ADULT FISHWAY INSPECTIONS ON THE COLUMBIA AND SNAKE RIVERS

2017 ANNUAL REPORT

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FISHWAY INSPECTIONS AT COLUMBIA AND SNAKE RIVER DAMS, 2017

INTRODUCTION

This season was the 33rd year of a continuing fish passage facilities inspection program that was coordinated through the Fish Passage Center (FPC) at 13 hydroelectric dams located on the Snake and Columbia rivers. These projects were inspected on a monthly basis by Federal or State Fish Agency personnel to assure that fish facilities were being operated according to established criteria documented in the Corps of Engineer (COE) Fish Passage Plan (FPP), or in the Fishery Operating Plans for the Public Utility District (PUD) projects in the Mid-Columbia. This report summarizes results obtained from the individual project inspections during the 2016 fish passage season.

The inspection program spans from April through October at all projects, with an additional inspection in March and/or November at the four lower Columbia projects. These months encompass the main passage season for adult and juvenile fish at the mainstem dams. The objective of a fishway inspection is to assess passage conditions at the time of the inspection and assure that facilities are operating according to established criteria. The agency inspector is responsible for coordinating immediate problems or out-of-criteria conditions to project personnel for resolution. The individual inspection reports and this final Report by the FPC operations coordinator will serve to alert the operating agency of problems that were noted during the inspections and areas that may require resolution.

BACKGROUND

Adult fish passage facilities were incorporated into 13 mainstem Columbia and Snake River dams as early as 1933 at Rock Island Dam with the latest dam construction at the Bonneville new powerhouse in 1981. Upstream passage of adult salmonids was blocked in the Columbia River with the completion of Grand Coulee Dam by 1938, and in the Snake River at Brownlee Dam in 1958 (Figure 1). Mainstem passage issues were addressed as each dam was built to assure that salmon species could pass and migrate safely to upstream spawning areas. Criteria were developed and refined through the years to achieve known hydraulic conditions within a fishway that were basically within the fishes' swimming abilities. In addition, research studies or modeling studies have been accomplished that have shown areas in the fishways where passage problems existed; be it potential migration delays or, in extreme cases, mortality of upstream migrating adult fish.

The COE and PUDs are to operate their fish facilities within standards in the agreed upon Fish Passage Plan at COE projects or according to standards to meet the NOAA Fisheries Biological Opinions (BiOp) and/or Habitat Conservation Plans (HCP) at the PUD projects. The operating agencies are responsible for maintenance of the fish facilities and for operating them at the agreed upon criteria year round, with special or annual maintenance accomplished during the winter maintenance period. Planned fishway outages occur mainly when adult fish passage is minimal, during the winter season. Repairs and other maintenance issues that could affect passage of adult fish during the fish passage season require special coordination between the operating entities and the fishery agencies and tribes.

At the COE and PUD dams, project personnel are required to daily inspect adult fish facilities. Most adult fishways operate in an automatic mode and require no manual adjustments unless the equipment

malfunctions. All fishways can be operated in Manual Mode should the automatic control system malfunction. Project operators or fishway attendants will normally restore an out-of-criteria item in the fishway as soon as the discrepancy is found or a Trouble Report issued if the problem requires additional mechanical, electrical, or other support to repair the item.

The State and Federal fishway inspectors schedule an inspection of the fish facilities with project personnel and check into the project office or with the project biologist prior to initiating an inspection. The inspectors are responsible for contacting project operations personnel to review the inspection and coordinate problems that require correction. A completed copy of the inspection report can be left at the project or later sent to the COE project operations biologist or PUD personnel. The FPC fishway coordinator receives a copy of the inspection report, reviews it, and then follows up on problem areas that were earlier noted or discussed with the COE project or district fish biologists.

Key items recorded during an inspection include:

- *Powerhouse operations including number of turbines operating and at what Megawatt or flow level, number of spill bays operating and quantity of spill, water temperature and turbidity,*
- *Weir gate depths or width of gate opening at the main fishway entrances,*
- *Hydraulic head differentials at the entrances and along the channels,*
- *Water velocities in the collection or transportation channels,*
- *Head differentials across trashracks and picketed leads,*
- *Depth of water over the fish ladder weirs,*
- *Condition or readability of staff gages or water level sensors and related controlling equipment for the fishway elevations,*
- *A comment section to list special conditions or out-of-criteria areas, and where applicable, Inspections of juvenile fish facilities are normally completed while on site.*

The Fish Passage Center has been coordinating fishway inspections at the mainstem Columbia and Snake River projects since 1984. The 2017 season was a continuation of the long-term inspection program that the State and Federal fish agencies have endorsed since the 1960s. Funding for the inspection program is provided from Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), National Oceanic and Atmospheric Administration (NOAA), and the United States Fish and Wildlife Service (USFWS).

Figure 1. Dams in the Columbia and Snake River Basins.

Dam	Year in Service	Miles to Mouth	Gross Head (Feet)	Miles of Reservoir	Operator	Adult Fish Passage
Bonneville	1938	146	65	45	COE	Yes
The Dalles	1957	192	85	24	COE	Yes
John Day	1968	216	105	76	COE	Yes
McNary	1953	292	75	61	COE	Yes
Priest Rapids	1959	397	82	18	Grant PUD	Yes
Wanapum	1963	416	84	38	Grant PUD	Yes
Rock Island	1933	453	54	21	Chelan PUD	Yes
Rocky Reach	1961	474	93	42	Chelan PUD	Yes
Wells	1967	515	72	30	Douglas PUD	Yes
Chief Joseph	1955	545	177	51	COE	No
Grand Coulee	1941	597	343	151	BOR	No
Ice Harbor	1961	334	100	32	COE	Yes
Lower Monumental	1969	366	100	29	COE	Yes
Little Goose	1970	395	100	37	COE	Yes
Lower Granite	1975	432	98	39	COE	Yes
Hells Canyon	1967	571	210	22	Idaho Power	No
Oxbow	1961	597	120	12	Idaho Power	No
Brownlee	1958	609	272	57	Idaho Power	No

GENERAL RESULTS

With few exceptions, the Fish and Wildlife Agencies inspected adult fish facilities at 13 mainstem Columbia and Snake River dams on a monthly basis from March/April through October/November. Fish agency inspection reports and results were normally coordinated with COE and PUD operations biologists or operations personnel at the time of the inspection.

Factors affecting fishway operations and/or the ability to inspect fishways at the mainstem dams during the 2017 fish passage season are listed below:

- The January to July runoff volume at The Dalles Dam was approximately 135 percent of normal (1981–2010) and the January to July runoff volume at Lower Granite Dam was approximately 152 percent of normal (1981–2010). There was spill at most projects during the spring and summer months to improve passage conditions for the juvenile fish migrations in the Snake and Columbia rivers.

SUMMARY BY PROJECT

Fishway inspections by the State and Federal fishery agencies were completed at the 13 mainstem dams between March and October with NOAA inspecting Bonneville, and McNary; FPC inspecting Ice Harbor; PSMFC inspecting Lower Monumental dam; FPC/CRITFC inspecting Priest Rapids and Wanapum dams; WDFW inspecting Rock Island, Rocky Reach, and Wells dams; and ODFW inspecting The Dalles, John Day, Little Goose and Lower Granite dams.

AGENCY	INSPECTOR	DAMS INSPECTED
CRITFC	Tom Skiles	Priest Rapids & Wanapum
NOAA	Gary Fredricks	Bonneville
NOAA	Jeff Brown	McNary
ODFW	Howard Takata	The Dalles & John Day
ODFW	Anne Dowdy	Little Goose & Lower Granite
USFWS	Dave Swank	Ice Harbor
PSMFC	Monty Price	Lower Monumental
WDFW	Paul P.	Wells
WDFW	Mauro Solorio	Rock Island & Rocky Reach

Results from inspections are summarized by project below. Dates of inspections and problem areas are noted as well as special activities that occurred during the year. Criteria used to evaluate operations of a fishway are found in the FPP or Operating Plans for each project.

CORPS OF ENGINEER DAMS

The four lower Columbia River dams, Bonneville to McNary dams, and the four Snake River dams, Ice Harbor to Lower Granite dams comprise the COE projects that were constructed with adult fishways incorporated into their original designs. Fish turbines or fish pumps along with gravity-flow systems were integrated into the fishway designs to supply water to the adult fishways. These eight COE dams have collection channels across the downstream face of the powerhouses with main fishway entrance gates at each end of the channel. Along the face of the collection channel, openings (orifice or sluice gates) were provided to allow entrance for adult fish approaching and passing along the powerhouses. In recent years, many of these collection channel gates have been closed and only the main entrance gates located at each end of the powerhouse are now operated. Most spill schedules have been modeled at the COE's hydraulic laboratory in Vicksburg, Mississippi, and were designed to improve juvenile passage at the dams, reduce high levels of dissolved gas entrainment in the tailwater at the projects, and still provide good passage conditions for adult fish approaching the projects. In many cases, the juvenile and adult spill schedules are similar. Normally, the COE has Project biologists stationed at each dam that complete fishway inspections on a daily basis.

BONNEVILLE DAM (photographs on page A-x)

Bonneville Dam has two powerhouses: the original powerhouse (PH1) constructed in the late 1930s and located on the Oregon shore or south shore of the Columbia River, and the new powerhouse (PH2) completed in 1980/81 and located on the Washington or north shore of the Columbia River. PH1 consists of ten main turbine units while PH2 has eight main turbine units and two smaller fish turbines that supply auxiliary water to the Washington shore fishway. Between the two powerhouses is the spillway (part of the original construction) that incorporates 18 spillbays to pass excess or designated flow past the project. Gravity-flow water supplies flow to the main fishway entrances at PH1 and the spillway entrances. At PH2, the two fish turbines each supply a maximum of 5,000 cfs of water to the auxiliary water system that distributes flow to the four main entrances and the orifice gates along the powerhouse collection channel.

In recent years, numerous improvements have been installed in Bonneville Dam fishways intended to aid in the passage of adult Lamprey. In 2002, a Lamprey Passage System (LPS) was designed and installed in the Bradford Island fishway exit. In 2004, the Bradford Island LPS was extended to the forebay and added PIT-tag readers and resting boxes. In 2007, a dual ramp LPS was installed in the Auxiliary Water Supply (AWS) channel of the Washington Shore Fishway. Also in 2007, nighttime tests were conducted at Washington Shore Entrances that compared standard head differentials (1–2 feet) versus reduced head differentials (0.5 feet) in an effort to evaluate if reduced entrance velocities would improve lamprey entrance rates. Results of the 2007 tests showed some variation in the number of lamprey entering the ladder during reduced nighttime head differentials between the north and south entrances; as a result, the tests were repeated in 2009 with more study blocks.

At the Cascade Island fishway, "keyhole" entrance weirs were installed in 2009 and intended to aid lamprey in entering the ladder by providing a wider opening at the bottom of the weir with reduced entrance velocities making it easier for lamprey to negotiate. In addition to the modified entrance weir, rock floors, a PIT-tag reader, and a prototype LPS were added to the Cascade Island ladder in 2009.

More recent improvements (2010/2011) to the Bonneville Dam fishways intended for lamprey include raising the Washington Shore picketed leads by 1.5 inches along with adding a ramp up to the base of the picketed leads to improve the use of the LPS in the AWS channel and to reduce the use of the serpentine section of the Washington Shore fishway (known problem area for lamprey). The picketed leads at the Washington Shore count station were replaced in 2012 with ¾-inch gap pickets.

Over the winter maintenance period of 2012/2013, several notable lamprey improvements were made at Bonneville Dam.

1. Bonneville Washington Shore entrance Lamprey Flume: Installed the prototype Lamprey Flume System (LFS) at the North Downstream Entrance intended to provide a bypass route around the fishway. A conventional Lamprey Passage Structure (LPS/lamprey ramp) connects to the terminus of the LFS and terminates in a holding tank on the tailrace deck.

2. Bonneville Cascade Island LPS modifications: Being converted into a fully volitional passage route with an exit directly into the forebay, adjacent to the Cascades Island fish ladder exi**t.**

Nine adult fishway inspections have taken place at Bonneville Dam:

Date	Inspector(s), Agency
March 10, 2017	Gary Fredricks (NOAA)
April 7, 2017	Gary Fredricks (NOAA)
May 5, 2017	Gary Fredricks (NOAA)
June 16, 2017	Gary Fredricks (NOAA)
July 14, 2017	Gary Fredricks (NOAA)
August 11, 2017	Gary Fredricks (NOAA)
September 8, 2017	Gary Fredricks (NOAA)
October 25, 2017	D. Benner (FPC)
November 14, 2017	Gary Fredricks, Trevor C .(NOAA), D. Benner (FPC)

Bradford Island (PH1) Fishway

The auxiliary water supply to the fishway is gravity-flow water from the forebay of the project. The auxiliary water source normally supplies required flow to meet fishway criteria through high and low tailwater elevations. The Bradford Island Fishway main entrances are operated in pairs (i.e., Gate 2 and Gate 64, or Gate 1 and Gate 65 depending on tailwater elevation).

PH1 Inspections

Weir Gate 1/2, located at the south end of PH1, had head differentials (site reading) that ranged between 1.1 ft and 1.6 ft and met criteria (1.0 ft) during all nine fishway inspections in 2017. The gate depths at Weir 1/2 ranged from a low of 6.4 ft to a high reading of 17.2 ft for the season. The gate depth was less than 8 ft during one of the nine inspections. During the October inspection the tailwater was below 10 ft. At tailwater elevation 13.5 ft or less, gate depth of 8 ft or > will exceed conduit pressure of 10 psi. With the sill at elevation 2 ft, any tailwater less than 10 ft will also result in gate depths of less than 8 ft. The Bonneville southern powerhouse tailwater was below 10 feet during the October inspection.

Weir Gate 64/65 was operating during each inspection in 2017. The gate depths at the A-Branch entrance (Gate 64/65) ranged from 6.2 ft. to 10.1 ft., with head differentials through the season ranging from 1.1 ft to 1.6 ft. The gate depth was less than 8 ft. during two of the nine inspections (October and November). During the October inspection the tailwater was too low to achieve criteria (less than 10 ft.), the gate depth missed criteria during the November inspection. The head differential at the A-branch entrance was within criteria (1.0–2.0 feet) during all nine inspections in 2017.

South Spillway or B-branch Fishway and the North Spillway or Cascades Island Fishway is part of the original fishway system at Bonneville Dam. Gravity flow water is supplied from the forebay, through a diffusion system and exits through the downstream entrance gates at the lower end of the fish ladder. It should be pointed out that the diffusion system suppling water to the A-Branch has developed some leaks, leading inspectors to note the presence of a "geyser." Both fishways have similar main entrances (design-wise) with side and downstream entrances that operate as continuously open free-flowing vertical slots. Adjacent to each entrance is a spill bay (1 or 18) that is operated at a minimum of 4–6 inches open and passes about 1.8 Kcfs of water. Each main entrance is operated to meet the head differential criteria of 1.0 to 2.0 ft with a preferred head differential of 1.5 ft.

The B-branch Fishway (South Spillway) head differentials ranged between 1.1 and 2.1 feet and were within criteria during all nine inspections in 2017.

The Cascades Island (North Spillway) entrances were operated throughout 2017. Head differentials at the Cascades Island fishway ranged from 0.6 to 2.0 ft. and were operated within criteria during seven of

nine inspections in 2017. Cascade Island tailwater gauge was missing/not readable during all six of nine inspections in 2017, head differentials came from PLC readings.

Fish Ladder: Depth of water measured over the Bradford Island fish ladder weirs ranged from 1.0 to 1.2 ft. in 2017. The Bradford Island weirs were within criteria during all inspections in 2017. The depth of water measured at A-Branch weir ranged from 1.0 ft. to 1.8 ft. during the year, meeting criteria during all inspections in 2017. The depth of water measured at the B-Branch weir ranged from 1.0 ft. to 1.4 ft. during the 2016 fishway inspection season, meeting criteria during each inspection. At the Cascades Island fish ladder, water depth over the weirs ranged from 0.9 ft. to 1.2 ft.; readings were within criteria during seven inspections of 2017, two inspections (August and November) fell just short of the 1.0 ft. minimum criteria (0.9 ft.). The fish ladder exit at Bradford Island was reported as clean during six of nine inspections in 2017. During the May, August, and September inspections the Bradford Island exit was noted as not clean.

PH2 Fishway

Fish Turbine Units F1 and F2 each supply a maximum of 5,000 cfs of water to the four main entrances and 12 orifice gates along the powerhouse collection channel. With the exception of F2 being off during the September inspection due to low tailwater, both fish turbines operated satisfactorily throughout the fish migration season in 2017.

Head differentials measured at the main entrances, North Upstream, North Downstream, South Upstream, and South Downstream ranged between 0.9 ft and 1.9 ft at the North entrance gates with the South entrance gates reporting head between 0.9 ft and 1.2 ft. Most readings at both the South and North shores were equal or greater than the 1.0 ft minimum. During both the April and July inspections, one of the four Washington Shore entrances recorded a head differential just shy of criteria (0.9 ft). Staff gauges during were clean during all nine fishway inspections at the Washington shore Fishway. Gate depths at the Washington Shore Fishway ranged between 5.8 ft. and 13.2 ft. for the season. Gate depth criteria at the Washington Shore Fishway is dependent upon the tailwater elevation. At tailwater elevations greater than 14 feet, the depths over the Washington Shore Entrances should be 13 feet or greater; at a tailwater below 14 feet entrance gates should be fully lowered. Along the Washington Shore powerhouse collection channel, floating orifice gates were operated well throughout inspections in 2017.

Fish Ladder: The fish ladder exit and the serpentine section of the Washington fish ladder was reported clear of debris during all nine inspections during 2017. Water depth measured over the Washington fish ladder weirs was 0.9ft to 1.1 ft at Weir 67 and was within the required range for all inspections in 2017 when the ladder was in service.

Table 1. Pertinent Data for Fish Facility Inspections in 2017 at BONNEVILLE DAM.

CRITERIA ITEMS		DATE OF INSPECTION								
Bradford Island Fishway		**10-Mar**	**7-Apr**	**5-May**	**16-Jun**	**14-Jul**	**11-Aug**	**8-Sep**	**25-Oct**	**14-Nov**
Bradford Island Entrances										
Criteria: (Head Differ. = 1.0-2.0 ft); (Weir Depth + 8 ft or >); (Depth over ladder weirs = 1-1.3 ft); (Velocity + 1.5-4.0 ft)										
Head at A-Branch entrance	ft	1.8	1.6	1.5	2.0	1.4	1.5	1.3	1.8	1.7
Depth over Gate 64/65	ft	9.4	10.1	8.5	8.0	8.9	8.5	8.2	6.2	7.6
Head at South ph entrance	ft	1.2	1.2	1.1	1.6	1.2	1.4	1.3	1.2	1.6
Depth over Gate 1/2	ft	13.3	17.2	14.8	14.9	10.5	9.6	8.6	6.4	8.6
Channel Velocity	fps	2.4	1.5	2.5	1.9	2.8	2.8	2.8	2.6	2.5
Depth- Bradford Is. ladder weirs	ft	1.0	1.1	1.0	1.2	1.2	1.0	1.0	1.0	1.0
Depth - A-Branch ladder weirs	ft	1.1	1.8	1.1	flooded	1.3	1.1	1.0	1.1	1.2
Exit clean (Yes or No)		yes	yes	no	yes	yes	no	no	yes	yes
B-Branch Entrance										
Head at B Branch entrance	ft	1.1	1.5	1.5	1.5	2.0	2.1	2.1	1.9	1.8
Staff gages clean		yes	yes	yes	yes	yes	yes	yes	yes	yes
Depth over ladder weir	ft	1.0	flooded	1.1	1.3	1.3	1.4	1.0	1.0	1.0
Cascades Island Entrance										
Head at main entrance	ft	1.8	1.3	0.6	0.9	1.2	1.8	1.7	2.0	1.2
Staff gages clean		yes	yes	no	no	no	no	no	no	yes
Depth over ladder weir	ft	1.0	1.0	1.0	1.0	1.2	0.9	1.0	1.0	0.9
Washington Shore Fishway										
WA Shore Entrance:										
Depth over entrance weir (Criteria = 13.0 ft or >)										
NUE	ft	13	11.5	11.0	11.3	13.2	13.4	11.2	8.1	10.8
NDE	ft	14.0	12.6	13.0	12.2	13.2	7.4	7.2	5.8	5.8
SUE	ft	14.9	15.5	12.9	13.2	13.2	12.4	11.2	7.9	10.7
SDE	ft	12.9	11.5	12.0	11.3	13.3	13.6	11.2	8.0	6.0
Head at entrance (Criteria = 1.0-2.0 ft)										
NUE	ft	1.7	1.2	1.4	1.3	1.4	1.6	1.4	1.7	1.7
NDE	ft	1.4	0.9	1.2	1.2	1.3	1.2	1.3	1.9	1.8
SUE	ft	1.8	1.0	1.4	1.1	1.2	1.5	1.0	1.3	1.0
SDE	ft	1.7	1.0	1.2	1.1	0.9	1.2	1.0	1.3	1.1
Depth over ladder weir (67)	ft	1.0	1.0	0.9	1.0	1.1	1.0	1.0	1.0	1.0
Channel Velocity (Elect. Meter)		2.3	2.0	1.5	2.0	2.5	2.5	2.0	2.6	2.2
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes	yes	yes
Staff gages clean		yes	yes	yes	yes	yes	yes	yes	yes	yes
Comment # (if applicable)		1	2		3	4	5	6		

Comments:

1. All avian lines not installed.
2. A brach ladder flooded, PH1 collection channel to slow, both spillway side entrances overtopping/banging around, gatewells 15b 15c and 18 a too quiet for an operating unit.
3. Several unreadble staff gauges, A branch staff gauge flooded
4. Large section of tree stuck in A-branch, could be stuck partially in orifice.
5. Light debris at Bradford Exit, cascades picketed leads need cleaning, multiple staff gauges need cleaning.
6. Multiple staff gauges need cleaning

Summary and Recommendations

Areas of note at Bonneville Dam in 2017:

- During the May, August, and September Inspections the Bradford Island exit was noted as not clean.
- Most head differential readings at the Washington Shore Fishway were equal or greater than the 1.0 ft. minimum (considering tailwater elevations).

THE DALLES DAM (photographs on page A-x)

The Dalles Dam was completed in 1957 with 22 main turbine units and two smaller turbine units. The two smaller turbines, Units F-1 and F-2, were part of the original construction and supply attraction flow water to the main fishway entrance gates on the Oregon fishway. The spillway is located between the powerhouse and north shore fishway and incorporates 20 spillbays to pass excess or designated flow past the project.

Approximately 5,000 cfs of water was originally distributed from these small turbines to the East, West, and South fishway entrances as well as to the orifice gates along the powerhouse collection channel. The closure of the orifice gates along the powerhouse collection channel in 2000 changed flow requirements to about 4,200 to 4,500 cfs to meet depth and head criteria at these main entrances. In the early 1990s, Wasco County PUD installed a small turbine on the old auxiliary water supply at the Washington shore fishway. This turbine normally supplies about 800 cfs through the diffusers to the operating entrance, usually Gate N-1.

In recent years, improvements have been implemented in The Dalles Dam fishways intended to aid in the passage of adult Lamprey. In the East Fish Ladder, ladder weir orifices have been chamfered (2-inch radius) in the lower section, lamprey plating has been installed, picketed leads have been raised 1.5 inches off the fishway floor, and the count slot slightly modified to provide better attachment points for lamprey. In the North Fish Ladder, ladder weir orifices have been chamfered (2-inch radius) and picketed leads have been raised 1.5 inches off the fishway floor.

Seven adult fishway inspections have taken place at The Dalles Dam:

Date	Inspector(s), Agency
March 21, 2017	Howard Takata (ODFW)
April 25, 2017	Howard Takata (ODFW)
May 23, 2017	Howard Takata (ODFW)
June 22, 2017	Howard Takata (ODFW)
September 28, 2017	David Benner (FPC)
October 3, 2017	Howard Takata (ODFW)
November 1, 2017	Howard Takata (ODFW)

Results of the inspections are discussed below and listed in Table 2.

East Fishway Inspections

The East fishway entrance gates (E-2 and E-3) were submerged 8.0 feet or greater on all inspections in 2017 (8.0-12.6 ft.). Head differentials ranged from 1.2 ft. to 1.8 ft. The East fishway entrances were operating within established criteria range for gate depths (8 ft. or >) and head differentials met criteria during all inspections in 2017. The East entrances generally pass the majority of the fish at The Dalles.

The West fishway entrances (W-1 and W-2) were submerged 8.0 feet or greater on all inspections during 2017. The gate depths ranged from 8.2 ft. to 12.4 ft. with head differential readings that ranged from 1.2 ft. to 1.8 ft. All inspections met criteria in 2017 at the West Entrances.

Flow to the South fishway entrances (S-1 and S-2) occurs through a separate channel that originates in the junction pool and ends near the South end of the spill basin. S-1 and S-2 met weir depth criteria in all seven inspections in 2017, ranging from 8.2 ft. to 10.0 ft. Head differentials ranged between 1.4 ft. and 1.7 ft. at S-1 and S-2, meeting criteria during all seven inspections.

Fish Ladder: The picketed leads located at the Oregon fish counting station were reported clear of debris on all inspections. The depth of water over the fish ladder weirs ranged between 1.0 ft and 1.3 ft during the season, meeting criteria on all inspections. The exit was reported clear of debris on all inspections.

North Shore Fishway Inspections

At the Washington fishway, a single fish turbine supplies flow through a diffuser system and to the main fishway entrance. The turbine is screened and a juvenile bypass facility is incorporated in the design and operation of the facility. Wasco PUD has operated the facility since the early 1990s. The fishway equipment and associated facilities operated satisfactorily throughout the 2017 fish passage season. Flow was sufficient to meet gate depth and head differential criteria at the North Shore for all inspections this season.

The North entrance gate, N-1, was operated throughout the fish passage season. Gate depths ranged from 9.0 to 10.8 feet over the season. Head differentials at N-1 ranged from 1.3 to 1.5 ft. The Washington fishway was operated within criteria during all inspections in 2017.

Fish Ladder: The ladder exit was reported clear of debris on all inspections and the PUD trash racks were reported clear of debris on all 2017 inspections. The picketed leads were reported clear of debris during all inspections during the passage season. The depth of water recorded over the ladder weirs showed the fish ladder in proper criteria during all seven inspections with a range of 1.0 ft. to 1.3 ft.

Summary and Recommendations

The Oregon and the Washington fishways at The Dalles Dam were operated very well in 2017. All aspects of the fishways were within criteria during the fish facility inspections completed in 2017.

Table 2. Pertinent Data for Fish Facility Inspections in 2017 at THE DALLES DAM.

CRITERIA ITEMS		DATE OF INSPECTION						
SOUTH SHORE FISHWAY		**21-Mar**	**25-Apr**	**23-May**	**22-Jun**	**28-Sep**	**3-Oct**	**1-Nov**
East Entrance:								
Depth over entrance weir								
E-1 (gate set at elev. 83.5 ft)	ft	na	na	na	na	na	na	na
E-2 (crit. = 8 ft or >)	ft	11.6	8.0	11.5	12.6	12.3	12.5	11.4
E-3 (crit. = 8 ft or >)	ft	11.5	8.2	11.5	12.6	12.3	12.5	11.4
Head at main entrance (crit. = 1-2 ft)	ft	1.4	1.2	1.8	1.4	1.2	1.3	1.4
Depth over ladr. weir (crit. = 1-1.3 ft)	ft	1.2	1.0	1.0	1.3	1.1	1.0	1.0
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Selsyns/PLC operating (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
West Entrance:								
Depth over entrance weir								
W-1 (crit. = 8 ft or >)	ft	na	8.2	12.4	11.6	9.1	8.2	8.2
W-2 (crit. = 8 ft or >)	ft	14.5	8.2	12.3	11.5	9.1	8.3	9.0
W-3 (crit. = 8 ft or >)	ft	14.6	na	na	na	na	na	na
Head at main entrance (crit. = 1-2 ft)	ft	1.8	1.2	1.4	1.5	1.3	1.5	1.4
South Entrance:								
Depth over entrance weir								
S-1 (Crit. = 8 ft or >)	ft	9.9	closed*	9.6	8.7	8.2	8.4	8.3
S-2 (Crit. = 8 ft or >)	ft	10.0	8.4	9.5	8.9	8.2	8.3	8.3
Head at main entrance (Crit. = 1-2 ft)	ft	1.4	1.7	1.4	1.5	1.4	1.4	1.4
NORTH SHORE FISHWAY								
North Shore Entrance:								
Depth over entrance weir								
N-1 (crit. = 8 ft or >)	ft	10.3	10.8	10.8	10.5	9.6	9.1	9.0
Head at main entrance (Crit. = 1-2 ft)	ft	1.3	1.4	1.5	1.4	1.5	1.4	1.4
Depth over ladr. weir (Crit. = 1-1.3 ft)	ft	1.1	1.0	1.0	1.3	1.1	1.0	1.0
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Selsyns operating		yes	yes	yes	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	yes	yes	yes
PUD trash rack clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Comment Number (if applicable)		1	2					

Comments

1. Using W3 instead of W1 at West Entrance.
2. Fish Turbine #2 offline, maintenece working on fixing. F1 running at max, S-1 closed other entrances reduced to 8 ft.

JOHN DAY DAM (photographs on page A-x)

John Day Dam is a COE-operated project that went on-line for power production in 1968 with 16 main turbine units and twenty spillbays located on the north end of the powerhouse. Major changes to the project have been the addition of spillway deflectors into the spillbays and the addition of a screened juvenile fish bypass system. The spillway deflectors allow additional flow to pass through spill without greatly increasing dissolved gas levels at the project.

Three turbine-driven pumps pull water from the tailwater of the dam and this water supplies attraction flow for adult fish passing the Oregon shore adult fishway. This water is supplied through a floor diffuser system and exits from one main entrance on the south shore and two main entrances at the north end of the powerhouse. The project can normally operate two of the three pumps to meet criteria levels of the main entrances as well as the floating orifice gates along the powerhouse collection channel. Six electric pumps are operable on the Washington shore to supply water to the diffusers located at the lower end of the fish ladder. However, a maximum of only four pumps (normally three pumps) can operate at any one time at the north shore. Beginning in 2000, only one main entrance gate at the north end of the spillway was operated rather than two as in previous years.

The exit section of the Oregon fish ladder was modified prior to the 2003 fish passage season. No longer is the section a serpentine-like ladder, but is now more similar to The Dalles north shore fish ladder exit. The modification has been successful in reducing holding of fish in the fish ladders while still providing a good passage route from the overflow weir section to the exit from the fish ladder. Over the winter of 2009/2010 a similar modification occurred on the north shore fish ladder and included lamprey passage improvements.

Seven adult fishway inspections have taken place at John Day Dam:

Date	Inspector(s), Agency
March 21, 2017	Howard Takata (ODFW)
April 25, 2017	Howard Takata (ODFW)
May 23, 2017	Howard Takata (ODFW)
June 22, 2017	Howard Takata (ODFW)
September 28, 2017	David Benner (FPC)
October 3, 2017	Howard Takata (ODFW)
November 1, 2017	Howard Takata (ODFW)

Table 3 lists the criteria items and the inspection dates for 2016, with the text below detailing some of the results.

South (Oregon Shore) Fishway Inspections

Gate SE-1 was operated at the South Shore Fishway throughout the season. The gate depth ranged from 8.0 to 8.7 ft. over the seven inspections. The head differential ranged from 1.0 ft. to 1.6 ft. for the season. All SE-1 head differentials and all gate depth met criteria during the 2017 fishway inspection season. Overall, entrance conditions at Gate SE-1 should have provided satisfactory fish passage during the 2017 inspections conducted by ODFW and FPC.

The North powerhouse entrance gates, NE-1 and NE-2, operated at head differentials within the range of 1.7 to 1.9 ft. with gate depths that ranged from 8.2 ft. to 11.3 ft. Gate depth and head differential criteria were met at NE-1 and NE-2 throughout the 2017 fishway inspection season. Attraction flows from these

gates should have provided satisfactory conditions for adult fish approaching those entrance gates over 2017.

Table 2. Pertinent Data for Fish Facility Inspections in 2017 at THE DALLES DAM.

CRITERIA ITEMS		DATE OF INSPECTION						
SOUTH SHORE FISHWAY		**21-Mar**	**25-Apr**	**23-May**	**22-Jun**	**28-Sep**	**3-Oct**	**1-Nov**
East Entrance:								
Depth over entrance weir								
E-1 (gate set at elev. 83.5 ft)	ft	na	na	na	na	na	na	na
E-2 (crit. = 8 ft or >)	ft	11.6	8.0	11.5	12.6	12.3	12.5	11.4
E-3 (crit. = 8 ft or >)	ft	11.5	8.2	11.5	12.6	12.3	12.5	11.4
Head at main entrance (crit. = 1-2 ft)	ft	1.4	1.2	1.8	1.4	1.2	1.3	1.4
Depth over ladr. weir (crit. = 1-1.3 ft)	ft	1.2	1.0	1.0	1.3	1.1	1.0	1.0
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Selsyns/PLC operating (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
West Entrance:								
Depth over entrance weir								
W-1 (crit. = 8 ft or >)	ft	na	8.2	12.4	11.6	9.1	8.2	8.2
W-2 (crit. = 8 ft or >)	ft	14.5	8.2	12.3	11.5	9.1	8.3	9.0
W-3 (crit. = 8 ft or >)	ft	14.6	na	na	na	na	na	na
Head at main entrance (crit. = 1-2 ft)	ft	1.8	1.2	1.4	1.5	1.3	1.5	1.4
South Entrance:								
Depth over entrance weir								
S-1 (Crit. = 8 ft or >)	ft	9.9	closed*	9.6	8.7	8.2	8.4	8.3
S-2 (Crit. = 8 ft or >)	ft	10.0	8.4	9.5	8.9	8.2	8.3	8.3
Head at main entrance (Crit. = 1-2 ft)	ft	1.4	1.7	1.4	1.5	1.4	1.4	1.4
NORTH SHORE FISHWAY								
North Shore Entrance:								
Depth over entrance weir								
N-1 (crit. = 8 ft or >)	ft	10.3	10.8	10.8	10.5	9.6	9.1	9.0
Head at main entrance (Crit. = 1-2 ft)	ft	1.3	1.4	1.5	1.4	1.5	1.4	1.4
Depth over ladr. weir (Crit. = 1-1.3 ft)	ft	1.1	1.0	1.0	1.3	1.1	1.0	1.0
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Selsyns operating		yes	yes	yes	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	yes	yes	yes
PUD trash rack clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Comment Number (if applicable)		1	2					

Comments

1. Using W3 instead of W1 at West Entrance.
2. Fish Turbine #2 offline, maintenece working on fixing. F1 running at max, S-1 closed other entrances reduced to 8 ft.

Fish Ladder: The exit from the fish ladder, staff gauges, and the picketed leads were all reported as clean during all inspections in 2017. The fishway exit was noted as clean during all inspections in 2017. The depth of water measured over the ladder weirs was 1.0–1.3 ft. for the 2017 season and were within the criteria range during all inspections.

North Shore Fishway Inspections

The north shore fishway entrance (N-1) has been replaced with a variable-width weir that is at a fixed elevation. Therefore, there is no longer an 8-foot depth criterion at the North Shore fishway. There continues to be head differential criteria at the N-1 entrance. In 2017, the head differentials at N-1 were maintained between 1.5 ft and 1.6 ft (targeted 1.5 ft) and met criteria during all inspections in 2017.

Fish Ladder: The exit from the ladder and the picketed leads at the count station were reported clear of debris on all inspections for the 2017 season. The depth over the North Shore ladder weirs met criteria during all 2017 inspections.

Summary and Recommendations

Overall, the main entrances at the Oregon and the Washington fishways were operated within criteria levels during the 2017 fish passage season. Overall, the fishways at John Day were operated well in 2017.

MCNARY DAM (photographs on page A-x)

McNary hydroelectric project is a COE-operated dam completed in 1953. Fourteen main turbine units and 22 spillbays are incorporated in this dam. The Oregon and Washington shore fish ladders incorporate full overflow weirs and have submerged orifices in each weir. On the Oregon fishway, three large electric fish pumps pull water from the tailrace of the project plus about 1,000 cfs of gravity flow from the forebay, and supply water to the main entrance gates located at each end of the powerhouse. Twelve floating orifice gates operate along the powerhouse collection channel with each gate supplying about 60 cfs of water to attract adult fish into the channel. In the mid-1990s, the water supply for the Washington fishway was changed from the pressurized system to a non-pressurized system as Wasco/Klickitat PUDs installed a small turbine on the water supply from the forebay that produces electricity for the PUD and also supplies flow (about 1,500 to 1,700 cfs) to meet gate depth and head differential requirements for the two main entrance gates. With the construction of the new juvenile bypass system, about 450 cfs of water (bleed-off from the bypass flow) is routed to the north end of the powerhouse and enters the fishway via a screened area at the NPEs.

Seven adult fishway inspections took place at McNary Dam in 2017:

Date	Inspector(s), Agency
April 26, 2017	Jeff Brown (NOAA)
May 15, 2017	Jeff Brown (NOAA)
June 26, 2017	Jeff Brown (NOAA)
July 17, 2017	Jeff Brown (NOAA)
August 14, 2017	Jeff Brown (NOAA)
September 18, 2017	Jeff Brown (NOAA)
October 5, 2017	David Benner (FPC)

Results of the inspections are discussed below with Table 4 displaying data collected from each inspection.

The project typically can meet criteria standards operating with two of the three pumps at the Oregon fishway. When three pumps operate, the angle opening normally ranges between 20°–24°. When two pumps operate the blade angle is typically increased several degrees to help achieve fish way criteria under fewer pumps. In addition to the pumped and gravity-flow water, about 450 cfs of water from the juvenile bypass system is added to the north end of the powerhouse. Wall screens are present to exclude adult fish from entering this water source.

South Shore (Oregon) Fishway Inspections

During 2017, Fish Pump #2 was out of service during the first three inspections of the season (April through June) and the Oregon Fishway at McNary Dam was therefore limited to a two pump operation during this period.

The main entrances at the south shore (SFEW-1 & 2) were reported with gate depths that ranged between 8.0 ft and 9.3 ft. for the year. All inspections in 2017 were at or above the 8.0-foot gate depth criteria at SFEW 1 & 2. The head differentials ranged from 1.1 to 1.6 ft. at SFEW-1 & 2, with all inspections having head differentials within criteria.

The north powerhouse entrances, NFEW 2 and 3, operated over 2017. North powerhouse entrances were primarily very close to or above criteria during all seven inspections recorded in 2017 as gate depths ranged from 7.5 ft. to 9.2 ft. During the August 14th, 2017 inspection, both the North Powerhouse entrances were below the 8.0 feet criteria (7.5 ft.). The North Powerhouse head differentials ranged from 1.2 ft. to 1.6 ft., and were at or above criteria during all inspections in 2017.

Surface velocity was estimated at the northern and southern end of the collection channel by timing a wood chip or floating object a given distance along the channel. Water velocity was within the criteria during all inspections in 2017 (1.5-4.0 fps).

Fish Ladder: The South Shore Fishway picketed leads were reported clean during all inspections in 2017. The ladder exit were reported clear of debris during all inspections in 2017. The depth of water reported over the south fishway ladder weirs ranged from 1.0 ft to 1.1 ft. and was within criteria on all inspections.

North Shore (Washington) Fishway Inspections

The Washington shore fishway entrances WFE 2 and 3 were operable over 2017. The Washington shore fishway entrances were submerged from 8.3 ft. to 10.0 ft., meeting criteria (8 ft. or greater) during all inspections in 2017. Head differentials at the Washington shore fishway ranged from 1.2 ft. to 1.5 ft. Head differentials were operated within acceptable criteria range throughout all of the 2017 season.

Fish Ladder: The fishway exit was reported as clean during all seven inspections in 2017. The picketed leads were reported as clean during all inspections in 2017. The depth of water reported over the north fishway ladder weirs ranged from 1.0 ft. to 1.3 ft. and were within criteria during all inspections in 2016.

Summary and Recommendations

Overall, the fishways at McNary Dam operated well considering the limitation to two fish pumps for the ffirst three inspections of the year.

Table 4. Pertinent Data for Fish Facility Inspections in 2017 at MCNARY DAM.

CRITERIA ITEMS

		DATE OF INSPECTION						
SOUTH SHORE FISHWAY		**26-Apr**	**15-May**	**26-Jun**	**17-Jul**	**14-Aug**	**18-Sep**	**5-Oct**
South Shore Entrance:								
Depth over entrance weir (Criteria: 8 ft or > gate depth at SFEW-1,2 & NFEW-1,2)								
SFEW-1	ft	9.1	9.3	8.0	8.5	8.8	8.9	9.1
SFEW-2	ft	9.2	9.2	8.0	8.4	8.7	8.9	9.1
Head at SFEW-1,2 (Crit.= 1-2 ft)	ft	1.1	1.3	1.3	1.3	1.6	1.5	1.5
Dep. over ladr. weir(Crit.= 1-1.3')	ft	1.1	1.0	1.0	1.0	1.0	1.1	1.0
Channel velocity (Crit.= 1.5-4.0 fps)	fps	yes	yes	yes	yes	yes	yes	yes
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	yes	yes	yes
Orifice Gates Operating - 12		yes	yes	yes	yes	yes	yes	yes
Pumps Operating & degrees open		2, 26	2, 24	2, 26-27	3, 11-26	3, 20-22	3, 22-23	3, 24
North Powerhouse Entrance:								
Depth over entrance weir								
NFEW-2	ft	8.9	9.2	8.0	8.5	7.5	8.2	8.3
NFEW-3	ft	8.9	9.2	8.0	8.5	7.5	8.2	8.3
Head at NFEW-2&3 (Crit. = 1-2 ft)	ft	1.3	1.2	1.5	1.3	1.4	1.3	1.6
WA.SHORE FISHWAY								
North Shore Entrance:								
Depth over entrance weir								
WFE-2 (Crit. = 8 ft or >)	ft	9.2	9.9	8.9	8.5	8.4	9.0	9.4
WFE-3 (Crit. = 8 ft or >)	ft	9.2	10.0	8.9	8.6	8.3	9.1	9.5
Head at WFE-2&3 (Crit. = 1-2 ft)	ft	1.4	1.2	1.2	1.4	1.5	1.4	1.3
Dep. over ladr. weir (Crit. = 1-1.3 ft)	ft	1.1	1.1	1.3	1.1	1.1	1.1	1.0
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	yes	yes	yes
Comment number (if applicable)		1	1	1				

Comments:

1. AWS pump #2 Out of Service.

ICE HARBOR DAM (photographs on page A-x)

Ice Harbor Dam was the initial dam constructed in the lower Snake River and was completed in 1961. The COE-operated project has six main turbine units and ten spillbays to pass water at the dam. A Removable Spillway Weir is now in place at the project and is operated throughout most of the fish passage season.

The adult fish passage facilities consist of a separate water supply system for the south and for the north shore fishway. Attraction flow to the south fishway is supplied by up to eight electric pumps and about 200 cfs bleed-off flow from the juvenile bypass system. The juvenile bypass flow is added into the pumped water supply system. Five to eight fish pumps operate, depending on the tailwater elevation. Under most river flow conditions, the project should have the capability to maintain the south fishway within acceptable criteria for gate depth and head differential. Two electric fish pumps supply attraction water to the north shore fishway with the pumped flow normally able to meet criteria under high to medium flow conditions. The north shore fishway does have three pumps available, but can operate only two at one time due to electrical constraints.

Improvements have been installed in fishways at Ice Harbor Dam intended to aid in the passage of adult lamprey. Adult lamprey passage improvements were made to upper fish ladder weirs at Ice Harbor Dam during the winter of 2011/2012. These included cutting horizontal slots in weirs at the fishway floor to allow adult lamprey attachment through a level pathway through the weir. Ramps were installed from the fish ladder floor to the bottom of elevated salmon orifices in the upper ladder weirs to assist lamprey moving through these areas. Additionally, plates were installed on diffuser grating adjacent to orifices in the Ice Harbor north fish ladder to provide attachment surfaces for lamprey in higher-velocity areas.

Six adult fishway inspections have taken place at Ice Harbor Dam:

Date	Inspector(s), Agency
April 27, 2017	Dave Swank (USFWS), David Benner (FPC)
May 18, 2017	Dave Swank (USFWS), David Benner (FPC)
June 15, 2017	Dave Swank (USFWS)
July 27, 2017	Dave Swank (USFWS)
August 18, 2017	Dave Swank (USFWS)
September 28, 2017	Dave Swank (USFWS)
October 27, 2017	Dave Swank (USFWS)

Details of the inspections are found in Table 5 and a summary of the inspections reported in the section below.

South Shore Fishway Inspections

Five to seven fish pumps were operating on all inspections completed this season. Excess flow from the juvenile bypass system and pumped flow water is passed through diffusers to supply water to the main fishway entrances and the orifice gates along the powerhouse collection channel.

The South shore entrance gate (SFEW-1) was submerged from 7.6 ft. to 10.5 ft. during the 2017 season. Gate SFEW-1 did not meet the 8-foot depth criteria during the last three inspections in 2017. During the last three inspections of 2017, gate SFEW-1 was recorded on sill and could not be lowered further. Head differentials measured at SFEW-1 ranged from 0.8 ft. to 1.5 ft. for the season. Head differential criteria were met during all inspections in 2017 with the exception of the September 28, 2017 inspection (0.8 ft).

Table 5. Pertinent Data for Fish Facility Inspections in 2017 at ICE HARBOR DAM.

CRITERIA ITEMS		27-Apr	18-May	15-Jun	27-Jul	18-Aug	28-Sep	27-Oct
SOUTH SHORE FISHWAY								
South Shore Entrance:								
Depth over entrance weir								
SFEW-1 (Crit. = 8 ft or >)	ft	9.6	8.7	10.5	8.3	7.6	7.8	7.9
Head at SFEW-1 (Criteria = 1-2 ft)	ft	1.4	1.1	1.5	1.0	1.2	0.8	1.1
Gate on Sill (yes or no) 332.25		no	no	no	yes	yes	yes	yes
Dep. over ladr. weir (Cr. = 1-1.3 ft)	ft	1.2	1.3	1.3	1.5	1.4	1.3	1.3
Channel velocity (Crit. = 1.5-4 fps)	fps	1.8	1.6	1.4	2.2	2.3	1.6	2.7
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		yes	yes	yes	no	no	yes	no
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Pumps Operating (8 available)		7	6	6	6	6	6	6
North Powerhouse Entrance:								
Depth over entrance weir								
NFE-2 (Criteria = 8 ft or >)	ft	12.3	10.0	12.3	8.8	8.2	9.0	8.5
Head at NFE-2 (Criteria = 1-2 ft)	ft	1.2	1.1	1.2	1.6	1.5	1.6	1.9
Gate on Sill (yes or no) 332.25		no	no	no	yes	no	yes	yes
Staff gages clean	ft	yes	yes	yes	no	no	no	no
NORTH SHORE FISHWAY								
North Shore Entrance:								
Depth over entrance weir								
NEW-1 (Criteria = 8 ft or >)	ft	12.2	5.9	10.4	7.3	6.2	8.6	7.9
Head at NEW-1 (Criteria = 1-2 ft)	ft	1.2	2.5	1.3	1.5	2.3	1.3	1.3
Gate on Sill (yes or no) 332.25		no	no	no	yes	yes	yes	yes
Dep. over ladr. weir (Crit. = 1-1.3 ft)	ft	1.2	1.2	1.3	1.2	1.2	1.3	1.2
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	yes	yes	yes
Pumps Operating (3 available)		2	2	2	2	2	2	2
Comment Number (if applicable)		1	2		3	3	3	3

Comments:

1. Picking beam on northshore entrance submerged atleast one ft, asked operator to raise gate while maintaining all criteria
2. Picking beam at northentrance several feet above water, northshore entrance all out of criteria- asked to have deeper gate depth which will reduce head differential.
3. Multiple broken/dirty staff gauges.

The north powerhouse entrance gate (NFE-2) was operating with weir depths that ranged between 8.2 ft. and 12.3 ft. for the season. Gate NFE-2 meet the 8-foot depth criteria during all inspections in 2017. Head differentials measured at NFE-2 ranged from 1.1 ft. to 1.9 ft. for the season. Head differential criteria were met during all inspections in 2017.

Four floating orifice gates operated satisfactorily along the powerhouse collection channel throughout the fish passage season. The collection channel velocity meter was functional for all seven inspections in

2017. The water velocity in the collection channel during over the 2017 season ranged between 1.6 and 2.7 fps; all recorded channel velocities were within the desired range (1.5–4.0 fps).

Fish Ladder: The exit from the fish ladder was reported clear of debris on all inspections. The picketed leads located at the counting station were also recorded as clean on all inspections. Depth of water over the ladder weirs was reported between 1.2 and 1.3 ft. for the seven inspections, all within criteria.

North Shore Fishway Inspections

Gate NEW-1 was submerged 8.0 ft. or more in depth during three of seven inspections. Gate depths ranged from 5.9 ft. to 12.2 ft. During the four inspections of 2017 (May, July, August, and October), the NEW-1 gate depth was below criteria; however, the gate was on sill and could not be lowered further. Head differentials were reported in the following range: 1.2 ft. to 2.5 ft. Head differentials at the North Shore Fishway were within criteria during all inspections in 2017.

Fish Ladder: The exit from the north shore fish ladder and also the picketed leads at the counting station were reported clear of debris throughout the inspection season. Depth of water over the ladder weirs was reported to be 1.2–1.3 ft. for all inspections. All inspections were within criteria.

Summary and Recommendations

Fish facilities at Ice Harbor appeared to operate in a satisfactory manner in 2017 considering entrance weir sill elevations. Overall, multiple gate depths did not meet criteria; however, in most cases, gates were operated as low as possible (on sill). Several issues though, could have been avoided: 1.The head differential at SFEW-1 did not meet the 1.0 ft. minimum criteria during the September 28, 2017 Inspection 2. The depth over the south fishway ladder weirs was above the criteria range (1.0-1.3 ft.) during both the July and August Inspections.

LOWER MONUMENTAL DAM (photographs on page A-x)

The COE completed construction and began operation of Lower Monumental Dam in 1969. Six main turbine units and eight spillbays pass flow at the project.

Three turbine-driven pumps pull water from the tailrace and supply water to a conduit that distributes this flow to the diffuser system along the collection channel and the north and south shore collection systems. The south shore fishway has a separate fish ladder, but no separate water supply was added to that side of the dam. After the completion of the new juvenile fish bypass system, about 200 cfs of excess water flow was added to the north shore supply diffusers. Normally the juvenile bypass system operates from March through December. Since that time, and with other changes made to the fish pumps, the project can normally meet gate depth and head differential criteria with two pumps, but standard operating procedure is to operate the three pumps on a continual basis. Floating orifice gates (formerly 4) remain permanently closed at this project.

Improvements have been installed in Lower Monumental Dam fishways intended to aid in the passage of adult lamprey. Like those made at Ice Harbor, adult lamprey passage improvements were made to upper fish ladder weirs at Lower Monumental Dam during the winter of 2011/2012. These included cutting horizontal slots in weirs at the floor to allow adult lamprey attachment through a level pathway through the weir. Additionally, ramps were installed from the fish ladder floor to the bottom of elevated salmon orifices in the upper ladder weirs to assist lamprey in maintaining attachment as they move through these areas.

Seven adult fishway inspections have taken place at Lower Monumental Dam:

Date	Inspector(s), Agency
April 19, 2017	Monty Price, PSMFC, David Benner, FPC
May 24, 2017	Monty Price, PSMFC
June 21, 2017	Monty Price, PSMFC
July 27, 2017	Monty Price, PSMFC
August 30, 2017	Monty Price, PSMFC
September 13, 2017	Monty Price, PSMFC
October 15, 2017	Monty Price, PSMFC

Data from the inspections are reported in the discussion below as well as in Table 6.

North Shore Fishway

The north shore fishway entrance gates, NSE-1 and NSE-2, were operated with gate depths ranging from 8.0 ft. to 8.3 ft. during the 2017 inspections. Gate depths at NSE-1 and NSE-2 were within criteria for all inspections in 2017. Head differentials ranged from 0.6 ft. to 1.6 ft. over the 2017 inspections and were within criteria during all inspections in 2017, with the exception of the June 21, 2017 Inspection when the recorded head differential was 0.6 ft. Discharge and velocity through the NSE-1 and NSE-2 entrance gates should have provided satisfactory passage conditions at the north shore entrance gates.

Table 6. Pertinent Data for Fish Facility Inspections in 2017 at LOWER MONUMENTAL DAM

CRITERIA ITEMS		DATE OF INSPECTION						
NORTH SHORE FISHWAY		**19-Apr**	**24-May**	**21-Jun**	**27-Jul**	**30-Aug**	**13-Sep**	**15-Oct**
North Shore Entrance:								
Depth over entrance weir								
NSE-1 (Criteria = 8 ft or >)	ft	8.1	8.0	8.0	8.0	8.3	8.3	8.2
NSE-2 (Criteria = 8 ft or>)	ft	8.1	8.0	8.0	8.1	8.0	8.1	8.1
Head at NSE-1 & 2 (Crit. = 1-2 ft)	ft	1.0	1.1	0.6	1.6	1.1	1.2	1.2
Gate on Sill (yes or no) 429ft								
Dep. over ladr. weir (Cr. = 1-1.3 ft)	ft	1.0	1.1	1.0	1.1	1.0	1.0	1.0
Channel velocity (Crit. = 1.5 - 4 fps)	fps	no reading	2.1	2.0	2.0	1.9	2.9	2.5
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
South Powerhouse Entrance:								
Depth over entrance weir								
SPE-1 (Criteria = 8 ft or >)	ft	8.1	7.6	9.2	5.3	6.5	7.8	7.1
SPE-2 (Criteria = 8 ft or >)	ft	8.1	7.6	9.4	5.3	6.5	7.8	7.1
Head at SPE-1 & 2 (Crit. = 1-2 ft)	ft	1.0	1.6	1.0	1.4	1.2	1.0	1.2
Gate on Sill (Yes or No) 432ft		no	yes	no	yes	yes	yes	yes
Staff gages clean/readable (yes or no)		yes	yes	yes	yes	yes	yes	yes
SOUTH SHORE FISHWAY								
South Shore Entrance:								
Depth over entrance weir								
SSE-1 (Criteria = 8 ft or >)	ft	8.1	6.5	8.1	6.0	7.1	8.0	8.1
SSE-2 (permanent) 6-feet	ft	6.0	6.0	6.0	6.0	6.0	6.2	6.2
Head at SSE-1 & 2 (Crit. = 1-2 ft)	ft	1.1	1.0	0.2	1.0	1.1	1.3	1.2
Gate on Sill (yes or no) 431ft		no	no	no	yes	yes	no	yes
Dep. over ladr. weir (Crit. = 1-1.3')	ft	1.0	1.0	1.0	1.1	1.1	1.1	1.1
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	ues	yes	yes
Pump speed	rpm	71/72	71/72	68/72	71/73	72/73	72/73	72/73
# of Pumps Operating (3 available)		2	2	2	2	2	2	2
Comment Number (if applicable)								

Comments:

An electronic velocity meter located in the northern end of the collection channel gave water velocity readings throughout the 2017 Inspection season. Over 2017, velocities ranged from 1.9 fps to 2.9 fps and were within criteria (1.5–4.0 fps).

The south powerhouse entrance gates, SPE-1 and SPE-2, were operated with gate depths ranging from 5.3 ft. to 9.4 ft. The SPE entrances met gate depth criteria (8 ft. or greater) during two of seven inspections in 2017; however the SPEs were on sill during all inspections in 2017 that did not meet standard criteria, so no further depth could be obtained. Head differentials recorded at the SPE gates ranged from 1.0 to 1.6 feet. The head differential readings met standard operating criteria (or sill criteria) during all seven inspections in 2017.

Fish Ladder: The depth of water over the north shore fish ladder weirs was 1.0–1.1 ft. on all inspections and therefore met criteria during all inspections in 2017. The North fishway exit was reported as clean

during all six inspections in 2017. The north picketed leads were reported as clean during all inspections in 2017. Staff gauges were reported as clean during the all inspections in 2017.

South Shore Fishway

Two south shore entrances are operated (both downstream, no side entrance) to attract fish to the spillway or south fish ladder. All auxiliary water is supplied from the north shore turbine-driven pumps except for the 200 cfs flow that enters from the juvenile bypass system. Gate SSE-2 is a fixed-open gate that remains 6-ft open while Gate SSE-1 is to be submerged 8 ft. or more during normal operation. Gate depths at SSE-1 ranged from 6.0 ft. to 8.1 ft. SSE-1 met standard gate depth criteria during the four of seven inspections. During all but one other inspections in 2017, SSE-1 was on sill and could not be lowered any further (sill criteria met). During the May 24th, 2018 inspection, SSE-1 was not operated within gate depth criteria, and was not on sill. The head differentials at the south entrances ranged from 0.2 ft. to 1.3 ft. and were within criteria for all inspections during the 2017season, with the exception of the June 21, 2018 inspection.

Fish Ladder: The south shore exit was recorded as clear of debris during all 2017 inspections. The picketed lead section at the fish counting station was reported clear of debris for all inspections this season. The depth of water over the ladder weir was 1.0-1.1 ft. during 2017 inspections.

Summary and Recommendations

Overall, fishways at the project were found to be operating well considering the constraints of gate sill elevations. The south shore fishway had one inspection that did not meet gate depth criteria and another that did not meet head differential criteria. The north shore fishway had one inspection in which head differential criteria was not met.

LITTLE GOOSE DAM (photographs on page A-x)

Little Goose Dam was completed in fall 1970 and is operated by the COE. The project consists of six main turbine units and eight spillbays to pass flow. A Spillway Weir was installed in spill bay 1 in 2009.

The adult fish passage facilities are comprised of one fish ladder located on the south shore, two south shore entrances, a powerhouse collection channel, two entrances at the north end of the powerhouse, and two north shore entrances with a transportation channel underneath the spillway to the powerhouse collection channel. All orifice gates along the powerhouse collection channel were closed in 2001. Three turbine-driven pumps and about 200 cfs excess flow from the juvenile bypass system supply water to the adult fishway. The adult fish facilities can normally operate near acceptable criteria through varying high and low flow conditions.

Over the last several years, improvements have been installed in Little Goose Dam fishways intended to aid in the passage of adult lamprey. In 2011, picketed leads were modified near the floor of the adult fish ladder at the count station. This was done to enable adult lamprey passage under the picketed leads, providing a low-velocity passage route for lamprey around the adult fish count slot. Over the 2012/2013 winter maintenance period, horizontal slots were cut in weirs at the floor to allow adult lamprey attachment through a level pathway through the weir. Additionally, ramps were installed from the fish ladder floor to the bottom of elevated salmon orifices in the upper ladder weirs to assist lamprey in maintaining attachment as they move through these areas.

Over the summer of 2017, temporary pumps were not used to draw deep and cooler forebay water up near the fishway exit. It is anticipated that permanent pumps at Little Goose will be installed by Spring 2018 that draw water from a depth where a cooler water layer exists to help alleviate temperature differentials in the fishway.

Seven adult fishway inspections have taken place in 2017 at Little Goose Dam.

Date	Inspector(s), Agency
April 18, 2017	A. Dowdy (ODFW)
May 18, 2017	A. Dowdy (ODFW)
June 23, 2017	A. Dowdy (ODFW)
July 26, 2017	A. Dowdy (ODFW), D. Benner (FPC)
August 28, 2017	A. Dowdy (ODFW)
September 29, 2017	A. Dowdy (ODFW)
October 31, 2017	A. Dowdy (ODFW)

During the 2017 Inspection season, all three pumps were in service and utilized. When all three pumps were in service, operations were between 66-75 rpm.

Fishway Inspections

The two South Shore Entrance Gates, SSE-1 and SSE-2, are operated to achieve an 8.0 feet or greater weir submergence with a head differential between 1.0 and 2.0 ft. During the 2017 fish passage season, gate depths at the SSEs ranged from 7.8 to 9.4 ft. with head differentials that ranged from 1.2 ft. to 1.6 ft. During the May 18, 2017 inspection, gate depths were below 8 ft.; however, the entrance weir was on sill. In 2017, all gate depths and head differentials met criteria (or sill criteria) during all inspections.

The North Powerhouse Entrances, NPE-1 and NPE-2, were operated to meet the depth criteria of 7.0 ft. or greater submergence below tailwater and head differential of 1.0 to 2.0 ft. The gate depths ranged from 5.6 ft. to 7.8 ft. with head differentials that ranged from 1.1 to 1.7 ft. The NPE gates were on sill during all seven inspections in 2017. During five inspections (April through August), gate depth criteria was not met at NPE 1 and 2; however gates were fully down to sill elevations. All head differentials at the north powerhouse entrances were within criteria during each inspection.

The water velocity measured at the north end of the collection channel gave readings that ranged from 1.7 fps to 2.2 fps over the seven inspections in 2017; all recordings met the minimum criteria of 1.5 fps. The water velocity measured at the north shore fishway ranged from 1.8 fps to 2.9 fps over the inspections in 2017 (no reading in April); all recordings met the minimum criteria of 1.5 fps.

The North Shore Entrances were set to operate at 6.0 ft. or more depth below tailwater, with the head differential in the range of 1.0 ft. to 2.0 ft. NSE-1 gate depths ranged from 6.1 ft. to 7.1 ft. and were on the sill elevation during the first five inspections of 2017. NSE-2 gate depths ranged from 4.6 ft. to 6.5 ft. and were also on sill during the first five inspections in 2017, during the April Inspection NSE-2 was restricted beyond the sill due to programming. All entrance gate depths met criteria or were on sill during all inspections in 2017. NSE head differentials ranged from 0.9 to 1.4 ft., meeting differential criteria during all seven inspections, with the exception of the October Inspection when the head differential was one tenth below criteria according to staff gauges but electronics showed this location was within criteria.

Fish Ladder: The fish ladder exit was clean during all inspections in 2017. The picketed lead section of the fish counting facility was reported as clear during all inspection in 2017. The depth of water over the fish ladder weirs was at 1.0 to 1.2 ft. during each inspection in 2017, all within the proper criteria range (1.0-1.3 feet). Staff gauges were reported as clean during inspections in 2017.

Summary and Recommendations

All in all, the adult fishways at Little Goose Dam were operated in a satisfactory manner considering the limitations of sill elevations.

Table 7. Pertinent Data for Fish Facility Inspections in 2017 at LITTLE GOOSE DAM.

CRITERIA ITEMS		DATE OF INSPECTION 18-Apr	18-May	23-Jun	26-Jul	28-Aug	29-Sep	31-Oct
SOUTH SHORE FISHWAY								
South Shore Entrance:								
Depth over entrance weir								
SSE-1 (Criteria = 8 ft or >)	ft	9.0	7.8	8.3	9.2	8.3	8.9	9.4
SSE-2 (Criteria = 8 ft or >)	ft	8.8	7.8	8.3	9.0	8.0	8.9	9.4
Head at SSE-1 & 2 (Criteria = 1-2 ft)	ft	1.5	1.6	1.6	1.2	1.5	1.4	1.4
Dep. over ladr. weir (Crit. = 1-1.3 ft)	ft	1.1	1.1	1.1	1.2	1.2	1.1	1.0
Channel velocity (Criteria = 1.5-4 fps)	fps	1.8	2.2	1.7	2.0	1.9	1.8	1.7
Channel velocity (North Shore)	fps	na	2.6	2.2	2.3	2.9	2.4	1.8
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (Criteria = 0.3' max)		0	0.1	0	0.1	0.1	0.1	0.1
North Powerhouse Entrance:								
Depth over entrance weir								
NPE-1 (Criteria = 7 ft or >)	ft	6.8	6.5	6.6	6.1	5.6	7.8	7.8
NPE-2 (Criteria = 7 ft or >)	ft	6.8	6.4	6.6	6.0	5.6	7.8	7.8
Head at NPE-1 & 2 (Criteria = 1-2 ft)	ft	1.7	1.1	1.4	1.5	1.6	1.4	1.2
Gate on Sill (Yes or No)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
Pump speed	rpm	74-75	66-75	69-73	71-72	73-74	73	69-73
Pumps Operating (3 available)		3	3	3	3	3	3	3
North Shore Entrance:								
Depth over entrance weir								
NSE-1 (Criteria = 6 ft or >)	ft	7.1	6.1	6.7	6.4	6.3	7.0	7.1
NSE-2 (Criteria = 6 ft or >)	ft	4.6	6.1	6.5	6.4	6.3	7.0	7.1
Head at NSE-1 & 2 (Criteria = 1-2 ft)	ft	1.4	1.3	1.1	1.0	1.2	1.3	0.9
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
Comment number (if applicable)		1	2	3				4

Comments:

1. NSE-2 Weir continues to be restricted due to computer program, project mechanics are trying to overide the program, fallout fence unattached.
2. Agrressive counterclockwise eddy at southshore, mild eddy at northshore.
3. NPE on sill, mild to moderate eddies at south and north shores.
4. Head differential at NSE was slightly below criteria via staff gauges, electronics showed a 1.1 ft differential.

LOWER GRANITE DAM (photographs on page A-xx)

Lower Granite Dam was the final lower Snake River project constructed by the COE; the project began operation in 1975. The powerhouse consists of six main turbine units and eight spillbays that are equipped with spillway deflectors. A removable spillway weir was incorporated into the south spillbay to pass juvenile fish at the project in 2002.

In the fish ladder, an adult fish sampling/trapping facility was incorporated in the original construction of the project. Since that date, major modifications to the facility have occurred. Presently, the site includes modern detection equipment, both CWT and PIT-tag automated detectors that have the ability to shunt adult fish to the holding facility or, in the case of the PIT-tag system, the fish can be separated by its PIT-tag code if desired. A new set of PIT-tag detectors was installed during winter 2003 in the upper exit section of the fish ladder and also worked satisfactorily through 2016. This system provides adult detection capabilities without handling the fish or diverting them to the adult trap return channel.

Three electric fish pumps supply water to the fishway; however, only two pumps can be operated at one time. Attraction flows are directed to two south shore entrances, two north powerhouse entrances, four operating orifice gates along the powerhouse collection channel, and two north shore entrances. No excess juvenile bypass water is incorporated into the adult attraction flow system at Lower Granite as occurs at the other three Snake River projects.

Over the last several years, improvements have been installed in Lower Granite Dam fishways intended to aid in the passage of adult lamprey. In 2011, picketed leads were raised and secured 1.5″ off of the floor of the adult fish ladder at the count station. This was done to enable adult lamprey passage under the picketed leads, providing a low-velocity passage route for lamprey around the adult fish count slot. Over the 2012/2013 winter maintenance period, horizontal slots were cut in weirs at the floor to allow adult lamprey attachment through the weir. Additionally, ramps were installed from the fish ladder floor to the bottom of elevated salmon orifices in the upper ladder weirs.

Over the winter maintenance period of 2015/2016 the COE installed multiple improvements geared toward reducing the upper ladder temperatures at Lower Granite Dam. The intake for the three forebay auxiliary supply pumps was extended from approximately 30 feet deep in the forebay to around 70 feet, which now feeds a 50 cfs “shower” which deposits in front of the fishway exit (a radius of 30-50 feet) (Picture in Appendix A).
In 2016, it appeared that the “shower” did have a positive impact in terms of lowering upper fishway temperatures.

Additionally, the intake to diffuser #14 was extended from 10-20 feet deep to approximatley 70 feet deep. To accomplish this, the COE used a chimney that extended from slighly above the forebay water surface, covered the intake to diffuser #14, and extended down to a depth of approximatley 70 feet Pict. Diffuser #14 supplies water into the upper overflow section of the Lower Granite Ladder and adult fish trap.

Seven adult fishway inspections have taken place at Lower Granite Dam in 2016:

Date	Inspector(s), Agency
April 25, 2017	A. Dowdy (ODFW)
May 26, 2017	A. Dowdy (ODFW)
June 30, 2017	A. Dowdy (ODFW)
July 26, 2017	A. Dowdy (ODFW), D. Benner (FPC)
August 31, 2017	A. Dowdy (ODFW)

September 29, 2017	A. Dowdy (ODFW)
October 19, 2017	A. Dowdy (ODFW)

Details of the inspections can be found in Table 8 and text that follows.

Fishway Inspections

Two fishway entrances, SSE-1 and SSE-2, are operated on the south shore of the project. The location of the entrances is fairly unique in that SSE-2 is downstream of the SSE-1 entrance by about 150 ft. These two entrance gates are narrow (4-feet wide) compared to most gates at other COE projects.

In 2017, gates SSE-1 and SSE-2 operated with depths that ranged from 7.8 ft. to 8.4 ft. and head differentials that ranged from 0.8 ft. to 2.1 ft. During the fish passage season, gate depths were operated within criteria at the SSE's during all seven inspection dates, with the exception of the October 19th, 2017 inspection when both SSE 1 and 2 were slightly below criteria. Head differentials at SSE 1 and 2 met criteria for all inspections in 2017, with the exception of the August 31st, 2017 inspection when both SSE 1 and 2 were slightly below criteria. It should be pointed out that although the head differential criteria were not met according to the visual readings on August 31st, 2017, head differentials did met criteria according to FSC board readings.

Water velocities at the southern end of the collection channel ranged between 1.5 fps to 2.8 fps. Velocity readings were within criteria in the southern end of the collection channel during all inspections in 2017.

The North Powerhouse Entrances, NPE-1 and NPE-2, were operated with the gates on sill for six of seven inspections. During most of the inspections that the NPE's were on sill, the project was unable to meet the 8.0 ft. criteria for gate depth. During the September 29, 2017 inspection when the gates were not on sill, the NPE gates did met or exceeded the 8.0 ft. criteria. Gate depths for the season ranged from 5.1 ft. to 9.1 ft. Head differentials ranged from 1.0 ft. to 1.8 ft. for the season; all seven inspections recorded differential readings within criteria in 2017. For the most part, inspections showed the NPE gates operating within criteria (given the sill elevations); head differentials were also within criteria during all inspections in 2017.

At the North Shore Entrances, NSE-2 was closed during all inspections of the year. Reported gate depths at the open NSE-1 entrance ranged between 6.8 and 9.1 feet, and met depth criteria during all inspections, with the exception of the October 19th, 2017 Inspection that was slightly below criteria. The project met head differential criteria during all seven inspections at North Shore Entrances over 2017.

Fish Ladder: The ladder exit was reported as clean during all seven inspections. The picketed leads (count station) were reported clear of debris during all seven inspections during the fish passage season. The depth of water over the fish ladder weirs ranged between 1.0 and 1.2 ft., and was within criteria during all inspections.

Table 8. Pertinent Data for Fish Facility Inspections in 2017 at LOWER GRANITE DAM.

CRITERIA ITEMS		DATE OF INSPECTION						
SOUTH SHORE FISHWAY		**25-Apr**	**26-May**	**30-Jun**	**26-Jul**	**31-Aug**	**29-Sep**	**19-Oct**
South Shore Entrance								
Depth over entrance weirs								
SSE-1 (Criteria = 8 ft or >)	ft	8.1	8.4	8.0	8.0	8.1	8.1	7.8
SSE-2 (Criteria = 8 ft or >)	ft	8.1	8.3	8.1	8.0	8.1	8.1	7.8
Head at SSE-1 & 2 (Crit. = 1 - 2 ft)	ft	1.4	1.4	2.1	1.0	0.8	1.6	1.9
Depth over ladr. Weir (Crit.= 1-1.3 ft)	ft	1.0	1.1	1.1	1.1	1.0	1.2	1.2
Channel velocity (Crit. = 1.5-4 fps)	fps	1.8	1.6	1.5	2.2	2.3	2.8	2.6
Channel velocity (n shore)		2.2	2.1	1.7	1.7	1.9	0.9	1.1
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	no	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	na	yes
North Powerhouse Entrance:								
Depth over entrance weir								
NPE-1 (Criteria = 8 ft or >)		7.4	8.1	5.8	5.8	6.2	8.0	7.7
NPE-2 (Criteria = 8 ft or >)		7.5	9.2	5.1	6.2	closed	8.0	7.6
Head at NPE-1&2 (Criteria = 1-2 ft)		1.2	1.0	1.7	1.1	1.0	1.5	1.8
Gate on sill (Yes or No)		yes	yes	yes	yes	yes	No	yes
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
North Shore Entrance:								
Depth over entrance weir								
NSE-1 (Criteria = 7 ft or >)		9.8	8.4	7.4	9.1	9.0	7.2	6.8
NSE-2 (Criteria = 7 ft or >)		closed	closed	closed	closed	closed	closed	closed
Head at NSE-1&2 (Criteria = 1-2 ft)		1.6	2.1	1.3	1.1	1.4	1.0	1.8
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
Ladder Exit Cooling Pumps (On/Off)		off	off	off	yes	yes	off	off
Comment number (if applicable)					1	2	3	3

Comments:

1. Head differential at SSE 1 and 2 was 0.8 ft from visual reading, was 1.0 ft accprding to FSC board.
2. Work being performed on NPE2.
3. Velocities at Northshore did not meet criteria.

Summary and Recommendations

Overall, Lower Granite Dam fishway operators did an excellent job of maintaining fishway criteria in 2017. Taking into account sill limitations, only one inspection had only slightly below criteria (0.2 ft.) gate depths (October 19, 2017). During the September Inspection, staff gauges on the south shore fishway were reported as not clean.

PUBLIC UTILITY DISTRICT PROJECTS

The Public Utility District Projects are comprised of five mainstem Columbia River dams from Priest Rapids Dam located above the free-flowing Hanford Reach section of the Columbia River to Wells Dam located about 45 miles upstream from Wenatchee, Washington. Grant County PUD owns and operates the lower two dams, Priest Rapids and Wanapum dams; Chelan County PUD – Rock Island and Rocky Reach dams; and Douglas County PUD – Wells Dam. These dams use a variety of pump systems or gravity-flow water to supply AWS channels that feed this water through diffusion systems into the main collection chambers. At Priest Rapids and Wanapum dams, orifice gates along the powerhouse collection were sealed off in 2002, and these gates will remain closed in future years. Adult fish will be attracted to and passed only through the main entrance gates. Rocky Reach still operates with six orifice gates along its powerhouse collection channel. Wells and Rock Island dams do not have orifice gates along their powerhouses; main entrance gates are located at each end of the powerhouse channel to attract fish to the fish ladder. In addition to the adult fish facilities, spill has been the main passage route that juvenile fish are bypassed to below an individual project. Spill schedules have been developed to assist juvenile fish passage but not impact adult fish passage. In 2003, a permanent surface bypass collector to pass juvenile salmonids was completed at Rocky Reach Dam and will continue to operate in future years.

Inspections of adult fish facilities are summarized for the individual projects in the sections below.

PRIEST RAPIDS DAM (photographs on page A-xx)

Construction of Priest Rapids Dam was completed in 1959. The hydropower plant contains ten main turbine units and 22 spillbays. The project is owned and operated by Grant County Public Utility District (GPUD). The adult fish facilities consist of two fishways, one located on the left bank and the other on the right bank of the Columbia River. Make-up water for the lower end of the fish ladder is stored in Auxiliary Water Supply (AWS) pools at each bank. The AWS pools are filled by five electric pumps that pull water from the tailrace and a Gravity Intake Gate (GIG) that pulls water from the forebay of the project. AWS pool water is channeled through a diffusion system (mostly floor diffusers) into the collection channel (left bank only) and lower end of the fish ladder at both shores of the project. The main slotted entrance on the Left Bank fishway is located at the eastern end (shore entrance) and the western end of the powerhouse. All orifice gates were closed along the powerhouse collection channel in late summer 2001. One main slotted entrance is operated at the right bank fishway. Adult PIT-tag detectors were added to the right and left bank fish ladders prior to the 2003 fish passage season.

Seven adult fishway inspections took place at Priest Rapids Dam in 2017:

Date	Inspector(s), Agency
April 25, 2017	Skiles (CRITFC), Benner (FPC)
May 24, 2017	Skiles (CRITFC), Benner (FPC)
June 27, 2017	Skiles (CRITFC), Benner (FPC)
July 27, 2017	Skiles (CRITFC)
August 28, 2017	Skiles (CRITFC)
September 25, 2017	Skiles (CRITFC)
October 31, 2017	Skiles (CRITFC)

An operator, a fish biologist or fish technician, and an engineer from Grant County PUD normally accompanied inspectors during the inspections. The adult fishways are computer controlled and computer printouts identifying set points and actual readings can be generated as needed. The computer-generated readings are normally compared to the site readings to assess whether calibration of the equipment was necessary, or if tailwater elevations or project operations were changed during the inspection.

Left Bank Fishway

Slotted entrance LSE-2 is located at the western end of the powerhouse and it was open continually throughout the fish migration season. The head differential target is 1.2 feet at LSE-2, with an acceptable range of 1 to 2 feet. Head differentials ranged from 1.4 ft to 2.1 ft over the seven inspections. The project was operating at acceptable criteria during the 2017 inspection season as the head differential was within the 1- to 2-foot range and always greater than the 1.2 ft target for the all of the seven inspections.

Slotted entrance LSE-4 is located on the eastern end of the powerhouse and operated continually throughout the fish migration season. The head differential target is 1.5 feet at LSE-4, with an acceptable range of 1 to 2 feet. Head differentials ranged from 1.2 ft. to 1.5 ft. over the seven inspections. During the 2017 inspection season all the head differentials meet the criteria range and three inspections were equal or greater than the target of 1.5 feet.

Water velocity in the collection channel was estimated at the upstream end of the powerhouse channel and readings ranged between 1.2 and 2.8 fps. Water velocities in the collection channel were equal or above the 1.5 fps criteria on all inspections over the 2017 season with the exception of the October 31st, 2017 Inspection when the velocity recorded was several tenths below the criteria.

Fish Ladder: At the left bank fish ladder, the depth of water over the ladder weirs ranged between 1.0 and 1.1 ft during all seven inspections. All depth over left bank ladder weir readings were within the acceptable range of 1–1.2 feet. The exit from the fish ladder was clear of debris for the season and the staff gauges were reported clean during all but two inspections on the left bank fishway.

Right Bank Fishway

Slotted Entrance RSE-1 operated during the 2017 fish passage season. RSE-1 is required to operate within the following range: 1.0 to 2.0 ft for head differential with the target being 1.5 ft.

RSE-1 had head differentials ranging from 1.2 to 1.6 ft for the season. RSE-1 was operated within the acceptable criteria range of 1.0 to 2.0 ft during each fishway inspection in 2017. RSE-1 was within head differential target levels during two of the seven inspections.

Fish Ladder: The depth of water reported over the fish ladder weirs was at 1.0–1.1 ft on all inspections in 2017. The depth over the right bank ladder weir was within criteria for each inspection in 2017. The ladder exit was reported clear of debris on all inspections and the right bank staff gauges were reported clean during all inspections in 2017.

Table 9. Pertinent Data for Fish Facility Inspections in 2017 at PRIEST RAPIDS DAM.								
CRITERIA ITEMS								
LEFT BANK FISHWAY		**25-Apr**	**24-May**	**27-Jun**	**27-Jul**	**28-Aug**	**25-Sep**	**31-Oct**
Left Bank Entrance:								
Head at main entrances (Criteria = 1-2 ft)								
LSE-2 (1.2 ft target)	ft	1.5	1.9	1.2	2.1	1.4	1.6	1.7
LSE-4 (1.5 ft target)	ft	1.2	1.6	1.2	1.5	1.4	1.3	1.5
Depth over ladr. weir (Crit. = 1-1.2 ft)	ft	1.1	1.1	1.1	1.0	1.0	1.1	1.0
Water velocity (Crit. = 1.5-4 fps)	fps	2.7	2.8	2.3	2.0	1.8	1.6	1.2
Ladder exit clean (Crit. = yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (Crit. = yes or no)		yes	yes	yes	no	yes	no	yes
RIGHT BANK FISHWAY								
Right Bank Entrance:								
Head at Entrance (Criteria = 1-2 ft)								
RSE-1 (1.5 ft target)	ft	1.4	1.2	1.5	1.6	1.4	1.4	1.2
Depth over ladr. weir (Crit. = 1-1.2 ft)	ft	1.2	1.1	1.1	1.0	1.0	1.0	1.0
Ladder exit clean (Crit. = yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (Crit. = yes or no)		yes	yes	yes	yes	yes	yes	yes
Comment number (if applicable)							1	
Comments:								
1. LSE-2 staff gauge unreadbable.								

Summary and Recommendations

- Overall, Priest Rapids Fishways were found to be in good condition in 2017. Entrance head differentials met criteria at all entrances in 2017. The velocity in the collection channel was slightly less than criteria during the October 31st, 2017 Fishway Inspection and several staff gauges were reported as not clean on the Left Bank Fishway in 2017.

WANAPUM DAM (photographs on page A-xx)

Wanapum Dam hydro project was completed in 1963 with ten main turbine units for power production and 12 spill gates to pass excess flow. The project is owned and operated by Grant County PUD. Two turbine-operated pumps that pull water from the tailwater of the dam and are driven by gravity flow water from the forebay of the dam supply make-up water to the left bank Auxiliary Water Supply (AWS) pool. Two 10-foot diameter butterfly valves provide a backup system for the turbine-driven pumps. Fishway water flows through the two main slotted fishway entrances: LSE-2 at the eastern end of the powerhouse (shore), and LSE-3 at the western end of the powerhouse. Auxiliary water for the right bank fishway is a gravity-flow system that pulls water from the forebay of the dam. This water normally supplies sufficient flow to the diffusers located in the lower end of the fish ladder to meet head differential criteria established for slotted entrance, RSE-2.

Seven adult fishway inspections took place at Wanapum Dam in 2017:

Date	**Inspector(s), Agency**
April 25, 2017	Skiles (CRITFC), Benner (FPC)
May 24, 2017	Skiles (CRITFC), Benner (FPC)
June 27, 2017	Skiles (CRITFC), Benner (FPC)
July 27, 2017	Skiles (CRITFC)
August 28, 2017	Skiles (CRITFC)
September 25, 2017	Skiles (CRITFC)
October 31, 2017	Skiles (CRITFC)

A summary of the inspections is listed in Table 10 and in the text below.

Left Bank Fishway

The east slotted entrance LSE-2 operates as the primary entrance with a head differential criterion of 1.0 ft to 2.0 ft and a target of 1.5 ft. Slotted entrance LSE-2 operated within a range of 1.1 ft. to 1.5 ft. over seven inspections in 2017. Head differentials at LSE-2 were within the acceptable criteria range over the entire season (1–2 feet) and at or above the target head differential for two of seven inspections in 2017. Entrance conditions for adult fish at LSE-2 should have been excellent throughout the 2017 migration season.

The operational criterion for LSE-3 head differential is from 1.0 ft. to 2.0 ft. with the targeted head differential of 1.2 ft. LSE-3 operated within the following range: 1.3 ft. to 1.5 ft. for the fish passage season. The head differential target at LSE-3 was exceeded during all inspections in 2017. LSE-3 should have provided excellent entrance conditions for adult fish throughout the 2017 passage season.

Water velocity was estimated at the upstream end of the powerhouse channel and readings ranged between 1.1 and 2.8 fps. All readings met or exceeded the minimum criteria of 1.5 fps during the 2017 Inspection season with the exception of the October 31st, 2017 Inspection when the velocity recorded was several tenths below the criteria.

Fish Ladder: The depth of water over the left bank fish ladder weirs was 1.0 to 1.1 ft. during each inspection in 2017; all readings were satisfactory for the season. The ladder exit was clear of debris on all inspections in 2017.

Right Bank Fishway

The right bank slotted entrance RSE-2 is targeted to operate with a head differential of 1.2 ft. and within the range of 1.0 ft. to 2.0 ft. RSE-2 was operated with head differentials that ranged from 1.4 ft. to 1.7 ft. during the 2017 season. All inspections met and exceeded the head differential target in 2017.

Fish Ladder: The right bank fish ladder operated with a depth of water over the weir crests ranging between 1.0 ft. and 1.1 ft. for the season. All readings were satisfactory for the season. The fish ladder exit was clear of debris and staff gauges were clean on all inspections.

Summary and Recommendations

Overall, the Wanapum Dam fish facilities were well maintained throughout the 2017 fish passage season. The velocity in the collection channel was slightly less than criteria during the October 31st, 2017 Fishway Inspection.

Table10. Pertinent Data for Fish Facility Inspections in 2016 at WANAPUM DAM.

CRITERIA		DATE OF INSPECTION						
LEFT BANK FISHWAY		**26-Apr**	**24-May**	**26-Jun**	**27-Jul**	**24-Aug**	**28-Sep**	**25-Oct**
Left Bank Entrance:								
Head at entrances (Criteria = 1-2 ft)								
LSE-2 (target head = 1.5 ft)	ft	1.6	1.4	1.6	1.7	1.9	1.5	1.4
LSE-3 (target head = 1.2 ft)	ft	1.7	1.6	1.8	1.5	1.4	1.3	1.6
Dep. over ladr. weir (Crit. = 1.0-1.2ft)	ft	1.0	1.1	1.1	1.1	1.0	1.0	1.1
Channel velocity (Crit. = 1.5-4.0 fps)	fps	1.8	1.9	2.2	2.0	2.0	2.0	1.5
Staff gages clean (Crit. = yes or no)		yes	yes	yes	yes	yes	yes	yes
Auxiliary H20 Pumps	rpm	99/0	135/141	138/141	136/137	117/139	99/102	97/102
Ladder exit clean (Crit. = yes or no)		yes	yes	yes	yes	yes	yes	yes
RIGHT BANK FISHWAY								
Right Bank Entrance:								
Head at Entrance (Criteria = 1-2 ft)								
RSE-2 (target head = 1.2 ft)	ft	1.6	1.5	1.7	1.4	1.6	1.6	1.5
Depth over ladder weir	ft	1.1	1.0	1.0	1.1	1.0	1.0	1.1
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
Comment number (if applicable)								
Comments:								

ROCK ISLAND DAM (photographs on page A-xx)

The Rock Island hydro-project is owned and operated by Chelan County PUD. The dam is comprised of two powerhouses: an old powerhouse with ten main turbine units that was constructed in 1933, with a major upgrade of the turbine units in 1953. A new powerhouse with eight main turbine units and located on the right bank of the Columbia River was completed in 1979. The spillway, consisting of 32 spillbays, is located between the two powerhouses. Several spill gates have been notched to provide "surface flow" for the juvenile fish to pass downstream of the project.

The old powerhouse adult fish facilities consist of the left bank fishway and the middle or spillway fishway, with the right bank fishway located at the new powerhouse. Gravity-fed water is used to supply attraction flows to the fishways at the old powerhouse with a combination of pumped and gravity-fed water at the new powerhouse. Each fishway has a fish counting station located near the top of the fish ladder and new PIT-tag systems located in the exit section of each ladder. The final installation of the adult PIT-tag system was completed prior to the 2004 adult fish passage season.

Seven adult fishway inspections have taken place at Rock Island Dam in 2017:

Date	Inspector(s), Agency
April 19, 2017	Solorio (WDFW)
May 24, 2017	Solorio (WDFW), Benner (FPC)
June 22, 2017	Solorio (WDFW)
July 19, 2017	Solorio (WDFW)
August 23, 2017	Solorio (WDFW)
September 27, 2017	Solorio (WDFW)
October 25, 2017	Solorio (WDFW)

Results and discussion of the inspections follow in the text below and in Table 11.

Left Bank Fishway

Gravity-fed water is supplied from the forebay to the lower end of the left bank fish ladder through diffuser gratings. This auxiliary water supplies sufficient flow to allow Gates LO5 and LO6 to operate at 6.0 ft or greater depth with a corresponding head differential of 1.0 ft. minimum at all tailwater elevations.

Gates LO5 and LO6 were submerged a similar depth during the 2017 season. Gate depths ranged from 7.4 ft. to 10.0 ft. Left bank fishway head differentials ranged between 1.0 ft. and 1.5 ft. The gate depth and head differential readings were all found within acceptable criteria range through the 2017 inspection season.

Fish Ladder: Depth of water measured over the left bank fish ladder weirs was 1.0-1.1 ft. during all inspections of the 2017 passage season. The trash racks located at the exit from the fish ladder and the picketed leads at the counting station were clear of debris during all the inspections.

Middle Fishway

Gravity-fed water from the forebay of the dam supplies water to the lower end of the fish ladder through floor diffusers. The end gate and a fixed-open side gate operate to attract adult fish from the spillway section of the dam. The end gate, MO3, is required to operate at 8.5 ft. or greater depth below tailwater,

while the side gate is continually open and depends on head differential to be within acceptable criteria. The head differential required for both gates is the standard 1.0-ft to 2.0-ft range.

Gate MO3 depths recorded at the Middle Ladder during the inspections ranged from 8.9 ft. to 10.5 ft. with head differentials that ranged from 1.0 ft. to 1.1 ft. Middle fishway gate depths and head differentials at the entrances met criteria during all inspections in 2017.

Fish Ladder: The depth of water over the fish ladder weirs was reported as 1.0-1.1 ft during all seven inspections in 2017. The picketed leads and the ladder exit were clear of debris during the inspections.

Right Bank Fishway

Auxiliary water is supplied to the right bank fishway from three fish pumps that pull water from the tailwater and gravity-fed water from the forebay of the dam. Most of this flow enters the fishway in the lower end of the fish ladder through sidewall diffusers. This attraction water is distributed to an entrance at the downstream end of the project, one main entrance at the left end of the powerhouse, and through two entrances at the right end of the powerhouse. Each entrance has a 3-foot wide opening, but its depth will increase as flow and tailwater elevation increases. The entrances are operated to meet head differential criteria of 1.0 to 2.0 ft. In addition to the entrance flow, a high velocity flow of water is discharged below the water surface near the right powerhouse entrances. The purpose of this high velocity flow is to attract fish to the right powerhouse entrances from across the face of the dam. The three pumps are normally operated at 60%–100% open with the gravity water valve operated at 35%-100% open.

The entrance gates, TPE, LPE, and the RPEs were reported with head differentials that ranged from 1.0 ft. to 1.9 ft. throughout the season. Head differentials at the right fishway were met during all inspections in 2017.

Water velocity recorded in the powerhouse transportation channel was measured using a portable flow meter; velocities ranged between 3.4 to 4.6 fps during the inspections. Even with these higher-measured water velocities in the Rock Island transport channels, adult fish pass through both channel sections with little or no delay based on radio telemetry studies.

Fish Ladder: Depth of water measured over the ladder weirs was 1.0–1.1 ft. for all seven inspections at the right ladder and met criteria in all inspections in 2017. The exit from the fish ladder was clear of debris during all inspections, as were the picketed lead section at the fish counting station.

Summary and Recommendations

Overall, fishway attendants at Rock Island Dam have done an excellent job of maintaining adult fishway criteria in 2017.

Table 11. Pertinent Data for Fish Facility Inspections in 2017 at ROCK ISLAND DAM

CRITERIA ITEMS		DATE OF INSPECTION						
		19-Apr	24-May	22-Jun	19-Jul	23-Aug	27-Sep	25-Oct
LEFT BANK FISHWAY								
Left Bank Entrance:								
Depth over entrance weir								
LO5 (Criteria = 6.0 ft or >)	ft	7.4	7.4	9.7	8.6	9.0	10.0	7.6
LO6 (Criteria = 6.0 ft or >)	ft	7.4	7.4	9.7	8.6	8.9	10.0	7.6
Head at LO5 & 6 (Crit. = 1-2 ft)	ft	1.5	1.4	1.1	1.2	1.0	1.0	1.1
Depth over ladder weir (Criteria = 1.0-1.2 ft)	ft	1.0	1.0	1.0	1.1	1.0	1.1	1.1
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
CENTER FISHWAY								
Center Entrance:								
Depth over entrance weir								
MO3 (Criteria = 8.5 ft or >)	ft	9.5	10.5	9.7	9.4	9.6	9.5	8.9
Head at MO3 (Criteria = 1-2 ft)	ft	1.0	1.1	1.0	1.1	1.1	1.0	1.0
Depth over ladder weir (Criteria = 1.0-1.2 ft)	ft	1.1	1.0	1.0	1.1	1.0	1.1	1.1
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
RIGHT BANK FISHWAY								
Right Bank Entrance:								
Head Differential (Crit. = 1-2 ft)								
LPE-1	ft	1.2	1.3	1.3	1.3	1.7	1.8	1.5
RPE-1 and RPE-2	ft	1.1	1.3	1.1	1.3	1.4	1.4	1.9
TRE	ft	1.1	1.3	1.1	1	1.3	1.7	1.6
Depth over ladder weir (Criteria = 1.0-1.2 ft)	ft	1.0	1.0	1.1	1.1	1.0	1.1	1.1
Channel veloc(Cr. = 1.5-4 fps)	fps	4.6	3.4	3.5	4.0	4.6	4.6	3.5
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Pumps operating								
Pump Gate Openings	%	94-98.8	97.3-99.3	67.7-95	61.3-96.2	64.9-98.9	38.9-101.0	48-97.9
Comment number (if applicable)								

Comments:

ROCKY REACH DAM (photographs on page A-xx)

Rocky Reach Dam was completed in 1961 and is owned and operated by Chelan County PUD. The project is comprised of 11 main turbine units and 12 spillbays to pass water through the dam. Originally, four turbines were fixed-blade units (8–11); however, these units have been modified and were adjustable blade turbines over the 2016 fish passage season. Flow from the turbine units is at right angle to the river and spillway flow.

The adult fish facilities are comprised of three turbine-driven propeller-type fish pumps that supply water from the tailwater of the project for the powerhouse fishway entrances, most of the spillway entrance flow, and the six orifice gates along the powerhouse collection channel. The fish pumps operated satisfactorily during the 2016 fish passage season. Additional gravity-flow water can be supplied at the main spillway entrance to maintain the agreed upon criteria for that entrance. The powerhouse collection, left powerhouse, and spillway channels merge in the junction pool area to form the transportation channel that guides fish to the lower end of the fish ladder. The fish ladder exit is located on the right bank of the Columbia River.

A prototype juvenile fish passage facility was tested for several years at the project with the new Corner Surface Collector completed prior to the 2003 fish passage season. The system has operated satisfactorily since that time with the juvenile bypass season that lasts from about April 1 to late August. When the bypass system operates, the south powerhouse turbines (1–5) are normally prioritized to attract juvenile fish to the area of the juvenile collector's entrances.

Seven adult fishway inspections have taken place at Rocky Reach Dam in 2017:

Date	Inspector(s), Agency
April 19, 2017	Solorio (WDFW)
May 24, 2017	Solorio (WDFW), Benner (FPC)
June 22, 2017	Solorio (WDFW)
July 19, 2017	Solorio (WDFW)
August 23, 2017	Solorio (WDFW)
September 27, 2017	Solorio (WDFW)
October 25, 2017	Solorio (WDFW)

Table 12 lists inspections and pertinent data with the text filling in details of the activities for this season.

Powerhouse Entrances

The Right Powerhouse Entrances, RPE-1 and RPE-2, are rotary wing gates that operate with a 3-ft opening, and require head differential of 1.0 ft. to 2.0 ft. The head differentials at RPE-1 and RPE-2 ranged from 1.0 ft. to 1.3 ft. for the season, all within criteria.

All orifice gates were closed in 2017 following a vote by the HCP coordinating Committee in late July of 2016.

The Left Powerhouse Entrances, LPE-1 and LPE-3, are located at the left end of the powerhouse nearest to Main Turbine #11. Gate depths at LPE-1 and LPE-3 ranged from 10.7 ft. to 11.7 ft., with head differentials that ranged from 1.0 ft. to 1.3 ft. Head differential were within the required range on all inspections and gate depths were above 10 ft. on all inspections. The LPEs were operated within criteria through the entire 2017 inspection season.

The water velocity meter is installed about 150 ft upstream from the junction pool and centered in the transportation channel. In 2017, the transportation channel velocities ranged from 1.8 to 2.1 fps, all above the minimum criteria of 1.5 fps.

Spillway Entrance

The spillway entrance was operated from May through October inspection dates. The spillway gate (MSE) is to be submerged 10 ft. or greater unless the gate is on sill. During the year, weir depths ranged between 9.4 and 11.6 feet and were 10 feet or greater during all inspections when the spillway entrances were open with the exception of the October 25th, 2017 inspection when low tailwater prevented the 10 foot criteria from being met. Head differentials were reported from 1.1 ft. to 1.3 ft. during the 2017 inspection dates. All inspections had satisfactory head differential and gate depth readings.

Fish Ladder: The exit from the fish ladder was clear of debris during the 2017 inspection season. The depth of water over the fish ladder weirs was 1.1-1.3 ft. during all inspections and was within the criterion range of 1.0 and 1.3 ft.

Summary and Recommendations

Overall, fishway attendants at Rocky Reach have done an excellent job of maintaining adult fishway criteria.

Table 12. Pertinent Data for Fish Facility Inspections in 2017 at ROCKY REACH DAM.

CRITERIA ITEMS		DATE OF INSPECTION						
		19-Apr	24-May	28-Jun	19-Jul	23-Aug	27-Sep	25-Oct
ADULT FISHWAY								
Left Powerhouse Entrance:								
Depth over entrance weirs								
LPE-1 & 3 (Depend. On Tw Elev)	ft	10.7	11.7	11.0	11.2	11.7	11.5	11.5
Head at LPE-1 & 3 (Crit. = 1-2 ft)	ft	1.3	1.2	1.3	1.2	1.1	1.0	1.1
Depth over Ladr Weir (Crit = 1-1.3 ft)	ft	1.1	1.0	1.0	1.0	1.0	1.0	1.1
Channel velocity (Crit. = 1.5-4 fps)	fps	1.8	2.1	1.9	1.9	1.9	1.8	1.8
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Turbine 11 Operating (yes or no)		no	no	no	no	no	no	no
Right Powerhouse Entrance:								
Wing gate opening (Criteria = 3.0 ft)								
RPE-1 and RPE-2	ft	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Head at RPE-1&2 (Crit. = 1-2 ft)	ft	1.1	1.3	1.2	1.1	1.1	1.3	1.2
Orif. Gates Oper - (1,2,3,16,18, 20)	y/n	na	na	na	na	na	na	na
Pumps operating		3	3	3	3	3	3	3
Pump Gate Openings	%	49	67	56	52	55	57	52
Spillway Entrance:								
Depth over entrance weir								
MSE (Dependent on Tailwtr Elev.)	ft	closed	11.6	11.1	11.1	10.3	11.5	9.4
Head at MSE (Criteria = 1-2 ft)	ft	closed	1.3	1.2	1.2	1.1	1.1	1.3
Comment number (if applicable)								1

Comments:

1. MSE on sill due to low tailwater.

WELLS DAM (photographs on page A-xx)

Wells Dam was completed in 1967 with 10 main turbine units and the spillbays placed directly above them. The hydropower project is owned and operated by Douglas County PUD.

The adult fish passage facilities were built and incorporated into the project during the construction phase. The west and east bank fishway entrances are similar in design and in past years normally operated with an end gate and a side gate open. Two fish turbine pumps are operated per bank and supply attraction flows through floor and wall diffuser gratings into the main channel that leads to the downstream gate at each fishway. Only the downstream entrance gate is now operated per fishway and is open the maximum width of 8 ft. The depth of water passing through the entrance gates extends from near floor level of the fishway to the water surface elevation in the entrance pool. High velocity water discharge pipes originally operated near the side entrances but were also closed when the side entrance gates were permanently closed.

Six adult fishway inspections have taken place at Wells Dam in 2017.

Date	Inspector(s), Agency
May 25, 2017	Paul P. (WDFW)
June 7, 2017	Paul P. (WDFW)
July 1, 2017	Douglas PUD
August 7, 2017	Douglas PUD
September 3, 2017	Douglas PUD
October 20, 2017	Douglas PUD

Results of the inspections are summarized in Table 13 with discussion relating to overall inspections for the year in the text below.

The fish pumps operated satisfactorily throughout the 2017 fish passage season with no reported out-of-service time. The Wells project can meet head differential criterion at the main downstream entrances through all tailwater and flow conditions.

East and West Fishways

The head differentials reported at the East entrances for the 2017 season ranged between 1.3 ft. and 1.6 ft. At the east entrances, minimum head differential criteria were met on all six inspections. The head differential readings at the West fishway entrances ranged between 1.4 ft. and 2.3 ft., meeting the minimum criteria during all inspections.

Fish Ladder: The exits from the fish ladders appeared clear of debris throughout the year. The picketed leads at the counting stations were clear of debris during all inspection dates. The depth of water over the ladder weirs ranged from 1.0 ft. to 1.2 ft. at the west and east ladders. The depth of water over both the east and west ladder weirs met minimum criteria during all inspections in 2017.

Summary and Recommendations

Overall, the adult fishways at Wells Dam were well operated over the 2017 fish passage season.

Table 13. Pertinent Data for Fish Facility Inspections in 2017 at WELLS DAM.

CRITERIA ITEMS *EAST FISHWAY:*		25-May	7-Jun	1-Jul	7-Aug	3-Sep	20-Oct
Head at main entrance (Target = 1.5ft)	ft	1.3	1.5	1.6	1.6	1.3	1.5
D/Stream entrance open (Criteria = 8-ft)	ft	8 ft	8 ft	8 ft	8 ft	8 ft	8 ft
Depth over ladder weir (Crit.= 1-1.2 ft)	ft	1.1	1.0	1.1	1.0	1.1	1.0
Ladder exit differential	ft	0.7	0.5	na	na	na	na
Staff gages clean/readable (yes or no)		yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes
Auxiliary Fish Pump Speed (rpm)		52/70	45/68	36/31	50/50	41/44	42/42
WEST FISHWAY: (Criteria same as East)							
Head at main entrance	ft	1.4	1.5	2.0	2.3	1.7	1.5
Downstream entrance open	ft	8 ft	8 ft	8 ft	8 ft	8 ft	8 ft
Depth over ladder weir	ft	1.2	1.1	1.0	1.0	1.0	1.1
Ladder exit differential	ft	0.7	0.6	na	na	na	na
Staff gages clean/readable		yes	yes	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	yes	yes
Auxiliary Fish Pump Speed (rpm)		53/51	48/52	46/54	48/49	48/49	47/43
Comment Number (if applicable)							

Comments:

GENERAL PROJECT RECOMMENDATIONS

Most recommendations relating to adult fish passage and improvements to fish facilities are normally discussed at the FPOM committee meetings for COE projects or in MCOL committee meetings both prior to and during a year. Main issues relating to passage of adult fish have been addressed in a broad way via the Biological Opinion that was completed by NOAA Fisheries. Some general recommendations to improve fish passage conditions follow.

- Projects should assure that water-measuring devices are easy to read at all water elevations during the year. Preferred conditions would be those where staff gauges can be cleaned easily and/or have benchmarks available so sensor readings can be taken.
- Projects should evaluate back-up water supply sources to assure that adequate water is available to attract adult fish should the main water supply fail.
- Projects should monitor ladder temperatures during warm water periods of the year. At projects such Lower Granite where adult passage has been impacted by water temperature differentials between the ladder and tailrace, plans should continue to be developed that attempt to alleviate this issue.
- Projects should assure that diffuser gratings are intact and clear of debris before the main fish passage season begins and at some point during the season. Videotape, divers, or other acceptable means should accomplish this task.
- All projects should have a plan of action on how to deal with removal of debris from the forebay of each dam. This would help assure that fish turbines/pumps, exits from the dams, picketed leads, or other areas would have less chance of plugging or causing damage to mechanical systems of the fishways or to the adult or juvenile fish passing the dams.
- Sharp projections or other obstacles located in the fish ladders, collection or transportation channels, should be removed.
- Based on past performance of the fishway equipment, the projects should purchase spare parts of critical operating equipment that would allow “quick” fix during the fish passage season should equipment fail.
- Dewatering plans or other fish handling tasks should be reviewed and annually updated where necessary.

SUMMARY OF FISHWAY CRITERIA

Summary of fishway criteria for mainstem dams on the Columbia and Snake River

Detailed criteria for COE dams can be found in the COE's Fish Passage Plan, or at PUD projects in Fishery Operating Plans (adult criteria) for each District. This Appendix summarizes the general standards for the fishways at each project.

Entrance Head Differentials: 1.0 to 2.0 feet standard at all projects.
Wells, Wanapum, Priest Rapids, and Bonneville dams target 1.5 ft at some entrances, Priest Rapids and Wanapum target 1.25 ft.

Entrance Weir Gate Depths:

Bonneville - At the old powerhouse, maintain 8.0 ft or more depth at Gate 1/2 and 64/65; at the new powerhouse maintain 13′ or > depth when tailwater elevation is above elevation 14 (sill = elev 1.0′).

The Dalles, John Day (OR fishway), McNary (OR fishway and north shore), Ice Harbor (south, north ph) Lower Monumental, Little Goose (south), and Lower Granite (south, north ph) - 8 ft or > depth at Entrance Gates.

Rock Island (spillway entrance) - 8.5 ft or > gate depth.

Rock Island left bank, Little Goose north shore - 6.0 ft or > gate depth.

Lower Granite north shore, Little Goose north powerhouse - 7.0 ft or > gate depth.

Rocky Reach left powerhouse & spillway - 10' or > gate depth.

Entrance Wing Gate Openings:

Wells - 8.0 ft open end gate.

Rock Island - 2.0 ft open on center fishway side gate; 3.0 ft open on the new powerhouse entrance gates.

Rocky Reach - 3.0 ft open on right powerhouse gates.

Entrance (fixed-open) Gates: Maintain head differential of 1.0-2.0 ft

Bonneville (spillway entrances)
Wanapum (all entrances)
Priest Rapids (all entrances)
John Day North
Lower Monumental (south shore, SSE-2 is a permanent fix 6-ft open gate)**.**

Turbine Unit Operating Priority: Specific to each dam (See year 2016 FPP for COE projects).
Spillway Operation: Specific to each dam (See 2016 FPP for COE projects and DFOP/LSOP and HCPs for PUD projects).
Collection or Transportation Channel Velocities: 1.5 to 4.0 fps at all projects.
Staff Gauges or other Elevation Gauges: At all projects, gauges must be maintained throughout the fish passage season and readable at all elevations.

Fish Ladder

Depth of Water over Fish Ladder Weirs: 1.0 ft ± 0.1 ft; most projects use a 1.0 ft to 1.2 ft or 1.3 ft.
Head on Picketed Leads: Maximum of four inches at most projects (0.3 ft); 6.0 inches is required at Chelan PUD projects.
Head on Exit Trash Racks: Maximum of 0.5 ft greater than reading with a clean trash rack. Debris should be removed when significant amounts accumulate.

CKNOWLEDGMENTS

Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, CRITFC, USFWS PSMFC, and NOAA Fisheries provided personnel to inspect adult fishways during the 2016 fish passage season. The Fish Passage Center appreciated the time and commitment from the individual inspectors and from the Agencies who assured that fishery personnel were available to complete inspections at the mainstem dams each month. Fishery agency personnel who participated in the inspection program during 2016 are listed below.

AGENCY	INSPECTOR	DAMS INSPECTED
CRITFC	Tom Skiles	Priest Rapids & Wanapum
NOAA	Gary Fredricks	Bonneville
NOAA	Jeff Brown	McNary
ODFW	Howard Takata	The Dalles & John Day
ODFW	Anne Dowdy	Little Goose & Lower Granite
USFWS	David Swank	Ice Harbor
PSMFC	Monty Price	Lower Monumental
WDFW	Paul P.	Wells
WDFW	Mauro Solorio	Rock Island & Rocky Reach

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