Priest Rapids Project
Video Fish-Counting Program
Annual Report 2007

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Executive Summary

On May 3, 2004, the National Marine Fisheries Service (NMFS - then referred to as NOAA Fisheries) issued its Biological Opinion of the effects (Biological Opinion) of the proposed action on listed species, in accordance with Section 7 of the Endangered Species Act of 1973 as amended (16 USC 1531 et seq.), regarding the Federal Energy Regulatory Commission's proposed action amending Public Utility District No. 2 of Grant County's (Grant PUD's) existing license for the Priest Rapids Hydroelectric Project (Project) to authorize implementation of an Interim Protection Plan for listed anadromous salmonids. The Biological Opinion required Grant PUD to install a Video Fish Counting (VFC) system at Priest Rapids and Wanapum dams by 2006. Grant PUD began development of a VFC system at Wanapum Dam in 1996 and VFC systems were in place and operational at both Grant PUD dams by the beginning of the fish passage season on April 15, 2006.

The current VFC system configuration at each dam uses digital video cameras installed in the fishways, streaming data to digital video recorders (DVRs) at each dam. These DVRs are networked and are accessible by fish counters via computers from the fish-counting room at Priest Rapids Dam. In 2007, all fish passage was recorded and reviewed and there was no motion filtering conducted. Fish counters playback data on computers in a fast-forward mode and identify and count passing fish. At the end of each day all counts are tallied and a fish-count report is generated and posted to the Grant PUD external website (www.gcpud.org/stewardship/fishcounts.htm). The VFC system allows 24 hours of fish counting to be completed in a few hours during periods of low fish passage and in approximately one day during periods of high fish passage. The annual fish-counting season for the Project is April 15 through November 15.

Grant PUD significantly improved the functionality and reliability of the VFC system in 2007, primarily by recording and viewing of 100% of all fish passage. However, due to several malfunctions in 2007, including the locking up and restarting of the DVR system during heavy use and multiple-counting of the same fish, Grant PUD proposes to modify and relocate the VFC in-ladder infrastructure at Wanapum Dam for the 2008 fish-counting season. Moving the VFC cameras to the old manual-count station locations and reducing the number of cameras to one per fishway at Wanapum Dam is a relatively simple procedure and will facilitate more accurate fish counts.

This annual report provides information concerning 2007 video fish-counting operations at both Wanapum and Priest Rapids dams, and planned improvements and operations at those facilities in 2008.

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1.0 Introduction

Public Utility District No. 2 of Grant County, Washington (Grant PUD) owns and operates the Priest Rapids Hydroelectric Project (Project) located downstream of Vantage, Washington along the Columbia River, which includes the Wanapum and Priest Rapids dams. The video fish-counting (VFC) program at Wanapum and Priest Rapids dams has been in development since 1996 and was initially conceived as a way to count adult fish traversing adult fishways more accurately and efficiently than has historically been possible to accomplish with count-board-style manual counting. The original VFC system utilized motion-filtering software to classify data from the digital cameras in the fishways by presence or absence of motion. Only those data classified as containing motion were retained and viewed by fish counters. After many trials and repeated malfunctions, this motion filtering-based system was abandoned in 2007 for a digital video recorder-based (DVR) system.

The current VFC system continues to use digital video cameras installed in the fishways to assist with counting migrating fish. Digital video data are streamed 24 hours per day to DVRs at each dam. Fish counters then playback these data on computers in a fast-forward mode to identify and count passing fish. At the end of each day all counts are tallied and a fish-count report is generated and posted on Grant PUD's Fish, Wildlife, and Water Quality website (www.gcpud.org/stewardship/fishcounts.htm). The VFC system allows 24 hours of fish counting to be completed in a few hours during periods of low fish passage, and in approximately one day during periods of high fish passage. The fish-counting season for the Project runs from April 15 through November 15 annually.

1.1 Regulations Defining Action 24

On May 3, 2004, the National Marine Fisheries Service (NMFS - then referred to as NOAA Fisheries) issued a Biological Opinion of the effects of the proposed action on listed species, in accordance with Section 7 of the Endangered Species Act of 1973 as amended (16 USC 1531 et seq.), regarding the Federal Energy Regulatory Commission's proposed action amending Grant PUD's existing license for the Project to authorize implementation of an Interim Protection Plan for listed anadromous salmonids. On December 16, 2004, FERC adopted the Biological Opinion, which includes NOAA Fisheries' Reasonable and Prudent Alternative (RPA) Actions and Incidental Take Statement for Upper Columbia River (UCR) spring-run Chinook salmon (*Oncorhynchus tschawytscha*) and UCR steelhead (*O. mykiss*).

Action 24 of the Biological Opinion requires Grant PUD to:

> *"…develop video-monitoring capability for counting adult salmonids migrating through the right- and left-bank fishways at Priest Rapids and Wanapum dams. Video counting was to be in operation by 2006 at both dams, and reports submitted for inclusion in regional databases. The horizontal counting boards at Priest Rapids Dam were to be removed once the video counting equipment was operational."*

1.2 Program History

Discussions to develop a VFC system at Wanapum Dam, and eventually Priest Rapids Dam, began in 1997. The VFC system was designed under a joint venture between Ecologic, LLC and Harza Engineering. Ecologic, LLC entered into contract with Grant PUD in December 1997 to implement the VFC system and develop the necessary software. Grant PUD installed the in-ladder infrastructure which houses the windows, digital video cameras, and window lighting (Figure 1). Ecologic, LLC developed the software and installed the electronic equipment at Wanapum Dam.

Figure 1 Wanapum in-ladder camera box with fishway dewatered

1.2.1 Wanapum Dam

The VFC system infrastructure at Wanapum Dam was constructed by PBI, Inc., of Clackamas, Oregon, and installed in the fishways by Grant PUD during the winter ladder outage of 1997-1998. Cameras, computers, wiring, and software were installed once the in-ladder infrastructure was secure. Ecologic, LLC was responsible for developing and testing all software. During development of the original, computer-filtered digital fish counting system, recorded fish passage was counted via VHS tapes and time-lapse VCRs. These tapes were reviewed and fish counted by students at Central Washington University from 1998 through 2000. Fish passage was recorded on VHS in 2001, as well, but not reviewed because VHS methodology was found to be time-consuming, inaccurate and produced unrepeatable results.

The motion filtering-based VFC system was nearly complete and ready for full testing in the spring of 2002. Grant PUD engaged the necessary staff to oversee the project and coordinate activities with contractors to test, troubleshoot, and develop an operations manual during 2003. Grant PUD also employed a program analyst during 2003 to serve as technical support for the VFC system. There was no further development of the Wanapum VFC system until 2004.

1.2.2 Priest Rapids Dam

Installation of the VFC system infrastructure at Priest Rapids Dam was complete in March 2003. The in-ladder infrastructure was built by Wheco, Corporation of Kennewick, Washington, and installed by Grant PUD. The left-bank in-ladder camera box was installed on Weir 7. The right-bank in-ladder box was installed on Weir 3 (Figure 2). Passive integrated transponder-tag (PIT-tag) detection antennas were installed on the upstream side of the boxes in March 2003. Video Fish Counting electronics were installed over the next year and initial testing began in April 2004. Full-scale testing began in the spring of 2005. This system utilized the software developed by Ecologic, LLC, but was installed and operated by Grant PUD.

Rigorous testing of the Priest Rapids Dam system was conducted throughout the summer of 2005. Generation of official Priest Rapids Dam fish counts via the motion filtering-based VFC system began on August 8, 2005 and continued throughout the fish counting seasons of 2005 and 2006. The motion filtering-based system was abandoned after the 2006 fish-counting season, and the DVR-based system was implemented.

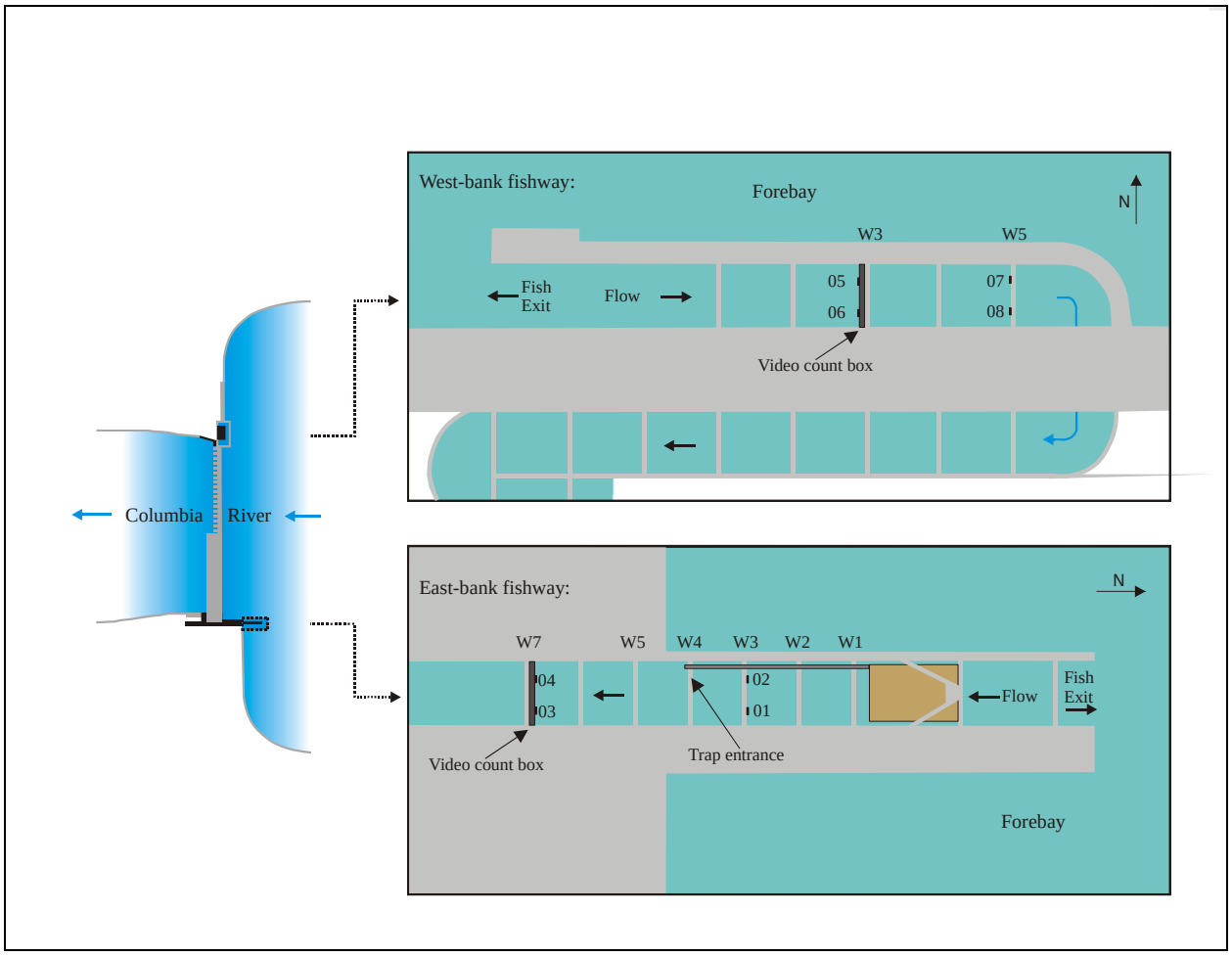


Figure 2 Locations of Priest Rapids in-ladder camera boxes.

2.0 VFC System Configuration

The layout of the in-ladder equipment is outlined in Figure 3. Each fishway has a steel box installed in its orifice-weir-only section (Figures 1 and 4). The box rests on the bottom of the fishway and extends above the water level.

Fish must pass through tunnels along the ends of the box that align with the existing orifice weirs. As fish pass through the lighted tunnels, they are captured by a constantly-running digital camera that faces each window (Figure 6). The streaming digital data from each camera are sent to DVRs located at each dam. Both DVRs are networked with the fish-counting computer workstations at Priest Rapids Dam.

Fish counters use these computers to access the fish passage data on the DVRs and play them back at up to 4 times real-time speed via a proprietary program provided by the DVR manufacturer. All fish recorded on the DVRs are identified by species and relative age (jack-versus-adult salmon), and are counted via a stand-alone tallying program developed by Grant PUD. These counts are written to a database housed at Grant PUD

headquarters in Ephrata, WA. Once a fish-passage day has been completely reviewed and all fish have been counted, a process assembles the fish counts and posts them to www.gcpud.org/stewardship/fishcounts.htm.

The primary electronic VFC equipment is summarized in Table 1. A still shot of recorded fish passage viewed during data playback is provided in Figure 6. An example of a fish-count report is provided in Appendix D.

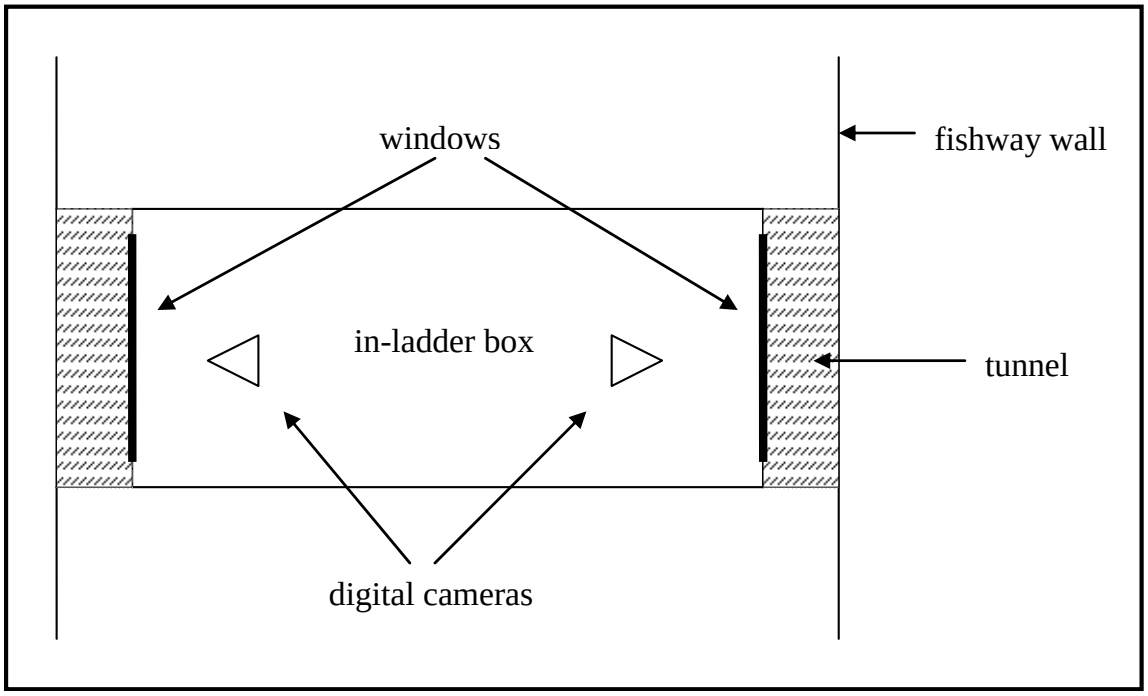


Figure 3 Schematic of in-ladder camera box.

2.1 Wanapum Dam Configuration

The VFC system at Wanapum Dam has undergone many reconfigurations. The current in-ladder equipment is the same as used in 2006. Four cameras (two in each fishway) stream data via fiber-optic cable from the right bank and CAT-5 wire from the left bank, to a DVR located inside the dam, as well as to live-feed video monitors. The DVR is networked with the fish-counting computer workstations at Priest Rapids Dam.

2.2 Priest Rapids Dam Configuration

The VFC system layout at Priest Rapids Dam is similar to the system at Wanapum Dam. Digital data from each video camera is streamed to a DVR inside the fish-counting room via fiber-optic cable, as well as to live-feed video monitors. This DVR is also networked with the fish-counting computer workstations.

Figure 4 In-ladder box during assembly and installation at Wanapum Dam.

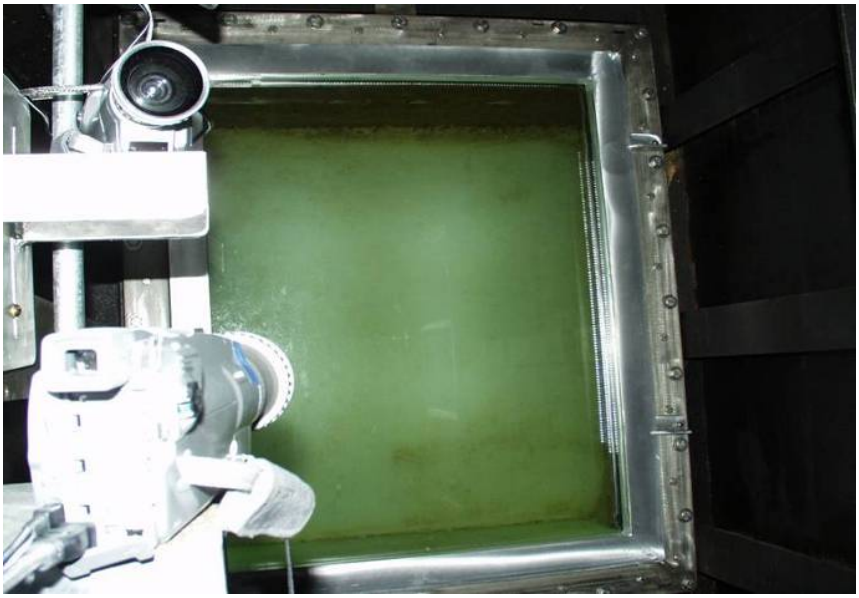


Figure 5 Video cameras and window at Priest Rapids Dam.

Table 1 Primary VFC electronic equipment located at Wanapum and Priest Rapids dams in 2007.

Wanapum Dam	Priest Rapids Dam
Sony digital video cameras (4)	Sony digital video cameras (4)
Fiber-optic transceivers (3)	Fiber-optic transceivers (8)
Firewire-CAT 5 converters (4)	Windows-based computers (7)
Digital video recorders (2)	Digital video recorder (1)
Video monitor (1)	Video monitor (1)

Figure 6 Example of recorded fish passage viewed during data playback.

3.0 Maintenance

No physical maintenance is required on the VFC system due to the absence of moving mechanical parts; however, equipment functionality and computer processes are monitored daily to assure proper operation. Unless a component fails and needs to be replaced, there is minimal hands-on maintenance. Updates to software or operating systems are installed as needed. In-ladder infrastructure requires maintenance activities, including cleaning of the in-ladder box window and camera lens.

3.1 Window Cleaning

Algae grow on the water side of the windows and on the walls of the tunnels in the in-ladder camera boxes. Any growth on the glass obscures the digital cameras' view and blocks the background light from the window light frames. This algal buildup is amplified with increasing water temperatures during the summer months. During the coolest months of spring and fall the windows are cleaned approximately once every two weeks. During the warmest months of the summer windows need cleaning at least once per week.

Tunnels and windows can be cleaned during normal fishway operations. The tunnels on the ends of the in-ladder boxes are attached to an overhead electronic chain hoist. These tunnels can be lifted free of the in-ladder box via guiding tracks, and scrubbed to remove any algae or clinging debris. The glass can be cleaned once the tunnels are removed. The same tracks that guide the tunnels accommodate a metal carriage that supports a long-handled brush. The brush moves vertically within this support. With the long-handled brush in place, the carriage is set into the tracks and lowered via the chain hoist. Once the carriage and brush head are lowered to the top of the window frame a worker standing on the deck of the in-ladder box removes the algae by scrubbing the window glass with a stiff-bristled brush.

Once a window is clean, the carriage and long-handled brush are removed from the tracks and disconnected from the chain hoist which is then reconnected to the tunnel. The tunnel is then lowered in place. Fish passage and fish-passage data capture are not interrupted during this process.

4.0 Schedule of VFC Operation

Video fish counts from Wanapum and Priest Rapids dams are produced annually April 15 through November 15. On April 6, 2007 fish counters began VFC training and fish identification practice prior to the start of the counting season. Grant PUD counted fish passage for Priest Rapids and Wanapum dams with a day-shift schedule only.

5.0 VFC System Challenges in 2007

Grant PUD significantly improved the functionality and reliability of the VFC system in 2007. The main improvement was the recording and viewing of 100% of all fish passage; there was no motion-filtering attempted in 2007. The most frequent equipment malfunction encountered in 2007 was the locking up and restarting of the DVRs during periods of high fish passage and the accompanying intense data recall demands placed on the DVRs by fish counters. When reviewing fish passage data, playback is constantly manipulated. Empty frames are fast-forwarded and frames with fish are often slowed, rewound, paused, and/or played back and forth in order to identify and count all fish. With multiple counters heavily tasking the DVRs simultaneously, the DVR would intermittently freeze and require automatic re-setting. Although inconvenient and time inefficient, these short-term (two-minute) breakdowns did not significantly affect the VFC program's overall accuracy. These temporary breakdowns occurred only during periods when fish counters were working.

An additional data accuracy problem experienced in 2007 was the inability to produce accurate jack-versus-adult counts. The VFC tunnels through which fish pass are necessarily large because of the volume and velocity of water that must pass, making it difficult to determine the size of a fish. A passing fish can be close to the window or as distant as 26 inches from the glass. Additionally, a passing fish has a vertical range of approximately 30 inches through which it can pass. Such wide spatial range can make accurate identification and sizing of fish difficult, primarily because each fish may pass a camera at a wide range of focal lengths and angles. Providing lighting for this tunnel size and with adequate water penetration distance has also proven very difficult.

Another data accuracy problem experienced in 2007 was inconsistent salmonid counts between Priest Rapids and Wanapum dams. Because runs of spring and summer Chinook, steelhead, and coho are all destined for points upstream of both dams, the counts for these species and runs should be similar for both dams. It is suspected that, as a result of high water velocities in the section of the Wanapum fishways housing the VFC in-ladder camera boxes have led to the same fish being counted multiple times. Fish moving back and forth multiple times past the VFC window exhibit this behavior more frequently in some fishways than others, particularly in the east-bank fishway at Wanapum Dam. Fish move rapidly through a fishway when swimming downstream and, as a result, are difficult for fish counters to detect because recorded data are necessarily reviewed in a fast-forward mode. When these fish turn around and pass the VFC window again, they are detected by the fish counter and re-counted. If this occurs multiple times per fish, and with many different fish, inaccurate counts may result. Because data must be reviewed in a fast-forward mode in order for fish counts to be completed in a timely manner, slowing data playback during review is not a viable option. Grant PUD has determined that this back-and-forth fish behavior is the cause of elevated fish counts for some runs and species at Wanapum Dam.

6.0 VFC System Improvements in 2008

Grant PUD proposes to modify and relocate the VFC in-ladder infrastructure at Wanapum Dam for the 2008 fish-counting season. Moving the VFC cameras to the old manual-count station locations and reducing the number of cameras to one per fishway at Wanapum Dam is a relatively simple procedure and will facilitate more accurate fish counts. The following justifications support the new locations.

- The low-water velocities encountered here will eliminate the current-induced rapid speeds at which fish move downstream within the fishway. This will significantly reduce the likelihood of fish being counted multiple times as they pass back and forth past the window.

- The tunnel size can be smaller because water velocity is lower through these relatively slow sections of the fishways.

- The reduced tunnel size will facilitate accurate identification of fish and accurate classification of relative size (adult-versus-jack) because all fish will pass the

camera at the same focal length and within the same vertical plane, which will allow use of a fixed-ruler on the tunnel's background.

- Installing the camera windows near the surface of the water will allow natural ambient daylight to help illuminate the tunnels, thereby facilitating clearer and brighter conditions for fish identification, and reducing the reliance on artificial lighting during daylight hours.

- These sections of the fishways maintain a constant water elevation at all forebay elevations. This is not the case with fishway exits, which were considered as an alternative relocation site.

- A single-window system reduces the number of required video cameras, as well as requirements for associated peripheral equipment, data storage, and system maintenance.

- A single-window system will be consistent with the other two mid-Columbia PUD systems (Chelan and Douglas PUDs have one window and camera per fishway).

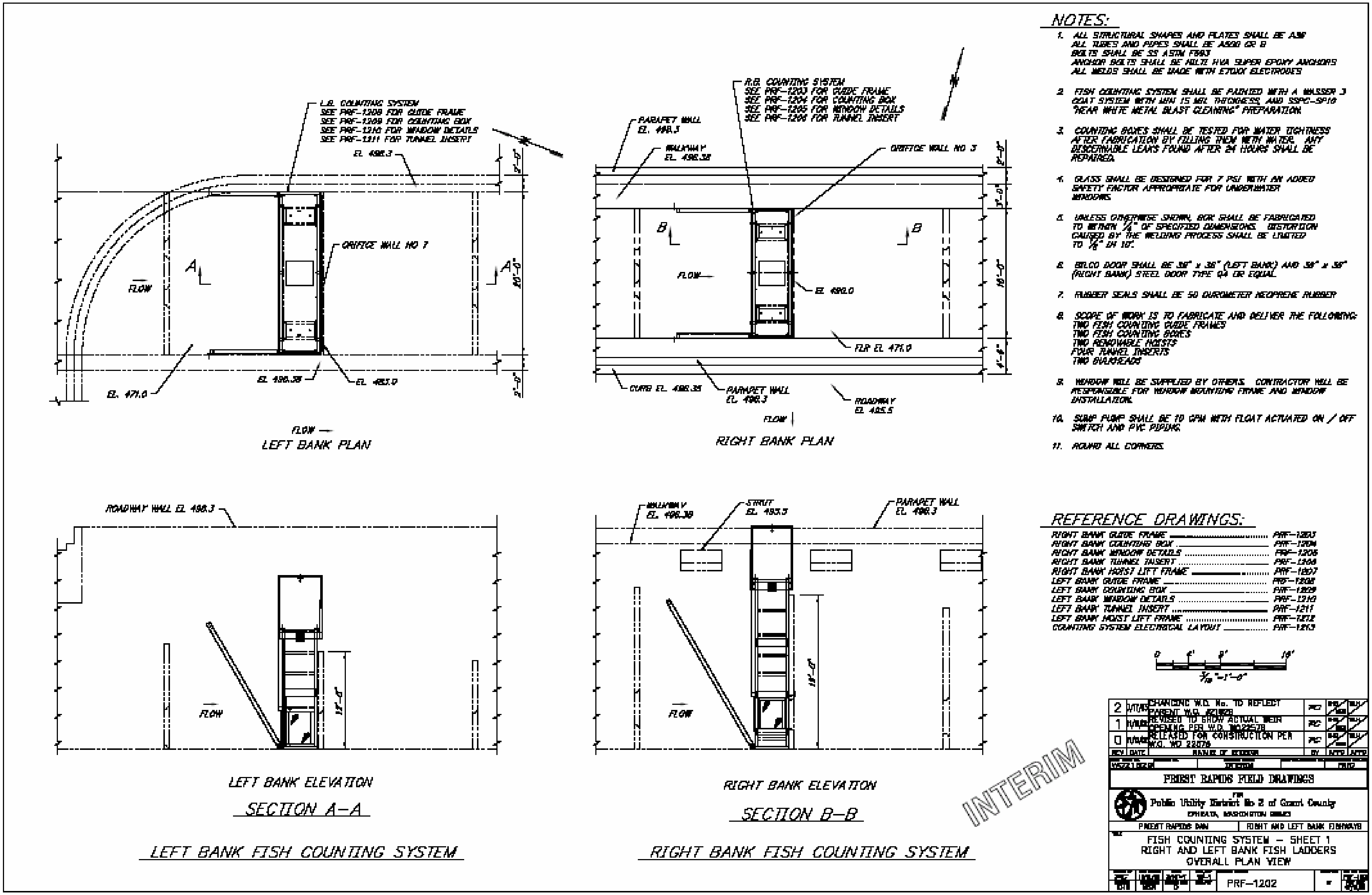
- The shallow positions of the windows and the lower water velocities will make window cleaning easier, leading to more thoroughly and frequently cleaned windows and thereby enhancing fish identification conditions.

- The proposed locations are where the historic manual-count boards were located. The historic mounting infrastructure is still imbedded in the concrete and can be used for mounting the new VFC infrastructure.

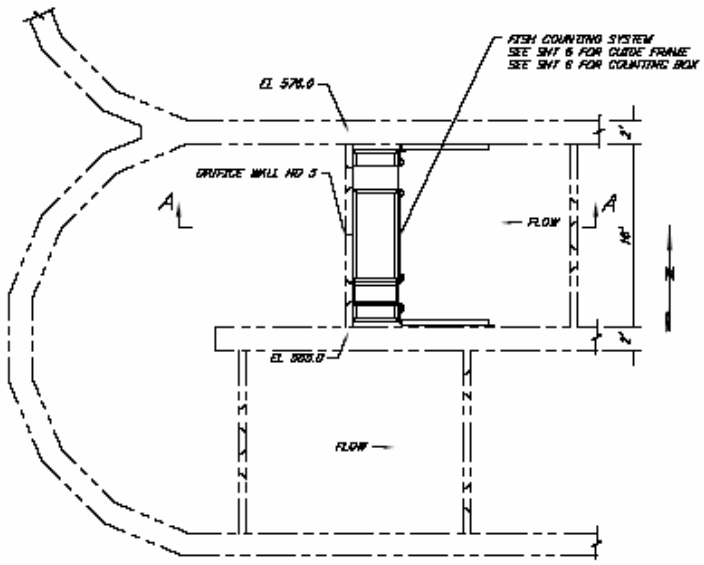
6.1 Quality Assessment/Quality Control

The data quality assessment/quality control protocol used for VFC-generated fish counts in 2007 involved comparisons of multiple counters reviewing the same data set, as time allowed. When large discrepancies were observed between a counter's work and the work of others, extra training and assistance were provided. Because all inter-counter comparisons have not yet been analyzed, a summary of comparisons is not available at this time.

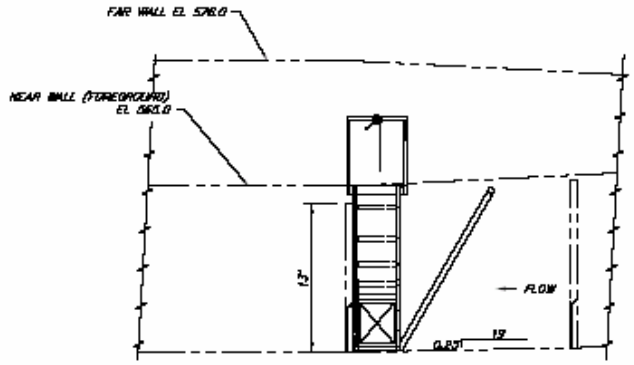
Appendix A
Priest Rapids Dam Fish Counting System – Sheet 1
Right and Left Bank Fish Ladders Overall Plan View


LEFT BANK PLAN
RIGHT BANK PLAN
LEFT BANK ELEVATION
SECTION A–A
RIGHT BANK ELEVATION
SECTION B–B
LEFT BANK FISH COUNTING SYSTEM
RIGHT BANK FISH COUNTING SYSTEM
ORIFICE WALL NO 7
ORIFICE WALL NO 3
FLOW
ROADWAY WALL EL 498.3
PARAPET WALL
WALKWAY
STRUT
NOTES:
1. ALL STRUCTURAL SHAPES AND PLATES SHALL BE A36
ALL TUBES AND PIPES SHALL BE A500 GR B
BOLTS SHALL BE SS ASTM F593
ANCHOR BOLTS SHALL BE HILTI HVA SUPER EPOXY ANCHORS
ALL WELDS SHALL BE MADE WITH E70XX ELECTRODES
2. FISH COUNTING SYSTEM SHALL BE PAINTED WITH A WASSER 3 COAT SYSTEM WITH MIN 15 MIL THICKNESS, AND SSPC-SP10 "NEAR WHITE METAL BLAST CLEANING" PREPARATION.
3. COUNTING BOXES SHALL BE TESTED FOR WATER TIGHTNESS AFTER FABRICATION BY FILLING THEM WITH WATER. ANY DISCERNABLE LEAKS FOUND AFTER 24 HOURS SHALL BE REPAIRED.
4. GLASS SHALL BE DESIGNED FOR 7 PSI WITH AN ADDED SAFETY FACTOR APPROPRIATE FOR UNDERWATER WINDOWS.
5. UNLESS OTHERWISE SHOWN, BOX SHALL BE FABRICATED TO WITHIN 1/4" OF SPECIFIED DIMENSIONS. DISTORTION CAUSED BY THE WELDING PROCESS SHALL BE LIMITED TO 1/8" IN 10'.
6. BILCO DOOR SHALL BE 36" x 36" (LEFT BANK) AND 36" x 36" (RIGHT BANK) STEEL DOOR TYPE Q4 OR EQUAL
7. RUBBER SEALS SHALL BE 50 DUROMETER NEOPRENE RUBBER
8. SCOPE OF WORK IS TO FABRICATE AND DELIVER THE FOLLOWING:
TWO FISH COUNTING GUIDE FRAMES
TWO FISH COUNTING BOXES
TWO REMOVABLE HOISTS
FOUR TUNNEL INSERTS
TWO BULKHEADS
9. WINDOW WILL BE SUPPLIED BY OTHERS. CONTRACTOR WILL BE RESPONSIBLE FOR WINDOW MOUNTING FRAME AND WINDOW INSTALLATION.
10. SUMP PUMP SHALL BE 10 GPM WITH FLOAT ACTUATED ON / OFF SWITCH AND PVC PIPING.
11. ROUND ALL CORNERS.
REFERENCE DRAWINGS:
RIGHT BANK GUIDE FRAME ... PRF-1203
RIGHT BANK COUNTING BOX ... PRF-1204
RIGHT BANK WINDOW DETAILS ... PRF-1205
RIGHT BANK TUNNEL INSERT ... PRF-1206
RIGHT BANK HOIST LIFT FRAME ... PRF-1207
LEFT BANK GUIDE FRAME ... PRF-1208
LEFT BANK COUNTING BOX ... PRF-1209
LEFT BANK WINDOW DETAILS ... PRF-1210
LEFT BANK TUNNEL INSERT ... PRF-1211
LEFT BANK HOIST LIFT FRAME ... PRF-1212
COUNTING SYSTEM ELECTRICAL LAYOUT ... PRF-1213
INTERIM
PRIEST RAPIDS FIELD DRAWINGS
Public Utility District No 2 of Grant County
PRIEST RAPIDS DAM
RIGHT AND LEFT BANK FISHWAYS
FISH COUNTING SYSTEM – SHEET 1
RIGHT AND LEFT BANK FISH LADDERS
OVERALL PLAN VIEW
PRF–1202

Appendix B
Wanapum Dam Fish Counting System
Right and Left Bank Fish Ladders Overall Plan View



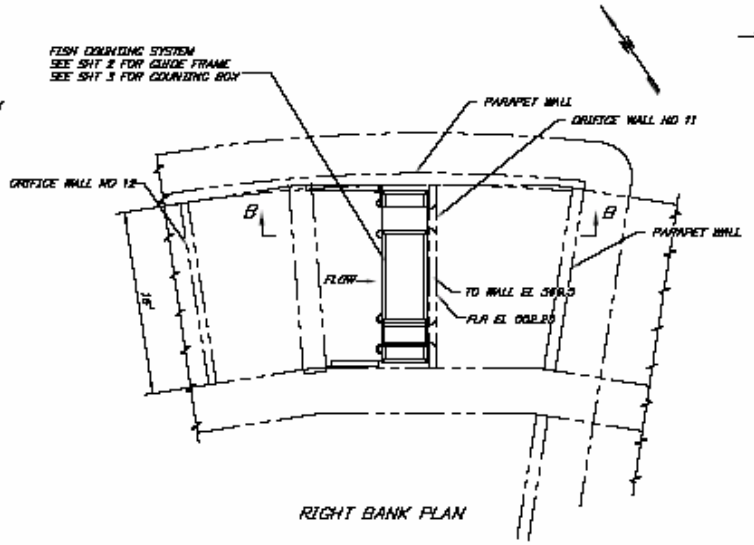
LEFT BANK PLAN



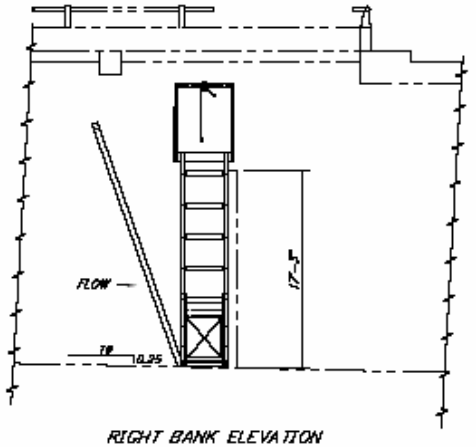
LEFT BANK ELEVATION

SECTION A–A

LEFT BANK FISH COUNTING SYSTEM



RIGHT BANK PLAN



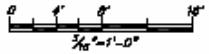
RIGHT BANK ELEVATION

SECTION B–B

RIGHT BANK FISH COUNTING SYSTEM

NOTES:

1. ALL STRUCTURAL SHAPES AND PLATES SHALL BE A36
   ALL TUBES AND PIPES SHALL BE A500 GR B
   BOLTS SHALL BE SS ASTM F593
   ANCHOR BOLTS SHALL BE HILTI HVA SUPER EPOXY ANCHORS
   ALL WELDS SHALL BE MADE WITH E70XX ELECTRODES
2. FISH COUNTING SYSTEM SHALL BE PAINTED WITH A WASSER 3 COAT SYSTEM WITH MIN 15 MIL THICKNESS, AND SSPC-SP10 "NEAR WHITE METAL BLAST CLEANING" PREPARATION.
3. COUNTING BOXES SHALL BE TESTED FOR WATER TIGHTNESS AFTER FABRICATION BY FILLING THEM WITH WATER. ANY OBSERVABLE LEAKS FOUND AFTER 24 HOURS SHALL BE REPAIRED.
4. GLASS SHALL BE DESIGNED FOR 7 PSI WITH AN ADDED SAFETY FACTOR APPROPRIATE FOR UNDERWATER WINDOWS.
5. UNLESS OTHERWISE SHOWN, BOX SHALL BE FABRICATED TO WITHIN 1/8" OF SPECIFIED DIMENSIONS. DISTORTION CAUSED BY THE WELDING PROCESS SHALL BE LIMITED TO 1/8" IN 10'.
6. BELCO DOOR SHALL BE 36" X 36" STEEL DOOR TYPE CH OR EQUAL.
7. ELECTRICAL AND LIGHTING WILL BE BY OTHERS
8. ACCESS TO COUNTING SYSTEM TO BE PROVIDED BY GRANT CO PUD. INSTALLATION TO BE PROVIDED BY GRANT CO PUD.
9. RUBBER SEALS SHALL BE 60 DUROMETER NEOPRENE RUBBER
10. SCOPE OF WORK IS TO FABRICATE AND DELIVER THE FOLLOWING
    TWO FISH COUNTING GUIDE FRAMES
    TWO FISH COUNTING BOXES
    FOUR REMOVABLE HOISTS
    FOUR TRAMMEL INSERTS
    TWO SLUICEHEADS
11. WINDOW WILL BE SUPPLIED BY OTHERS. CONTRACTOR WILL BE RESPONSIBLE FOR WINDOW MOUNTING FRAME AND WINDOW INSTALLATION.
12. SUMP PUMP SHALL BE 10 GPM WITH FLOAT ACTUATED ON / OFF SWITCH AND PVC PIPING.
13. ROUND ALL CORNERS.



REV	DATE	REVISION OF DESIGN	BY	APPD	ACCP
2	1/16/97	UPDATED TO P.U.D. STANDARDS PER W.O. WO 22579	JMC		
		AS-BUILT			HADA

HAEZA ENGINEERING COMPANY

Public Utility District No 2 of Grant County
EPHRATA, WASHINGTON 98823

WANAPUM DAM | RIGHT AND LEFT BANK FISHWAYS

FISH COUNTING SYSTEM
RIGHT AND LEFT BANK FISH LADDERS
OVERALL PLAN VIEW

DRAWN	TRACED	CHECKED	APPROVED	DRAWING NO.	SHEET NO.	REV
SK	SK	D		D1	1	2

Appendix C
Video Fish-Counting System User Instructions

VFC System User's Guide

Grant County Public Utility District

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1.0 Introduction

Grant PUD began development of a video fish-counting (VFC) system in 1996 at Wanapum Dam. In 2004 the National Marine Fisheries Service issued reasonable and prudent alternative 24 within its biological opinion, which required Grant PUD to have a VFC system in place at Priest Rapids and Wanapum dams by 2006. VFC systems were in place and operational by the beginning of the fish passage season on April 15, 2006. The VFC system configuration at each dam involved digital video cameras in each fishway streaming data to processing computers in rooms at each dam. These processing computers then ran the data through a motion-filtering algorithm and separated the data into those containing movement and those not containing movement. The data containing movement were then viewed by fish counting staff at a central location via networked desktop computers, and the number and species of fish observed were tallied. The VFC system at Wanapum Dam experienced major malfunctions in 2006 and fish counts from that facility were not produced. The VFC system at Priest Rapids Dam was considerably more reliable and all efforts in 2006 were switched to maintaining that system but problems were still experienced, which forced the search for a new fish-counting method.

In 2007 Grant PUD transitioned to a high-quality digital video recorder (DVR) -based system to assist in the counting of adult fish passing Priest Rapids and Wanapum dams. Microsoft Windows-based computers are used to playback digital video that has been captured on the DVRs, and also to allow users to count fish via a simple fish-tallying interface. This system is intended to allow a fish counter to view and tally 24 hours-worth of fish passage during an eight-hour shift. During periods of high fish passage, it is expected that longer shifts will be required in order to complete a 24-hour period of fish counts.

2.0 System Configuration

The layout of the in-ladder equipment is outlined in Figure 1. Each dam has two fishways, and each fishway has a steel box installed in its orifice-weir-only section. The box's bottom rests on the bottom of the fishway and extends above the water level. Each box houses two digital video cameras, which makes a total of eight cameras between both dams.

Table 1 Fishway locations of VFC cameras.

Left-bank Fishways	Right-bank Fishways
green cameras	orange cameras
red cameras	blue cameras

The cameras within the left-bank fishway at each dam are named red and green. The cameras within the right-bank fishway at each dam are named orange and blue.

Fish must pass through tunnels along the ends of the box that align with the existing orifice weir openings. As fish pass through the tunnels, which are lit by lights around the inside of the glass windows, they are captured by a constantly-running digital video camera that faces each

window. The streaming digital data from each camera is sent to its respective dam's DVR for temporary storage. Fish counters then view these data on the DVR and count any fish observed. When no fish are being observed by fish counters during playback the data is played back at faster than real-time speed. If a fish is seen and cannot be identified at that playback speed, the fish counter can reverse playback and take a better look. By playing back fish passage recordings at faster than real-time speeds, fish counts can be completed in a significantly reduced time frame in comparison to conducting real-time counts.

The DVRs from both dams are networked with the fish-counting workstations located in the VFC room at Priest Rapids Dam. This computer network allows fish counting for both dams to occur within the VFC room at Priest Rapids, or any other computer configured to be on the network.

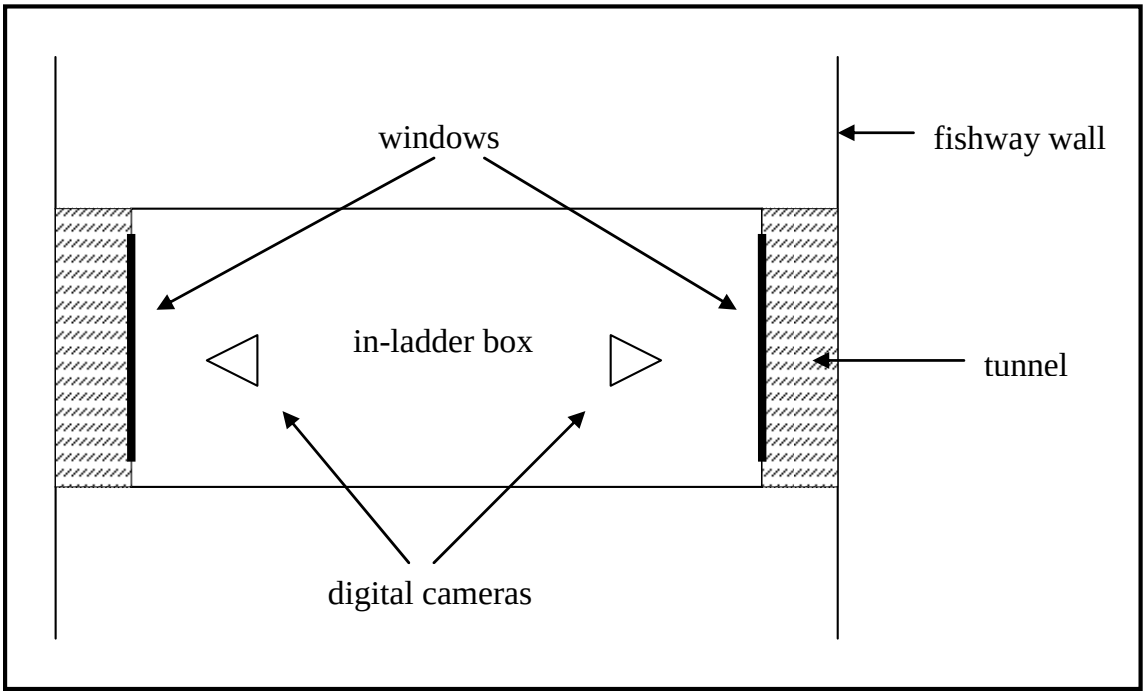


Figure 1 Schematic of in-ladder camera box and cameras.

3.0 Daily Start-up and Reviewing Fish Passage Data

Playback of data on the DVR is done with a fish-counting workstation computer via a program called NetVu. Stepwise instructions of how to playback data are outlined below.

1. Move the mouse to awaken the computer, or power on the computer, if necessary.
2. Enter the password onefishtwofish. Hit 'Enter'. Wait for the computer to warm up.
3. Lauch the DM NetVu program by double-clicking the DM NetVu observer icon.
4. Once NetVu has loaded, double-click Priest Rapids or Wanapum in the tree on the top-left part of the screen, depending on which dam's data you will review.
5. Single-click your camera color from the expanded tree. Make sure it is highlighted.
6. Go to the date/time bar in the lower center part of the screen. Click on the drop-down arrow on the right-hand side of the date/time bar.

7. Select the date from which you wish to view data from the calendar by single clicking it. Make sure it highlights in yellow.
8. Enter the time in 24-hour format for which you wish to begin viewing data. You can select that time by clicking on the up/down arrows next to the hh:mm:ss fields; click-and-drag within each time field to highlight the field, then type in your desired time; click within the field then use the backspace or delete keys to clear the field before typing in your desired time. Once you have enter your desired time, click O.K.
9. Confirm you are now set to view data from the correct dam, camera, date and time by checking the respective displays on your screen.
10. Set your ffwd/rwd speed to 4x by clicking and dragging the control slider. Remember, if you click on >> (ffwd) once it's in ffwd mode, your ffwd speed will increase each time you click. Do not view data at a rate faster than 4x or you may miss fish.
11. Normally view the data at 4x ffwd. speed and watch for fish.

If you are unable to accurately identify a fish that passes your screen at this speed, reverse the playback then slow it down when the fish comes by again. After you have identified and tallied the fish, resume 4x playback speed.

4.0 Tallying Fish via FishCount

From the computer's desktop, double-click the FishCount icon, which will launch the FishCount program. This is the program you will use to actually count fish. Position the FishCount window over the NetVu window's right-hand side by clicking and dragging the FishCount window by its title bar. This will enable you to see the NetVu screen and the FishCount window simultaneously.

1. Set Date and Camera. Along the top of the FishCount application's window you can see two fields: Date and Camera. It is ***critical*** that you set these fields to match what you are viewing within NetVu. Example - if you are viewing WANorange data from 8/13/07 within NetVu, set the date to 8/13/07 and camera to WANorange within FishCount. Use the drop-down menus to set these fields.

2. Tally Fish. You can tally fish by either clicking on the virtual form's fish species categories and directions with the mouse, or by using the programmed keys on the keyboard. Do not worry about fishes' upstream travel versus downstream travel; the program knows which is up/downstream based on the camera being viewed.

>Using the Mouse. When a passing fish is observed, simply click on the species designation within the form, making sure the circle adjacent to the selection fills with green, then click on the direction the fish traveled across the window (left or right). Example - if an adult Chinook swims across the screen from the right-hand side to the left-hand side, click on 'Chinook adult', then the button 'left'.

>Using the Keyboard. Specific keys have been programmed to represent fish species designations. Striking a fish species key will tally that fish traveling to the left. Holding the 'Shift' key while simultaneously striking a fish species key will tally fish traveling to the right. Example - striking the 'a' key will tally a Chinook adult traveling left. Holding the 'shift' key and

simultaneously striking the 'a' key will tally a Chinook adult traveling right. Table 1 outlines the fish species you may encounter, and their designated keyboard keys.

Note: *Always make certain the FishCount window is active (its title bar is bright blue) when tallying fish via the keyboard*. If the FishCount window is not active when you tally fish using keyboard keys, the key strokes will not be recognized by the program and the fish will not be tallied. Click anywhere in the window to make it active.

Table 2 Fish species likely to be encountered, and their respective keyboard designations.

Chinook adult	a		Shad	w
Chinook adult ad. Clip	s		Lamprey	e
Chinook jack	d		Whitefish	t
Chinook jack ad clip	f		Sturgeon	p
Chinook mini-jack	g		Bull trout	o
Chinook mini-j ad clip	h		Trout	i
Coho adult	j		Pikeminnow	u
Coho adult ad clip	k		Walleye	y
Coho jack	l		Bass	1
Coho jack ad clip	z		Crappie	2
Coho mini jack	x		Bluegill	3
Coho mini jack ad clip	c		Catfish	4
Sockeye	v		Yellow perch	5
Sockeye ad clip	b		Carp	6
Steelhead	n		Sucker	7
Steelhead ad clip	m		Misc. minnow	8
Unidentified salmon	q		Bullhead	9

Viewing Your Daily Tally. Simply click the 'Show Count' button on the FishCount virtual form to view a table showing the number of fish you have counted by species and by camera that day.

5.0 Daily Shutdown

At the end of a shift, once all of the previous day's fish passage data have been reviewed, close all programs and log off of the computer workstation.

To close the FishCount application click on the red X found at the top right-hand corner of the FishCount window.

To close the NetVu application, click on the 'File' menu found at the top left-hand corner of the NetVu window, then click on 'Exit'.

To log off of the computer workstation, click on the 'Start' menu found in the lower left-hand corner of the desktop. Select log off. You should shutdown and power off the computer workstation approximately once per week.

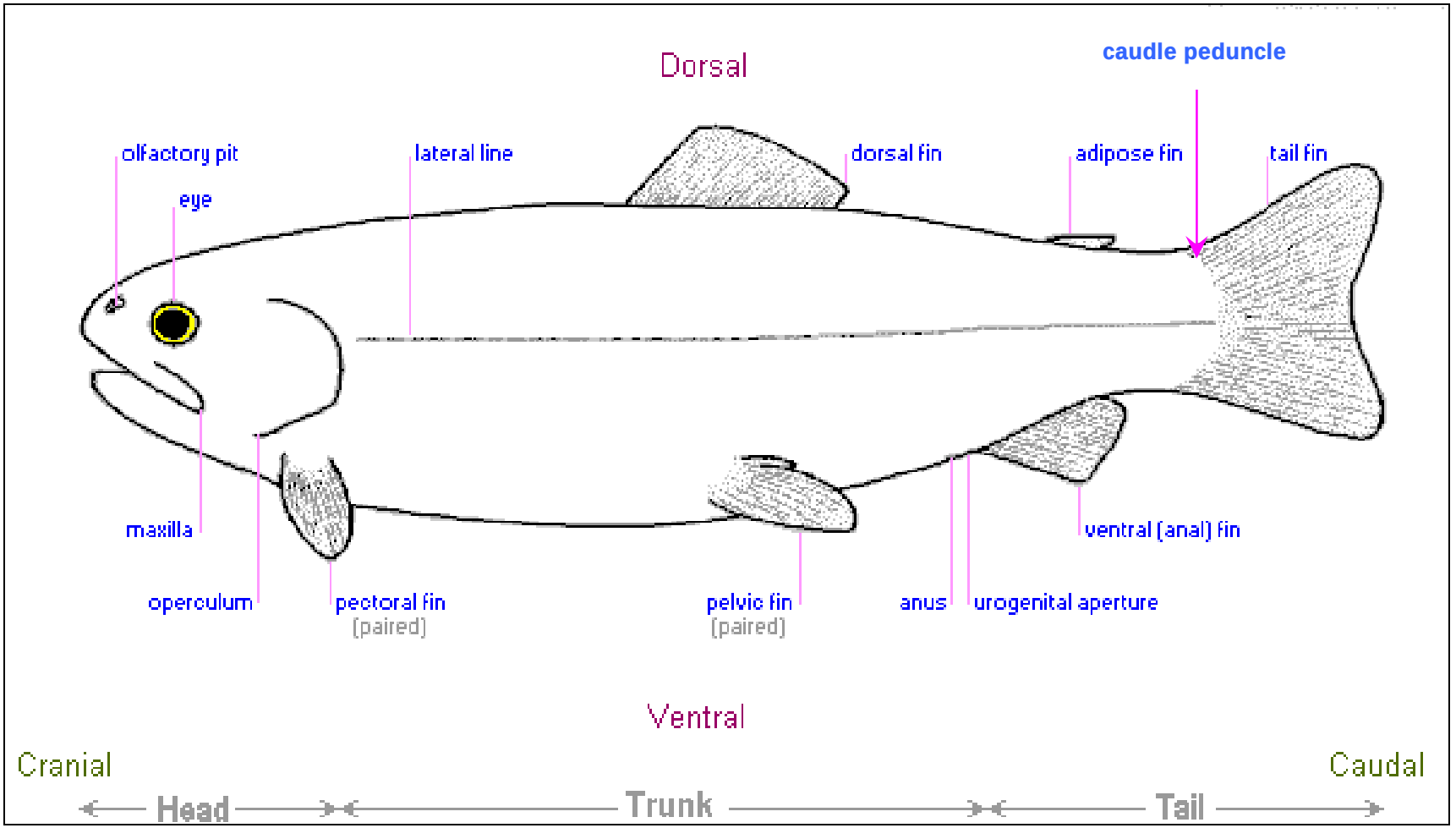
sockeye salmon
(body spotless; large, golden eye)

coho salmon
(light mouth, white gums; wider caudle peduncle than Chinook)

Chinook salmon
(dark mouth, black gums; narrow caudal peduncle)

(photos from WDFW http://wdfw.wa.gov/fish/identification/pac_salmon.htm)

General Fish Anatomy



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Appendix D
Example of Fish-Count Report

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
138			CHINOOK						COHO						SOCKEYE		STEELHEAD		BULL TROUT		TOTALS			SHAD		STURGEON		LAMPREY		
139	DATE		ADULT		JACK		MINI JACK		ADULT		JACK		MINI JACK		ADULT						LEFT	RIGHT	COMBINED	ADULT						GRAND
140			LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	BANK	BANK		LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	TOTAL
141	1-Jul-07		771	389	0	4	0	0	0	0	0	0	0	0	956	332	12	2	0	0	1739	727	2466	128	0	0	0	2	0	2596
142	2-Jul-07		445	931	13	1	0	0	0	0	0	0	0	0	1212	252	16	1	0	0	1686	1185	2871	0	0	0	0	1	0	2872
143	3-Jul-07		656	579	3	16	0	0	0	0	0	0	0	0	1142	254	7	5	0	0	1808	854	2662	134	1	0	0	0	0	2797
144	4-Jul-07		428	355	4	2	0	0	0	0	0	0	0	0	1074	390	2	3	0	0	1508	750	2258	-1	2	0	0	0	1	2260
145	5-Jul-07		733	630	3	10	0	0	0	0	0	0	0	0	1013	410	5	2	0	0	1754	1052	2806	70	1	0	0	2	1	2880
146	6-Jul-07		1183	443	9	0	0	0	0	0	0	0	0	0	1405	156	11	2	0	0	2608	601	3209	65	0	0	0	7	1	3282
147	7-Jul-07		540	386	2	3	2	0	0	0	0	0	0	0	916	113	9	7	0	0	1469	509	1978	3	17	0	0	8	0	2006
148	8-Jul-07		395	521	0	0	0	0	0	0	0	0	0	0	829	172	22	0	0	0	1246	693	1939	0	0	0	0	3	2	1944
149	9-Jul-07		525	443	9	5	0	0	0	0	0	0	0	0	786	136	19	14	0	0	1339	598	1937	1	0	0	0	2	1	1941
150	10-Jul-07		580	212	1	1	1	0	0	0	0	0	0	0	764	188	22	3	0	0	1368	404	1772	99	0	0	0	4	1	1876
151	11-Jul-07		534	160	3	8	0	0	0	0	0	0	0	0	770	23	20	2	0	0	1327	193	1520	5	1	0	0	3	0	1529
152	12-Jul-07		679	181	0	0	0	0	0	0	0	0	0	0	585	36	43	1	0	0	1307	218	1525	137	0	0	0	4	0	1666
153	13-Jul-07		813	38	9	0	0	0	0	0	0	0	1	0	800	52	21	8	0	0	1644	98	1742	33	0	0	0	8	1	1784
154	14-Jul-07		541	110	3	0	0	0	0	0	0	0	0	0	469	16	18	4	0	0	1031	130	1161	1	0	0	0	6	1	1169
155	15-Jul-07		551	333	6	0	0	0	0	0	0	0	0	0	253	39	13	7	0	0	823	379	1202	0	14	0	0	10	1	1227
156	16-Jul-07		307	72	2	1	1	1	0	0	0	0	0	0	338	19	24	4	0	0	672	97	769	20	0	0	0	4	1	794
157	17-Jul-07		485	117	3	0	3	0	0	0	0	0	0	0	258	49	42	4	0	0	791	170	961	0	3	0	0	2	0	966
158	18-Jul-07		417	138	5	5	0	2	0	0	0	0	0	0	267	62	61	8	0	0	750	215	965	4	0	0	0	3	0	972
159	19-Jul-07		532	284	7	0	2	0	0	0	0	0	0	0	314	64	31	8	0	0	886	356	1242	-1	1	0	0	6	1	1249
160	20-Jul-07		432	243	16	0	4	1	0	0	0	0	0	0	299	37	29	8	0	0	780	289	1069	0	0	0	0	7	3	1079
161	21-Jul-07		273	265	3	0	8	0	0	0	0	0	0	0	223	47	46	15	0	0	553	327	880	0	4	0	0	5	3	892
162	22-Jul-07		254	199	8	1	12	0	0	0	0	0	0	0	225	28	35	8	0	0	534	236	770	0	0	0	0	8	0	778
163	23-Jul-07		153	152	9	0	15	0	0	0	0	0	0	0	154	35	40	10	0	0	371	197	568	0	0	0	0	9	1	578
164	24-Jul-07		204	169	3	0	2	0	0	0	0	0	0	0	206	28	36	4	0	0	451	201	652	0	0	0	0	12	1	665
165	25-Jul-07		300	144	3	0	0	0	0	0	0	0	0	0	133	28	53	9	0	0	489	181	670	7	0	0	0	13	5	695
166	26-Jul-07		233	91	5	2	0	1	0	0	0	0	0	0	106	11	91	10	0	0	435	115	550	0	0	0	0	19	0	569
167	27-Jul-07		260	70	26	0	2	0	0	0	0	0	0	0	88	7	43	8	0	0	419	85	504	9	0	0	0	23	0	536
168	28-Jul-07		255	98	16	0	8	0	0	0	0	0	0	0	77	7	71	9	0	0	427	114	541	29	0	0	0	18	0	588
169	29-Jul-07		442	125	4	1	2	0	0	0	0	0	0	0	85	14	84	14	0	0	617	154	771	3	1	0	0	25	1	801
170	30-Jul-07		389	164	12	1	0	0	0	0	0	0	0	0	34	2	95	12	0	0	530	179	709	17	0	0	0	13	0	739
171	31-Jul-07		252	125	10	3	3	0	0	0	0	0	0	0	54	11	88	13	0	0	407	152	559	0	0	0	0	18	1	578
172	TOTAL		14562	8167	197	64	65	5	0	0	0	0	1	0	15835	3018	1109	205	0	0	31769	11459	43228	763	45	0	0	245	27	44308
173			22729		261		70		0		0		1		18853		1314		0		73.5%	26.5%		808		0		272		