figure 6-7, antennas shown in green). This alternative is only being considered for Bay 1 or Bay 18 since these are the only bays that provide space to locate the transceiver system equipment, and construction would occur at only one of these due to cost. Bay 1 was chosen in the Decision Matrix. See Plate G-001 for location.

Figure 6-7. Spillway Ogee Flat-Plate Antenna Array



6.7.2. Structural Design Components

Modification and demolition of the concrete surface profile of the ogees in Spillbays 1 or 18 is expected. In order to execute this installation safely, the system must be isolated from spilling and tailwater, so a caisson or cofferdam will be required to complete construction. This dewatering mechanism would likely be retained for future repair to the antenna system.

6.7.3. Electrical Design Components

Transceiver and associated electronics will be provided by PSMFC and installed by a USACE contractor. USACE will provide transceiver power and fiber optics for PIT tag data transmission to PSMFC data collection electronics. The only bays that have space available to locate the transceiver system are Bays 1 and 18. There is no space available on the Spillway deck to locate equipment for the remaining bays.

6.7.4. Mechanical Design Components

None. It is assumed that the transmission of the PIT tag data to existing collection electronics will not require any extra cooling. There are no other mechanical impacts for this alternative.

6.7.5. Advantages

Biological: Potential for capturing some PIT tag data not previously available.

6.7.6. Disadvantages

Hydraulics: Constructing on ogee face may cause dam safety issues, highly turbulent flow is present, large tailwater fluctuations occur (coupled with small antenna read range), and possible change in spill pattern. With the relatively high velocities passing over the plates, there is a danger of plucking off the plate if an into-the-flow offset develops between the upstream concrete surface and the plate.
Biological: Only provides detection in one of eighteen bays.

Electrical: Space required to locate necessary electrical equipment is only available at Bays 1 and 18. Not feasible to utilize any other bays for detection.

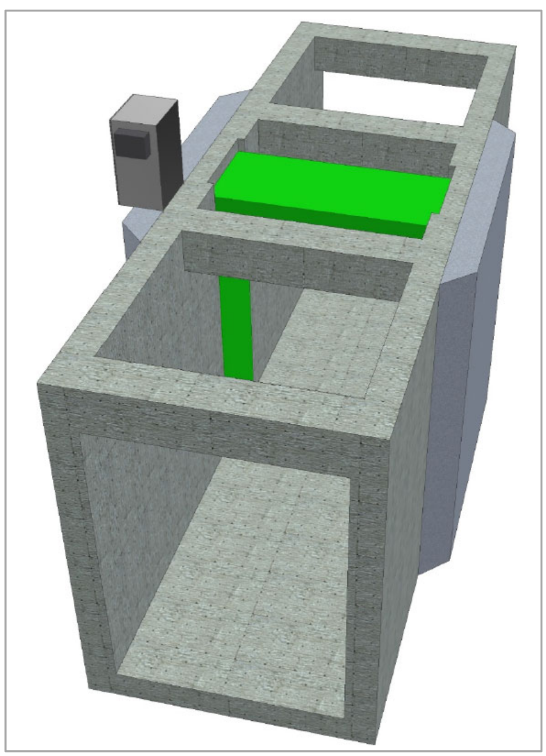
6.8. Alternative 8 – B2CC Channel (Additional Pass-through Antenna)

6.8.1. General Description

This alternative would consist of an additional pass-through antenna installed in the B2CC channel downstream from the existing antenna. An additional antenna would increase the detection efficiency of the corner collector (CC) system by providing redundancy (Figure 6-8, antenna shown in green). A second flush-mounted antenna array would be installed toward the exit of the B2CC flume, requiring concrete demolition in dry conditions. It is important to note that this particular antenna has not been prototyped. Construction cost for this alternative will be significantly less than the original antenna due to reduced concrete removal and no need for new electrical and mechanical buildings. See Section 6.8.3 and 6.8.4. If the new antenna design is not successful, or as effective as the existing antenna, it is likely that a version of the existing antenna would be implemented. The proposed location of the second antenna would require a taller antenna than the existing B2CC antenna because flow depths increase down the length of the flume. See Plate G-001 for location.

Figure 6-8. B2CC Additional Pass-Through Antenna

PROPOSED LOCATION



CHANNEL INSTALLATION

6.8.2. Structural Design Components

Similar to Alternative 4, the installation of a flush-mounted antenna array along B2CC would require concrete demolition in dry conditions. For this alternative, a 6-inch by 9-inch rectangular demolition of the concrete channel walls and floor would be required in order to properly in-set the array, so that its face is flush with the existing channel walls. This style of antenna would include a ferrite tile shield to minimize the interference of surrounding metal (concrete rebar, metal guides, etc.). The affected wall sections would then need to be reinforced with buttressing or similar supports. See Figure 6-8 for a concept drawing of the modifications needed to the flume.

6.8.3. Electrical Design Components

Transceiver power and data transmission will be provided from the existing room. There would be no need for an additional electronics room. Transceiver and associated electronics would be provided by PSMFC and installed by a USACE contractor. Antenna design would utilize a new NOAA flat cable design.

6.8.4. Mechanical Design Components

None. It is assumed that the transmission of the PIT tag data to existing collection electronics will not require any extra cooling. The NOAA flat cable design antenna will not require a HVAC system as did the existing antenna, therefore a new mechanical building will not be required. There are no other mechanical impacts for this alternative.

6.8.5. Advantages

Hydraulics: Antenna would be flush against walls and floor with no change in geometry. Low-turbulence flow expected through antenna.

6.8.6. Disadvantages

Biological: This alternative does not provide potential for detection of additional passage routes (i.e. spillway or B1).

6.9. Alternative 9 – JBS Outfall Piers

6.9.1. General Description

PSMFC and NOAA investigated this alternative for conceptual design and found little opportunity for antenna placement (Figure 6-9). This alternative will not be investigated any further due to significant disadvantages inherent within the site and equipment. The structural integrity of the piers (where the antenna would be mounted), the antenna's read range (only a couple of feet), and variable tailwater elevation below Bonneville all imply that this location is not ideal for fish detection. This alternative will not be scored in the Decision Matrix. See Plate G-001 for location.

Figure 6-9. JBS Outfall Piers

6.10. Alternative 10 – Downstream PIT Tag Barge Antenna Array

6.10.1. General Description

The barge alternative would be purchased as a self-contained unit. BPA is developing the barge antenna array for the purposes of fish detection downstream of Bonneville. Development and testing is anticipated to be completed in 2020 and, after proof of concept is complete, would be available to anchor at, or upstream, of the JBS outfall piers for detection of PIT-tagged fish at the Bonneville Project. It consists of a fin-type antenna array with complete electronics (transceiver, wireless communications, photovoltaic power supply, etc.), all of which is mounted to a floating barge that moves up and down with tailwater. Hence, the antenna would sit at a fixed depth below the water surface. An automated motor is provided to lift the antenna array out of the water due to debris loading (Figure 6-10). See Plate G-001 for anticipated location.

Figure 6-10. Barge Antenna Array

6.10.2. Structural Design Components

There are no structural design considerations for this alternative. The entire barge structure would be designed and constructed by a contractor.

6.10.3. Electrical Design Components

All electrical equipment would be provided as a part of the barge. Data transmission of PIT tag information would be done via wireless communications.

6.10.4. Mechanical Design Components

No additional mechanical equipment would be needed to support the barge or the processing of the PIT tag data. All mechanical equipment would be provided, in whole, as a part of the barge.

6.10.5. Advantages

Potential for capturing some PIT tag data in the mainstem Columbia throughout the juvenile salmonid run, which has not been available in the past. BPA has funded the development and testing of the PIT tag barge and therefore, a fully functioning barge could be purchased outright.

Hydraulics: Low turbulence expected for micro region (immediately adjacent to fins) despite the macro region (entire river) being turbulent. No dam safety concerns.

6.10.6. Disadvantages

Hydraulics: High, variable tailwater elevations and, at times, high water velocities.

Biological: Number of juvenile fish using a specific location for passage is unknown and will depend on barge location, depth of fins (antenna), and river hydraulics (background noise).
O&M: Routine maintenance will involve deployment of the barge during juvenile migration season and removal (and storage) after the migration season passes, due to concerns regarding debris and flow impacts to the barge.

7. ALTERNATIVES EVALUATION

7.1. Alternatives Matrix

The alternatives were developed by PDT members with suggestions provided by NOAA and PSMFC technical experts. Alternatives were initially screened utilizing the following constraints:

- The prototype must fit within the existing infrastructure.
- The existing water channel profiles must be maintained.
- The prototype cannot hinder fish passage during operation by obstructing a passage route.
- The prototype cannot affect hydraulics such that it impacts fish passage, the integrity of the dam structure, or operations required for safety, passing debris, or regular and continued maintenance.
- The prototype must be based on technology that either exists or could exist by the time of construction.

After the initial screening of the alternatives, a Decision Matrix (Table 7-1) was used to evaluate and compare the remaining alternatives developed in this study. The alternatives were compared utilizing the criteria described below. The criteria were refined based on input from the Fish Facilities Design and Review Work Group (FFDRWG) members at the 01 August 2019 FFDRWG meeting.

- **Detection Delta**: This criteria is mathematically valued on the estimated ‘boost’ in Project-wide PIT tag detection expected from implementing the different alternatives. Calculations to determine what this boost would be were calculated and then mathematically converted to the appropriate scale for scoring. See Appendix D for details.

- **Cost**: Cost only considers USACE direct construction costs. Cost ratings are based upon a linear calculation, with the lowest cost alternative receiving the highest rating (5.0) and the highest cost alternative receiving the lowest rating (1.0). Depending on the antenna type, and if pre-assembled off-site by PSMFC, then the cost of the antenna would be paid for by BPA and not be included. Total costs are included in Appendix B.

- **O&M Burden**: Post-construction routine O&M costs are those incurred by USACE personnel at the Bonneville Project only. Maintenance of the antennas is performed by PSMFC, and funded by BPA, as outlined in the USACE-BPA MOU.

- **Constructability**: Considerations for constructability include the amount of concrete drilling and additions, facility outages required, Project support needed, etc.

- **Reliability and Durability**: Reliability is concerned with the antenna, transceiver system, cabling, and anything else associated with the data collection system itself (and not the supporting infrastructure), as well as how durable the antenna is expected to be with the anticipated debris load at the specific location.

- **Secondary Biological Uses**: This criteria involves biological benefits not associated with an increase in PIT tag detection at a location for survival estimation. Secondary uses of the antenna at a location would include gaining fish use information of a passage route that previously did not have PIT tag detection, adult fallback information, and both juvenile and adult fish use of a year-round surface passage route.

- **Hydraulics**: This criteria considers dam safety, however it mostly accounts for changes in geometry. If the geometry does cause the hydraulic profile to change considerably, it may be able to be mitigated elsewhere in the system.

Weighting factors ranged from 1.0 to 2.0 (least important to most important) for each criteria and were assigned by the PDT based upon the relative importance of a criteria to the scope of the project and likelihood to impact implementation. Scoring of the alternatives under each criteria ranged from 1 to 5 (poor to outstanding). See Appendix D for further explanation of weighting factors and how values were assigned.

The alternatives were initially scored by the PDT, and updated, as information on the detection efficiencies of PIT tag antennas were tested by NOAA and PSMFC, and the complexity of installation and design were discussed. See Table 7-1 and Appendix D for why and how specific scores were generated. This scoring resulted in the following top three alternatives:

- Alternative 3 (B1 ITS Automated Gates With Flat-Plate Antenna Arrays): 39.4
- Alternative 1 (B1 ITS Fixed Gates With Flat-Plate Antenna Arrays): 38.1
- Alternative 8 (B2CC Additional Antenna): 35.2

Table 7-1. Alternatives Decision (Evaluation) Matrix

Decision Matrix											
			Weight: 1 - 2 (1 = Least Important, 2 = Most Important)								
			2.0	1.6	1.0	1.1	1.5	1.3	1.2		TOTALS (sum of ratings x weights)
Criteria			Detection Delta	Cost	O&M Burden	Constructability	Reliability/ Durability	Secondary Biological Uses	**Hydraulics**	Remarks	
Antenna Location/Description		Alternative No.	Rating: 1 - 5 (1 = Poor, 5 = Outstanding)								
B1	**ITS Fixed Gate (Flat-Plate)**	1	3.7	4.9	5	3	3	5	**3**		**38.1**
B1	ITS Fixed Gate (Pass-Thru)	2								Eliminated due to concern from Biomark. of technical feasiblity	0.0
B1	**ITS Auto Gate (Flat-Plate)**	3	5.0	5.0	5	3	2	5	**3**		**39.4**
B1	ITS Outfall (Pass-thru)	4								Eliminated due to concern from Biomark. of technical feasiblity	0.0
B1	Extend ITS Channel/Outfall (Pass-thru)	5								Doesn't meet contraint for staying within the existing infrastructure	0.0
B1	Reroute/Extend ITS Channel/Outfall (Pass-thru)	6								Doesn't meet contraint for staying within the existing infrastructure	0.0
Spillway	Bay 1 or Bay 18 (Flat-Plate array)	7	1.0	1.0	5	1	4	3	**1**		20.8
B2	**B2CC (Pass-thru)**	8	4.4	2.8	5	3	5	1	**4**		**35.2**
Downstream	JBS Oufall Piers	9								Eliminated due to concern from PSMFC of technical feasiblity	0.0
Downstream	PIT barge in tailrace (Fin Array)	10	2.6	4.9	1	5	1	1	**5**		28.4

7.2. Preliminary Cost Estimates

The cost estimate for each alternative is a Class 5 Rough Order Magnitude (ROM) estimate derived from a combination of sources such as historical data, quotes from manufacturers, and engineering estimates from structural, mechanical, and electrical engineers. The Class 5 construction cost estimates include a 20 percent contingency and is only provided for alternatives 1, 3, 7, 8 and 10.

The Class 5 construction cost estimate includes the cost associated with providing the required infrastructure and installation of the antenna system. The estimate does not includes the system programming, calibration, and final testing for a complete and functional system. The estimate also does not include the antennas and transceiver system electronics. These will be provided by BPA and installed by a USACE contractor. See Appendix B for complete cost data.

7.3. Alternative Selection

Based on the evaluations shown in Table 7-1, the selected alternative is Alternative 3 with the highest score of 39.4. This alternative was evaluated using all three automated ITS entrance gates. Flat-plate antenna arrays will be installed on the top of each automated gate, so the gates could continue to operate as normal. Plate E-002 shows how the transceiver system would be configured. Some minor programming for the gate control would be necessary to account for the thickness of the antennas on top of the gates.

Table 7.2 provides calculations for the USACE funded construction cost (see Appendix B) per estimated percent boost in Project-wide detection (Appendix D, Table D-2) for each of the scored alternatives.

Table 7-2. Estimated Cost per Percent Boost in Project-Wide Detection.

Alternative #	Antenna Location	Cost (App B)	%boost (App D)	cost/%boost
1	ITS Fixed Gate (Flat-Plate)	$699,902	1.6	$437,439
3	ITS Auto Gate (Flat-Plate)	$438,812	2.2	$199,460
7	Bay 1 or Bay 18 (Flat-Plate array)	$8,640,587	0.2	$43,202,935
8	B2CC (Pass-through)	$4,865,633	1.9	$2,560,859
10	PIT barge in tailrace (Fin Array)	$630,000	1.0	$630,000

7.4. Regional Coordination

Regional review of this EDR has been conducted through the FFDRWG. FFDRWG review is part of USACE's Proposed Action and 2019 Biological Opinion for the Columbia River System Operation (CRSO). The FFDRWG is comprised of representatives from federal, state, and tribal partners who work closely with USACE to provide input to engineering and design of fish facility modifications and improvements at USACE-operated CRSO facilities. The FFDRWG has been briefed of progress throughout the study. Notes from FFRDWG meetings can be found online at http://pweb.crohms.org/tmt/documents/FPOM/2010/FFDRWG/FFDRWG.html. Comments received from the 60 percent EDR, as well as responses, are included in Appendix C.

At the 06 June 2019 FFDRWG meeting, FFDRWG members requested that USACE consider biological information gained by the addition of passage routes as a consideration in the decision-making process. This request was incorporated into the decision matrix under the criteria 'Secondary Biological Uses'. In NOAA written comments (see Appendix C), they additionally stated they would not support placing antennas at only the ITS fixed or auto gates; instead those alternatives should be combined.

8. RECOMMENDATIONS

While each alternative is evaluated separately, it is the intention of the PDT that alternatives may be combined. The PDT evaluated the ITS fixed and auto gates separately, due to the unique challenges and different antenna designs specific to each gate type. However, the PDT recommends combining the fixed and auto gate alternatives (Alternatives 1 and 3) so that PIT tag antennas would be placed at all five operating forebay entrances to the ITS. FFDRWG representatives have stated they would not support placing antennas at only fixed or auto gates, but desired full PIT tag antenna coverage at all five ITS gates in operation (see Appendix C). See Plates E-001 and E-002 for diagrams of transceiver systems.

The PDT recommends combining the flat-plate antenna at the ITS auto gates with the flat-plate antenna at the ITS fixed gate. Doing so would result in an overall boost in project-wide PIT detection of 3.8% at an estimated cost of $1,138,714, for an overall cost per percent detection boost of roughly $300,000 (see Table 8.1).

Table 8-1. Information for the Combined Alternative

Antenna Location	Cost (App B)	%boost (App D)	Cost/%boost
Combine ITS Fixed + Auto gates (Flat-Plate)	$1,138,714	3.8	$299,662

APPENDIX A – PRODUCT DEVELOPMENT TEAM

NAME	DISCIPLINE	ORGANIZATION
Brandt Bannister	Electrical Engineer (TL & Design)	CENWP-ENC-DE
Joe Brackin	Electrical Engineer (DQC)	CENWP-ENC-DE
Ron Payne	Mechanical Engineer (Design)	CENWP-ENC-DM
Ben Filan	Mechanical Engineer (DCQ)	CENWP-ENC-DM
Sean Crosley	Structural Engineer (Design)	CENWP- ENC-DS
Matt Hanson	Structural Engineer (DQC)	CENWP- ENC-DS
Max Wilson-Fey	Hydraulic Engineer (Design)	CENWP-ENC-HD
Steve Schlenker	Hydraulic Engineer (DQC)	CENWP-ENC-HD
Manuel Bejarano	Construction/Cost Engineer	CENWP-ENC-CC
Ida Royer	Fish Biologist	CENWP- PM-EF
Anthony Johnson	Technical Writer-Editor	CENWP- ENC-TC
Dan Costan	POC, Bonneville Project	CENWP-OD-B
Leif Halvorson	Biologist, Bonneville Project	CENWP-OD-B

APPENDIX B – COST ESTIMATE

1.1. Basis of Cost Estimate

The cost estimates for the alternatives of the Bonneville Juvenile PIT Tag Detection are based upon the conceptual design drawings in this report and the drawings of similar features used at Bonneville 2 Corner Collector (B2CC), Lower Granite Spill Way PIT Tag, and other historical data with similar work. The estimates are Class 5 estimates and, as such, the contingency range of this estimate is 15 to 30 percent.

Cost Estimates were completed for five alternatives:

Alternative 1: B1 ITS Fixed Entrance Gate (Flat Plate Antenna)
Alternative 3: B1 ITS Automated Entrance Gate (Flat Plate Antenna)
Alternative 7: Spillway Bay (Flat Plate Array)
Alternative 8: B2CC Channel (Additional Pass-Through Antenna)
Alternative 10: Downstream PIT Tag Barge Antenna Array

1.2. Cost Items

The cost estimates prepared for this EDR present the estimated cost that USACE will pay to the construction contractor, or Total Contract Cost. The Total Project Cost represents the total contract cost plus the costs associated with planning, engineering, and construction management. The elements that are added to Total Contract Cost include:

- The Engineering Documentation Report (EDR)
- Plans and Specifications (P&S)
- Supervision and Administration (S&A) During Construction
- Engineering Services During Construction (EDC)
- Escalation
- Contingency

The Total Project Cost is the final cost associated with the USACE Project including hazardous material mitigation, permitting, monitoring and evaluation, legal, administration, and other related costs required to complete the project.

For the EDR alternatives comparisons, the cost estimates presented within this section are Total Project Costs.

1.3. Abbreviated Risk Analysis

An abbreviated risk analysis was performed for each alternative.

1.3.1. Alternative 1: B1 ITS Fixed Entrance Gate (Flat Plate Antenna)

Abbreviated Risk Analysis

Project (less than $40M): **Bonneville Juvinel Pit Tag Dectection** — **Alternative: Alt 1**

Project Development Stage/Alternative: **Alternative Formulation**

Risk Category: **Low Risk: Typical Construction, Simple** — **Meeting Date: 10/15/2019**

Total Estimated Construction Contract Cost = $ 699,902

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ -		0.00%	$ -	$ -
1	04 DAMS	Mob/Demob	$ 2,130		21.70%	$ 462	$ 2,592
2		PIT TAG Detection 1 - Bay 1A	$ 348,886		23.52%	$ 82,044	$ 430,930
3		PIT TAG Detection 2 - Bay 1B	$ 348,886		21.70%	$ 75,692	$ 424,578
11			$ -		0.00%	$ -	$ -
12	All Other	Remaining Construction Items	$ -	0.0%	0.00%	$ -	$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	$ 71,422		23.52%	$ 16,796	$ 88,218
14	31 CONSTRUCTION MANAGEMENT	Construction Management	$ 38,111		23.52%	$ 8,962	$ 47,073
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)					$ -	

Totals	Contract Cost	% Contingency	$ Contingency	Total
Real Estate	$ -	0.00%	$ -	$ -
Total Construction Estimate	$ 699,902	22.60%	$ 158,198	$ 858,100
Total Planning, Engineering & Design	$ 71,422	23.52%	$ 16,796	$ 88,218
Total Construction Management	$ 38,111	23.52%	$ 8,962	$ 47,073
Total Excluding Real Estate	**$ 809,435**	**23%**	**$ 183,956**	**$ 993,391**

	Base	50%	80%
Confidence Level Range Estimate ($000's)	$809k	$919k	$993k

* 50% based on base is at 5% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analsyis. Must include justification. Does not allocate to Real Estate.	

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

Printed:10/17/2019
Page 1 of 2

PROJECT: Bonneville Juvenile Pit Tag Detection
PROJECT NO P2 xxxxxx
LOCATION: Bonneville Dam ALT 1

DISTRICT: Portland District PREPARED: 10/15/2019
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez

This Estimate reflects the scope and schedule in report; EDR

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 10/1/2016 ($K)	TOTAL FIRST COST ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
04	DAMS	$700	$158	22.6%	$858	0.0%	$700	$158	$858	$0	$858	1.0%	$707	$160	$867
	CONSTRUCTION ESTIMATE TOTALS:	$700	$158		$858	0.0%	$700	$158	$858	$0	$858	1.0%	$707	$160	$867
30	PLANNING, ENGINEERING & DESIGN	$193	$45	23.5%	$238	0.0%	$193	$45	$238	$0	$238	1.3%	$196	$46	$242
31	CONSTRUCTION MANAGEMENT	$102	$24	23.5%	$126	0.0%	$102	$24	$126	$0	$126	2.9%	$105	$25	$130
	PROJECT COST TOTALS:	$995	$228	22.9%	$1,223		$995	$228	$1,223	$0	$1,223	1.3%	$1,008	$230	$1,238

__________ CHIEF, COST ENGINEERING, Eileen Rodriguez

__________ PROJECT MANAGER, Jeff Hicks

__________ CHIEF, REAL ESTATE, xxx

__________ CHIEF, PLANNING, Eric Stricklin

__________ CHIEF, ENGINEERING, Elizabeth Wells

__________ CHIEF, OPERATIONS, Dwane Watsek

__________ CHIEF, CONSTRUCTION, Karen Garmire

__________ CHIEF, CONTRACTING, Tracy Wickham

__________ CHIEF, PM-PB, Don Erickson

__________ CHIEF, DPM, Kevin Brice

ESTIMATED FEDERAL COST:	100%	$1,238
ESTIMATED NON-FEDERAL COST:	0%	$0
ESTIMATED TOTAL PROJECT COST:		$1,238

Filename: TPCS Non-CAP Alt 1 - BON Pit Juvenile Pit Tag TPCS

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

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****** CONTRACT COST SUMMARY ******

PROJECT: Bonneville Juvenile Pit Tag Detection
LOCATION: Bonneville Dam
This Estimate reflects the scope and schedule in report; NA

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez
PREPARED: 10/15/2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 15-Oct-19 Effective Price Level: 1-Oct-19				Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19								
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	RISK BASED CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	PHASE 1 or CONTRACT 1													
04	DAMS	$700	$158	22.6%	$858	0.0%	$700	$158	$858	2020Q3	1.0%	$707	$160	$867
	CONSTRUCTION ESTIMATE TOTALS:	$700	$158	22.6%	**$858**		$700	$158	$858			$707	$160	$867
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$18	$4	23.5%	$22	0.0%	$18	$4	$22	2020Q2	0.9%	$18	$4	$22
1.0%	Planning & Environmental Compliance	$7	$2	23.5%	$9	0.0%	$7	$2	$9	2020Q2	0.9%	$7	$2	$9
15.0%	Engineering & Design	$105	$25	23.5%	$130	0.0%	$105	$25	$130	2020Q2	0.9%	$106	$25	$131
1.0%	Reviews, ATRs, IEPRs, VE	$7	$2	23.5%	$9	0.0%	$7	$2	$9	2020Q2	0.9%	$7	$2	$9
1.0%	Life Cycle Updates (cost, schedule, risks)	$7	$2	23.5%	$9	0.0%	$7	$2	$9	2020Q2	0.9%	$7	$2	$9
1.0%	Contracting & Reprographics	$7	$2	23.5%	$9	0.0%	$7	$2	$9	2020Q2	0.9%	$7	$2	$9
3.0%	Engineering During Construction	$21	$5	23.5%	$26	0.0%	$21	$5	$26	2020Q4	2.9%	$22	$5	$27
2.0%	Planning During Construction	$14	$3	23.5%	$17	0.0%	$14	$3	$17	2020Q4	2.9%	$14	$3	$18
1.0%	Project Operations	$7	$2	23.5%	$9	0.0%	$7	$2	$9	2020Q2	0.9%	$7	$2	$9
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$70	$16	23.5%	$86	0.0%	$70	$16	$86	2020Q4	2.9%	$72	$17	$89
2.0%	Project Operation:	$14	$3	23.5%	$17	0.0%	$14	$3	$17	2020Q4	2.9%	$14	$3	$18
2.5%	Project Management	$18	$4	23.5%	$22	0.0%	$18	$4	$22	2020Q4	2.9%	$19	$4	$23
	CONTRACT COST TOTALS:	$995	$228		$1,223		$995	$228	$1,223			$1,008	$230	$1,238

Filename: TPCS Non-CAP Alt 1 - BON Pit Juvenile Pit Tag
TPCS

1.3.2. Alternative 3: B1 ITS Automated Entrance Gate (Flat Plate Antenna)

Abbreviated Risk Analysis

Project (less than $40M): Bonneville Juvinel Pit Tag Dectection — Alternative: Alt 3
Project Development Stage/Alternative: Alternative Formulation
Risk Category: Low Risk: Typical Construction, Simple — Meeting Date: 10/15/2019

Total Estimated Construction Contract Cost = $ 438,812

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ -		0.00%	$ -	$ -
1	04 DAMS	Mob/Demob	$ 5,996		21.70%	$ 1,301	$ 7,297
2		PIT TAG Detection 1 - Bay 3B	$ 144,272		23.52%	$ 33,927	$ 178,199
3		PIT TAG Detection 2 - Bay 6C	$ 144,272		23.52%	$ 33,927	$ 178,199
4		PIT TAG Detection 1 - Bay 10B	$ 144,272		17.73%	$ 25,582	$ 169,854
12	All Other	Remaining Construction Items	$ -	0.0%	0.00%	$ -	$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	$ 71,422		23.52%	$ 16,796	$ 88,218
14	31 CONSTRUCTION MANAGEMENT	Construction Management	$ 38,111		23.52%	$ 8,962	$ 47,073
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)					$ -	

Totals	Contract Cost	% Contingency	$ Contingency	Total
Real Estate	$ -	0.00%	$ -	$ -
Total Construction Estimate	$ 438,812	21.59%	$ 94,736	$ 533,548
Total Planning, Engineering & Design	$ 71,422	23.52%	$ 16,796	$ 88,218
Total Construction Management	$ 38,111	23.52%	$ 8,962	$ 47,073
Total Excluding Real Estate	$ 548,345	22%	$ 120,494	$ 668,839

	Base	50%	80%
Confidence Level Range Estimate ($000's)	$548k	$621k	$669k

* 50% based on base is at 5% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analsyis. Must include justification. Does not allocate to Real Estate.	

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

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PROJECT: Bonneville Juvenile Pit Tag Detection
PROJECT NO P2 xxxxxx
LOCATION: Bonneville Dam Alt 3

DISTRICT: Portland District PREPARED: 10/15/2019
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez

This Estimate reflects the scope and schedule in report; EDR

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis) Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19						TOTAL PROJECT COST (FULLY FUNDED)			
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 10/1/2016 ($K)	TOTAL FIRST COST ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
04	DAMS	$440	$95	21.6%	$535	0.0%	$440	$95	$535	$0	$535	1.0%	$444	$96	$540
	CONSTRUCTION ESTIMATE TOTALS:	$440	$95		$535	0.0%	$440	$95	$535	$0	$535	1.0%	$444	$96	$540
30	PLANNING, ENGINEERING & DESIGN	$119	$28	23.5%	$147	0.0%	$119	$28	$147	$0	$147	1.3%	$121	$28	$149
31	CONSTRUCTION MANAGEMENT	$64	$15	23.5%	$79	0.0%	$64	$15	$79	$0	$79	2.9%	$66	$15	$81
	PROJECT COST TOTALS:	$623	$138	22.2%	$761		$623	$138	$761	$0	$761	1.3%	$631	$140	$771

ESTIMATED FEDERAL COST: 100%	$771
ESTIMATED NON-FEDERAL COST: 0%	$0
ESTIMATED TOTAL PROJECT COST:	$771

_____________ CHIEF, COST ENGINEERING, Eileen Rodriguez

_____________ PROJECT MANAGER, Jeff Hicks

_____________ CHIEF, REAL ESTATE, xxx

_____________ CHIEF, PLANNING, Eric Stricklin

_____________ CHIEF, ENGINEERING, Elizabeth Wells

_____________ CHIEF, OPERATIONS, Dwane Watsek

_____________ CHIEF, CONSTRUCTION, Karen Garmire

_____________ CHIEF, CONTRACTING, Tracy Wickham

_____________ CHIEF, PM-PB, Don Erickson

_____________ CHIEF, DPM, Kevin Brice

Filename: TPCS Non-CAP Alt 3 - BON Pit Juvenile Pit Tag
TPCS

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

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**** CONTRACT COST SUMMARY ****

PROJECT: Bonneville Juvenile Pit Tag Detection
LOCATION: Bonneville Dam
This Estimate reflects the scope and schedule in report; NA

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez
PREPARED: 10/15/2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: / Effective Price Level:			15-Oct-19 / 1-Oct-19	Program Year (Budget EC): / Effective Price Level Date:			2020 / 1 OCT 19					
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	RISK BASED CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	PHASE 1 or CONTRACT 1													
04	DAMS	$440	$95	21.6%	$535	0.0%	$440	$95	$535	2020Q3	1.0%	$444	$96	$540
	CONSTRUCTION ESTIMATE TOTALS:	$440	$95	21.6%	**$535**		$440	$95	$535			$444	$96	$540
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$11	$3	23.5%	$14	0.0%	$11	$3	$14	2020Q2	0.9%	$11	$3	$14
1.0%	Planning & Environmental Compliance	$4	$1	23.5%	$5	0.0%	$4	$1	$5	2020Q2	0.9%	$4	$1	$5
15.0%	Engineering & Design	$66	$16	23.5%	$82	0.0%	$66	$16	$82	2020Q2	0.9%	$67	$16	$82
1.0%	Reviews, ATRs, IEPRs, VE	$4	$1	23.5%	$5	0.0%	$4	$1	$5	2020Q2	0.9%	$4	$1	$5
1.0%	Life Cycle Updates (cost, schedule, risks)	$4	$1	23.5%	$5	0.0%	$4	$1	$5	2020Q2	0.9%	$4	$1	$5
1.0%	Contracting & Reprographics	$4	$1	23.5%	$5	0.0%	$4	$1	$5	2020Q2	0.9%	$4	$1	$5
3.0%	Engineering During Construction	$13	$3	23.5%	$16	0.0%	$13	$3	$16	2020Q4	2.9%	$13	$3	$17
2.0%	Planning During Construction	$9	$2	23.5%	$11	0.0%	$9	$2	$11	2020Q4	2.9%	$9	$2	$11
1.0%	Project Operations	$4	$1	23.5%	$5	0.0%	$4	$1	$5	2020Q2	0.9%	$4	$1	$5
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$44	$10	23.5%	$54	0.0%	$44	$10	$54	2020Q4	2.9%	$45	$11	$56
2.0%	Project Operation:	$9	$2	23.5%	$11	0.0%	$9	$2	$11	2020Q4	2.9%	$9	$2	$11
2.5%	Project Management	$11	$3	23.5%	$14	0.0%	$11	$3	$14	2020Q4	2.9%	$11	$3	$14
	CONTRACT COST TOTALS:	$623	$138		$761		$623	$138	$761			$631	$140	$771

Filename: TPCS Non-CAP Alt 3 - BON Pit Juvenile Pit Tag
TPCS

1.3.3. Alternative 7: Spillway Bay (Flat Plate Array)

Abbreviated Risk Analysis

Project (less than $40M): Bonneville Juvinel Pit Tag Dectection — **Alternative:** Alt 7
Project Development Stage/Alternative: Alternative Formulation
Risk Category: Moderate Risk: Typical Project Construction Type — **Meeting Date:** 10/15/2019

Total Estimated Construction Contract Cost = $ 8,640,587

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ -		0.00%	$ -	$ -
1	04 DAMS	Spillway Bay Flat Plate Array	$ 8,640,587		28.50%	$ 2,462,843	$ 11,103,430
2					0.00%	$ -	$ -
3					0.00%	$ -	$ -
4					0.00%	$ -	$ -
5					0.00%	$ -	$ -
6					0.00%	$ -	$ -
7					0.00%	$ -	$ -
8					0.00%	$ -	$ -
12	All Other	Remaining Construction Items	$ -	0.0%	0.00%	$ -	$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	$ 71,422		24.66%	$ 17,610	$ 89,032
14	31 CONSTRUCTION MANAGEMENT	Construction Management	$ 38,111		24.66%	$ 9,397	$ 47,508
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)					$ -	

Totals	Contract Cost	% Contingency	$ Contingency	Total
Real Estate	$ -	0.00%	$ -	$ -
Total Construction Estimate	$ 8,640,587	28.50%	$ 2,462,843	$ 11,103,430
Total Planning, Engineering & Design	$ 71,422	24.66%	$ 17,610	$ 89,032
Total Construction Management	$ 38,111	24.66%	$ 9,397	$ 47,508
Total Excluding Real Estate	$ 8,750,120	28%	$ 2,489,849	$ 11,239,969

	Base	50%	80%
Confidence Level Range Estimate ($000's)	$8,750k	$10,244k	$11,240k

* 50% based on base is at 5% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analsyis. Must include justification. Does not allocate to Real Estate.	

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

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PROJECT: Bonneville Juvenile Pit Tag Detection
PROJECT NO P2 xxxxxx
LOCATION: Bonneville Dam   Alt 7

DISTRICT: Portland District   PREPARED: 10/15/2019
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez

This Estimate reflects the scope and schedule in report; EDR

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 10/1/2016 ($K)	TOTAL FIRST COST ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
04	DAMS	$8,650	$2,465	28.5%	$11,115	0.0%	$8,650	$2,465	$11,115	$0	$11,115	1.0%	$8,737	$2,490	$11,227
	CONSTRUCTION ESTIMATE TOTALS:	$8,650	$2,465		$11,115	0.0%	$8,650	$2,465	$11,115	$0	$11,115	1.0%	$8,737	$2,490	$11,227
30	PLANNING, ENGINEERING & DESIGN	$2,382	$587	24.7%	$2,969	0.0%	$2,382	$587	$2,969	$0	$2,969	1.3%	$2,413	$595	$3,008
31	CONSTRUCTION MANAGEMENT	$1,254	$309	24.7%	$1,563	0.0%	$1,254	$309	$1,563	$0	$1,563	2.9%	$1,291	$318	$1,609
	PROJECT COST TOTALS:	$12,286	$3,362	27.4%	$15,648		$12,286	$3,362	$15,648	$0	$15,648	1.3%	$12,441	$3,403	$15,844

ESTIMATED FEDERAL COST:	100%	$15,844
ESTIMATED NON-FEDERAL COST:	0%	$0
ESTIMATED TOTAL PROJECT COST:		$15,844

CHIEF, COST ENGINEERING, Eileen Rodriguez

PROJECT MANAGER, Jeff Hicks

CHIEF, REAL ESTATE, xxx

CHIEF, PLANNING, Eric Stricklin

CHIEF, ENGINEERING, Elizabeth Wells

CHIEF, OPERATIONS, Dwane Watsek

CHIEF, CONSTRUCTION, Karen Garmire

CHIEF, CONTRACTING, Tracy Wickham

CHIEF, PM-PB, Don Erickson

CHIEF, DPM, Kevin Brice

Filename: TPCS Non-CAP Alt 7 - BON Pit Juvenile Pit Tag
TPCS

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

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**** CONTRACT COST SUMMARY ****

PROJECT: Bonneville Juvenile Pit Tag Detection
LOCATION: Bonneville Dam
This Estimate reflects the scope and schedule in report; NA

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez
PREPARED: 10/15/2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 15-Oct-19 Effective Price Level: 1-Oct-19				Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19								
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	RISK BASED CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	PHASE 1 or CONTRACT 1													
04	DAMS	$8,650	$2,465	28.5%	$11,115	0.0%	$8,650	$2,465	$11,115	2020Q3	1.0%	$8,737	$2,490	$11,227
	CONSTRUCTION ESTIMATE TOTALS:	$8,650	$2,465	28.5%	**$11,115**		$8,650	$2,465	$11,115			$8,737	$2,490	$11,227
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$216	$53	24.7%	$269	0.0%	$216	$53	$269	2020Q2	0.9%	$218	$54	$272
1.0%	Planning & Environmental Compliance	$87	$21	24.7%	$108	0.0%	$87	$21	$108	2020Q2	0.9%	$88	$22	$109
15.0%	Engineering & Design	$1,298	$320	24.7%	$1,618	0.0%	$1,298	$320	$1,618	2020Q2	0.9%	$1,310	$323	$1,633
1.0%	Reviews, ATRs, IEPRs, VE	$87	$21	24.7%	$108	0.0%	$87	$21	$108	2020Q2	0.9%	$88	$22	$109
1.0%	Life Cycle Updates (cost, schedule, risks)	$87	$21	24.7%	$108	0.0%	$87	$21	$108	2020Q2	0.9%	$88	$22	$109
1.0%	Contracting & Reprographics	$87	$21	24.7%	$108	0.0%	$87	$21	$108	2020Q2	0.9%	$88	$22	$109
3.0%	Engineering During Construction	$260	$64	24.7%	$324	0.0%	$260	$64	$324	2020Q4	2.9%	$268	$66	$334
2.0%	Planning During Construction	$173	$43	24.7%	$216	0.0%	$173	$43	$216	2020Q4	2.9%	$178	$44	$222
1.0%	Project Operations	$87	$21	24.7%	$108	0.0%	$87	$21	$108	2020Q2	0.9%	$88	$22	$109
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$865	$213	24.7%	$1,078	0.0%	$865	$213	$1,078	2020Q4	2.9%	$890	$220	$1,110
2.0%	Project Operation:	$173	$43	24.7%	$216	0.0%	$173	$43	$216	2020Q4	2.9%	$178	$44	$222
2.5%	Project Management	$216	$53	24.7%	$269	0.0%	$216	$53	$269	2020Q4	2.9%	$222	$55	$277
	CONTRACT COST TOTALS:	$12,286	$3,362		$15,648		$12,286	$3,362	$15,648			$12,441	$3,403	$15,844

Filename: TPCS Non-CAP Alt 7 - BON Pit Juvenile Pit Tag
TPCS

1.3.4. Alternative 8: B2CC Channel (Additional Pass-Through Antenna)

Abbreviated Risk Analysis

Project (less than $40M): Bonneville Juvinel Pit Tag Dectection — Alternative: Alt 8
Project Development Stage/Alternative: Alternative Formulation
Risk Category: Moderate Risk: Typical Project Construction Type — Meeting Date: 10/15/2019

Total Estimated Construction Contract Cost = $ 4,865,633

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ -		0.00%	$ -	$ -
1	04 DAMS	B2CC Channel - Additional Pass-Thru Antenna	$ 4,865,633		24.66%	$ 1,199,659	$ 6,065,292
2			$ -		0.00%	$ -	$ -
3			$ -		0.00%	$ -	$ -
11			$ -		0.00%	$ -	$ -
12	All Other	Remaining Construction Items	$ -	0.0%	0.00%	$ -	$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	$ 71,422		24.66%	$ 17,610	$ 89,032
14	31 CONSTRUCTION MANAGEMENT	Construction Management	$ 38,111		24.66%	$ 9,397	$ 47,508
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)					$ -	

Totals	Contract Cost	% Contingency	$ Contingency	Total
Real Estate	$ -	0.00%	$ -	$ -
Total Construction Estimate	$ 4,865,633	24.66%	$ 1,199,659	$ 6,065,292
Total Planning, Engineering & Design	$ 71,422	24.66%	$ 17,610	$ 89,032
Total Construction Management	$ 38,111	24.66%	$ 9,397	$ 47,508
Total Excluding Real Estate	$ 4,975,166	25%	$ 1,226,666	$ 6,201,832

	Base	50%	80%
Confidence Level Range Estimate ($000's)	$4,975k	$5,711k	$6,202k

* 50% based on base is at 5% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analsyis. Must include justification. Does not allocate to Real Estate.	

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

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PROJECT: Bonneville Juvenile Pit Tag Detection
PROJECT NO P2 xxxxxx Alt 8
LOCATION: Bonneville Dam

DISTRICT: Portland District PREPARED: 10/15/2019
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez

This Estimate reflects the scope and schedule in report; EDR

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 10/1/2016 ($K)	TOTAL FIRST COST ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
04	DAMS	$4,900	$1,208	24.7%	$6,108	0.0%	$4,900	$1,208	$6,108	$0	$6,108	1.0%	$4,949	$1,221	$6,170
	CONSTRUCTION ESTIMATE TOTALS:	$4,900	$1,208		$6,108	0.0%	$4,900	$1,208	$6,108	$0	$6,108	1.0%	$4,949	$1,221	$6,170
30	PLANNING, ENGINEERING & DESIGN	$1,348	$332	24.7%	$1,680	0.0%	$1,348	$332	$1,680	$0	$1,680	1.3%	$1,366	$337	$1,702
31	CONSTRUCTION MANAGEMENT	$711	$175	24.7%	$886	0.0%	$711	$175	$886	$0	$886	2.9%	$732	$180	$912
	PROJECT COST TOTALS:	$6,959	$1,716	24.7%	$8,675		$6,959	$1,716	$8,675	$0	$8,675	1.3%	$7,047	$1,738	$8,784

______________ CHIEF, COST ENGINEERING, Eileen Rodriguez

______________ PROJECT MANAGER, xxx

______________ CHIEF, REAL ESTATE, xxx

______________ CHIEF, PLANNING, Eric Stricklin

______________ CHIEF, ENGINEERING, Elizabeth Wells

______________ CHIEF, OPERATIONS, Dwane Watsek

______________ CHIEF, CONSTRUCTION, Karen Garmire

______________ CHIEF, CONTRACTING, Tracy Wickham

______________ CHIEF, PM-PB, Don Erickson

______________ CHIEF, DPM, Kevin Brice

ESTIMATED FEDERAL COST:	100%	$8,784
ESTIMATED NON-FEDERAL COST:	0%	$0
ESTIMATED TOTAL PROJECT COST:		$8,784

Filename: TPCS Non-CAP Alt 8 - BON Pit Juvenile Pit Tag
TPCS

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

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**** CONTRACT COST SUMMARY ****

PROJECT: Bonneville Juvenile Pit Tag Detection
LOCATION: Bonneville Dam
This Estimate reflects the scope and schedule in report; NA

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez
PREPARED: 10/15/2019

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: / Effective Price Level:			15-Oct-19 / 1-Oct-19	Program Year (Budget EC): / Effective Price Level Date:			2020 / 1 OCT 19					
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 or CONTRACT 1													
04	DAMS	$4,900	$1,208	24.7%	$6,108	0.0%	$4,900	$1,208	$6,108	2020Q3	1.0%	$4,949	$1,221	$6,170
	CONSTRUCTION ESTIMATE TOTALS:	$4,900	$1,208	24.7%	**$6,108**		$4,900	$1,208	$6,108			$4,949	$1,221	$6,170
30	PLANNING, ENGINEERING & DESIGN													
2.5%	Project Management	$123	$30	24.7%	$153	0.0%	$123	$30	$153	2020Q2	0.9%	$124	$31	$155
1.0%	Planning & Environmental Compliance	$49	$12	24.7%	$61	0.0%	$49	$12	$61	2020Q2	0.9%	$49	$12	$62
15.0%	Engineering & Design	$735	$181	24.7%	$916	0.0%	$735	$181	$916	2020Q2	0.9%	$742	$183	$925
1.0%	Reviews, ATRs, IEPRs, VE	$49	$12	24.7%	$61	0.0%	$49	$12	$61	2020Q2	0.9%	$49	$12	$62
1.0%	Life Cycle Updates (cost, schedule, risks)	$49	$12	24.7%	$61	0.0%	$49	$12	$61	2020Q2	0.9%	$49	$12	$62
1.0%	Contracting & Reprographics	$49	$12	24.7%	$61	0.0%	$49	$12	$61	2020Q2	0.9%	$49	$12	$62
3.0%	Engineering During Construction	$147	$36	24.7%	$183	0.0%	$147	$36	$183	2020Q4	2.9%	$151	$37	$189
2.0%	Planning During Construction	$98	$24	24.7%	$122	0.0%	$98	$24	$122	2020Q4	2.9%	$101	$25	$126
1.0%	Project Operations	$49	$12	24.7%	$61	0.0%	$49	$12	$61	2020Q2	0.9%	$49	$12	$62
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$490	$121	24.7%	$611	0.0%	$490	$121	$611	2020Q4	2.9%	$504	$124	$629
2.0%	Project Operation:	$98	$24	24.7%	$122	0.0%	$98	$24	$122	2020Q4	2.9%	$101	$25	$126
2.5%	Project Management	$123	$30	24.7%	$153	0.0%	$123	$30	$153	2020Q4	2.9%	$127	$31	$158
	CONTRACT COST TOTALS:	$6,959	$1,716		$8,675		$6,959	$1,716	$8,675			$7,047	$1,738	$8,784

Filename: TPCS Non-CAP Alt 8 - BON Pit Juvenile Pit Tag
TPCS

1.3.5. Alternative 10: Downstream PIT Tag Barge Antenna Array

Abbreviated Risk Analysis

Project (less than $40M): **Bonneville Juvinel Pit Tag Dectection** — **Alternative:** **Alt 10**
Project Development Stage/Alternative: **Alternative Formulation**
Risk Category: **Low Risk: Typical Construction, Simple** — **Meeting Date:** **10/15/2019**

Total Estimated Construction Contract Cost = $ 630,000

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ -		0.00%	$ -	$ -
1	04 DAMS	Pit Barge	$ 630,000		25.47%	$ 160,470	$ 790,470
2			$ -		0.00%	$ -	$ -
3			$ -		0.00%	$ -	$ -
11			$ -		0.00%	$ -	$ -
12	All Other	Remaining Construction Items	$ -	0.0%	0.00%	$ -	$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	$ 71,422		23.52%	$ 16,796	$ 88,218
14	31 CONSTRUCTION MANAGEMENT	Construction Management	$ 38,111		23.52%	$ 8,962	$ 47,073
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)					$ -	

Totals	Contract Cost	% Contingency	$ Contingency	Total
Real Estate	$ -	0.00%	$ -	$ -
Total Construction Estimate	$ 630,000	25.47%	$ 160,470	$ 790,470
Total Planning, Engineering & Design	$ 71,422	23.52%	$ 16,796	$ 88,218
Total Construction Management	$ 38,111	23.52%	$ 8,962	$ 47,073
Total Excluding Real Estate	$ 739,533	25%	$ 186,228	$ 925,761

	Base	50%	80%
Confidence Level Range Estimate ($000's)	$740k	$852k	$926k

* 50% based on base is at 5% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analsyis. Must include justification. Does not allocate to Real Estate.	

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

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PROJECT: Bonneville Juvenile Pit Tag Detection
PROJECT NO P2 xxxxxx
LOCATION: Bonneville Dam Alt 10

DISTRICT: Portland District PREPARED: 10/15/2019
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez

This Estimate reflects the scope and schedule in report; NA

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 10/1/2016 ($K)	TOTAL FIRST COST ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
04	DAMS	$630	$160	25.5%	$790	0.0%	$630	$160	$790	$0	$790	1.0%	$636	$162	$798
	CONSTRUCTION ESTIMATE TOTALS:	$630	$160		$790	0.0%	$630	$160	$790	$0	$790	1.0%	$636	$162	$798
30	PLANNING, ENGINEERING & DESIGN	$173	$41	23.5%	$214	0.0%	$173	$41	$214	$0	$214	1.3%	$175	$41	$216
31	CONSTRUCTION MANAGEMENT	$92	$22	23.5%	$114	0.0%	$92	$22	$114	$0	$114	2.9%	$95	$22	$117
	PROJECT COST TOTALS:	$895	$223	24.9%	$1,118		$895	$223	$1,118	$0	$1,118	1.3%	$906	$226	$1,132

____________ CHIEF, COST ENGINEERING, Eileen Rodriguez

____________ PROJECT MANAGER, xxx

____________ CHIEF, REAL ESTATE, xxx

____________ CHIEF, PLANNING, Eric Stricklin

____________ CHIEF, ENGINEERING, Elizabeth Wells

____________ CHIEF, OPERATIONS, Dwane Watsek

____________ CHIEF, CONSTRUCTION, Karen Garmire

____________ CHIEF, CONTRACTING, Tracy Wickham

____________ CHIEF, PM-PB, Don Erickson

____________ CHIEF, DPM, Kevin Brice

ESTIMATED FEDERAL COST:	100%	$1,132
ESTIMATED NON-FEDERAL COST:	0%	$0
ESTIMATED TOTAL PROJECT COST:		$1,132

Filename: TPCS Non-CAP Alt 10 - BON Pit Juvenile Pit Tag TPCS

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

Printed:10/17/2019
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**** CONTRACT COST SUMMARY ****

PROJECT: Bonneville Juvenile Pit Tag Detection
LOCATION: Bonneville Dam
This Estimate reflects the scope and schedule in report; NA

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Rodriguez
PREPARED: 10/15/2019

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: 15-Oct-19 Effective Price Level: 1-Oct-19				Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19								
WBS NUMBER A		Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	RISK BASED CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
		PHASE 1 or CONTRACT 1													
04		DAMS	$630	$160	25.5%	$790	0.0%	$630	$160	$790	2020Q3	1.0%	$636	$162	$798
		CONSTRUCTION ESTIMATE TOTALS:	$630	$160	25.5%	**$790**		$630	$160	$790			$636	$162	$798
30		PLANNING, ENGINEERING & DESIGN													
	2.5%	Project Management	$16	$4	23.5%	$20	0.0%	$16	$4	$20	2020Q2	0.9%	$16	$4	$20
	1.0%	Planning & Environmental Compliance	$6	$1	23.5%	$7	0.0%	$6	$1	$7	2020Q2	0.9%	$6	$1	$7
	15.0%	Engineering & Design	$95	$22	23.5%	$117	0.0%	$95	$22	$117	2020Q2	0.9%	$96	$23	$118
	1.0%	Reviews, ATRs, IEPRs, VE	$6	$1	23.5%	$7	0.0%	$6	$1	$7	2020Q2	0.9%	$6	$1	$7
	1.0%	Life Cycle Updates (cost, schedule, risks)	$6	$1	23.5%	$7	0.0%	$6	$1	$7	2020Q2	0.9%	$6	$1	$7
	1.0%	Contracting & Reprographics	$6	$1	23.5%	$7	0.0%	$6	$1	$7	2020Q2	0.9%	$6	$1	$7
	3.0%	Engineering During Construction	$19	$4	23.5%	$23	0.0%	$19	$4	$23	2020Q4	2.9%	$20	$5	$24
	2.0%	Planning During Construction	$13	$3	23.5%	$16	0.0%	$13	$3	$16	2020Q4	2.9%	$13	$3	$17
	1.0%	Project Operations	$6	$1	23.5%	$7	0.0%	$6	$1	$7	2020Q2	0.9%	$6	$1	$7
31		CONSTRUCTION MANAGEMENT													
	10.0%	Construction Management	$63	$15	23.5%	$78	0.0%	$63	$15	$78	2020Q4	2.9%	$65	$15	$80
	2.0%	Project Operation:	$13	$3	23.5%	$16	0.0%	$13	$3	$16	2020Q4	2.9%	$13	$3	$17
	2.5%	Project Management	$16	$4	23.5%	$20	0.0%	$16	$4	$20	2020Q4	2.9%	$16	$4	$20
		CONTRACT COST TOTALS:	$895	$223		$1,118		$895	$223	$1,118			$906	$226	$1,132

Filename: TPCS Non-CAP Alt 10 - BON Pit Juvenile Pit Tag
TPCS

APPENDIX C – REGIONAL COORDINATION

Comments for the 60% report were received by Bonneville Power Administration (BPA) and the National Oceanic and Atmospheric Administration (NOAA). Responses to those comments were drafted and sent to each respective agency. Those comments and responses are provided below.

File Memorandum
From: Scott Bettin and Leah Sullivan, BPA
Subject: Comments on August 2019 draft of the report 'Juvenile PIT Tag Detection Prototype for Precision Increase'.

BPA comments on the report are below.

I did not see a value for what the detection increase is by route or what we are targeting.

> There is no hard target for detection increase; no such target has been provided by NOAA in the 2019 Biological Opinion. The detection increase by route will be provided in the final decision matrix as the 'detection delta' variable with all associated calculations in Appendix D.

I did not find the value of the spill (lost power) through any of the routes? It would be relevant if we were to look at making all five gates at BON 1 automated with antenna on the top of the gate (Alternative 5+). This alternative would allow best detection and have all gates follow the forebay. If this isn't enough coverage then an antenna could be placed near the surface when the first two gates antenna becomes too deep.

> There is no current plan by USACE to make all ITS gates automated; if this changes in the future the decision matrix can be updated. The alternatives here assume Project operations will remain the same. No change to amounts of flow through any dam routes are anticipated due to antenna installation. A surface antenna at the ITS forebay gates was not considered due to consensus among the PDT, NOAA researchers, and PSMFC that such an antenna would not withstand debris impacts with the debris load that the ITS experiences.

Alternative 7: This one is not comparable to LWG antenna design. The RSW passes 10 kcfs and the spillways at BON will vary much more than that. There is also the problem of the potential for a 30 foot change in tailrace at BON which can never occur at LWG.

> Agreed. The PDT considered these differences between the LWG and BON spillway bays and concluded that the BON bays were very different hydraulically and structurally and an antenna in this location would therefore perform quite poorly. This is reflected in the final score for the spillway antenna alternative. Verbiage was also added to Alternative 7.

Building on Alternative 7 could a new ogee be built in the B1 sluiceway to incorporate the same technology at LWG?

A new ogee may be feasible. However, due to the hydraulics in the B1 ITS, the water flow over the ogee would not be 'smooth' enough to allow a significant PIT detection efficiency at that location.

Alternative 8: I believe the current antenna was built with a thought of adding in a second antenna very close to it. I was surprised to see the second antenna so far from it. I also did see if they thought was to cut out that section and replace with non-ferrous aggregate or just cut a trench and use ferrite tiles for the shielding? The current antenna cost close to $10 million to build.

The location of the second antenna was based on the original B2CC designs that originally set aside a location for a second PIT antenna at the location mentioned in the report. A new antenna design may be feasible that would lower overall construction cost; however conventional concrete work is still needed and the antenna will need to be an estimated nine feet long.

Alternative 10: Did the team consider deploying the antenna in the B2 CC? The problem with the last time we tried it was on startup of the channel. If the antenna were deployed after the channel is watered and in the location indicated for the second antenna in Alternative 8 this might be a viable application.

A hydrofoil design in the entrance bay of the B2CC was not considered by the PDT due to the complete lack of success of the first effort.

GENERAL COMMENTS:

- Document is looking well organized and we appreciate the way it is written and tied back to the BiOp Terms & Conditions as well as Conservation Recommendations

USACE appreciates your comment.

- Consider defining more of abbreviations used (before using abbreviations, e.g., VBS and STS in Section 2.1.2., although in glossary it makes the document easier to read if stated when first used);

Agreed. Report is updated.

- BPA suggests additional considerations by the Corps in creating similar autogate structures at PH1, Unit 1A and 1B for retrofitting PIT tag detection antennas in the future due to PH1 unit priority (beginning at Unit 1, year-round, all FPP periods of operation);

As noted above, changed the fixed ITS forebay gates to automatic gates is not planned by USACE, or within the scope of this report.

- Are flows slow enough that adult and/or juvenile fish could reject passing at the ITS autogates and still be detected by the PIT tag antenna? (e.g., Could they "turn around" or if "tail first" swim back upstream after being detected at the ITS autogates?);

> It's feasible that on the northern ITS gate (10B), at high forebay, the velocities over the weir into the ITS may be slow enough to allow fish to swim back upstream. USACE believes this potential to be small. However, fixed gate 1A had been set at 68' MSL and will be raised by the Project to 70' MSL; this should lower the ITS channel elevation from what it has been the past few years and increase velocities over the ITS forebay weirs.

- We appreciated the presentation of materials at the last FFDRWG meeting and look forward to seeing the evaluation criteria updated in next version of the report, Section 7.0, as well as along with other remaining pieces, e.g. recommendations in Section 8.0, appendices, etc.

> USACE appreciates your comment and will indeed be updating the report based on further alternative development by the PDT, FFDRWG feedback, and comments received by BPA and other agencies.

SPECIFIC COMMENTS:

- Section 1.2, consider adding more content on advances in PIT telemetry to provide additional context;

> Text added.

- Section 2.0, suggest adding a figure that highlights at the project where these locations are discussed in subsections 2.1.1 and 2.1.2 (it will also help for digesting information in Section 5.0) - maybe move image on last page forward in the document?;

> This figure was in the original report but may not have downloaded with the document correctly; this technical error has been corrected.

- Section 2.1.1., second sentence - edit "Tag" to "tag" in sentence: PIT tag detection is provided by a single full...;

> Agreed. Text changed.

- Section 5.4.2., will there be backup power considerations for the receivers installed to reduce the potential of lost data collection (if yes, please describe);

> Text has been added. PSMFC will have, and currently has for all their systems, back-up UPSs for receivers and computer systems.

- Section 6.1.1., see general comment above and if there is consideration of altering gates U1A and/or U1B, there would be design impacts (flat plate antenna considerations could change to be similar to 3B, 6C and 10B, be cheaper and easier O&M);

> No such design change is planned. See above comment responses.

- Section 6.3, would only one flat plate be installed at either 3B, 6C or 10B, or would 3 antennas be installed in total (needs clarification - if est. 7% of yearling Chinook use the ITS per Ploskey et al. (2013), by only having 1 of 5 gates monitored seems to greatly reduce the overall potential of increasing PIT tag detection efficiency. Also, if only 1 gate is to be equipped with antenna, where would Corps install it? Please consider turbine Unit operations if only choosing 1 location);

> The alternatives consider installing antennas at all auto gates as one alternative, and at all fixed gates as one alternative. Clarification will be provided in the final report.

- Section 6.7., related to spillway antenna considerations, there is biological data from 2010 and 2011 reported spillway passage rate of 52% for subyearling Chinook salmon in 2010 (Ploskey et al. 2012) and 57% for yearling Chinook salmon in 2011 (Ploskey et al. 2013) when spilling 100 kcfs at BON in the spring and 75-95 kcfs (at times, gas cap spill at night) in the summer. However, we understand that these estimates are only relative as fish passage operations have changed and are likely a conservative estimate of current spillway passage rates;

> Agreed. At the 1 August FFDRWG, consensus among agencies was that the 2010-2011 data was the best available information available, and in spite of operational changes in the intervening years, it should still be utilized to estimate detection efficiencies at each location. Text stating such has been added to Section 1.2. Recent operational changes (increased spill) are expected to make the detection efficiencies for alternatives located at PH1 and PH2 slightly inflated and the spillway alternative slightly low. However, estimating how much the updated operations would change detection efficiencies is incalculable and would introduce unknown amounts of error into the values provided in the decision matrix.

- Section 6.10, suggest updating graphics with updated design visited July 22, 2019, downstream of Bonneville Dam, as well as information form 2018 and 2019 testing on potential for capturing PIT tag data. Additional considerations for this section include updating PIT tag detection efficiency information (recall from FFDRWG meeting, the presented efficiency estimates were not accurate), reconsider characterization of hydraulics as "turbulent" - this does not seem to accurate either post-site visit, and perhaps a paragraph on how the barge concept has advanced in the most recent years (new technology, larger, deeper fins, etc.);

> Graphics have been updated. Hydraulic description has been updated. Detection efficiencies in the decision matrix were estimated based on the expertise of NOAA researchers.

- Section 7.0, Table 7-1, weighted approach seems reasonable and that detection delta is weighted heaviest, then cost and reliability; and,

> USACE appreciates your comment.

- Section 7.0, Table 7-1, antenna efficiencies seem low for alternative 7 and 10 and too high for B2CC pass thru antenna per current estimates (e.g., 85%?), please revisit and check with NOAA, PSMFC, West Fork. etc.

> NOAA and PSMFC are providing the detection efficiency estimates for each antenna location and are updating those estimates as more research and information is completed. The final report will have the most up-to-date estimates based on their expertise.

File Memorandum
From: Trevor Conder, NOAA Fisheries

Subject: Comments on August 2019 draft of the report 'Juvenile PIT Tag Detection Prototype for Precision Increase'.

NOAA comments on the report are numbered below.

USACE responses are in blue after each comment. We thank you for your comments.

1. The intro purpose states the goal is to increase system survival estimates. I think that is a typo since the goal should be something to the effect of: to increase detection rates thereby improving the precision and accuracy of system survival estimates.

> Agreed. Language has been updated.

2. As discussed at FFDRWG, the way detection delta is being estimated in this document is difficult to follow. I suggest using the available information to develop the most reasonable estimates or range of estimates possible predicting how much the detection rates would increase with each alternative. Once this number or range is estimated, a rating can then be made based on this. This will require many assumptions, but it will still help to understand how much increase we can expect, it doesn't have to be perfect. From this we can answer, which alternative will likely detect more fish, the corner collector alternative or one of the ITS alternatives for example.

> The 'Detection Delta' variable has been updated and modified as you requested, and as discussed at the 1 August 2019 FFDRWG meeting. A breakdown of how the new variable was calculated is included in Appendix D.

3. The document states the ITS is operated year round, this is incorrect as it is closed December to March. Also, the first powerhouse only operates one unit for much of the year, and this will be more of a factor in the spring when under 125% 150K flex spill. This will be even more of a factor when B2 is fully rated again. This should all be considered in the efficiency estimate.

> The ITS is operated year-round (reference FPP section 2.4.1.12). The efficiency estimate utilizes the passage proportion data from 2010-2011 studies, as agreed upon at the 1 August 2019 FFDRWG meeting, which is the best information currently available on juvenile fish passage proportions through the ITS. Speculating on relative changes to ITS passage efficiency at varying spill volumes would likely introduce unwanted error into the efficiency estimates. Recent operational changes in spill should however be considered when interpreting the efficiency data and decision matrix.

4. The document makes several references to laminar flow which is inaccurate. True laminar flow is not achievable in the flow environment considered.

> This distinction is noted and the language in the report has been updated to reflect this.

5. The document is not clear why the entire sluice-way fixed and auto gates are not considered as a single alternative. Splitting them up will decrease detection in an area that we are lucky to get 6% of the passage in a good year. I am unlikely to support antennas just on the auto gates

of the ITS. I think this would be a wasted effort for most of season with relatively few units operating at B1, especially with B2 allowed to operate at upper 1%.

> We have updated the report to better explain the reasoning behind not combining all the ITS weir gates into one alternative. As the fixes and auto gates require different antenna designs with different challenges, the PDT kept them separated to flush out what those challenges may be for future decision making. The fixed gates had different antenna design possibilities and keeping those alternatives separate allowed the PDT to evaluate those different designs on their own merit. It is the intention to eventually marry the fixed and auto gate designs as one management option in the final report.

6. I am not likely to be supportive of moving forward with spillway concept due to excessive cost and little detection benefit. Around 50% of the fish pass the spillway at BON under past ops, and 18 bays comes to 2.7% of fish assuming 100% eff. Not enough to justify that much work.

> We concur that the spillway alternative has significant challenges. This is borne out in the decision matrix as a low score.

7. The PIT barge is a different project that BPA is looking at, and it is difficult to follow how the two are related. It would be cleanest if it was considered separate from this. At SCT, we are being told the PIT barge is covered by BPA solely as a separate project.

> The PIT barge alternative presented here is separate from the BPA research effort, but does lean on the information gleaned from the BPA research. It was suggested as an option to add PIT detection at Bonneville Project (in the footprint of the dam), which is within the scope of the PDT effort. We have updated the report to better explain the difference.

8. A more substantial comment is to have NOAA Pasco (Gordy's shop) look at the flow issue in the ITS outfall and see what they think about detection rates there. I am not sold that we couldn't detect fish at a similar high rate with similar PIT tech to what is being in used in B2CC which also has higher velocity and fairly chaotic flow. I think the ITS alternatives have some useful ancillary benefits of all the alternatives, so trying to pin down a single or two antenna system at the ITS outfall seems worth any additional thought.

> We agree that the ITS outfall chute is an ideal location for a PIT antenna. We have been working closely with NOAA and PSMFC to identify an antenna design and associated detection efficiency for this location. Based on their expertise, this location would be unworkable due to the turbulent flows, the required infrastructure for a viable PIT antenna, and the very low resultant detection efficiencies estimated for any antenna in this location. The difference between the ITS outfall chute and the B2CC location is the turbulence of the ITS outfall chute owing to the relatively short distance between the forebay drop and outfall, as well as the location of the outfall chute which sits directly at the powerhouse with surrounding work areas that limit the amount of concrete work that can be done.

Comments for the 60% report were received from Pacific States Marine Fisheries Commission (PSMFC). Those comments and responses are provided below.

1. Section 6 - We don't see the guidance curtain that Gordy Axel (NOAA) proposed to re-deploy at the B2CC entrance. It is our understanding that the guidance curtain was shown to increase the number of fish going through the B2CC, increasing the possibilities of detecting PIT tagged fish. Why was that discontinued, and can it be brought back?

> Response from Brad Eppard (NWP-PM-E): It was removed because the cost(s) to maintain and/or repair it combined with it being a safety hazard did not pencil out relative to the small benefit it provided. Without looking up the numbers I recall there was no benefit for STHD, a modest benefit for CH-1, and no benefit for Subs.

2. Figure 6-1 - We'll send you a new graphic that doesn't include the floating antennas. It does include shielding described in the next comment.

> New graphic was used to replace the existing graphic in the report.

3. Section 6.1.3 – Shielding of the concrete (rebar) and metal infrastructure will be required, see (the new as of 8-7-2019) Fig 6-1. The guides for the trash rack, stop logs and gates may need to be shielded as well.

> Language added to Section 6.1.1 regarding shielding.

4. Section 6.2.2 – RF shielding external to the antenna assemblies may be required.

> Language added to Section 6.2.1 regarding shielding.

5. Section 6.2.6 – We envision the pass-through antenna design to include the gate. Referring to Figure 6-2, in Bay 1A the antenna is fixed at 68'msl as per the fish passage plan (FPP). The gate portion (on the bottom of the antenna assembly) is in the gate slot and thus not seen. In Bay 1B, part of the gated is visible as that antenna is fixed at 70'msl as per the FPP. In both cases the gates are available for use by pulling the antenna assemblies upward.

Non-concur. Because the antenna is attached or resting atop the fixed gate, it must be removed prior to gate operation. This is an impact to O&M burden. Leaving the antenna attached to the gate could lead to damage on the antenna due to environment or accidental impact from crane operations.

6. Section 6.3.6 – The flat plate antenna design shouldn't have anything for debris to catch on.

> Concur with comment. Wording changed to reflect that antenna has not yet been prototyped & alternatively is likely not viable.

7. Section 6.4.6 – This antenna has not been prototyped. PSMFC, NOAA and Biomark all now have reservation as to whether this alternative is viable due to water speed and turbulence.

> Concur with comment. Antenna unlikely to accumulate debris. Wording added mentioning modification to gate control to keep desired head over gate with additional height from antenna.

8. Section 6.8.2 – This antenna (flush-mounted antenna array) has not been prototyped. If this antenna design proves inadequate, the fallback would be to recreate the existing antenna, including the dehumidification equipment room and infrastructure.

> Language added to Section 6.8.1 to address this.

APPENDIX D – DECISION MATRIX CALCULATIONS

1.1. Basis of Decision Matrix

The decision matrix relied on data from fish passage studies in 2010 and 2011 to generate passage proportions through various dam routes, as well as the technical knowledge of PSMFC and NOAA to estimate detection efficiencies of the PIT tag antenna technology that would be used in a specific location. Table D-1 shows passage proportion estimates for juvenile yearling Chinook (CH1) and steelhead (STH) passing downstream through Bonneville Dam, taken from Ploskey et al. (2012).

Table D-1. Bonneville Dam Passage Proportions (Ploskey et al. 2012)

Dam Section	Juvenile Passage Routes	CH1 (2010 - 2011)	STH (2010 - 2011)	Average of CH1, STH
PH2	Juvenile Bypass	0.055	0.038	**0.047**
	Turbines	0.12	0.1	**0.110**
	B2CC	0.11	0.201	**0.156**
Spillway	Spillway	0.547	0.475	**0.511**
PH1	ITS	0.043	0.053	**0.048**
	Turbines	0.12	0.133	**0.127**

The average passage proportions (bold font) listed in Table D-1 are utilized in the Table D-2 column labeled ‘passage proportion’. For the ITS auto and fixed gates, and for the spillway, the listed alternatives required estimating the number of fish passing through specific gates or bays of each passage route. For the ITS auto and fixed gates, it was assumed that 50 percent of the flow (and therefore fish) went through the fixed gates (1A and 1B), and 50 percent went through the auto gates (3B, 6C, and 10B) due to the estimated amount of flow going through each type of gate. For the spillway bays, previous research was utilized to estimate the proportion of fish passing through each spillway bay. Weiland et al. (2016), utilizing the same data set at Ploskey et al. (2012), estimated that 6.6 percent of fish passing the spillway went through Bay 1, and 4.1 percent went through Bay 18. Due to the limited range of PIT tag antenna cables, these end bays are the only viable spillway bays to place a PIT tag antenna, and Bay 1 was chosen over Bay 18 to be represented as an alternative due to the relatively higher number of fish passing through that bay. All of these numbers are utilized in Table D-2 to estimate final passage proportions for each alternative.

To estimate the final Detection Delta value utilized in the Decision Matrix, each percentage of ‘Anticipated boost in Project-wide PIT tag detection’ listed in Table D-2 needed to be converted to a 1 – 5 scale. The lowest percentage (0.2 percent for Spill Bay 1) was given a score of 1 and the highest percentage (2.2 percent for the ITS auto gates) was given a score of 5. The remaining percentages were mathematically converted to the 1 – 5 scale using the formula 2x + 0.6, where x is the percent boost in project-wide PIT tag detection.

Table D-2. Calculations Utilized to Generate 'Detection Delta'

Alternative	Passage proportion	Detection Efficiency	Estimated number of fish passing BON detected[1]	Current PIT tag detection	Anticipated boost in Project-wide PIT tag detection[2]	Detection Delta
ITS Fixed Gates (Flat-Plate) - 2 gates total	0.047 (ITS) x 0.5 (Fixed gates) = 0.024	85%	1.6%	No	1.6%	3.7
ITS Fixed Gates (Pass-Thru) - 2 gates total	0.047 (ITS) x 0.5 (Fixed gates) = 0.024	50%	1.2%	No	1.2%	3
ITS Auto Gates (Flat-Plate) - 3 gates total	0.047 (ITS) x 0.5 (Auto gates) = 0.024	90%	2.2%	No	2.2%	5
ITS Outfall (Pass-thru)	0.048	20%	1.0%	No	1.0%	2.6
Spillway Bay 1 or Bay 18 (Flat-Plate array)	0.51 (Spillway) x 0.06 (Bay 1) = 0.03	5%	0.2%	No	0.2%	1
B2CC (Pass-thru)	0.16	85%	12.8%	Yes	1.9%	4.4
JBS Outfall Piers	~0.03	50%	1.7%	No	1.4%	3.4
PIT Tag Barge in Tailrace (Fin Array)	~0.01	90%	1.2%	No	1.0%	2.6

[1] Calculated by multiplying the previous two columns together.
[2] This value is the number of fish passing BON detected, adjusted for any fish that would have already been detected. The B2CC value assumes that the second antenna will detect 85% of the undetected fish from the original antenna, for an added efficiency of 12.75%. The JBS Outfall Piers and PIT Tag Barge in Tailrace values assume that 17% of fish were already detected at Bonneville Dam.
Note: Detection Efficiency values are ballpark estimates provided by NOAA and PSMFC based upon anticipated antenna performance.

1.1.1. Hydraulic Consideration - Turbulence

With regard to detection efficiency, favorable flow (i.e. near laminar) would occur with the ITS auto gate flat plate alternative. Unfavorable flow (i.e. severely turbulent) would occur with both the spillway antenna array and ITS outfall alternatives. This is reflected well within Table D-1, as the detection efficiency for the ITS auto gates is 90 percent while the spillway and ITS outfall alternatives have detection efficiencies of 5 and 20 percent, respectively.

1.2. Weighting Factors

Below are the weighting factors for each criteria utilized in the decision matrix to generate the final score. Rationale for each weighting is described for each.

- Detection Delta (2.0): This criteria is the driver for this study, and therefore, was given the highest weighting factor.
- Cost (1.6): Cost is for construction only. Cost is expected to be a key consideration in whether an alternative gets constructed, therefore it was ranked relatively high.
- O&M Burden (1.0): The routine O&M Burden was not estimated to be considerable for any of the alternatives; however, it is important to Bonneville Project that the PIT barge alternative would require seasonal deployment and removal by Project personnel. Therefore, this criteria was retained, but given a low weighting factor.
- Constructability (1.1): Constructability considers the environmental coordination, amount of concrete work, underwater work (divers or caisson), etc., that add technical complexity to construction at a specific alternative. This criteria is specific to work that USACE would perform as part of antenna installation. This was given a low weighting factor due to the relatively low amount of construction work required for most of the alternatives.
- Reliability/Durability (1.5): This criteria was given a higher weighting factor due to the desire for any antenna to operate over long time periods with minimal need for repair or maintenance. This considers both performance of the antenna itself as well as any physical impacts to the antenna over time, specifically debris that may strike an antenna at a location and potentially damage the equipment.
- Secondary Biological Uses (1.3): This criteria was given a moderately low score due to the fact that this criteria is secondary to the main objective of increasing overall PIT tag detection at Bonneville Project. However, based on input from Fish Facility and Design Review Work Group (FFDRWG) representatives at the 01 August 2019 meeting, this criteria has regional support and interest as it considers biological information gained from specific passage routes.
- Hydraulics (1.2): This criteria was given a moderately low score because although it considers dam safety, it mostly accounts for changes in geometry. If

the geometry does cause the hydraulic profile to change considerably, it may be able to be mitigated elsewhere in the system.

1.3. Criteria and Scoring

Each alternative was given a unique score for each criteria, utilizing a 1-5 scale with 1 being poor and 5 being outstanding. Below lists each criteria and how alternatives were evaluated for each criteria. Calculations for the Detection Delta criteria is presented in Table D-2 and is not discussed here.

1.3.1. Cost

The cost of the spillway was given the lowest score due to the amount of concrete work and construction required to install an antenna on the spillway ogee. The B2CC was the next-expensive option due to the concrete work required to install an antenna. The highest score was for the ITS auto gates; the gates can be removed for construction and the antennas can be installed out of the water, making the impacts less severe. The ITS fixed gate however would require construction in place and a caisson or divers for antenna installation, bumping up the cost compared to the ITS auto gate alternative.

1.3.2. O&M Burden

The PIT tag barge was given the lowest score due to the need for Project personnel to deploy and then remove the barge before and after the juvenile migration season (April – August) each year. The other alternatives require no routine maintenance by Project personnel, and accordingly, received a higher score.

1.3.3. Constructability

Placing an antenna on the JBS outfall piers was determined to be virtually impossible by PSMFC, and was given a low score. A spillway antenna would be very intensive to construct with significant dam safety and hydraulic concerns, therefore, it was also given a low score. The ITS outfall chute has challenges associated with concrete excavation and shoring up the chute to maintain stability and was ranked low. The need for divers or a caisson for a flat plate on the ITS fixed gates, and the concrete work on the B2CC resulted in middle scores for those alternatives. The constructability of the remaining options was deemed less intensive.

1.3.4. Reliability and Durability

The reliability and durability of specific alternatives were generally scored high if an antenna is currently operating with no issues (B2CC), or would sit flush with concrete and provide minimal opportunity for debris to hit the antenna (B2CC, ITS outfall chute). The remaining scores were PDT estimates of the likelihood that debris would strike and potentially damage an antenna. Due to the JBS outfall piers and PIT tag barge sitting in the main tailrace flow, they received the lowest score.

1.3.5. Secondary Biological Uses

The B2CC antenna, JBS outfall piers, and PIT tag barge alternatives received the lowest scores. An antenna in the B2CC would not provide much additional information on fish behavior due to an antenna already being located in the B2CC. The JBS outfall piers and PIT tag barge antennas would detect fish after they had already passed the dam, and therefore do not provide information on fish passage route. A spillway antenna would provide route of passage information for a previously-undetected location, but the spillway is only operated from 10 April – 31 August each year, meaning adult fallback information would be largely missed. The ITS is scored highest due to its operation year-round, and the fact that no PIT tag detection at B1 currently exists, meaning an antenna at that location would provide the most fish passage information.

1.3.6. Hydraulics

The decision matrix has the spillway alternative scoring the lowest because, although changes in geometry are not expected, major dam safety issues are at play and that takes precedent. The flat plate antennas, whether on ITS fixed or auto gates, scored in the middle because they might not affect dam safety considerably, but will change the geometry of the flow path to some degree. Scoring slightly higher is the B2CC pass-through antenna because it will be installed flush with the concrete, not proving to be a geometry issue and only a slight dam safety issue. The highest score goes to the PIT tag barge because there are no dam safety issues and no changes in geometry.

APPENDIX E – BONNEVILLE ICE AND TRASH SLUICEWAY FLAT-PLATE ANTENNA TESTING

IT&S Antenna Tests

Gabriel Brooks (NOAA Fisheries), Scott Livingston (PSMFC), Erek Arnold (WFE)

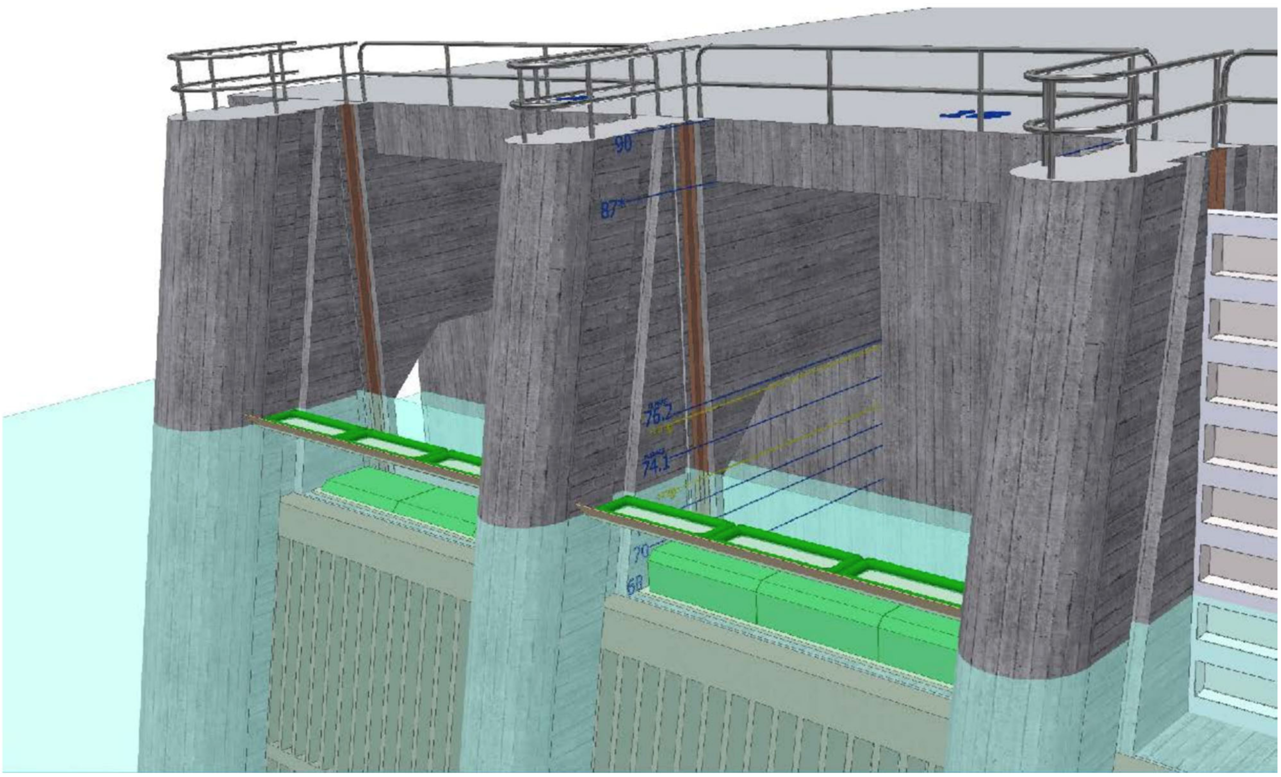

Figure 1 Bonn. I&TS Flat-Plate Proposal

General Description

In order to provide Passive Integrated Transponder (PIT) detection for tagged fish traveling through the Bonneville I&TS bays A1 and B1, a flat-plate antenna design has been proposed. The proposed position of this antenna would lie between the turbine intake trashracks and the fixed gate structure, with exciter cables extending from the antenna to the deck through custom fabricated stainless-steel conduit. Environmentally controlled equipment cabinets would be mounted on the deck above the antennas, providing short cable runs, easy visual antenna assessment with the potential to perform in-situ read range measurements.

Advantages of flat-plate design:

- The smaller proposed antenna would reduce possible EMI generated by nearby equipment.
- Read field and construction methods of such an antenna are well understood.
- Less costly to manufacture and transport than a large pass-through antenna.

Disadvantages of flat-plate design:

- Antenna would likely detect tagged fish that may ultimately "dip" into the read field and escape without passing through the I&TS thus providing erroneous route-passage data.
- May require the use of a caisson or cofferdam to dewater the area for installation.
- Custom exciter cable conduit would be needed to provide protection against damage from passing debris.

Flat-Plate Prototype Testing (Pasco, Aug. 13, 2019)

NMFS along with PSMFC and West Fork Environmental constructed two prototype antennas designed to operate with the Biomark FS3001 Ogee transceiver. These two antennas were used to test the potential read range which could be expected from both a barge mounted fin antenna and a flat-plate pass-by antenna.

Both antennas were operated with the same FS3001 (SN12) transceiver using 75' of exciter cable. Read range measurements were accomplished with a standard 12 mm APT test tag. Note that the read ranges below were accomplished in a relatively low noise environment. Several factors will impact read range on an installed antenna, including ambient EMI, proximity to ferrous metal, submersion and final construction methods which would likely include shielding and the use of ferrite tiles to shape the field. It is impossible to determine final antenna performance characteristics, but the read ranges below give a general indication of what should be expected.

Figure 2. Test Antenna Setup Jig

Antenna Characteristics

	Antenna 1	Antenna 2
Size	22’ x 32.75”	17’ x 4’
Inductance (1 kHz)	437 µH	420 µH
Antenna Current	28.1 A	28 A
Maximum Read Range	44”	55”

	Antenna 1	Antenna 2
100% Tag Activation	36”	48”
Antenna Wire	10 AWG Litz	10 AWG Litz
Winding Spacing	2-s-2-s-2	6
Winding Pitch	6 mm	6 mm

Additional Considerations

After further consideration and discussion with PSMFC, it may be possible to develop a precast concrete antenna housing which would include the shield and antenna. This design may allow for the installation of the antenna utilizing divers in lieu of a caisson or cofferdam. It may also be possible to develop a heavily weighted antenna that would be held in place by means of weight, friction and minimal loading on the stoplog guides.

Large Pass-Through Antenna Testing

NOAA and PSMFC also performed a test utilizing the Flex Antenna Cable (FAC) previously designed by NOAA for use in the lower Columbia river for the Flexible Antenna Array. Due to time constraints related to LGR antenna testing, only one antenna size was tested. NOAA and PSMFC constructed a very large pass-through antenna (38’ x 17’) out of a single loop of FAC. The antenna inductance was 420 μH (100 kHz). The antenna was elevated off the ground ~6’ and tuned. Although the antenna tuned properly, noise on the antenna was significant and read ranges were poor. A standard 12 mm APT tag could only be read within 30” of the windings for the coil.

Future testing will address the current size of the proposed pass-through antenna (22’ x 15’) and effort will be made to address possible noise emitters near the test site (such as the operational LGR system ~200 m away). Our hope is to conduct this test in conjunction with the LGR synchronization test in September.

Figure 3. Large Loop Antenna