

**ADULT FISHWAY INSPECTIONS
ON THE COLUMBIA AND SNAKE RIVERS**

2005 ANNUAL REPORT

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COLUMBIA BASIN FISH AND WILDLIFE AUTHORITY

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FISHWAY INSPECTIONS AT COLUMBIA AND SNAKE RIVER DAMS, 2005

INTRODUCTION

This season was the 21st 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 2005 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 projects. These months encompass the main passage season for adult and juvenile fish at the mainstem dams. In total, the fish facilities are inspected 7 or 8 times during the season by the State or Federal inspector with the FPC coordinator normally accompanying the inspectors twice during the inspection season. The monthly project inspections were coordinated with the salmon managers as well as the operating agencies, i.e., the COE and PUD through periodic updates or forums such as the Fish Passage Operations and Maintenance Committee (FPOM). 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.

Since 2001, security at the COE and PUD projects has increased with check-in at specific security gates the norm for all projects. Identification and check-in procedures are now required at the Projects and unannounced inspections are not completed under present security conditions.

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. Most passage problem areas have been addressed and in recent years, mostly refinement and improving passage timing of adult fish through individual fishways has become a primary goal (examples are the modifications completed in the South fish ladder exit at John Day Dam and proposed new modifications to the Lower Granite Dam junction pool and fishway weirs – 2006 completion).

The COE and PUD 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 Opinion 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, that is 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, 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 fish turbines operating and at what Mw or flow level , number of spill bays operating and quantity of spill, and other measurements,*
- *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 2005 season was a continuation of the long-term inspection program that the State and Federal fish agencies have endorsed since the 1960's. 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 Marine Fisheries Service (NMFS), and the United States Fish and Wildlife Service (USFWS).



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. Other pertinent adult fish passage information was disseminated at FPOM or other FPC reports or memos.

Factors affecting fishway operations at the mainstem dams during the 2005 fish passage season are listed below:

- The Snake and Columbia rivers began the water year well below normal with snowpacks also below normal throughout the Columbia River basin. The January to July runoff volume at The Dalles Dam was approximately 81 million acre-feet or 75 percent of normal. There was spill at some projects during the spring with Court-ordered spill during the summer months to improve passage conditions for the juvenile fish migrations in the Snake and Columbia rivers. Reduced river flows during the spring resulted in less large debris/trash at the projects in April through June.
- The Snake River projects were again operated at Minimum Operating Pool (MOP) plus 1-ft during the spring and summer months to improve juvenile fish passage conditions. The additional 1-ft was required to assist passage of navigation barges up and downstream through the lock channel. During part of the passage season, some fishway entrances at the Snake River dams were operated at reduced weir depths due to the gates resting on sills (no additional depth can be achieved). In the Columbia River, low tailwater elevations at Bonneville Dam resulted in reduced depth at main fishway entrances at the New and Old powerhouse as the gates rest on sill during the late summer and fall months.
- Mechanical failures on essential fishway equipment such as fish pumps, fish turbines, or other auxiliary water equipment were minimal during the 2005 fish passage season; with problem areas discussed in the individual Project Sections. Only two of the 3 fish pumps at McNary and Lower Granite dams (part of season at Lower Granite) were operable during the season. Fortunately, the two pumps at both projects ran satisfactorily for the 2005 season with no backup pump available.
- As in previous seasons, large quantities of floating aquatic grasses such as milfoil, elodea, etc., were present in the upper and lower Columbia Rivers, and these grasses caused problems with trashracks, diffuser gratings, and other equipment at the dams. Most projects were affected to some degree by the influx of these grasses at the fish facilities. The heaviest grass problems occur mainly at the upper three Columbia River dams. This may require a fishway be taken out of service for a portion of a day while the grasses are removed from the trash racks or from the wall screens at the various projects (See photos from Rock Island Dam).
- Spring, summer and fall-run salmon (species) passed Columbia and Snake River dams with minimal delays and/or injuries associated with passage facilities at these projects. At Bonneville Dam, flow to the old powerhouse was initiated during September to reduce numbers of adult salmonids passing through the New Powerhouse fish ladders. Normally the old powerhouse is operated on a last on/first off basis to prioritize flow to the new powerhouse. This operation in September helps reduce numbers of adult fish that pass on the WA shore by spreading out the flow, hence adult fish also move to and pass the old powerhouse at higher rates during this month when adult Chinook, coho, and steelhead are present at the project in high numbers (usually ranging between 5,000 to 40,000 adult fish) each day.
- Conversion rates of salmon through the dams appeared satisfactory when compared to previous years. Water temperatures began rising during the late summer and fall, resulting in steelhead (mainly) holding longer than normal in some of the lower tributaries until the water temperatures reduced in the mainstem Columbia River. At one time, there was a count differential between Bonneville and The Dalles Dam of greater than 130,000 adult steelhead.

- Summertime spill in the Snake River at Little Goose Dam resulted in near impassable conditions for adult salmon for about a 10-day period until the spill patterns were adjusted and spill reduced to about 30% of flow during daytime hours. The ODFW biologist checked the fishways on several occasions to assure that the facilities were operating within criteria. They were, however, large eddies were prevalent across the face of the powerhouse and basically rendered the entrances impassable.

SUMMARY BY PROJECT

State and Federal Fish agency personnel who completed fish facilities inspections throughout the fish passage season were as follows for the 2005 season.

AGENCY	INSPECTOR	DAMS INSPECTED
NOAA	Bryan Nordlund	Priest Rapids & Wanapum
NOAA	Gary Fredricks	Bonneville
NOAA	Larry Swenson	McNary
ODFW	Wayne van der Naald	The Dalles & John Day
ODFW	Anne Dowdy	Little Goose & Lower Granite
WDFW	Steve Richards	Ice Harbor & Lower Monumental
WDFW	Larry Stillweigh	Wells
WDFW	Steve Gacek	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 or about 3-days per week basis.

BONNEVILLE DAM (photographs on page 49)

Bonneville Dam has two powerhouses: the old 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. The old powerhouse consists of ten main turbine units while the new powerhouse has eight main turbine units and two smaller fish turbines that supply auxiliary water to the WA shore fishway. Between the two powerhouses is the spillway (part of the old 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 supply about 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 2004, a corner collection system was installed at the South end of the new powerhouse to improve passage for juvenile fish at the project. In addition, an experimental fishway system for passage of adult lamprey was tested at the Bradford Island fish ladder in 2004 and 2005 with excellent passage results. Permanent fish facilities to improve lamprey passage will be ongoing at the Bradford Island fish ladder as well as at the WA fishway entrance in 2006.

Gary Fredricks of NOAA Fisheries completed eight fishway inspections at Bonneville Dam during the following months, from late March through October (Table 1). Results from the inspections can be noted in the Bonneville Table and discussion below.

Bradford Island (old powerhouse) 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 old powerhouse main entrances are operated in pairs, i.e., Gate 2 and Gate 64, or Gate 1 and Gate 65 depending on tailwater elevation. The orifice/slucice gates were closed for the 2005 season and will remain closed in future years at the Dam.

2005 Inspection Results

The New Powerhouse was again highest priority for turbine operation at Bonneville Dam for the 2005 fish passage season. This resulted in non-operation of the turbine units at the Old Powerhouse or at times 1-3 turbine units might be operating during an inspection. In our inspections, flow from entrance Gate 64 would be very pronounced in the tailwater. Flow from the Ice/Trash Sluiceway partially occludes the flow from Gate 2. The Sluiceway was operated during the entire inspection season whether the powerhouse was operating or not.

Old Powerhouse Inspections

Weir Gate 2, located at the south end of the old powerhouse, had head differentials (site reading) that ranged between 0.3 ft and 1.9 ft. The computer reading and the site reading did not compare favorably for the season with the site and PLC readings sometimes varying by about 1-ft. The head differential from the computer during the September inspection read 1.3 ft at the South entrance while the visual reading of the channel minus the tailwater (computer) was only 0.3 ft, well below the minimum 1-ft requirement. The gate depths ranged from a low of 5.6 ft to a high reading of 12.5 ft for the season. The gate depth was less than 8 ft on 2 of the 8 inspections. The criterion on gate depth was changed in recent years to include: minimum depth = 8-ft or > at the entrance with 1.0 ft – 2.0 ft head differential. 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. Because of the system limitation to read tailwater elevation and gate depth at this site, computer readings are normally used. Gate 2 was on sill during the final two inspections and 8-ft or greater weir depth could not be achieved.

Gate 64 was operating during each inspection in 2005. The gate depths at the A-Branch entrance (Gate 64) ranged from 5.5 ft to 8.6 ft, with head differentials through the season ranging from 1.2 ft to 2.4 ft. Gate depths and head differentials were operated near acceptable elevations, 8.0 ft or > or else on sill during the fishway inspection season. Gate 64 usually operates satisfactorily, i.e., within acceptable criteria range while the South end of the powerhouse collection system at Gate 2 can be on the edge of operating within criteria. During the September inspection, tailwater elevation was very low and Gate 64 was submerged only 5.5 ft.

Water velocity along the powerhouse collection channel ranged from near 1.0 fps at the north end of the channel to 2.7 fps at the south end of the channel. The velocity meter at the north end of the channel is located where the slowest water velocities occur in the channel.

South Spillway or B-branch Fishway and the **North Spillway or Cascades Island Fishway** are 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. 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 spillbay (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.

During 2005, the **B-Branch entrances** and the **Cascades Island entrances** were operated continuously throughout the fish passage season. Computer readings with set points and elevations of the tailwater and channel levels were available for part of the season due to problems with sensors, etc., and when in manual control, we were unable to obtain immediate comparison of staff gauge and the computer elevation readings. Lacking suitable locations to measure tailwater with staff gauges, the computer reading normally allows the inspector a better opportunity to obtain an accurate tailwater elevation at both the B-Branch and Cascades Island entrances. For the 2005 inspections, head differentials for the **B-branch** ranged from 0.6 to 2.1 ft with 4-inspections having head differentials less than 1.0 ft. The **Cascades Island** fishway reported head differentials that ranged from 1.1 ft to 2.3 ft during the season with all readings having head differentials that exceeded the minimum 1.0 ft and 5 of 8 inspections at or above the target of 1.5 ft. The Cascades Island fishway entrances were operated on "auto" for most of the 2005 season while the B-Branch fishway was operated on Manual mode for the season. Cascades Island fishway does not have a tailwater staff gauge while the B-Branch staff gauge in the tailwater may be unreadable or difficult to read when spill levels were at higher levels. If the computer control system is operating correctly, the inspector can compare elevations where needed and especially critical is the Cascades Island tailwater reading that must be obtained from the computer since there is no staff gauge to read. Overall, the Cascades Island fishway appeared to operate satisfactorily for the season with the B-Branch fishway operating outside the desired criteria due mainly to lack of automated control system this year.

Fish Ladder: Depth of water measured over the Bradford Island fish ladder weirs ranged from 0.7 to 1.3 ft. The respective readings normally were in the proper range to achieve about 1.0 ft and 1.3 ft of water down the individual A- and B-branch fish ladders. During the October inspection, the low reading of 0.7 ft resulted in low readings for the year at the A-Branch (also 0.7 ft) and the B-Branch (0.8 ft). The depth of water measured at A- Branch ranged from 0.7 ft to 1.4 ft during the year, normally within satisfactory range. The depth of water measured at the B-Branch ranged from 0.8 ft to 1.2 ft and readings were usually within satisfactory range. At the Cascades Island fish ladder, water depth over the weirs ranged from 0.9 ft to 1.3 ft; all readings were within normal range through the inspection season. The fish ladder exit at Bradford Island was reported with some level of debris during two of the inspections this year.

Table 1. Pertinent Data for Fish Facility Inspections in 2005 at BONNEVILLE DAM.

<u>CRITERIA ITEMS</u>	<u>DATE OF INSPECTION</u>								
	<u>24-Mar</u>	<u>22-Apr</u>	<u>18-May</u>	<u>29-Jun</u>	<u>22-Jul</u>	<u>31-Aug</u>	<u>22-Sep</u>	<u>13-Oct</u>	
<u>Bradford Island Fishway</u>									
<u>Bradford Island Entrances</u>									
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	2.2	1.9	2.4	1.3	1.2	1.9	1.6	1.9
Depth over Gate 64/65	ft	8.1	8.6	8.4	8.4	8.3	8.3	5.5	7.9
Head at South ph entrance	ft	1.5	0.9	1.9	0.7	0.7	0.8	0.3	1.0
Depth over Gate 1/2	ft	9.8	10.4	12.5	9.4	9.6	8.2	5.6	7.2
Channel Velocity	fps	~0.8	1-2.4	1.1-2.5	1.2-2.6	1-2.3	1-2.7	1-2.6	0.7-2.7
Depth- Bradford Is. ladder weirs	ft	1.1	1.0	1.2	1.3	1.2	1.1	1.0	0.7
Depth - A-Branch ladder weirs	ft	1.2	1.2	1.4	1.4	1.3	1.2	1.1	0.7
Exit clean (Yes or No)		yes	no	yes	yes	yes	yes	no	yes
<u>B-Branch Entrance</u>									
Head at B Branch entrance	ft	0.9	0.6	0.6	1.5	0.6	1.7	2.0	2.1
Staff gages clean		yes	yes	yes	yes	yes	yes	yes	yes
Depth over ladder weir	ft	1.0	1.0	1.2	1.2	1.2	1.1	0.9	0.8
<u>Cascades Island Entrance</u>									
Head at main entrance	ft	1.5	1.1	1.4	2.0	1.2	1.6-2	1.9	2.3
Staff gages clean		yes	na	yes	yes	yes	yes	yes	yes
Depth over ladder weir	ft	1.2	1.2	0.9	1.3	1.3	1.1	1.1	1.1
<u>Washington Shore Fishway</u>									
<u>WA Shore Entrance:</u>									
Depth over entrance weir (Criteria = 13.0 ft or >)									
NUE	ft	11.6	14.5	13.8	14.1	14.2	10.2	~8.0	9.0
NDE	ft	11.6	13.7	13.8	14.4	14.2	9.7	~8.0	9.0
SUE	ft	11.6	14.6	13.2	14.0	14.2	9.8	8.1	9.0
SDE	ft	11.6	12.1	12.7	13.6	13.7	9.7	8.0	9.0
Head at entrance (Criteria = 1.0-2.0 ft)									
NUE	ft	2.4	2.1	2.2	1.6	1.6	1.8	1.5-2	2.0
NDE	ft	1.9	1.9	2.2	1.1	1.3	1.3	1.5-2	2.0
SUE	ft	1.5	1.4	1.8	1.0	1.1	1.2	~1.5	1.5
SDE	ft	1.3	0.8	1.5	0.9	1.0	1.3	~1.5	1.5
Depth over ladder weir (67)	ft	1.0	1.0	1.2	1.1	1.0	1.0	1.1	1.1
Channel Velocity (Elect. Meter)		OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS
Ladder exit clean		yes	yes	yes	no	yes	yes	yes	yes
Staff gages clean		yes	yes	yes	yes	yes	yes	no	no
Comment # (if applicable)			1		2	3		4	5

Comments:

1. The auto-control for the B-Branch ladder was inoperable resulting in Out-of-criteria readings. The Readings at the New ph entrances also varied considerably between the on-site and FSC board readings for elevations.
2. Sticks were present in the turning vanes above WA shore count window.
3. The B-branch h. differential too low (only 0.6') and requires better automated control for system. The SA-24 board should be repaired (lights on north diffusers inoperable). PSMFC reported periodic flooding of the juvenile fish separator.
4. Staff gauges at ph2 were almost impossible to read; BI exit had ~ 1+ ft of water pouring over the rack and required cleaning; the chaingate at old ph appeared out of proper sequence.
5. **The COE should come up with a method or means to clean the bottom 6-inches of the fish counting windows. Both were very dirty and made it difficult for the fish counter to identify fish that were 1. Smaller (jacks or small steelhead) or 2. Were swimming on the bottom of the count board.**

Powerhouse 2 Fishway

Fish turbines F1 and F2 supply about 5,000 cfs of water to the four main entrances and 12 orifice gates along the powerhouse collection channel. Both Fish turbines operated satisfactorily throughout the fish migration season and remained in service until winter maintenance began. One special criterion in the FPP states that the fish turbines can be shut down in the evenings (midnight to 3 a.m.) to float debris off the trashracks and reduce the head differential (keep less than 1.0 ft of head) across the racks. This was done on an as needed basis. In 2006 and future years, the project should have a trash rack raking system that will allow the Project to remove trash and debris without having to shut down the fish turbines.

This was the second year of operation for the corner collector at the WA shore of the new powerhouse. The system was operated successfully from spring season through August 31 to improve collection and passage of juvenile fish at the project. The outfall from the flume is located about 1-mile below the project and appears to have no effect on adult fish approaching the project.

Head differentials measured at the main entrances, North Upstream, North Downstream, South Upstream, and South Downstream ranged between 1.1 ft and 2.4 ft at the North entrance gates with the South entrance gates reporting head between 0.8 ft and 1.8 ft. Two of the readings at the South shore were less than the 1.0 ft minimum, with the remainder greater than 1.0 ft. For the season, the head differentials averaged 1.9, 1.65, 1.38, and 1.23 at the respective NUE, NDE, SUE, and SDE. Gate depths ranged between 8.0 ft and 14.6 ft for the season when both fish turbines were operating. The lower readings of 8.0 ft gate depth occurred when the tailwater elevations were near 9.0 ft. Sill elevation is 1.0 ft so that resulted in the low gate depths for the September inspection. As in previous years, the on-site staff and mechanical readings varied somewhat from the Panel readings on most inspections. Again, the inspector normally used the site readings unless staff gauges were unreadable during the inspection.

Along the powerhouse collection channel, all floating orifice gates operated satisfactorily throughout the season. None were submerged such that water was flowing over the top of the orifice gates. In the previous year, modifications were completed on the orifice gates that would allow them to be closed off should one of the fish turbines fail. This modification has greatly improved the fishway's operation when a fish turbine has failed.

The velocity meter was relocated to the south end of the WA shore powerhouse collection channel but was not installed properly and did not work for the entire season.

Fish Ladder: The fish ladder exit and the serpentine section of the WA fish ladder was reported clear of debris on most inspections during 2005 with some sticks in the turning vanes above the PIT detectors. Water depth measured over the WA fish ladder weirs was 1.0-1.2 ft at Weir 67 and was within the required range throughout the fish passage season.

Overall, fish passage at Bonneville Dam during 2005:

- Tailwater elevations were high enough until early July to allow operation of the Old and New Powerhouse fishway entrances at near normal submergence. When tailwater elevations were reduced, the project normally maintained head differentials at 1.0 ft or greater to maximize water through this condition.
- Sea lions in the immediate tailwater of dam pose serious problems for the adult chinook and lamprey that search for the main entrance gates or openings to pass the project. Mortality or injury from these marine mammals remained a problem in 2005; a program to discourage sea lions from preying on salmon was initiated with some limited success.

- Adult fish passage at Bonneville Dam in 2005 should have been satisfactory as equipment and adult facilities were operated at near criteria levels throughout most of the year with few if any problems at the Bradford Island and WA shore fishways.

Areas that still require improvement are:

- **The Cascades Island and B-Branch fishway computers and related control sensors were not fully functional in 2005 with the B-Branch fishway operated in Manual control for most of the fish passage season.**
- The project should modify its fishway control panel at ph2 and assure that the controlling system is calibrated with the on-site readings as well as in the Control Room of the dam. This comment is similar to the preceding season. We record differences between the elevations on most inspections.
- **There were inspections when staff gauges were unreadable; some of these gauges should be replaced during the winter maintenance season (2005/06). There is no staff gauge located in the tailwater area at the ph1 south shore and at the north spillway.**
- Keep debris from the new powerhouse fish turbine units and trashracks remained an ongoing problem at the project. Throughout 1998-2005, the fish turbines were taken off-line for about three hours per evening as needed to reduce buildup of debris on the trashracks. My understanding is that there will be a trash rack crane that can handle debris and remove it without shutting down auxiliary water flow. The new system should be installed and workable by 2006.
- How do you keep Sea lions from preying on salmon species and lamprey at the dam? The quick answer is that you don't, rather keeping the Sea lions from the fish ladders and potentially the near entrance area will help eliminate the ease of preying on these fish. In an open water body, chinook salmon and lamprey would have a much greater opportunity to escape from these predators. With Bonneville being the first dam these fish encounter and searching by the fish for the entrance gates, these species of fish are at a big disadvantage from the sea lions (See Stansell, 2005).

THE DALLES DAM

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. The spill basin is shallow with no fliplips installed to dissipate the spilled flow. One change completed prior to the 2004 fish passage season was the addition of a larger training wall near Bay 8 and a smaller extension of the North Shore Entrance to keep flows moving quickly downstream when spilling at the Project (now mainly through Bays 1-8 located on the North End of the Project). It is working satisfactorily for juvenile passage and has not appeared to affect passage of the adult fish at the North (WA) shore entrance.

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 WA shore fishway. This turbine normally supplies about 800 cfs through the diffusers to the operating entrance, usually Gate N-1.

Wayne van der Naald, Oregon Department of Fish & Wildlife (ODFW) inspector for the 2005 fish passage season, completed eight-fishway inspections beginning on March 28 and ending on October 19. 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 12.0 feet or greater on all inspections (range was 12.0 ft to 13.7 ft; average depth = 12.6 ft). Head differentials ranged from 1.1 ft to 2.1 ft and averaged 1.5 ft during the 8 inspection trips. The East fishway entrances were operating in established criteria range for gate depths (8 ft or >) with the head differentials within the designated range as well during the inspections completed in 2005. The East entrances pass the majority of the fish at the project with exception of the time frame when spill might cause a larger percentage to use the North Shore entrances.

The channel velocity was taken via a continuous recording unit at the eastern end of the powerhouse collection channel and normally visually estimated by the inspector at the western end of the channel. Water velocity in the collection channel ranged between 1.5 fps and 2.5 fps throughout the season and readings were satisfactory on all inspections during the fish passage season. A Problem area for water velocity appears to be from the Junction Pool to Unit 20 where velocity may be less than 1.0 fps. Surface velocity (estimated) increases to greater than 1.5 fps after passing Unit 20 in the channel.

The **West** fishway entrances (W-1 and W-2) were submerged 8.0 feet or greater on 7 of 8 inspections during 2005. The gate depths ranged from 7.5 ft to 9.4 ft and averaged 8.5 ft depth with head differential readings that ranged from 1.1 ft to 2.0 ft and averaged 1.5 ft through the season; gate depth readings and head differentials met the criteria at the West Entrances. When the 7.5 gate depth occurred (September inspection), the head differential was 2.0 ft, so adequate flow was met at these Entrance gates.

Flow to the **South** fishway entrances (S-1 and S-2) is via a separate channel that originates in the Junction Pool and ends near the South end of the Spill basin. This season, S-1 and S-2 were operated with gate depths that ranged from 8.1 ft to 9.5 ft and averaged 8.8 ft for the 8 inspections. Head differentials ranged between 1.3 ft and 1.5 ft with the average at 1.4 ft. All inspections showed the gate depths and head differentials operating at proper criteria at the South Entrances.

Fish Ladder: The picketed leads located at the OR fish counting station were reported clear of debris on all inspections. The depth of water over the fish ladder weirs ranged between 0.7 and 1.4 ft during the season. We believe that this was a short-term malfunction of the control system during the July inspection; all other readings were acceptable during the inspection season. The exit was reported clear of debris on all inspections as well.

North Shore Fishway Inspections

At the WA 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 2005 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 8.7 to 9.6 feet and averaged 9.2 ft for the season. Head differential at N-1 ranged from 1.7 to 2.6 ft. The WA fishway was operated close to criteria during all eight inspections in 2005; note that during the May inspection, the head differential was at 2.6 ft. Although this was greater than 2.0 ft, spill is concentrated on the WA shore and these higher entrance flows likely help draw fish to the entrances.

Table 2. Pertinent Data for Fish Facility Inspections in 2005 at THE DALLES DAM.

CRITERIA ITEMS	DATE OF INSPECTION								
	28-Mar	28-Apr	26-May	30-Jun	28-Jul	31-Aug	22-Sep	19-Oct	
SOUTH SHORE FISHWAY									
<i>East Entrance:</i>									
Depth over entrance weir									
E-1 (gate set at elev. 83.5 ft)	ft								
E-2 (crit. = 8 ft or >)	ft	12.0	12.9	12.8	12.6	13.7	12.5	12.4	12.3
E-3 (crit. = 8 ft or >)	ft	12.2	12.4	12.8	12.4	12.7	12.5	12.4	12.3
Head at main entrance (crit. = 1-2 ft)	ft	1.3	1.9	2.1	1.6	1.1	1.3	1.5	1.2
Depth over ladr. weir (crit. = 1-1.3 ft)	ft	1.2	1.2	1.3	1.4	0.7	1.2	1.2	1.2
Channel Velocity (crit. = 1.5 - 4.0 fps)	fps	2.5	1.5	~2.0	1.8-2.0	2.0	1.5-1.7	1.5-1.8	1.5-2.5
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes	yes
Selsyns/PLC operating (yes or no)		yes	yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes	yes
<i>West Entrance:</i>									
Depth over entrance weir									
W-1 (crit. = 8 ft or >)	ft	8.3	8.8	9.4	8.5	9.1	8.5	7.5	8.3
W-2 (crit. = 8 ft or >)	ft	8.3	8.8	9.4	8.5	9.1	8.5	7.5	8.1
Head at main entrance (crit. = 1-2 ft)	ft	2.0	1.4	1.3	1.4	1.4	1.1	2.0	1.3
<i>South Entrance:</i>									
Depth over entrance weir									
S-1 (Crit. = 8 ft or >)	ft	9.5	9.3	9.5	8.8	8.5	8.5	8.2	8.2
S-2 (Crit. = 8 ft or >)	ft	9.5	9.3	9.5	8.6	8.5	8.5	8.1	8.1
Head at main entrance (Crit. = 1-2 ft)	ft	1.4	1.3	1.4	1.4	1.3	1.3	1.5	1.3
NORTH SHORE FISHWAY									
<i>North Shore Entrance:</i>									
Depth over entrance weir									
N-1 (crit. = 8 ft or >)	ft	8.9	9.6	9.4	9.3	9.3	9.3	8.7	8.8
Head at main entrance (Crit. = 1-2 ft)	ft	1.8	1.4	2.6	1.8	1.7	1.7	1.8	1.7
Depth over ladr. weir (Crit. = 1-1.3 ft)	ft	1.0	1.1	1.0	1.4	0.9	1.1	1.0	1.1
Ladder exit clean		no	yes	yes	yes	yes	yes	yes	yes
Selsyns operating		yes	yes	yes	yes	yes	yes	yes	yes
Picket leads clean		no	no	yes	fair	yes	yes	yes	yes
PUD trash rack clean (yes or no)		yes	yes	no	yes	0.6'	0.5'	0.5'	yes
Spill Pattern w/i Criteria (yes or no)		n/sp	yes	yes	yes	yes	yes	n/sp	n/sp

Comment Number (if applicable)	1	2	3	4	5				
Comments									
1.	There was a small amount of debris on the exits from the fish ladders as well as some debris on n. pickets.								
2.	The trash rack at the North Ladder Exit was being repaired and was out of the water.								
3.	Differential through PUD trashrack was 0.5 ft. The electronic velocity meter was OOS and visual reading was used for estimation. The head differential at the N. fishway entrance was 2.6 ft, somewhat high.								
4.	Operating in shad mode with depth over ladder weirs at 1.3 ft; both ladders were at 1.4 ft.								
5.	It would appear that the 12' spillgate opening in bays 1 & 2 would reduce passage of fish at the WA shore. The depth of water over the OR fish ladder weirs was only 0.7' on this inspection.								

Fish Ladder: The ladder exit was reported clear of debris on 7 of 8 inspections while the PUD trashracks were reported with debris present during 4 of the 8 inspections. The picketed leads were reported clear of debris during 6 of the 8 inspections during the passage season. The depth of water recorded over the ladder weirs showed the fish ladder in proper criteria on all inspections with a range of 0.9 ft to 1.4 ft. The actual criteria range is 1.0 to 1.3 ft \pm 0.1 ft. The juvenile passage bypass system was in proper range through the season as well.

Overall, the OR and the WA fishways were operating within or near satisfactory criteria during the fish facility inspections completed in 2005 with only minor outages.

Some areas of concern or positive changes made to the Project are listed below.

- The PLC operated satisfactorily for the season and allowed better operation of entrance depths and head differentials for the season.
- The COE should assure that the PUD trashracks are cleaned on a regular basis. This cleaning should be moved to higher priority for the project. This appears an on-going problem at The Dalles.
- All cables and equipment operated without failure this season. This season's inspections were improved over previous years and may be the best recorded when related to entrance operations. With the closure of the orifice gates there is sufficient flow to meet and exceed gate depth and head differentials at the OR shore.

JOHN DAY DAM

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 fliplips into the spillbays and the addition of a screened juvenile fish bypass system. The fliplips 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, two main entrances at the north end of the powerhouse, and as of 2005 only 4 floating orifice gates along the collection channel; six orifice gates were closed prior to the 2005 season. The project can normally operate two of the three pumps to meet criteria levels of operating the main entrances as well as the floating orifice gates along the powerhouse collection channel. Six electric pumps are operable on the WA 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.

Wayne van der Naald, ODFW completed eight inspections of the fish facilities from March 28 through October 19 at the John Day project. Table 3 lists the criteria items and the inspection dates for 2005, with the text below detailing some of the results below.

South (Oregon Shore) Fishway Inspections

Gate SE-1 was operated at the South Shore Fishway throughout the season. The gate depth ranged from 7.8 to 9.4 ft and averaged 8.6 ft for the 8-inspections. The head differential ranged from 1.0 ft to 1.8 ft

and averaged 1.4 ft for the season. Overall, entrance conditions at Gate SE-1 should have provided satisfactory fish passage during the 2005 inspections conducted by ODFW. The July inspection gave site reading and panel reading for the gate depth that varied by 0.6 ft; the site reading was 7.8 ft while the panel reading was 8.4 ft. In either case, the entrance should have been near criteria.

Table 3. Pertinent Data for Fish Facility Inspections in 2005 at JOHN DAY DAM.

CRITERIA ITEMS		DATE OF INSPECTION							
		28-Mar	28-Apr	26-May	30-Jun	28-Jul	31-Aug	22-Sep	19-Oct
SOUTH SHORE FISHWAY									
South Shore Entrance:									
Depth over entrance weir									
SE-1 (Crit. = 8 ft or >)	ft	8.1	8.7	8.1	9.3	7.8	9.4	8.6	8.6
Head at SE-1 (Crit. = 1-2 ft)	ft	1.2	1.8	1.6	1.5	1.0	1.1?	1.7	1.4
Dep. over ladr. weir (Crit.=1.0 +/-0.1)									
ft [normal] & 1.3 ft shad season)	ft	1.0	1.0	1.0	1.3	1.0	0.9	0.9	1.0
Channel Veloc (Crit. = 1.5 - 4.0 fps)	fps	1.5	1.0	1.8	1.7	1.6	1.7	1.4	1.7
Ladder exit clean (Yes or No)		yes	yes	yes	yes	yes	yes	yes	yes
Staff gages clean (Yes or No)		yes	yes	yes	yes	yes	no	yes	yes
Picket Leads Clean (Yes or No)		yes	no	yes	yes	yes	yes	yes	yes
Pumps operating		3	3	3	3	3	3	3	3
Rpm for pumps		56-60	56-58	53-58	52-58	49-56	58.0	56-57	56-59
North Powerhouse Entrance:									
Depth over entrance weir									
NE-1 (Crit. = 8 ft or >)	ft	9.5	8.6	9.5	8.4	8.4	9.1	8.9	9.4
NE-2 (Crit. = 8 ft or >)	ft	9.5	8.6	9.5	8.4	8.9	9.2	8.9	9.4
Head at NE-1&2 (Crit. = 1-2 ft)	ft	1.3	1.8	1.5	1.4	1.5	1.2	1.6	1.4
Staff gages clean (yes or no)		yes	no	yes	no	yes	yes	yes	yes
NORTH SHORE FISHWAY									
North Shore Entrance:									
Depth over entrance weir									
N-1 (Crit. = 8 ft or >)	ft	9.1	7.7	9.9	7.2	8.5	9.2	8.1	8.5
Head at N-1(Crit. = 1-2 ft) Targ - 1.5'	ft	1.5	1.3	1.3	1.0	1.5	0.8	2.0	1.6
Depth over Idr weir (Crit.=1.0 +/-0.1)	ft	1.0	1.1	1.0	1.3	1.1	1.0	1.0	0.9
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes	yes
Staff gages clean		yes	yes	yes	no	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	yes	yes	yes	yes
Pumps Operating		3	3	3	2	3	3	3	3
Comment number (if applicable)					1	2	3	4	

Comments:

1. Tailwater staff gages at NE-1&2 and N-1 and N-1 water surface were not clean; elevations estimated.
2. Water velocity through the channel has been on the slower side of the curve this year.
3. According to the Project Biologist, the south turbine pumps were set at 58 rpm to increase flow of water to the fishway as they were having problems maintaining enough head differential at the South/North ends of the powerhouse. In addition, the project had pulled the staff gauge in the entrance at the south shore. I used the elevation at the north end of the powerhouse to obtain the s shore elevation for the channel. The calibration of the N LED was completed by project.
4. The water velocity through the powerhouse collection channel has been minimal this season: 1-1.8 fps. I called the Project biologist to assess what changes were made to reduce this velocity. They may be associated with closing 6 orifice gates along the channel; changing diffuser settings; and pump operation.

The **North powerhouse entrance gates**, NE-1 and NE-2, operated at head differentials within the following range: 1.2 to 1.8 ft with gate depths that ranged from 8.4 ft to 9.5 ft. Gate depth and head differential were within proper criteria range for the 2005 season. Part of the increase in gate depth and head differential may have been due to the closure of the 6-orifice gates along the powerhouse collection channel (the middle 6 gates were closed leaving the end two gates open). Attraction flows from these gates should have provided satisfactory conditions for adult fish approaching those entrance gates for the season.

Water velocity along the powerhouse collection channel ranged from 1.0 to 1.8 fps as measured at the velocity meter installed near the south end of the channel. The electronic velocity meter appeared to work satisfactorily during the 2005 fish passage season. Potentially velocity down the collection channel was somewhat reduced from previous years, and this may have resulted from the change in diffuser operation and orifice gate closure that occurred prior to the 2005 season.

Fish Ladder: The exit from the fish ladder was clear of debris through the season, and staff gages were reported as clean with exception of the August inspection. The picketed leads were reported clear of debris with exception of the April inspection. The depth of water measured over the ladder weirs ranged between 0.9 ft and 1.3 ft for the season and was within the criteria range of 1.0 ft \pm 0.1 ft during the non-shad period and 1.3 ft \pm 0.1 ft during the shad passage season.

North Shore Fishway Inspections

The criteria settings for the North shore fishway entrances were changed prior to the 2000 season. Only one entrance gate, N-2, is now operated. Gate N-2 should be submerged 8.0 ft or more below tailwater, with the head differential maintained between 1.0 ft and 2.0 ft (targeted 1.5 ft).

The minimum 8.0-ft gate depth criterion was met on 6 of 8 inspections; the depths ranged from 7.2 ft to 9.9 ft. Head differentials ranged between 0.8 ft and 2.0 ft. The LED readings were checked against the staff readings and showed the LED readings required calibration. On one inspection, the staff gages were unreadable and an estimate was made for channel and tailwater elevations. On that occasion, the LED and staff readings varied by about 1-ft. The North Shore LED was calibrated in late August. **For the season, the gate depth and head differential readings were normally close to meeting criteria but did fall short on a couple of inspections.**

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 2005 season. Depth of water over the fish ladder weirs ranged from 0.9 ft to 1.3 ft, all satisfactory readings.

Overall, the main entrances at the Oregon and the Washington fishways were operated very close to criteria levels during the 2005 fish passage season. Areas of concern based on observations from the inspections are listed below.

- **The passage of adult fish through the North shore counting station has been and continues to be a problem, with a high percentage of fish falling back through the counting window (especially steelhead passing during late summer and fall run). A modification of the counting station or a change in the upstream exit section weirs is required.**
- Calibration of the FSC Board and the LED Readout should be completed prior to each passage season and maintained through the year. On two inspections, we noted a fairly high difference between the FSC board and the staff gauge reading.

- Diffuser settings should be verified prior to the season to account for any changes that might affect flows through the collection channel, example is the closure of six orifice gates prior to 2005 season.
- On a couple of occasions, the gate depth and head differential fell short of criteria at the North Shore fishway.

MCNARY DAM (photographs on page 51)

McNary hydroelectric project is a COE operated dam completed in 1953. Fourteen main turbine units and 22 spillbays are incorporated in this dam. Until 2002, the two end spillbays per side were split-leaf gates and did not have flippers installed below them; this design was changed to a 1-piece gate with flippers now present to reduce dissolved gases below the project. The OR and WA shore fish ladders incorporate full overflow weirs and have submerged orifices in each weir. The fish ladders carry at least double the Q as the newer fish ladders built at other COE dams. On the OR fishway, three large electric fish pumps pulling water from the tailrace of the project plus about 1,000 cfs of gravity flow from the forebay, 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 WA fishway was changed from the pressurized system to a non pressurized one 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 400 cfs of water (bleed-off from the bypass flow is shunted to the north end of the powerhouse and enters the fishway via a screened area at the NPEs.

Larry Swenson, NMFS, inspected the fish facilities at McNary Dam on eight separate occasions between March 30 and October 25, 2005. Results of the inspections are discussed below with Table 4 listing data collected from the inspections. A copy of the computer-generated Status Report of the fishway readings was normally compared with the field data taken at the main entrances. The site readings and the computer-generated report of the fishway readings normally should not vary more than 0.3 ft; if readings varied and were greater, the Project was asked to check calibration.

The project can meet criteria standards operating with two of the three pumps at the OR fishway. When three pumps operate, the angle open normally ranges between 20-24° while the blade angle is increased up to 28 to 32° when two pumps operate. In addition to the pumped and gravity-flow water, about 400 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. Figures : **Place photo of Screens.**

South Shore (Oregon) Fishway Inspections

During 2005, the Project operated with 2 fish pumps for the entire fish passage season as Pump 1 was out of service. As such there was no backup pump available should one fail during the operating year.

The main entrances at the South shore (SFEW-1 & 2) were reported with gate depths that ranged between 9.1 ft and 9.5 ft for the year. All were satisfactory readings. The head differential ranged from 1.0 to 1.8 ft and as such was within acceptable criteria of 1.0 to 2.0 ft. No out of criteria conditions were recorded during the 8-inspections at the South Entrances.

The North powerhouse entrances (NFEW-1 & 2) were operated within the required criteria as gate depths ranged from 8.9 ft to 9.4 ft and head differentials ranged from 1.0 ft to 1.5 ft. The North powerhouse entrances should have provided satisfactory flows during our inspections. With two fish pumps available,

the depth and head differential readings were normally within the criteria range for the South and North Powerhouse entrance gates.

Table 4. Pertinent Data for Fish Facility Inspections in 2005 at MCNARY DAM.

<u>CRITERIA ITEMS</u>	<u>DATE OF INSPECTION</u>								
	<u>30-Mar</u>	<u>13-Apr</u>	<u>10-May</u>	<u>23-Jun</u>	<u>12-Jul</u>	<u>8-Aug</u>	<u>27-Sep</u>	<u>26-Oct</u>	
SOUTH SHORE FISHWAY									
South Shore Entrance:									
Depth over entrance weir (Criteria: 9 ft or > gate depth at SFEW-1,2 & NFEW-1,2)									
SFEW-1	ft	9.3	9.2	9.3	9.2	9.1	9.3	9.4	9.6
SFEW-2	ft	9.3	9.2	9.4	9.2	9.1	9.3	9.5	9.6
Head at SFEW-1,2 (Crit.= 1-2 ft)	ft	1.1	1.3	1.0	1.0	1.8	1.2	1.3	1.2
Dep. over ladr. weir (Crit.= 1-1.3')	ft	1.0	1.0	1.0	1.3	1.4	1.1	1.1	1.0
Channel velocity (Crit.= 1.5-4.0 fps)	fps	1.8-3.0	1.5-3.5	2.0-3.5	1.5-3.3	1.2-3.9	1.2-2.9	2.3-3.5	1.0-3.1
Ladder exit clean		yes	yes	no	yes	no	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	yes	yes	yes	yes
Orifice Gates Operating - 12		ok	ok	ok	ok	ok	ok	ok	ok
Pumps Operating & degrees open		2	2	2	2	2	2	2	2
		29/30 ^o	unk	29-30 ^o	30	30	30	32/30	30
North Powerhouse Entrance:									
Depth over entrance weir									
NFEW-2	ft	9.1	9.1	9.2	9.4	9.0	9.1	8.9	9.4
NFEW-3	ft	9.1	9.1	9.2	9.3	9.0	9.1	8.9	9.4
Head at NFEW-2&3 (Crit. = 1-2 ft)	ft	1.5	1.2	1.4	1.0	1.1	1.0	1.1	1.0
WA.SHORE FISHWAY									
North Shore Entrance:									
Depth over entrance weir									
WFE-2 (Crit. = 8 ft or >)	ft	10.7	9.6	9.0	9.7	9.6	12.1	9.6	9.0
WFE-3 (Crit. = 8 ft or >)	ft	10.7	9.6	9.0	9.7	9.6	10.9	9.6	9.0
Head at WFE-2&3 (Crit. = 1-2 ft)	ft	1.2	1.5	1.5	1.5	1.6	1.1	1.7	1.6
Dep. over ladr. weir (Crit. = 1-1.3 ft)	ft	1.0	1.2	1.0	1.3	1.3	1.3	1.1	1.1
Ladder exit clean		no	yes	no	no	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	no	yes	yes	yes	yes
Comment number (if applicable)				1	2	3	4		

Comments:

- Both exits from the ladders had excess grasses and weeds that required cleaning. Seven FOGs overtopped with water.
- Two orifices open in 2B - Brad Eby indicated potential block in one orifice; lots of fish observed in 5c, Eby notified.
- Calibration required for South Entrance (channel elev) as it appeared to be ~0.5 ft off. Inspectors suggested that the tilting weirs (d/str ones) should be adjusted to reduce " head" at the counting station and through picket leads. In addition, OR shore counting window has been pitted by welding sparks.
- There were 3 Western Grebes in the downstream end of the juvenile collection channel. All juvenile orifice knife-gate valves were cycled and air purged during this inspection.

Water velocities were recorded via an electronic meter installed downstream of the junction pool and upstream of ph turbine unit #1. Surface velocity was estimated at the northern end of the channel by timing a wood chip or floating object a given distance along the channel. Basically, water velocity was between 1.2 fps and 2.3 fps at the south end of the collection channel and increased to 2.9 to 3.5 fps at the northern end of the channel. These readings should have allowed for fairly good passage through the collection channel for the 2005 fish passage season.

Fish Ladder: The picketed leads located at the OR fish ladder count station were reported clear of debris this season while the exit from the fish ladder was reported with some amount of debris on 2 of the 8 inspections. The depth of water reported over the OR fish ladder weirs ranged from 1.0 ft to 1.4 ft and was higher than desired on the July inspection. PIT tag detection antennas are located on the upstream exit and downstream entrance of the counting window as well as in the orifice sections of weirs in the lower end of the fish ladder. Both sets of PIT tag antennas worked satisfactorily throughout the fish passage season.

North Shore (Washington) Fishway Inspections

The WA shore fishway entrances, WFE-2 and WFE-3 were submerged from 9.0 ft to 12.1 ft (Average depth = 10 ft) with head differentials at the entrances ranging from 1.2 ft to 1.7 ft (Average head = 1.4 ft). The gate depths and head differentials were operated within acceptable criteria range throughout the season, i.e., greater than 8.0 ft gate depth with head differential from 1.0 ft to 2.0 ft. The computer-generated report gave fairly close correlation with the on-site readings.

Fish Ladder: The fishway exit was reported with some debris (tumbleweeds or other grasses) on four inspections. The picketed lead section located at the counting station in the WA fish ladder was reported with excessive debris during one inspection this season. The depth of water recorded over the ladder weirs ranged from 1.0 ft to 1.3 ft during the inspection season. The new modifications to the tilting weirs and related PLCs continued to operate satisfactory this season. The project normally cleared the picketed leads on Monday and Thursday of each week to keep the debris from building on leads. Similar to the Oregon ladder, PIT detectors were placed on a series of submerged orifices in the lower section of the WA fish ladder; no PIT detectors were placed at the counting station, but will be installed during this upcoming winter maintenance season and should be operable by the March 2006 time frame.

Overall, the Oregon and Washington fishways operated within or close to criteria on all inspection dates for the 2005 fish passage season. Some problem areas that exist or should be investigated further are:

- Two fish pumps operated successfully during the 2005 season with no major outages. The project should make every effort to complete rebuild of the 3rd fish pump so that a spare pump is available should one fail during the year.
- The modifications made to the tilting weirs at the OR fish ladder still had some bugs relating to initial startup of the new system.
- On one inspection, 7 floating orifice gates were overtopped with water; normally this means that the wheels or rails are in bad shape and require maintenance work.
- Debris or grasses can be a problem at the fish counting picketed leads at each fish ladder.

Inspections of the **juvenile fish passage system** showed some continued problem areas that were present during the inspection season.

- Western Grebes were reported in the juvenile bypass channel in 2005, similar to previous years. In 2005, there was no potential for lethal take by the Department of Agriculture and this resulted in several Grebes in the channel at one time. This increases predation of juvenile salmonids within an area where agencies and tribes are trying to protect and enhance passage conditions at dams. Every effort should be made to keep these birds away from the gatewells and bypass

channel where possible, as they are very effective predators on the juvenile fish in these enclosed areas.

- The District should continue development of a plan to reduce amounts of floating grasses that can enter into the juvenile bypass systems, especially when turbine units are operated at the higher Mw settings.

ICE HARBOR DAM (*photographs on page 52*)

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 recent change at the project has been the addition of flippers in the spillbays and a training wall (completed in 1999) to “straighten” flow on the south end of the spillway. A Removable Spillway Weir is now in place at the project is operated throughout most of the fish passage season, and appeared to operate satisfactory in passing juvenile fish at the project. This required development of new spill patterns for the project.

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 8 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. Three 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.

Steve Richards, WDFW completed seven adult fishway inspections at Ice Harbor Dam during the 2005 fish passage season. Details of the inspections are found in Table 5 and a summary of the inspections reported in the section below. A fishway inspection is completed as follows: the inspector obtains hydraulic information including river Q, spill patterns, and turbine operation from the control room as well as a computer printout of the elevations of the entrance gates, corresponding head differentials, etc. Comparison of the on-site readings and the computer system is made to check for correlation and for potential calibration of the two systems if required. Readings should be fairly close between the computer and the on-site elevations, especially during lower flows when tailwater elevations are more stable and spill levels are reduced.

South Shore Fishway Inspections

Eight fish pumps were operating on all 7 inspections completed this season, maximum capacity. 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 5.6 ft to 7.3 ft during the season. Gate SFEW-1 was recorded on sill only during the final inspection this season. Head differential measured at SFEW-1 ranged from 1.2 ft to 2.0 ft for the season with the head differentials between 1.5 and 2.0 ft on 6 of the 7 inspections. **Not once during the inspections did the Project meet actual gate depth criteria of 8.0 ft or greater. Head differential was sufficient to have allowed for additional gate depth during all inspection dates where deficiencies were noted.**

The **North powerhouse entrance gate (NFE-2)** was operating with weir depths that ranged between 6.2 ft and 15.3 ft for the season. Head differential ranged from 1.1 ft to 1.6 ft. The gate was on sill during the five of seven inspection dates this season so no greater depth could be attained during those inspections.

Head differential was within proper criteria on each inspection, i.e., between 1.0 and 2.0 ft. Gate depth was less than the required 8.0 ft on most inspections, but on only one inspection could the gate be lowered to obtain a greater depth.

Seven floating orifice gates operated satisfactorily along the powerhouse collection channel throughout the fish passage season. The water velocity in the collection channel was reported from >2.0 to 3.1 fps during the season; all reports were within the desired range.

Fish Ladder: The exit from the fish ladder was reported clear of debris on all inspections as were the picketed leads located at the counting station. Depth of water over the ladder weirs was reported at 1.1 ft for the seven inspections.

The gatewells (juvenile fish bypass system) across the powerhouse forebay deck were clear of debris during the 2005 inspection season.

North Shore Fishway Inspections

The North Shore Fishway has been a challenge to accurately estimate gate depth and head differential given the fact that the staff gage located in the tailwater has been in disrepair for several years. In addition, the LED channel reading is about 1-ft less than the staff gauge elevation taken in the channel. Prior to the 2003 fish passage season, the North Shore fish pumps were refurbished to improve reliability, and also to pump more water; however, it does not appear from the inspections that this goal has been achieved.

Gate NEW-1 was submerged 8.0 ft or more in depth on one of seven inspections, similar to 2004. Gate depths ranged from 4.3 ft to 10.3 ft. Head differentials were reported in the following range: 1.0 ft to 2.5 ft. The Gate was not on sill during the inspections and it appeared that gate depths could have been increased during most inspections. During the initial inspection, only 1 pump was operating at the North shore and that reduced flow from the entrance.

The North Shore LED readings were consistently less than the elevation readings taken from the channel staff gage. The differences ranged from 0.3 ft to 1.3 ft during the season and further verified the readings from the previous year's inspections. The location of the channel staff gage and the channel sensor should be near or at the same site in the channel to obtain similar readings. The sensor appears to monitor the channel elevation at a location where the channel water velocity was increasing and "velocity head" resulted in a lower elevation than from the more static head reading taken from the staff gage.

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 from 1.0 ft to 1.1 ft for the inspections.

Table 5. Pertinent Data for Fish Facility Inspections in 2005 at ICE HARBOR DAM.

CRITERIA ITEMS		DATE OF INSPECTION						
		26-Apr	17-May	27-Jun	19-Jul	26-Aug	4-Oct	24-Oct
SOUTH SHORE FISHWAY								
South Shore Entrance:								
Depth over entrance weir								
SFEW-1 (Crit. = 8 ft or >)	ft	6.9	5.6	7.3	6.2	6.5	7.1	6.2
Head at SFEW-1 (Criteria = 1-2 ft)	ft	1.6	1.2	1.5	1.7	1.6	1.9	2.0
Gate on Sill (yes or no)		no	no	no	no	no	no	yes
Dep. over ladr. weir (Cr. = 1-1.3 ft)	ft	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Channel velocity (Crit. = 1.5-4 fps)	fps	>2.0	>2.5	>2.0	>3.0	>3.0	>2.0	3.1
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Pumps Operating (8 available)		8	8	8	8	8	8	8
North Powerhouse Entrance:								
Depth over entrance weir								
NFE-2 (Criteria = 8 ft or >)	ft	10.7	15.3	7.2*	6.4	6.9	8.1	6.2
Head at NFE-2 (Criteria = 1-2 ft)	ft	1.0	1.1	1.5	1.4	1.4	1.4	1.6
Gate on Sill (yes or no)		no	yes	no	yes	yes	yes	yes
Staff gages clean	ft	yes	yes	yes	yes	yes	yes	yes
NORTH SHORE FISHWAY								
North Shore Entrance:								
Depth over entrance weir								
NEW-1 (Criteria = 8 ft or >)	ft	6.4/5.3	10.3	5.1	4.3	5.0	6.4	5.4
Head at NEW-1 (Criteria = 1-2 ft)	ft	0.8/1.7	1.0	2.5	2.3	2.3	1.8	2.1
Gate on Sill (yes or no)		no	no	no	no	no	no	no
Dep. over ladr. weir (Crit. = 1-1.3 ft)	ft	1.1	1.1	1.1	1.1	1.1	1.0	1.1
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Staff gages clean		yes	yes	*	yes	*	yes	yes
Picket leads clean		yes	yes	yes	yes	yes	yes	yes
Pumps Operating (3 available)		1	2	2	2	2	2	2
Comment Number (if applicable)		1	2	*	3	*		4

Comments:

1. N shore tailwater elevation was about 1.0 ft different between staff gauge and LED.
2. Same comment as #1; Gate SSE way below criteria depth of 8.0 ft.
*Tailwater staff gauge was out of water; Meter on the NPE gate winch was being repaired and reading was taken from the computer printout for this inspection.
3. The N shore entrance gate was way out of adjustment with relation to head differential (2.3') and gate depth - 4.3'.
* Same comment as * above on North Shore.
4. An oil sheen was observed in the tailrace below Unit 3south. The project operators were shown the oil slick for the COEs to take appropriate action.

Overall, fish facility inspections completed during 2005 were lacking on some of the following items.

- We noted discrepancies between the computer printout and the on-site readings and believe that there needs to be better correlation between the two readings. The staff gauge on the North shore was not usable all season. Basically, the project should provide good staff gauges or an area to take a sensor reading that will accurately portray the elevations at a similar point in the channel.
- It appeared from the inspection reports that sufficient water was available to meet criteria, but that the control system was not functioning properly or else the set points were not allowing gate depth to be within the proper range. The Project should improve the control system for the fishways and make it workable prior to the fish passage season. The 2005 season appeared to have very similar results as in 1997-2004 when the system was not balanced properly between head differential and gate depth.
- During the October inspection, we reported/showed oil sheen in the tailwater near 3c South to the Project operators at time of inspection. They began investigating the source of the problem.
- **One of the major problems, potentially visual rather than fish passage is the huge side eddy that forms immediately downstream from the NPEs when spill at some level is present. It would appear to obliterate passage through that entrance. If that is the case, then more emphasis should be placed on assuring that the SFEWs be given higher priority for being in criteria (weir depths were lacking throughout the 2005 season). Secondly, if the Project cannot maintain criteria on the South fishway then it should shut down the floating orifice gates and use that water to improve passage conditions at the South entrance.**

LOWER MONUMENTAL DAM

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. Fliplips were originally installed on six bays with completion of fliplips on the two end bays during winter 2002-03.

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) will remain permanently closed at this project.

The adult fish passage facilities at Lower Monumental Dam were inspected seven times by Steve Richards, WDFW during 2005. Inspections were from April 20 through October 24, with data from the inspections 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 8.6 ft during the inspections with the average depth of 8.3 ft. Head differentials ranged from 1.2 ft to 1.9 ft with the seasonal average for the 7-inspections of 1.7 ft. Total Q and velocity through those entrance gates should have provided satisfactory passage conditions for the seven inspections at the North shore entrance gates.

Table 6. Pertinent Data for Fish Facility Inspections in 2005 at LOWER MONUMENTAL DAM

CRITERIA ITEMS		DATE OF INSPECTION						
		20-Apr	17-May	27-Jun	19-Jul	24-Aug	26-Sep	24-Oct
NORTH SHORE FISHWAY								
North Shore Entrance:								
Depth over entrance weir								
NSE-1 (Criteria = 8 ft or >)	ft	8.3	8.6	8.1	8.2	8.3	8.5	8.4
NSE-2 (Criteria = 8 ft or >)	ft	8.3	8.6	8.0	8.0	8.4	8.5	8.6
Head at NSE-1 & 2 (Crit. = 1-2 ft)	ft	1.6	1.2	1.8	1.9	1.9	1.9	1.7
Gate on Sill (yes or no)		no	no	no	no	no	no	no
Dep. over ladr. weir (Cr. = 1-1.3 ft)	ft	1.0	1.1	1.1	1.1	1.0	1.1	1.1
Channel velocity (Crit. = 1.5 - 4 fps)	fps	>2.0	1.8	>2.0	>2.5	>2.0	>2.0	>2.8
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	no	yes
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	no	yes	yes
South Powerhouse Entrance:								
Depth over entrance weir								
SPE-1 (Criteria = 8 ft or >)	ft	7.2	8.7	6.5	6.0	6.6	6.9	7.5
SPE-2 (Criteria = 8 ft or >)	ft	7.3	8.7	6.5	6.0	6.6	7.0	7.6
Head at SPE-1 & 2 (Crit. = 1-2 ft)	ft	1.0	0.9	1.3	1.5	1.4	1.5	1.4
Gate on Sill (Yes or No)		yes	no	yes	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	8.0	10.8	6.8	6.5	8.1	8.0	8.4
SSE-2 (permanent) 6-feet	ft	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Head at SSE-1 & 2 (Crit. = 1-2 ft)	ft	1.4	0.9	1.3	1.5	2.1	1.5	1.2
Gate on Sill (yes or no)		no	yes	yes	yes	yes	yes	yes
Dep. over ladr. weir (Crit. = 1-1.3')	ft	1.1	1.1	1.1	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	yes	yes	yes
Pump speed	rpm	72-74	73	72-73	74-75	75-76	75	74
# of Pumps Operating (3 available)		2	3	3	3	3	3	3
Comment Number (if applicable)		1		2	3	4	5	

Comments:

1. Two pump operation during inspection.
2. The shade covers for both count stations required that they be re-installed over the count slots; the bubblers located at the north and south shore exits were not operating.
3. The southshore backboard and count slot needs cleaning.
4. The South Shore collection channel elevation gauge and the digital tailwater gauge appeared to be out of service or not reading correctly. There was a heavy build up of vegetation of the down stream picketed lead.
5. There was about 400 sq. ft of woody debris floating above the north shore ladder exit.

An electronic velocity meter located in the northern end of the collection channel gave water velocity readings that ranged from about 1.8-2.8 fps and were within the criteria bounds for water velocity in the channel.

The South powerhouse entrance gates, SPE-1 and SPE-2, were operated with gate depths ranging from 6.0 ft to 8.7 ft. The SPEs were on sill during all but one of the inspections, so no further depth could be attained. Head differentials recorded at these Gates ranged from 0.9 ft to a high of 1.5 feet. The head differential readings met standard operating criteria with exception of the May inspection when 0.9 ft was recorded. On the May inspection, 8.7 ft gate depth was reported and with the 0.9 ft head differential, flow from the two entrance gates should have produced satisfactory passage conditions for adult fish.

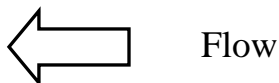
Fish Ladder: The depth of water over the North shore fish ladder weirs was 1.1 ft on 5 of 7 inspections and 1.0 ft on the remaining two. All readings were acceptable. The differentials reported at the fish ladder exit and at the picketed leads at the fish counting facility were normally clear of debris; however, on one occasion the exit had excessive debris and the picket leads were dirty and required cleaning. Normally, air from a high-pressure conduit, bubbles in near the surface of the water of the exit and this keeps debris away from the exit; **the bubbler was not operating during several of the inspections in 2005.**

Velocity measurements in the north adult fish counting slot at Lower Monumental Lock and Dam.

On 30 November 2005 Velocity measurements were taken in the north adult fish counting slot at Lower Monumental Lock and Dam. The velocity measurements were taken with a Swoffer current meter, model 2100, with the velocity averaging time set to medium. Two velocity measurements were taken at each location and then averaged. The factory recommended calibration factor of 186 was used. The calibration factor was verified in accordance with the Swoffer recommended calibration method prior to taking the velocity measurements. The measurements were taken with both the upstream and downstream picketed leads in the deployed or down position. Twelve Velocity measurements (three horizontal locations by four vertical locations) were taken in a grid pattern near the viewing window. The horizontal measurement locations were approximately: 1 inch downstream of the upstream edge of the viewing window, the center of the viewing window, and 1 inch upstream of the downstream edge of the viewing window. The vertical measurement locations were at elevations of 3 inches, one foot, two feet, and three feet from the floor of the slot. See the following diagram with the associated velocities. Measurements were taken in the middle of the approximately 18 inch wide slot.

Counting Window at North Shore Fish Ladder

	Left 1 in from edge	Center	Right 1 in. from edge
3 ft above floor	4.34	4.17	4.16
2 ft above floor	4.29	4.21	4.20
1 ft above floor	4.24	4.31	4.29
3 in above floor	3.68	3.82	3.81



This work and write-up were done by Dale Lentz, civil engineer, Hydrology Section, NWW. Also, the paddle gates were parallel to the flow.

The water velocities through the counting slot appear to fall within the normal expected velocities through counting windows at the COE projects where velocities have been recorded. Generally water velocities

will fall within the 1.5 to 5 fps range through the slots. Maintaining a good consistent flow from the upstream to downstream end of the counting window gives the adult fish good hydraulic conditions through the slot and normally less turnaround occurs in the windows when these conditions are prevalent.

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 80 cfs flow that enters from the fish ladder. 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 6.8 ft to 10.8 ft, with the gate on sill 6 of 7 inspections completed this season. The head differentials at the South entrances ranged from 0.9 ft to 1.5 ft and were within or near acceptable criteria for the season. Overall, the volume of flow and velocities should have been satisfactory at the South fishway entrance for most of the season.

Fish Ladder: The South shore exit and the picketed lead section at the fish counting station was reported clear of debris this season. The depth of water over the ladder weirs was 1.1 ft on all inspections and was within acceptable criteria.

Overall, fishways at the project were found operating within acceptable criteria for most of the 2005 inspection season with minor problems noted. The computer-controlled fishway appeared to perform very well again this season and readings from the computer were normally close to the site readings obtained by the inspector.

- We believe that using the air bubbler system at the exits from the fish ladder aids in keeping debris from entering the fish ladder and should be operated either continuously or whenever debris is present in that area.
- As RSWs or spill is changed in future years, assess what patterns are effective in adult fish passage as well as the normal juvenile fish evaluation.

LITTLE GOOSE DAM *(photographs on page 53)*

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. Only six of the eight spillbays are equipped with flippers, and at present, Spillbays 1 and 8 do not operate to pass normal spill at the project.

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.

Anne Dowdy, ODFW completed seven inspections of the Little Goose Dam fish facilities, commencing April 13 and ending October 20. Details of the inspections are given below and summarized in Table 7.

During 2005, all 3 fish pumps operated with rpm levels ranging between 71 and 75 rpm (normal operation for the pumps) with no outages during the season.

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 ft to 2.0 ft. In previous years, the Project normally operated the south shore entrances to achieve 9.0 ft or more submergence depending on the tailwater elevation. As an example, in 2004 the 7-inspections were reported with gate depths that ranged from 9.0 ft to 11.3 ft and head differentials that ranged from 1.0 ft to 1.3 ft. During the 2005 fish passage season, gate depths at the SSEs ranged from 8.1 to 8.5 ft with head differentials that ranged from 1.1 ft to 1.6 ft. In 2005, the Project opted to reduce gate depths at the South shore entrances albeit that the head differentials were greater this season on average than in previous years.

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 4.9 ft to 7.1 ft with head differentials that ranged from 1.3 to 1.8 ft. The NPE gates were on sill for five of the seven inspections in 2005. The NPE gates were submerged at 7.1 ft during the two inspection dates where the Gates were off sill. All readings were satisfactory as the Gates were on sill for 5-inspections so no further depths could be attained. With the reduced gate depths at the SSEs, higher head differentials were maintained at the NPEs for the season; however, gate depth did not increase due to the low tailwater elevations that are maintained when the Snake River system is at MOP.

The water velocity measured at the south end of the collection channel gave readings that ranged from 0.9 fps to 2.7 fps throughout the season with the lower velocities normal for the metered velocity and the higher velocity of about 2.0 fps for the surface velocity that was taken where a chunk of wood was timed through a specified distance. Visual measurement of the surface velocity in the North Shore collection channel was taken by timing a floating chunk of wood through a distance of 100 ft. The water velocity ranged from 0.9 to 2.2 fps. With reduced flow at the North Shore this year, water velocity was reduced from the preceding year.

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. To begin the season, the NSEs had cable problems and essentially both gates were inoperable; we listed about 1.8 ft gate depth with the head differential way up to 1.9 ft. The NSE-1 cables were repaired/replaced by April 27th and only this Gate was operated fully for the 2005 season. Based on information from the COE, NSE-2 was originally to be repaired near the end of May, but this did not occur during the whole season. NSE-1 was operated with submergence of 5.7 to 6.1 ft through the season with the head differential reported between 1.1 and 1.6 ft. The head differentials were satisfactory during all inspections. Relating to NSE-2, from mid-July to the end of the season, it appeared to be set near elevation 533 and most readings were approximately 4.0 ft at that entrance.

Fish Ladder: The fish ladder exit as well as the picketed lead section of the fish counting facility was clear of debris throughout the 2005 season. The depth of water over the fish ladder weirs was at 1.1 ft or 1.2 ft on the individual inspections. All readings were reported within an acceptable range of 1.0 ft to 1.3 ft.

Table 7. Pertinent Data for Fish Facility Inspections in 2005 at LITTLE GOOSE DAM.

<u>CRITERIA ITEMS</u>		<u>DATE OF INSPECTION</u>						
		<u>13-Apr</u>	<u>18-May</u>	<u>15-Jun</u>	<u>14-Jul</u>	<u>18-Aug</u>	<u>15-Sep</u>	<u>20-Oct</u>
SOUTH SHORE FISHWAY								
<i>South Shore Entrance:</i>								
<u>Depth over entrance weir</u>								
SSE-1 (Criteria = 8 ft or >)	ft	8.5	8.4	8.4	8.1	8.2	8.5	8.5
SSE-2 (Criteria = 8 ft or >)	ft	8.5	8.4	8.4	8.1	8.2	8.4	8.5
Head at SSE-1 & 2 (Criteria = 1-2 ft)	ft	1.6	1.5	1.5	1.6	1.1	1.5	1.4
Dep. over ladr. weir (Crit. = 1-1.3 ft)	ft	1.1	1.1	1.2	1.2	1.2	1.2	1.1
Channel velocity (Criteria = 1.5-4 fps)	fps	0.9-1.6	1-2.5	2.5	2.5	0.9-2.14	1.2-2.7	1.2-2.4
Channel velocity (North Shore)	fps	0.9	1.7	1.7	2.2	2.2	1.8	1.9
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		no	yes	yes	yes	yes	yes	yes
Picket leads clean (Criteria = 0.3' max)		yes	yes	yes	yes	yes	yes	yes
<i>North Powerhouse Entrance:</i>								
<u>Depth over entrance weir</u>								
NPE-1 (Criteria = 7 ft or >)	ft	7.0	7.0	6.2	5.5	5.3	7.1	7.1
NPE-2 (Criteria = 7 ft or >)	ft	7.1	7.0	6.1	5.4	4.9	7.1	7.1
Head at NPE-1 & 2 (Criteria = 1-2 ft)	ft	1.8	1.7	1.8	1.5	1.6	1.3	1.3
Gate on Sill (Yes or No)		yes	yes	yes	yes	yes	no	no
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
Pump speed	rpm	73	71-73	71-73	71-75	73	73-74	71-73
Pumps Operating (3 available)		3	3	3	3	3	3	3
<i>North Shore Entrance:</i>								
<u>Depth over entrance weir</u>								
NSE-1 (Criteria = 6 ft or >)	ft	1.8	5.9	5.9	6.1	6.0	6.0	5.7
NSE-2 (Criteria = 6 ft or >)	ft	0.0			~4.0	~4.0	10.4	~4.0
Head at NSE-1 & 2 (Criteria = 1-2 ft)	ft	1.9	1.4	1.6	1.3	1.3	1.1	1.1
Staff gages clean		yes	yes	yes	no	yes	yes	yes
Comment number (if applicable)		1	2	3	4	5	6	

Comments:

1. Basically, NSE 1 and 2 were closed for repair of cables. NSE-1 was replaced by 4/27/05. Staff gauges in the forebay and 1st exit pool were illegible so no differential was taken.
2. NSE-2 is OOS; due to be repaired near end of May. The upstream picketed lead is visibly vibrating in its slot and should be stabilized. Gatewell 3c had little flow up to gatewell surface. **Reported to COE FOR ACTION.**
3. This is the 3rd month that the North Shore Entrance was not repaired (NSE-2). The Project no longer is operating the SSE gates at 9.0 ft or greater. This could likely reduce rate of passage at Little Goose.
4. NSE-2 still not repaired; temporarily the gate was set near 4.0 ft submergence to provide additional flow through that entrance. A Chinook (adult) was found dead on the north side of the ladder walkway adjacent to the viewing room and likely jumped up and over the 4' fencing enclosing the ladder sides. An earlier mortality occurred when another adult Chinook jumped out of the ladder downstream of the counting station. The COE needs to place netting or devices to assure that fish are confined to the fish ladder.
5. Same comment as #2; NSE is still out of service and not repaired. An oil containment boom was deployed in the tailrace to minimize the effect of a leak in gatewell 4C.
6. MOP operations completed for year; higher tailwater elevations with NPEs off sill.

Overall, the project operated the main SSE and NPE fishway entrances close to acceptable limits during the 2005 fish passage season. Areas that should be considered or improved follow:

- During two inspections, staff gauges were not clean and resulted in estimates or generated computer readings were used to verify elevation readings.
- **This was the first season that the SSEs were not operated at 9.0 ft or greater for many years. With the SSEs being the major entrance gates it would appear that these gates should receive maximum flow to attract adult fish.**
- **The NSEs did not operate at full criteria for the entire season due to the Project's inability to fully repair the Gates and cables at that location.**
- Based on bullets 2 and 3, these factors may have potentially contributed to the inability of adult fish to pass the dam during the time when the Judge-ordered spill was initiated at the project.
- **The Judge-ordered spill for the Snake River slowed passage of summer Chinook and potentially to a lesser extent, steelhead at Little Goose Dam. Until spill volume was reduced to 30% of the daytime flow volume did adult fish begin to find entrance gates and pass the dam in large numbers. Again, this points out the requirements that excessive spill volume and improper spill patterns can totally disrupt and stop a fish run.**
- A clipped Chinook was found dead on the north side of the fish ladder walkway adjacent to the viewing room. It apparently had jumped up and over the 4' fencing enclosing the ladder sides. This area should receive netting over it or some preventative measure to keep adult fish from bailing out of the fish ladder.

LOWER GRANITE DAM *(photographs on page 54)*

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 flippers. A removable spillway weir was incorporated into the South spillbay to pass juvenile fish at the project in 2002. It was successfully deployed and worked satisfactorily through the 2005 spring and early summer season with research tests still being conducted at the Project.

In the fish ladder, an adult fish sampling/trapping facility was incorporated in the original construction of the project. Since that date, major modification of the facility has 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 2005. This system provides adult detection capabilities without handling the fish or shunting the fish to the adjacent fish ladder where the trapping facility is located.

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.

Anne Dowdy, ODFW completed seven fishway inspections at Lower Granite Dam during 2005. Details of the inspections can be found in Table 8 and text that follows.

Table 8. Pertinent Data for Fish Facility Inspections in 2005 at LOWER GRANITE DAM.

CRITERIA ITEMS	DATE OF INSPECTION							
	15-Apr	18-May	16-Jun	15-Jul	17-Aug	15-Sep	20-Oct	
SOUTH SHORE FISHWAY								
<i>South Shore Entrance</i>								
<u>Depth over entrance weirs</u>								
SSE-1 (Criteria = 8 ft or >)	ft	8.4	8.2	7.8	8.1	8.4	8.4	8.1
SSE-2 (Criteria = 8 ft or >)	ft	8.5	8.3	8.0	8.1	8.3	8.4	8.1
Head at SSE-1 & 2 (Crit. = 1 - 2 ft)	ft	1.9	1.6	1.8	1.6	1.5	1.4	1.6
Depth over ladr. Weir (Crit.= 1-1.3 f	ft	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Channel velocity (Crit. = 1.5-4 fps)	fps	0.8	0.8-2.5	0.8-2.1	0.7-2.0	0.8-2.2	0.7-2.3	0.8-2.2
Channel velocity (n shore)		1.8	1.8	1.5	1.9	1.6	1.6	1.3
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		no	no	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	0.2'	yes	yes
<i>North Powerhouse Entrance:</i>								
<u>Depth over entrance weir</u>								
NPE-1 (Criteria = 8 ft or >)		6.6	7.7	7.3	5.7	5.6	7.0	8.0
NPE-2 (Criteria = 8 ft or >)		6.6	7.7	7.3	5.7	5.6	7.0	8.0
Head at NPE-1&2 (Criteria = 1-2 ft)		1.4	1.3	1.0	1.4	1.4	1.4	1.3
Gate on sill (Yes or No)		yes	yes	yes	yes	yes	yes	no
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
<i>North Shore Entrance:</i>								
<u>Depth over entrance weir</u>								
NSE-1 (Criteria = 7 ft or >)		4.7	5.1	6.8	5.0	5.3	4.6	4.4
NSE-2 (Criteria = 7 ft or >)		5.4	5.8	6.1	5.9	6.1	5.2	5.1
Head at NSE-1&2 (Criteria = 1-2 ft)		1.1	1.2	0.8	1.3	1.1	1.0	1.1
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
Comment number (if applicable)		1	2	3	4	4	5	

Comments:

1. Gate NSEs way too low; only 4.7 and 5.4 ft each. SSE channel staff gauge illegible.
2. The North Shore Entrances were well below criteria of 7.0 ft gate depth.
3. Same comment as above. In addition, head differential was only 0.8 ft at the NSEs.
4. Same comment as #2 above; however, head differential was satisfactory on this inspection. All spillgates were in service as well as the RSW.
5. NPEs still on sill; however L. Goose ceased MOP operations on 9/14. The NSEs about 2-ft below criteria.

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-1 is downstream of the SSE-2 Gate about 150 ft. It was originally thought that this downstream gate would be an effective attractor for the adult fish traveling along the shoreline. This has not proven to be the case, but it still operates at full criteria. These two entrance gates are narrow (4-footers) compared to most gates at other COE projects.

In 2005, Gates SSE-1 and SSE-2 operated with depths that ranged from 7.8 ft to 8.5 ft and head differentials that ranged from 1.4 ft to 1.9 ft. The gate depths averaged 8.2 ft submerged below tailwater elevation for the season with the head differential averaging 1.6 ft. During the passage season, head differentials were operating within criteria at the SSEs during the 7-inspection dates. The SSE-1 was submerged less than 8.0 ft on 1 occasion when it was at 7.8 ft on the June 16 inspection.

Water velocity was recorded via an electronic meter at the southern end of the collection channel and the water velocities ranged between 0.7 fps to 0.8 fps. In 2004 we began implementing measuring water surface velocity in the same area as the electronic meter and found the surface velocities to be in the lower 2.0 fps range (range = 2-2.5 fps). The velocity meter is located at the start of the collection channel and in the slowest part of the channel. Water velocities recorded at the North Shore channel ranged from 1.3 fps to 1.9 fps. Velocities were less than desired at the south powerhouse-recording site using the meter, but were satisfactory when visual surface velocity was measured. At the N. shore site, the water velocity was at the lower end of the velocity range (average was 1.6 fps for season).

The North Powerhouse entrances, NPE-1 and NPE-2, were operated with the Gates on sill for six of seven inspections, same as 2004. During the single inspection that the NPEs were not on sill, the project was able to meet the 8.0 ft criteria for gate depth. Gate depths for the season ranged from 5.6 ft to 8.0 ft. Head differentials ranged from 1.0 ft to 1.4 ft for the season. All inspections showed the NPE gates operating satisfactorily and within criteria (given the water elevations) during this season's fishway inspections, similar to the past three years.

The North Shore entrances, NSE-1 and NSE-2, reported gate depths that ranged from 4.4 ft to 6.8 ft and head differentials that ranged from 0.8 ft to 1.3 ft. In 2005, the project attempted to meet head differential at the entrances rather than meet the gate depth criteria of 7.0 ft or greater. The project failed to meet gate depth of 7.0 ft or greater on all seven inspections for the 2005 fish passage season, and failed to meet head differential of 1.0 ft minimum on one of seven inspections.

Fish Ladder: The ladder exit and picketed leads (count station) were reported clear of debris on all inspections during the fish passage season. The depth of water over the fish ladder weirs was 1.1 ft during each inspection and was satisfactory for the season.

Overall, the adult fish facilities operated with the fish pumps working throughout the year, no known failures. Several limitations of the fish facilities still exist.

- The project has three fish pumps, but only two can be operated due to hydraulic limitations of the system. As a result, the north shore entrance gates cannot operate to meet both gate depth and head differential criteria under most conditions, even though the gates could be lowered further in the gate slot, i.e., the gates are normally not operated on sill at the NSEs.
- Water velocity through the beginning of the southern end of the powerhouse collection channel was less than or close to the minimum criteria desired for most of the fish passage season when using the electronic meter. The surface velocities were reported as satisfactory in the same area.
- **The COE should assess whether fish passage and hydraulic conditions in the powerhouse channel and at the North Shore would be improved by closing the floating orifice gates as accomplished at Lower Monumental and Little Goose dams. Closure of the orifices would potentially allow better operation of the entrance gates at the project.**
- Assess passage through SSE2 and benefit of operating that entrance gate where substantial fallback of adult fish has occurred based on radio telemetry reports. Maximizing flow through SSE-1 would appear a better option than running both entrances.

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, WA. 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 also 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 55)*

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. Makeup 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 (right bank only) and lower end of the fish ladder at both shores of the project. Main entrance gates on the Left Bank fishway are 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 entrance gate is operated at the Right Bank fishway. All main entrance gates are slotted. Adult PIT tag detectors were added to the Right and Left Bank fish ladders prior to the 2003 fish passage season.

Bryan Nordlund, NOAA Fisheries, completed seven inspections of the adult fish facilities at the project during the 2005 season beginning May 2 and ending October 25 (Table 9). An operator, a fish biologist or fish technician, and an engineer from Grant County PUD normally accompanied Bryan 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

Gate 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 1.2 ft to 1.5 ft over the seven inspections. The project was operating

at acceptable criteria during the 2005 inspection season as the head differential was within the 1 to 2 foot range and always was equal to or greater than the 1.2 ft target for the seven inspections.

Gate 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 1.6 ft over the seven inspections. Although the project was operating within acceptable criteria during the 2005 inspection season as all the head differentials were within the 1 to 2 foot range, five of the seven inspections had head differentials at LSE-4 that were below the target of 1.5 feet.

Water velocity in the collection channel was visually estimated and ranged from a low of 1.0 fps to a high of 2.0 fps. Water velocities in the collection channel were improved in 2005. After the first inspection with a velocity reading of 1.0 fps, Bryan Nordland (NOAA) asked that water be added near LSE-2 to increase collection channel differential and velocity. In response, GCPUD raised LEW5 three feet to in an attempt to improve channel velocity. This raising of LEW5 improved velocities significantly, in fact velocities ranged between 1.7 and 2.0 fps for the remaining six inspections of 2005. Although Q from the LSE-4 was somewhat reduced, this action sent more flow through and around the downstream end of the junction pool and upper end of the collection channel. The action resulted in the increased velocity through that area where we measure the water velocity in the channel.

Since 2004, Grant PUD has operated the sluice gate/new juvenile bypass system during the late summer and through November 15 to provide a route for the adult fish to fallback at the dam. Priest Rapids Dam normally has a substantial number of adult fish that overshoot the project and then must fallback to the area below the dam where they are destined, such as Ringold or Priest Rapid hatcheries or the Hanford Reach section of the Mid-Columbia River. This should continue to provide positive benefits to those adult fish that overshoot the dam.

Fish Ladder: At the Left Bank fish ladder, the depth of water over the ladder weirs ranged between 0.9 ft and 1.1 ft for the season. The reading of 0.9 feet on October 25th was not within the acceptable range of 1-1.2 feet. The exit from the fish ladder was clear of debris for the season. The picketed leads at the counting station were reported clear of debris in all inspection through July 18th. After July 18th, the picketed leads at the old counting station were open, in response to the new video counting station located in the exit section of the fish ladder.

Right Bank Fishway

Auxiliary water from the Left Bank is transported via a large conduit to the Right Fishway. This water flows through diffuser gratings into the lower end of the right bank fish ladder. Slotted Entrance Weir, RSE-1, operated during the 2005 fish passage season. The main gate is required to operate within the following range: 1.0 to 2.0 ft for head differential with the target "head" being 1.5 ft.

Gate RSE-1 had head differentials ranging from 1.3 to 1.6 ft for the season. The Gate was operated within the acceptable criteria range of 1.0 to 2.0 ft, but was less than the target of 1.5 ft on 4 of 7 inspections. Although passage conditions should have been satisfactory through the Right Bank fishway in 2005, some improvements could be made in keeping differentials at or above the 1.5 ft target.

Fish Ladder: The depth of water reported over the fish ladder weirs was at 1.0-1.1 ft on all inspections. All readings were satisfactory. The ladder exit was reported clear of debris on 6 of 7 inspections, with only minor debris during the October inspection. The picketed leads at the counting station were reported clear of debris in all inspections through July 18th. After July 18th, the picketed leads at the old counting station were open, in response to the new video counting station located in the exit section of the fish ladder.

Table 9. Pertinent Data for Fish Facility Inspections in 2005 at PRIEST RAPIDS DAM.

CRITERIA ITEMS	DATE OF INSPECTION							
	2-May	26-May	20-Jun	18-Jul	29-Aug	21-Sep	25-Oct	
LEFT BANK FISHWAY								
Left Bank Entrance:								
Head at main entrances (Criteria = 1-2 ft)								
LSE-2 (1.2 ft target)	ft	1.2	1.4	1.3	1.5	1.2	1.2	1.4
LSE-4 (1.5 ft target)	ft	1.3	1.5	1.2	1.2	1.3	1.2	1.6
Depth over ladr. weir (Crit. = 1-1.2 ft)	ft	1.0	1.0	1.1	1.1	1.0	1.1	0.9
Water velocity (Crit. = 1.5-4 fps)	fps	1.0	1.7	2.0	2.0	2.0	2.0	2.0
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	no	yes	yes
Picket leads clean (Crit. = yes or no)		yes	yes	yes	yes	open	open	open
RIGHT BANK FISHWAY								
Right Bank Entrance:								
Head at Entrance (Criteria = 1-2 ft)								
RSE-1 (1.5 ft target)	ft	1.4	1.5	1.4	1.4	1.3	1.6	1.5
Depth over ladr. weir (Crit. = 1-1.2 ft)	ft	1.1	1.0	1.0	1.1	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	no	yes	yes
Picket leads clean (Crit. = yes or no)		yes	yes	yes	yes	open	open	open
Comment number (if applicable)		1	2	3	4			

Comments:

1. Channel velocity was less than the target, but was within criteria. Entrance head differential at LSE-4 was 0.2 ft less than targeted 1.5 ft. Bryan requested additional flow be added near LSE-2 to increase entrance head and collection channel differential.
2. LEW5 was raised 3-ft to improve collection channel water velocity. Velocity was 1.7 fps averaging 4 readings.
3. The project was asked to assess depth over ladder weir on rt. Bank - reading = 0.95; project will calibrate stillwell.
4. Fish counting is completed via the new video counting station located in the exit section of each fish ladder. The old stations now have their pickets open and the count boards removed.

Overall, some major changes were completed at the Priest Rapids fish facilities during the 2005 season that should be beneficial in the long run at the Dam for adult fish passage facilities and passage of adult salmonids at the Project.

- With the new counting facilities now in place on both fish ladders, there will be no more upkeep of picketed leads or other related fish count board observations that can annually occur. In future years, accuracy of fish counts should be improved, although that will take continued training of employees to go from a visual count to a video-type recognition of species.
- Operation of the LSE-4/LEW-5 was changed with LEW-5 raised approximately 3-ft to reduce by some amount, the volume of water from the LSE4. The resulting action was intended to push more flow around the junction pool corner and increase the water velocity through the upstream end of the collection channel. From the 2nd inspection through the end of the fish inspections in October, water velocities were increased to near 2.0 fps and fell within the acceptable range of 1.5-4.0 fps.
- The Project could improve head differentials at LSE-4 and RSE-1 to be closer to the 1.5 ft target. In 2005, only two of seven inspections recorded head differentials equal or greater than 1.5 feet at LSE-4 and only three of seven inspections recorded head differentials equal or greater than 1.5 feet at RSE-1.

WANAPUM DAM *(photographs on page 56)*

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 makeup 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. In late 2001, the ten operating orifice gates along the powerhouse collection channel were permanently closed. 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 Q to the diffusers located in the lower end of the fish ladder to meet head differential criteria established for main entrance gate, REW-2.

Bryan Nordlund, NOAA Fisheries completed seven inspections of the adult fish facilities during the 2005 fish passage season. The inspections encompassed from the initial one on May 2nd through the final one on October 25th. 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 weir with a head differential criterion of 1.0 ft to 2.0 ft and a target of 1.5 ft. Gate LSE-2 operated within a range of 1.3 ft to 1.8 ft over the seven inspections in 2005. Head differentials at LSE-2 were within the acceptable range over the entire season (1-2 feet), however one inspection recorded a head differential less than the target (May 26th). After the May 26th inspection, NOAA recommended that adjustments be made to valves to provide additional water supply to the LSE-2 entrance gate. Passage conditions for adult fish at the LSE-2 should have been satisfactory throughout the 2005 migration season.

Prior to the fish passage season, LSE-3 was relocated to the front of the powerhouse due to the start of construction of the cofferdam for bypass construction. The operational criterion for head differential is from 1.0 ft to 2.0 ft with the targeted head differential of 1.25 ft (1.2-1.3 ft). Gate LSE-3 operated within the following range: 1.3 ft to 1.9 ft for the fish passage season. The target head differential of 1.25 ft was

exceeded on all seven inspections in 2005. Gate LSE-3 should have provided satisfactory entrance conditions for adult fish throughout the 2005 passage season.

Water velocity was estimated at the upstream end of the powerhouse channel and readings ranged between 2.5 and 3.3 fps. All readings exceeded the minimum criteria of 1.5 fps during the 2005 inspection season. Orifice gates along the channel are sealed since summer 2001 and this action contributes to the excellent water velocity readings recorded again this season.

Fish Ladder: The depths of water over the fish ladder weirs ranged from 1.0 ft to 1.1 ft for the season and readings were satisfactory for the season. The ladder exit was clear of debris around the exit on 5 of the 7 inspections.

Right Bank Fishway

The right bank slotted entrance weir, RSE-2, is targeted to operate with a head differential of 1.25 ft and within the range of 1.0 ft to 2.0 ft. Gate RSE-2 is the operating entrance weir at the Right Bank Fishway and operated with head differentials that ranged from 1.3 ft to 1.5 ft. All inspections met or exceeded the targeted head differential of 1.25 ft in 2005.

Fish Ladder: The right fish ladder operated with depth of water over the weir crests ranging between 1.1 ft and 1.2 ft for the season. All readings were satisfactory for the season. The fish ladder exit was clear of debris in all but one inspection in 2005.

Spill Patterns: Spill was used to pass juvenile fish downstream of the project. Changes to the spill schedule were coordinated through the fish agencies and tribes.

Overall, the Wanapum fish facilities were operated satisfactorily throughout the fish passage season.

- A major change was initiated prior to the 2005 fish passage season at Gate LSE3. The entrance weir slot was moved from its original opening that put the attraction water into the spill/skeleton bay area to a location where the flow now enters the tailwater adjacent to Unit 1 at the western end of the powerhouse collection channel. Visual observations showed the fish attraction flows reaching satisfactorily downstream from the entrance without being over “powered” by either the Turbine Unit boil or spill from the sluiceway flow. Although it is unknown at present what numbers of fish use the new entrance position, we believe that the change in location was justified and works satisfactorily at its new position.
- During the winter maintenance season, one of the two fish turbine pumps received major overhaul. Both pumps worked throughout the fish passage season with no breakdowns or other outages due to the pumps.

Table10. Pertinent Data for Fish Facility Inspections in 2005 at WANAPUM DAM.

CRITERIA		<u>DATE OF INSPECTION</u>						
		<u>2-May</u>	<u>26-May</u>	<u>20-Jun</u>	<u>18-Jul</u>	<u>29-Aug</u>	<u>21-Sep</u>	<u>25-Oct</u>
LEFT BANK FISHWAY								
<i>Left Bank Entrance:</i>								
<u>Head at entrances (Criteria = 1-2 ft)</u>								
LSE-2 (target head = 1.5 ft)	ft	1.7	1.3	1.5	1.7	1.6	1.6	1.8
LSE-3 (target head = 1.25 ft)	ft	1.5	1.3	1.3	1.4	1.5	1.9	1.3
Dep. over ladr. weir (Crit. = 1.0-1.2ft)	ft	1.1	1.1	1.1	1.1	1.1	1.1	1.0
Channel velocity (Crit. = 1.5-4.0 fps)	fps	3.3	2.8	2.8	2.9	2.5	3.1	2.8
Staff gages clean (Crit. = yes or no)		yes	yes	yes	yes	no	yes	yes
Auxiliary H2O Pumps	rpm	122/130	123/136	129/138	130/130	125/130	118/133	125/135
Ladder exit clean (Crit. = yes or no)		yes	yes	no	yes	no	yes	yes
RIGHT BANK FISHWAY								
<i>Right Bank Entrance:</i>								
<u>Head at Entrance (Criteria = 1-2 ft)</u>								
RSE-2 (target head = 1.25 ft)	ft	1.3	1.3	1.3	1.4	1.5	1.4	1.5
Depth over ladder weir	ft	1.2	1.2	1.1	1.2	1.2	1.1	1.1
Ladder exit clean		fair	fair	yes	yes	yes	yes	yes
Staff gages clean		yes	yes	yes	yes	no	yes	yes
Comment number (if applicable)		1	2		3			4

Comments:

1. LSE-3 has been relocated to front of powerhouse due to start of construction of cofferdam for bypass.
2. The project was to make adjustments to the valves and provide additional water supply to the LSE-2 Entrance Gate.
3. Spill was only through sluiceway per PRCC spill Committee.
4. Bryan requested that the contractors cover grating/manhole covers over the fishway under the work benches.

ROCK ISLAND DAM (photographs on page 57)

The Rock Island hydro-project is owned and operated by Chelan County PUD. The Dam is comprised of two powerhouses; an old powerhouse with 10 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. In recent years several spillgates 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 system was completed prior to the 2004 adult fish passage season.

Steve Gacek, WDFW completed seven inspections of the adult fish facilities at Rock Island Dam during the 2005 fish passage season beginning April 19 and ending October 19 (Table 11). Results and discussion of the inspections follow in the text below.

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 through all tailwater elevations.

Gates LO5 and LO6 were normally submerged the same depth or within a tenth or two of the other gate during the 2005 season. Gate depths ranged from 6.6 ft to 6.8 ft. Head differentials ranged between 1.0 ft and 1.3 ft. The gate depth and head differential readings were found within acceptable criteria range through the 2005 inspection season.

Fish Ladder: Depth of water measured over the Left Bank fish ladder weirs ranged between 1.0 and 1.1 ft during the 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 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 depths recorded at the Middle Ladder during the inspections ranged from 8.5 ft to 9.0 ft (same as in 2004) with head differentials that ranged from 1.1 ft to 1.4 ft. The gate depths and corresponding head differential at the entrances were within criteria for the entire inspection season and should have provided satisfactory attraction flows for adult fish at the Middle Ladder for 2005.

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

Table 11. Pertinent Data for Fish Facility Inspections in 2005 at ROCK ISLAND DAM

<u>CRITERIA ITEMS</u>		<u>DATE OF INSPECTION</u>						
		<u>20-Apr</u>	<u>26-May</u>	<u>29-Jun</u>	<u>20-Jul</u>	<u>24-Aug</u>	<u>22-Sep</u>	<u>25-Oct</u>
LEFT BANK FISHWAY								
<i>Left Bank Entrance:</i>								
Depth over entrance weir								
LO5 (Criteria = 6.0 ft or >)	ft	6.6	6.8	6.6	6.6	6.7	6.8	6.8
LO6 (Criteria = 6.0 ft or >)	ft	6.6	6.8	6.7	6.6	6.7	6.8	6.7
Head at LO5 & 6 (Crit. = 1-2 ft)	ft	1.0	1.1	1.2	1.3	1.2	1.3	1.2
Depth over ladder weir (Criteria = 1.0-1.2 ft)	ft	1.1	1.0	1.0	1.1	1.1	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								
<i>Center Entrance:</i>								
Depth over entrance weir								
MO3 (Criteria = 8.5 ft or >)	ft	8.5	8.9	9.0	8.6	8.6	8.8	8.9
Head at MO3 (Criteria = 1-2 ft)	ft	1.3	1.1	1.3	1.4	1.2	1.2	1.2
Depth over ladder weir (Criteria = 1.0-1.2 ft)	ft	1.1	1.0	1.0	1.1	1.1	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								
<i>Right Bank Entrance:</i>								
Head Differential (Crit. = 1-2 ft)								
LPE-1	ft	1.4	0.6	0.6	1.1	1.4	1.3	1.3
RPE-1 and RPE-2	ft	1.6	0.8	0.8	1.3	1.6	1.4	1.5
TRE	ft	1.5	0.6	0.6	1.2	1.5	1.1	1.4
Depth over ladder weir (Criteria = 1.0-1.2 ft)	ft	1.1	1.0	1.0	1.1	1.1	1.1	1.1
Channel veloc.(Cr. = 1.5-4 fps)	fps	4.1	4.3	4.3	4.2	4.8	4.6	4.4
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		3	3	3	3	3	3	3
Pump Gate Openings	%	44-100	95-98	100	100	74-100	74-100	100
Comment number (if applicable)			1	1			2	

Comments:

1. Head Differential way below criteria at the main entrance gates of New Powerhouse. Tailwater elevations about 576 ft during the inspection.
2. The Right Bank Wall Diffusers had significant debris buildup on the screens resulting in a large head differential across the screens. I recommended that the Project consider closing the ladder and removing the debris to reduce the head differential. The pumps were also less efficient with the debris buildup that was occurring across the screens.

Spillway: Specific spillbays at the project have been modified (notched) to improve passage for juvenile salmonids. Nine spillbays were affected for the year: 1, 16, 18, 24, 26, and 29 through 32. Normally the Project spills 20% of inflow during the spring migration with a higher percentage 30% during the summer migration season.

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 gate at the downstream end of the project, one main gate at the left end of the powerhouse, and through two gates at the right end of the powerhouse. Each entrance gate is opened 3-ft, but its depth (outflow) will increase as flow and tailwater elevation increases. The gates 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 entrance gates. 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 100% open with the gravity water valve also operated at 100% open.

The entrance gates, TPE, LPE, and the RPEs were reported with head differentials that ranged from 0.6 ft to 1.6 ft throughout the season. Head differential was less than 1.0 ft during the May and June inspections when high tailwater elevations from the higher flows resulted in respective readings of 0.6 ft, 0.8 ft, and 0.6 ft at the LPE, RPEs, and TPE during the May and June inspections. When tailwater elevations exceed or are close to elevation 574.5 ft, the head differentials can drop below the minimum 1.0 ft as was noted in the 2005 inspections for May and June. As the river flow dropped during the summer, the head differentials were reported from 1.1 to 1.6 ft for the remaining July through October inspections for the three entrance gates.

Water velocity recorded in the powerhouse transportation channel was measured using a portable flow meter; velocities ranged between 4.1 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.

The wall screens at the Right Bank fishway were noted with very little head loss this year until the September inspection when about 2-ft head was recorded. The fasteners and other required work was accomplished on these wall screens in winter 2004 that helped “beef” them up, but this high differential still required that the fish ladder be taken down and the screens cleaned during late September, (see photographs, page ___). The fish ladder dewatering was satisfactorily completed with about 50 adult salmon safely placed in the forebay of the dam. The cleaning was completed by 3 p.m. on September 28 with the startup at 7 a.m. that day. To date no further cleaning has been required though the inspector noted about 1-ft head differential on the final October inspection.

Fish Ladder: Depth of water measured over the ladder weirs was 1.0 to 1.1 ft for the seven inspections at the Right ladder. The exit from the fish ladder was clear of debris, as was the picketed lead section at the fish counting station.

Overall, the fish passage facilities operated 2005 fairly well during the adult fish passage season. Areas of concern are listed below.

- The Right Bank Fishway cannot meet head differential criteria at the main entrances when tailwater elevations increase to near or above elevation 574.5 ft.
- As noted in 2003, the Right Bank wall screens that supply flow to the adult fishway were plugged with grasses in late September and required the fish ladder be shut down and the wall screens cleaned.

As noted above, this was safely accomplished and the screens/pump system operated after that time frame. These grasses remain a major problem during late summer and early fall on most years.

ROCKY REACH DAM (*photographs on page 58*)

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 are now adjustable blade turbines. 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 2005 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 facilities 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 – 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.

Steve Gacek, WDFW, inspected the adult fish passage facilities seven times during 2005 with the initial inspection on April 19 and the final inspection on October 25. 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. On the initial inspection, April 19, the 6-orifice gates were temporarily shut down along the powerhouse collection channel. Despite the closure of the gates, the minimum head differential of 1.0 ft was still not achieved at the RPEs with only 0.6 ft reported for the April inspection. The 6-orifice gates were open and operated during the rest of the fish passage season. The head ranged from 0.6 ft to 1.1 ft for the season. Previous to this year, all readings at the RPEs have been taken at a stillwell located very close to the area where the velocity begins increasing rapidly through the entrance gate to the tailwater. This area was deemed too close to the entrance and the measuring point was moved upstream about 12 –15 ft where the water had not begun the downward drop out of the 3' gate. At this point in the channel, there was an area that appeared satisfactory to all parties that would give a better channel reading; hence it also gave a more positive head differential at the RPEs.

One of the unique characteristics of the project has been the varying elevation reported at the LPEs versus the RPEs. Normally, the channel elevation is at least 1.0 ft lower at the RPEs than at the head end of the channel. While this drop from one end of the channel to the other normally means that the water velocities are moving satisfactorily, a negative problem may be that the tailwater elevations from one end of the powerhouse to the other have not dropped a foot or greater. This lack of head has been a partial result of these factors. One other problem noted at Rocky Reach has been the large fluctuations in flow and tailwater elevations that daily occur. The overall result is that head differentials at the entrances may be out of criteria until the system equilibrates. During the final inspection, it appeared there might have

been a stillwell problem with the elevation readings at that site. This stillwell may require additional maintenance during the upcoming winter overhaul period.

Six orifice gates operated along the channel (1, 2, 3, 16, 18, and 20) from March through August. All gates operated satisfactorily.

The **Left Powerhouse Entrances, LPE-1 and LPE-2**, are located at the left end of the powerhouse nearest to Main Turbine #11. Flow from one-entrance discharges back toward the powerhouse with flow from the other entrance moving toward the retaining wall that separates the spillway flow from the powerhouse flow.

Gate depths at LPE-1 and LPE-2 ranged from 9.8 ft to 12.4 ft, with head differentials that ranged from 1.0 ft to 1.4 ft. The “head” was within the required range of 1.0 to 2.0 ft on all inspections while the gate depths were above 10 ft on the inspections except the August inspection when it was on sill and no further depth could be attained. The LPEs were operated in criteria through the 2005 inspection season.

The water velocity meter is installed about 150 ft upstream from the junction pool and centered in the transportation channel. In 2005, the meter ranged from 1.6 to 2.0 fps, all above the normal range of 1.5 to 4.0 fps.

Main Turbine Unit #11 was modified to an adjustable Kaplan-type turbine prior to the end of August 2002. Unit 11 was operating on three of seven inspections this season. With the new modification to the Turbine, the turbine boil was much reduced from previous years, and it appeared that this Unit could now be (or should be) operated as necessary to attract adult migrants to the LPEs.

Spillway Entrance

The Spillway Entrance was operated from May 1 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, depths were 10 feet or greater on 5 of the 6 inspections with the gate at 8.0 ft during the August inspection. Head differentials were reported from 1.0 ft – 1.6 ft during the 2005 inspection dates. All inspections had satisfactory readings for the year.

Fish Ladder: The exit from the fish ladder was clear of debris during the 2005 inspection season. The depth of water over the fish ladder weirs was 1.0 ft during all inspections and was within the criterion range of 1.0 and 1.2 ft.

Overall, the fishways were operating within criteria with exception of some lower but vastly improved readings taken at the RPEs. With the new measuring site within the RPE channel, head differential was near 1.0 ft this season. The fishway attendants continued coverage of the fishways over a larger part of the day to assure that the fishways were kept closer to criteria levels during the early morning hours when flows were rapidly changing at the project.

- Head differentials at the RPEs were improved and should come close to meeting criteria in future years.
- Floating grasses resulted in reduced pump efficiencies during August and September. The trash racks were cleared during two evening’s work. This resulted in improved operation of the fish pumps and no further problems occurred through the remainder of the fall.

Table 12. Pertinent Data for Fish Facility Inspections in 2005 at ROCKY REACH DAM.

CRITERIA ITEMS	DATE OF INSPECTION						
	19-Apr	25-May	29-Jun	27-Jul	24-Aug	22-Sep	25-Oct
ADULT FISHWAY							
Left Powerhouse Entrance:							
Depth over entrance weirs							
LPE-1 & 3 (Depend. On Tw Elev) ft	11.6	12.4	12.2	10.1	9.8	11.5	11.9
Head at LPE-1 & 3 (Crit. = 1-2 ft) ft	1.4	1.1	1.0	1.4	1.2	1.2	1.2
Depth over Ladr Weir (Crit = 1-1.3 ft	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Channel velocity (Crit. = 1.5-4 fps) fps	1.7	1.7	1.6	2.0	1.7	1.7	1.7
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	yes	yes	no	no	yes	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	0.6	0.4	1.1	0.9	1.8	1.0	1.1
Orif. Gates Oper - (1,2,3,16,18, 20 y/n	no	yes	yes	yes	yes	yes	yes
Pumps operating	3	3	3	3	3	3	3
Fish Pump Speed rpr	44	70	61	48	48	61	66
Spillway Entrance:							
Depth over entrance weir							
MSE (Dependent on Tailwtr Elev.) ft	OOS	12.2	11.7	9.9	8.0	10.9	12.0
Head at MSE (Criteria = 1-2 ft) ft		1.0	1.0	1.0	1.6	1.2	1.0
Comment number (if applicable)	1	2	2		2		

Comments:

1. Spillway entrance closed until May 1st or spill begins. Orifices along ph collection channel closed. Evaluation of RPEs for placement of staff gauges and stillwell will be looked at. Potential for moving stillwell to obtain a better/more accurate channel elevation reading. Regulating gates were being worked on at picket barrier.
2. Head differential measurements at RPEs were taken from new proposed site upstream of current stillwell as well as at new proposed. There is approximately 1-ft difference in head differential from the old to new reading.

WELLS DAM (photographs on page 59)

Wells Dam was completed in 1967 with 10 main turbine units and the spillbays placed directly above them. The turbine units are termed hydrocombines. 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.

Larry Stillweigh, WDFW, completed seven inspections of the adult fishways during 2005. The initial inspection was April 19 with the final inspection on October 31st. 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 2005 fish passage season with no reported out of service time. The project can meet head differential criterion at the main downstream entrance through all tailwater and flow conditions.

The West and East fish ladders incorporate trapping facilities for adult brood collection. Trapping schedules are coordinated among the various agencies with WDFW operating the trapping and sampling/handling at the Project.

Inspection procedures follow a given pattern, i.e., the inspector obtains the computer readings for plant operations from the Control Room. The inspector and operator then make a site visit to the fishway entrance and take readings from the staff gauges and deck gauges located at the entrances. The operator then contacts the Control Room operator to obtain the computer readings. The computer reads are then compared to the site readings. If the gauges vary by more than 0.3 ft, then the project would calibrate the deck gauge or Control Room sensors. This protocol works well as long as the tailwater and entrance staff gauges can be easily read or the tailwater elevation was somewhat flat.

East and West Fishways

The head differentials reported at the **East** entrances for the 2005 season ranged between 1.5 ft and 1.6 ft based on the staff gage readings. The head differential readings at the **West** fishway entrances ranged between 1.4 ft and 1.6 ft. At each fishway entrance, the head differential fell within the larger criteria of 1.0 – 2.0 ft for the season. The head differential target of 1.5 ft \pm 0.1 ft was met on all seven inspections at the East and six of seven at the West fishway entrance. As shown in the previous year, the 2005 operation of the fishways was very consistent with the head differentials from the 3-readings normally matching up well at time of the inspections and no calibration of sensors was required based on our inspections. The staff gauges were readable on all inspections this year.

Fish Ladder: At both fishways, the exits from the fish ladder were monitored for differential between the last fish ladder pool and the forebay elevation. In past years, the differential ranged from 0.5 ft to 0.8 ft, depending on the forebay elevation. Prior to the 2004 season, the exit gates were altered and the racks refitted with 28” spacing rather than the 32” spacing as in previous years. This modification of the spacing has definitely changed the head differentials measured across the racks from the first pool to the

tailwater. In 2005, differentials at the exits ranged from 0.9 ft to 1.2 ft with exception of a reading of 1.7 ft on the October 31 inspection. The exit from the fish ladder appeared clear of debris throughout most of the year, even when head differentials approached and exceeded the 1.2 ft difference. The picketed leads at the counting stations were clear of debris during the inspection dates. The depth of water over the ladder weirs ranged from 1.1 ft to 1.2 ft at the West and East ladders. Criterion for depth of water over ladder weir is 1.0 to 1.2 ft so they were operating in the correct range during the 2005 season.

Spill Basin: During 2005, spill was provided through the juvenile bypass system in bays 2, 4, 6, 8, and 10. Generally, 10-12 kcfs spill was passing through those spillbays during the spring and summer months; however, the numbers of bays open will depend on flow at the Project.

Overall, the fishway entrances at Wells Dam were recorded with head differentials that were either at or within 0.1 ft of the 1.5 ft target at the East and West ladders this passage season, same as the preceding year. Some comments relating to this year's inspections follow:

- For 2005, staff gauges at the project were clean and readable during the season and we definitely appreciated the clean staff gauges reported for this season.
- The 2005 inspections were similar to the 2004 season relating to head differentials at the main entrances and reduced debris/grasses in the auxiliary water supply; head differentials were all within criteria and that was again a positive point.

Table 13. Pertinent Data for Fish Facility Inspections in 2005 at WELLS DAM.

CRITERIA ITEMS	DATE OF INSPECTION						
	19-Apr	24-May	30-Jun	4-Aug	6-Sep	26-Sep	31-Oct
EAST FISHWAY:							
Head at main entrance (Target = 1.5ft ft)	1.5	1.5	1.5	1.5	1.6	1.5	1.5
D/Stream entrance open (Criteria = 8- ft)	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Depth over ladder weir (Crit.= 1-1.2 ft) ft	1.1	1.1	1.1	1.1	1.1	1.1	1.2
Ladder exit differential (Crit = 0.8-1.1ft) ft	1.0	0.9	1.1	1.0	0.9	1.1	1.7
Staff gages clean/readable (yes or no)	yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)	yes	yes	yes	yes	yes	yes	yes
Auxiliary Fish Pump Speed (rpm)	40/47	40/50	44/53	47/--	46/43	46/43	41/42
Fishway entrance jets	Closed	Closed	Closed	Closed	Closed	Closed	Closed
WEST FISHWAY: (Criteria same as East)							
Head at main entrance ft	1.6	1.5	1.4	1.5	1.5	1.5	1.5
Downstream entrance open ft	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Depth over ladder weir ft	1.2	1.1	1.1	1.1	1.2	1.2	1.2
Ladder exit differential ft	1.1	1.0	1.0	1.0	0.9	1.2	1.2
Staff gages clean/readable	yes	yes	yes	yes	yes	yes	yes
Picket leads clean	yes	yes	yes	yes	yes	yes	yes
Auxiliary Fish Pump Speed (rpm)	40/43	50/46	50/48	47/--	46/43	46/43	47/47
Fishway entrance jets	Closed	Closed	Closed	Closed	Closed	Closed	Closed
Comment Number (if applicable)			1	2			3

Comments:

1. Trapping schedules at the East and West fish ladders: 3-day per week @ 11h per day if necessary beginning on 7/5. There will also be some marking of wild summer chinook (radio telemetry study) and Douglas PUD has been trapping bull trout and placing radio tags in them - rel = star boat launch.
2. WDFW began trapping West ladder for adult steelhead on 8/1/05.
3. There was a large head differential across the trash racks on this inspection; potential for buildup of debris.

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 screening systems for the auxiliary water systems are adequate to reduce impacts that might occur when large amounts of debris are in the river.
- Projects should seal bulkhead slots along the powerhouse channel. This would reduce the amount of water that is basically wasted rather than going to the main entrances.
- Projects should fill or seal side entrance or other gates to reduce excessive noise from movement of gates currently set in these slots. This primarily relates to spillway or powerhouse gates on the spillway side of the dam. Much of this has already been completed at the dams.
- Projects should assure that water-measuring devices are easy to read, and that includes at all water elevations during the year. Preferred staff gages would be those that can be cleaned easily or have benchmarks available so sensor readings can be taken.
- Projects should evaluate backup water supply sources to assure that adequate water is available to attract adult fish should the main water supply fail.
- Projects should complete new or approved spill schedules prior to the fish passage season.
- Prior to the adult/juvenile fish passage season, a pre-season meeting should be held to discuss previous year's inspections and assess readiness for operation during the upcoming season. Issues at COE projects should continue to be discussed at the FPOM monthly meetings and individual meetings set with Douglas, Chelan, and Grant County PUDs.
- 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.
- Where known sharp projections or other obstacles are located in the fish ladders, collection or transportation channels, they 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.
- **The COE should assess present lighting in and through the channel sections from the North Shore Entrances at Lower Granite and Little Goose dams to the North Powerhouse area where it meets the powerhouse collection channel. As noted in the photographs, they appear dingy and do not adequately illuminate the channel area. Chelan PUD changed out their lighting system about three to four years ago and that improved illumination through their spillway channel and my understanding is that adult fish now pass through that area in greater numbers. Another example of excellent lighting is the channel from the Cascades Island fish ladder to the WA shore fish ladder.**

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 (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.

McNary (OR fishway) - 9.0 ft or > gate depths.

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)

Lower Monumental (south shore, SSE-2 is a permanent fix 6-ft open gate).

Turbine Unit Operating Priority: Specific to each dam (See year 2005 FPP for COE projects).

Spillway Operation: Specific to each dam (See 2005 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 Gages: At all projects, gages 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.

ACKNOWLEDGMENTS

Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, and NOAA Fisheries provided personnel to inspect adult fishways during the 2005 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 2005 are listed below. There was one new inspector for this year: Larry Stillweigh completed inspections at Wells Dam for WDFW. Others listed have completed inspections from two to ten years.

<u>Agency</u>	<u>Inspector</u>	<u>Dams inspected</u>
NOAA	Gary Fredricks	Bonneville
NOAA	Larry Swenson	McNary
NOAA	Bryan Nordlund	Priest Rapids & Wanapum
ODFW	Wayne van der Naald	The Dalles & John Day
ODFW	Anne Dowdy	Little Goose & Lower Granite
WDFW	Steve Gacek	Rock Island & Rocky Reach
WDFW	Larry Stillweigh	Wells
WDFW	Steve Richards	Ice Harbor & L. Monumental

Project operations personnel and biologists from Portland and Walla District Corps of Engineers provided on-site assistance whenever necessary to assure that the agency inspector could thoroughly inspect the adult and juvenile fishways. The inspectors were appreciative of assistance provided by Project personnel at Corps of Engineers dams.

Grant, Chelan and Douglas Public Utility Districts provided access and assistance for the State and Federal fishway inspectors at their projects. This continued cooperation and assistance was greatly appreciated by the NOAA and WDFW inspectors.

Funding for the FPC staff coordination of the inspections was provided by the following fishery agencies: ODFW, IDFG, WDFW, USFWS, and NOAA.

Photo credits for this report go to the following personnel:

- Bonneville Dam (figures 1) Robert Stansell, COE Fisheries Field Unit
- Priest Rapids Dam (figure) Mike Nichols, Grant PUD Engineer
- Rock Island Dam (figures ----) Thad Mosey, Chelan PUD biologist
- Rocky Reach Dam (figures---) Lowell Rainey, Chelan PUD Fishway Supervisor
- McNary Dam (figures ---) Rex Baxter, NPW operations biologist
- Remaining photographs – Larry Basham, FPC fish biologist

APPENDIX A (Project Photographs)

Bonneville Dam



Figure 1a. Bonneville Dam looking upstream into junction to spillway and into junction leading to the New Powerhouse.



Figure 1b. Bonneville Dam looking upstream to new juvenile bypass outfall from the Corner Collector at New powerhouse and upstream to the the Cascades Island adult fishway entrance located at the north end of the spillbasin.



Figure 2a. An adult sea lion swimming upstream in the Bonneville Dam fish ladder in late March 2005.



Figure 2b. Large sea lion upstream of counting window during this 2005 season.



Figure 3a. Sea lion excluders are placed in the new powerhouse entrance gates in mid to late May to keep these mammals outside the actual fishways.



Figure 3b. The large excluder gate is placed in the downstream gate slot with individual partitions

McNary Dam



Figure 4a. Tilting weirs at exit from OR shore fish ladder when dewatered for winter maintenance 2003.



Figure 4b. Tilting weir gates during the winter maintenance period when ladder was being dewatered in 2003.



Figure 4c. Red gate is the adult fish exit from the fish ladder. This photograph was taken during the winter maintenance period when the ladder was dewatered in 2003.

Ice Harbor Dam



Figure 5a. Steve Richards, WDFW, takes reading at NPE under misty conditions from spill basin.



Figure 5b. Spring spill conditions will affect fish Passage at the NPEs.



Figure 5c. Note the location of the juvenile bypass outfall pipe looking downstream from the powerhouse deck (unit 6) at Ice Harbor Dam. Photo taken May 05.

Little Goose Dam



Figure 6a. The 1st fish ladder weirs above the junction pool may be modified similar to the Lower Granite planned modifications that will be installed this winter, 2006. This modification should reduce fallout rates from the fishway, and, and in the long run reduce time to pass a facility and reduce mortality.



Figure 6b. The adult fish counting station is located upstream from Figure 6a. Note the camouflage netting which is used to cut down the direct sunlight into the fish counting slot.



Figure 6c. June 28 spill at Little Goose Dam that slowed or stopped passage of adult salmon for nearly 10 day until daytime spill level was reduced to about 30% of flow.

Lower Granite Dam



Figure 7a. These photographs show the extended weir crests at the 1st fish ladder weir located above the Junction Pool at the South shore of the Project. This whole area will be modified prior to the 2006 adult fish passage season.



Figure 7b. These two pictures show the poorly lighted area that should lead adult fish from the North shore fishway to this channel that connects to the North powerhouse channel. These lights do not appear to have good passage conditions for fish that enter the North shore and then pass through this lighted tunnel/channel to the North powerhouse area. The same condition would be in service at Little Goose Dam.

Priest Rapids Dam



Figure 8a. Old Right Bank fish counting station and last fish counting board on the Columbia River; removed from this Location in mid July 2005.



Figure 8b. See Description Below.



Figure 8c. See Description Below.

Figures a-c. The Wanapum and Priest Rapids new count stations are now located in the exit section of the Right and Left fish ladders. Cameras are enclosed in the caisson and record adult fish as they swim through the orifices of the slot and as noted have the PIT tag diction system on the upstream end of the counting area.

Wanapum Dam

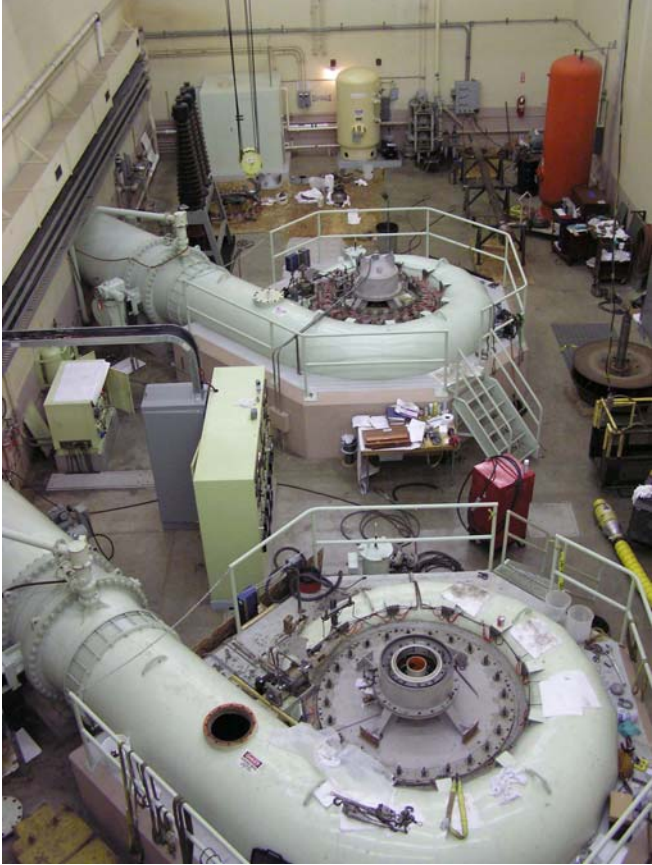


Figure 9a. Two turbine driven fish pumps that supply Attraction flows to the Left Bank adult fishway at Wanapum Dam. Pump 1 was overhauled during the 2005 winter maintenance period

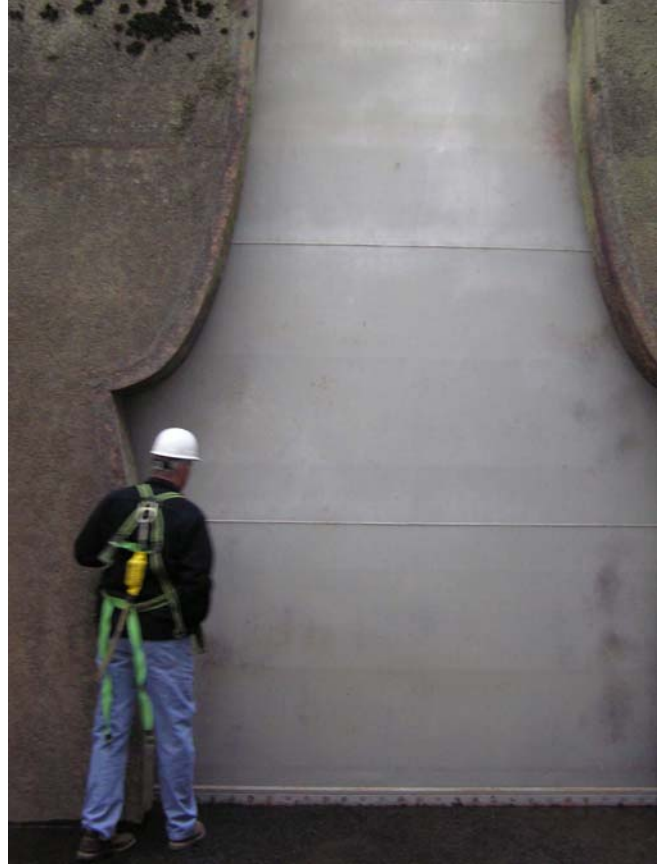


Figure 9b. Eric Lauver, Grant PUD biologist, standing next to the large elliptical end gate at Wanapum Dam during the past winter maintenance period.

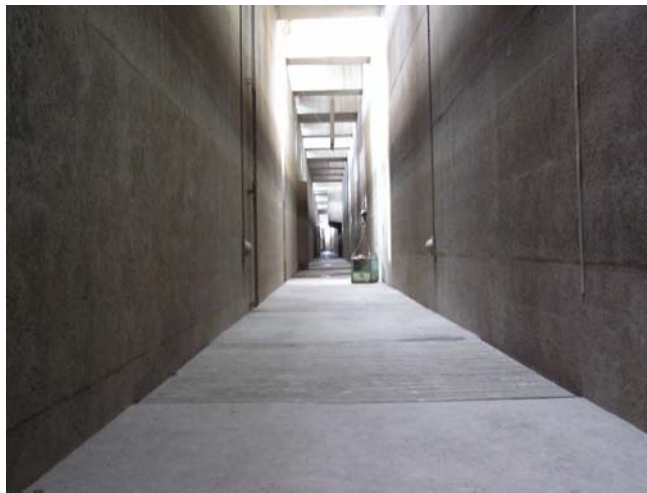


Figure 9c. The length of the collection channel spans the Powerhouse at the project. There are two main entrance gates to attract and pass adult fish at the Left Bank fishway.

Rock Island Dam



Figure 10a. Photograph taken during 2005 winter Maintenance season showing clean AWSs at the Right Bank fishway at Rock Island new powerhouse.



Figure 10b. Rock Island personnel cleaning the heavy grass load from the AWS screens in September 2005.

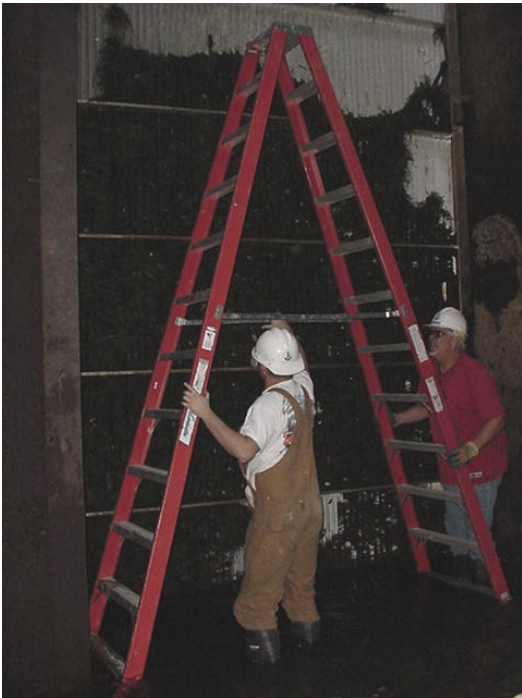


Figure 10c. Rock Island personnel cleaning AWS screens in September 2005.



Figure 10d. AWS screen cleaning took about 6 hours (including dewatering the ladder and removing the adult fish from the upper pool). The fish ladder was immediately watered up and fish passage continued.

Rock Reach Dam



Figure 11a. Photograph depicts pump intake screens with amounts of grasses, resulting in shutdown of the fish pumps until the screens were cleaned.



Figure 11b. Top edge of screen that was pulled from the intake valve.



Figure 11c. Crane holds screen in place while project personnel hose grasses from screen.



Figure 11d. Large mats of grasses are hosed from the screens during late summer cleaning of the intake valves a Rocky Reach Dam.

Wells Dam

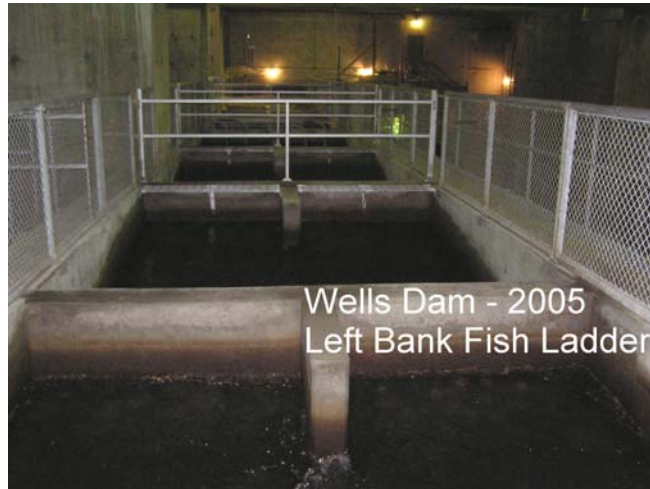


Figure 12a. Both fish ladders at Wells Dam are enclosed; i.e., the fish ladder has a roof over it and uses artificial lighting. Wells is the only fish ladder that is enclosed on the Columbia or Snake River.



Figure 12b. See Description Below



Figure 12c. See Description Below.

Figures 12b and 12c. Photographs of the fish count windows (similar on each ladder) during the winter maintenance period when the fish ladder was dewatered. The count windows are fairly narrow and are ramped up or down at each end of the count window with a downstream lead to guide the fish to the counting window.