Yakima and Touchet River Basins Phase II Fish Screen Evaluation

Annual Report 2006 - 2007

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**Yakima and Touchet River Basins
Phase II Fish Screen Evaluations in 2006**

Annual Report

April 2006 – April 2007

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Summary

In 2006, Pacific Northwest National Laboratory (PNNL) researchers evaluated 27 Phase II fish screen sites in the Yakima and Touchet river basins. Pacific Northwest National Laboratory performs these evaluations for Bonneville Power Administration (BPA) to determine whether the fish screening devices meet those National Marine Fisheries (NMFS) criteria for juvenile fish screen design, that promote safe and timely passage of juvenile salmonids.

The NMFS criteria against which the sites were evaluated are as follows:

- a uniform flow distribution over the screen surface to minimize approach velocity
- approach velocities less than or equal to 0.4 ft/s protects the smallest salmonids from impingement
- sweep velocities that are greater than approach velocities to minimize delay of out-migrating juveniles and minimize sediment deposition near the screens
- a bypass flow greater than or equal to the maximum flow velocity vector resultant upstream of the screens to also minimize delay of out-migrating salmonids
- a gradual and efficient acceleration of flow from the upstream end of the site into the bypass entrance to minimize delay of out-migrating salmonids
- screen submergence between 65% and 85% for drum screen sites.

In addition, the silt and debris accumulation next to the screens should be kept to a minimum to prevent excessive wear on screens, seals and cleaning mechanisms.

Evaluations consist of measuring velocities in front of the screens, using an underwater camera to assess the condition and environment in front of the screens, and noting the general condition and operation of the sites.

Results of the evaluations in 2006 include the following:

- Most approach velocities met the NMFS criterion of less than or equal to 0.4 ft/s. Of the sites evaluated, 31% exceeded the criterion at least once. Thirty-three percent of flat-plate screens had problems compared to 25% of drum screens.
- Woody debris and gravel deposited during high river levels were a problem at several sites. In some cases, it was difficult to determine the bypass pipe was plugged until several weeks had passed. Slow bypass flow caused by both the obstructions and high river levels may have discouraged fish from entering the bypass, but once they were in the bypass, they may have had no safe exit. Perhaps some tool or technique can be devised that would help identify whether slow bypass flow is caused by pipe blockage or by high river levels.
- Bypass velocities generally were greater than sweep velocities, but sweep velocities often did not increase toward the bypass. The latter condition could slow migration of fish through the facility.
- Screen and seal materials generally were in good condition.
- Automated cleaning brushes generally functioned properly; chains and other moving parts were typically well-greased and operative.

- Washington Department of Fish and Wildlife (WDFW) and U.S. Bureau of Reclamation (USBR) generally operated and maintained fish screen facilities in a way that provided safe passage for juvenile fish.
- Efforts with WDFW to find optimal louver settings at Naches-Selah were partly successful. The number of spots with excessive approach velocities was decreased, but we were unable to adjust the site to bring all approach values below 0.4 ft/s.
- In some instances, irrigators responsible for specific maintenance at their sites (e.g., debris removal) did not perform their tasks in a way that provided optimum operation of the fish screen facility. Enforcement personnel proved effective at reminding irrigation districts of their responsibilities to maintain the sites for fish protection as well as irrigation.
- We recommend placing datasheets providing up-to-date operating criteria and design flows in each site's logbox. The datasheet should include bypass design flows and a table showing depths of water over the weir and corresponding bypass flow. A similar datasheet relating canal gage readings and canal discharge in cubic feet per second would help identify times when the canal is taking more water than it should. This information is available at some of the sites and assists operators in determining if the site is running within the site specific design criteria.
- Data were collected at Gleed when the protective metal plates were set down to the forebay floor and when they were raised to expose most of the screens. These data were sent to USBR personnel for use in looking for ways to reduce high approach velocities and erratic flow pattern at Gleed.
- Alternatives to a screen site at Taylor are apparently being considered. A lot of effort was spent in 2005 and 2006 trying to increase water to the site, but it still was unable to operate within NMFS criteria for much of the year and may be a hazard to juvenile salmonids at times.

Conditions at most Phase II sites evaluated by PNNL in 2006 would be expected to provide safe passage for juvenile fish. We were not able to coordinate with the WDFW and USBR in 2006 to find solutions to the problems at Congdon, Union Gap, and Yakima-Tieton. If time allows, it may be possible to monitor changes in louvers or stoplogs at these sites and provide immediate feedback on the effects on approach velocities. Perhaps optimal settings can be found for these sites so they meet the NMFS design criteria.

Pacific Northwest National Laboratory has performed evaluations at many of these sites over the past 10 years, providing information WDFW and USBR personnel can use to perform their work related to design, operations, and maintenance of Phase II fish screen facilities more effectively. Bonneville Power Administration also learns the effectiveness of some of the mitigation and operations and maintenance projects they fund. Consequently, overall effectiveness of the screens facilities has improved over time.

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Abbreviations and Acronyms

ADV	acoustic Doppler velocimeter
BPA	Bonneville Power Administration
cfs	cubic feet per second
fps	feet per second
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPPC	Northwest Power Planning Council
O&M	operations and maintenance
PNNL	Pacific Northwest National Laboratory
RMS	root mean square
USBR	U.S. Bureau of Reclamation
WDFW	Washington Department of Fish and Wildlife
WIP	Wapato Irrigation Project

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1.0 Introduction

Irrigation has played an important role in the development of the middle Columbia River basin. Water has been diverted from western rivers since the mid-1850s to irrigate crops. During the 1920s, some of these diversions were equipped with fish-protection devices, but it was not until the Mitchell Act of 1938 provided funding to protect fish that screening irrigation diversions and evaluating their effectiveness truly got under way (Bryant and Parkhurst 1950; McMichael et al. 2004).

In more recent history, the Bonneville Power Administration (BPA), under guidance from the Northwest Power and Conservation Council (NPCC, formerly the Northwest Power Planning Council [NPPC]) expanded screening efforts to protect and enhance fish populations. The NPCC Columbia River Fish and Wildlife Program lists effective screening of irrigation diversions as an essential element in its plan to restore declining steelhead and salmon runs (NPPC 1984, 1987, 1994, 2000).

Research on the effectiveness of fish-screening devices initiated changes in design and operating procedures of screening facilities over the years. For example, maximum allowable screen size openings decreased as protecting fish at their earliest developmental stages became a concern. These and other new requirements for fish protection are developed by the National Marine Fisheries Service (NMFS 1995)^(a) and adopted by individual state agencies. In addition, the BPA has established a monitoring and evaluation program to ensure that new and updated screening facilities meet current fish protection standards.

The NMFS criteria for juvenile fish screen site design can be used to define velocity and general operational conditions that would be expected to promote safe fish passage through Phase II screen sites (NMFS 1995). These include the following:

- a uniform flow distribution over the screen surface to minimize approach velocity
- approach velocities less than or equal to 0.4 ft/s
- sweep velocities that are greater than approach velocities
- a bypass flow greater than or equal to the maximum flow velocity vector resultant upstream of the screens (generally the sweep velocity)
- a gradual and efficient acceleration of flow from the upstream end of the site into the bypass entrance to minimize delay of emigrating salmonids
- screen submergence between 65% and 85% for drum screen sites.

Silt and debris accumulation near the screens contributes to wear on screens, seals and cleaning mechanisms and could cause approach velocity “hot” spots and should be kept to a minimum.

As a part of the BPA monitoring and evaluation program, Pacific Northwest National Laboratory (PNNL) researchers have conducted fish screen evaluations in the Yakima River basin since 1985. Initially, PNNL monitored Phase I screening facilities to determine whether fish that entered irrigation canals were guided back to the river safely (Neitzel et al. 1985, 1987, 1988, 1990a, 1990b). Additional

(a) Although the NMFS now is known as the National Oceanic and Atmospheric Administration (NOAA) Fisheries, criteria were issued under the NMFS and are referred to as such in this report.

studies examined water velocities in front of the screens to determine whether NMFS criteria were being met (Abernethy et al. 1989, 1990). Two studies conducted at the PNNL Aquatics Laboratory in Richland, Washington, used modular drum screens constructed by the Washington Department of Fish and Wildlife (WDFW) to determine fish survival through submerged orifices and the relative effectiveness of two screen configurations at bypassing fish (Abernethy et al. 1996; Neitzel et al. 1997). The methods currently used for evaluating screening facilities were developed while these earlier studies were conducted, then refined over the next several years (Blanton et al. 1998, 1999, 2000; McMichael et al. 2004). Results of previous evaluations can be found in the documents by Blanton as well as in Chamness et al. (2001), Carter et al. (2002, 2003), and Vucelick et al. (2004, 2005).

As the Phase II screening program continued, PNNL evaluated more sites for the BPA. In 2000, 21 Phase II sites were evaluated. The Powell-LaFortune and Wilson Creek sites were added in 2001, and Packwood and Selah-Moxee were added in 2004, for a total of 25 sites. For 2005, the new Huntsville Mill site on the Touchet River was added, while the Bull Ditch site, which was removed in September 2004, was taken off our list. The last of the Phase II sites, Fogarty Ditch, was completed early in 2006 and added to the schedule. Old Union, an older Phase II site that had never been evaluated, also was added in 2006.

The evaluations of these sites addressed two main questions:

1. Are screens designed, operated, and maintained to meet NMFS criteria over a wide range of conditions?
2. Are screen sites effective at protecting fish from injury and from unnecessary migration delay?

In this report, PNNL compares the field measurements of water velocity, underwater video, and general data observations collected for each screen site in 2006 to the NMFS criteria and to previous screening facility performance evaluations. Methods used to collect data are described in Section 2.0. In Section 3.0, results common to many of the sites are provided. This is followed by the results of evaluations at each site, with comparisons to previous years and to NMFS criteria, as well as each site's overall conditions and general observations.

2.0 Methods

Twenty-six operating screen sites in the Yakima River basin (Figure 2.1) and one site in the Touchet River basin (Figure 2.2) were evaluated at least three times each between May 15 and September 21, 2006. Pacific Northwest National Laboratory researchers collected three types of data at each site, including water velocity measurements, underwater video recordings of conditions, and observations of general operational indicators (e.g., screen submergence, bypass conditions, fish presence). Equipment and techniques used to collect these data are provided in the following sections.

Figure 2.1. Yakima River Basin Phase II Fish Screen Facilities

Figure 2.2. Huntsville Mill Fish Screen Location in the Touchet River Basin

2.1 Water Velocity Measurements

Water velocities in front of the screens and in the bypass are measured using a SonTek acoustic Doppler velocimeter (ADV). The ADV emits sound at 10 kHz. The frequency of the returning sound waves increases or decreases depending on whether the water is flowing toward or away from the ADV receiver. The difference between the emitted frequency and the received frequency is used to calculate the velocity of the water. The probe uses three receivers extending out at an angle from the transmitter to calculate the three-dimensional water velocity at a point 10 cm below the probe.

As shown in Figure 2.3, the ADV probe is mounted securely to a horizontal metal arm extending approximately 12 in. from a vertical pole. The probe sits upstream or to the side of the vertical pole to minimize interference when velocity readings are taken. The length of the horizontal arm and its position on the vertical pole are adjustable. Velocities typically are recorded at each sampling point along the screen for 30 s at a rate of 2 Hz (this provides 60 data points in 30 seconds at each sampling point) and stored in a computer file. Turbulence, as measured by the root mean square (RMS) of velocity fluctuations about the mean measured velocity, is calculated by the software and stored with the data. Velocity and associated turbulence data are plotted and presented by site in Section 3 of this report.

Figure 2.3. Acoustic Doppler Velocimeter Probe Equipment

All measurements are taken with the axes of the probe oriented to measure water flowing parallel (sweep) and perpendicular (approach) to the screen face. Measurements of water velocity are taken at two to five evenly spaced points along the front of each screen and in the entrance to the fish bypass. At drum screen, vertical traveling screen and some vertical flat-plate sites the vertical pole is placed close to but not touching the front surface of the screen. The cross-arm is parallel to the screen face, and the probe is positioned as close to the screen surface as possible, usually about 3 in., although the curve of the drum screen prevents the probe from getting that close at lower positions.

At most vertical flat-plate screens, automated sweeper arm brushes keep the screens clean. The rails that support the sweeper arm keep the vertical probe pole at least 8 in. away from the screen face. This year, in an effort to get the probe closer to the screen face, we reconfigured the probe and placed the cross-arm perpendicular to the screen face. This allows the probe to be within 3 in. of the screen face. At a few

sites (i.e., Younger, Packwood), with multiple brushes and a short stroke, it is too difficult to get the probe in place and record data before the next brush gets too close.

Probe height depends on depth of water in the forebay. If the distance between water surface and the sill on which the screen sits is less than 48 in., one measurement is made at 0.6 depth from the surface. If the distance is greater than or equal to 48 in., measurements are taken at 0.2 and 0.8 depths from the surface. Bypass velocities are measured with the probe at the same positions as the other measurements. The pole is set inside the bypass entrance with the probe pointing toward the forebay.

When the screen site is operating, flow measurements are taken in front of every screen during site visits. Automatic cleaning brushes are usually turned off during velocity measurements, while drum screens are allowed to operate normally during measurements. Sweep and approach velocities are measured during each visit if the site is operational.

Graphical representations of velocity data include lines for mean sweep and approach velocity measurements, a reference line at 0.4 ft/s (which represents the NMFS criterion for approach velocity), and a shaded area representing sediment accumulation in front of the screens as estimated with the support pole for the velocity probe, where the pole came to rest on the sill and in the bypass. The error bars on the velocity graphs represent the RMS, or turbulence, about the mean velocity.

2.2 Underwater Video Evaluations

Underwater video is used to inspect the conditions of the seals, to look for gaps between the seals and the screens that could allow small fish to pass through the site into the canal or be entrained or otherwise harmed, to record fish presence at the sites, and to monitor and document sediment and debris accumulation in front of the screens. The latter is important because debris can severely decrease seal life, cause drag on screen motors, and provide cover for fish predator species.

The video system consists of a digital deep-sea camera (DeepSea Power and Light, Inc., Model MULTI-SEACAM 1050) connected to a digital video recorder (Sony Video Walkman, Model GV-D800), which, in turn, is connected to a pair of video glasses (Olympus Eye-Trek, Model FMD-200; Figure 2.4). The advantage of this system is that it allows the person operating the camera to see underwater in real time, thus providing better video quality and a greater potential for problem identification. In addition, the end product of this system is digital video, which greatly improves the quality of still pictures captured from the video.

The camera is mounted securely on a vertical pole and adjusted as needed at each site. The camera is usually angled slightly downward to look for potential gaps between the screen and the bottom seal. The camera is usually moved from upstream to downstream, following the side and bottom seal/screen interfaces. The bypass also is inspected, looking both upstream and downstream for signs of excessive debris, the position of the flush gate (if present), and fish presence.

Written observations are made in the field when something of interest is seen with the camera (i.e., debris, gaps, and fish). All videos are later reviewed in detail, and images of interest are digitally captured using VideoWave image-capturing software (Roxio Labs).

2.3 General Data

In addition to the velocity data and videotapes, information is recorded on the general condition and environment at the sites. This information includes

- general site descriptions and photographs
- screen and seal conditions
- screen submergence levels
- cleaning system operation and occurrence of head loss across the screen face
- bypass conditions

Figure 2.4. Underwater Video System

- bypass outfall conditions
- caulking between drum screen frame and cement structure
- fish presence
- observations of debris or sediment in the forebay, bypass, or outfall
- presence or absence and condition of operator control aids such as water gages and drum submergence marks on screen frames.
- any interesting notes recorded in the onsite log book.

For our evaluations, the accumulation of silt and/or debris is considered excessive if the intersection of the seal and the screen is buried, or if the debris impacts the ability of the site to pass fish safely.

2.4 Problem Tracking

A problem identification and tracking program was implemented in 2002 in response to comments from the NPPC Independent Scientific Review Panel. The problem tracking program provides increased accountability of operations and maintenance in situations where problems could be fixed within the season. When a problem such as a blocked bypass or excessive submergence is identified at a screen site, field personnel immediately notify the responsible operations and maintenance (O&M) agency (Table 2.1), which is asked to notify PNNL when the problem is rectified or when a repair schedule is implemented. When PNNL receives notice that a problem is fixed, the site is reevaluated to determine whether operating conditions met NMFS design criteria for safe fish passage.

Table 2.1. Agency Responsible for the Operation and Maintenance of Each Fish Screen Facility

Fish Screen Facility	Responsible Agency	Fish Screen Facility	Responsible Agency
Bachelor-Hatton	USBR	New Cascade	WDFW
Clark	WDFW	Old Union	WDFW
Congdon	WDFW	Packwood	WDFW
Ellensburg Mill	WDFW	Powell-LaFortune	WDFW
Fogarty Ditch	WDFW	Selah-Moxee	WDFW
Fruitvale	WDFW	Snipes-Allen	WDFW
Gleed	WDFW	Taylor	WDFW
Huntsville Mill	WDFW	Toppenish Pump	USBR
John Cox	USBR	Union Gap	WDFW
Kelley-Lowry	WDFW	Upper WIP	USBR
Lindsey	WDFW	Wilson Creek	WDFW
Lower WIP	USBR	Yakima-Tieton	USBR
Naches Cowiche	WDFW	Younger	WDFW
Naches Selah	WDFW		
USBR = U.S. Bureau of Reclamation. WDFW = Washington Department of Fish and Wildlife.			

3.0 Results and Discussion

The overall results we obtained in 2006 are presented first, followed by more a detailed discussion of findings at each site. The site-by-site findings are organized by screen type into three groups: rotary drum screens, flat-plate screens, and vertical traveling screens. For this report, screens are always counted from upstream to downstream.

3.1 General Results

Water Velocity Measurements

At most sites evaluated, average sweep and approach values were lower near the bottom of the forebay, but specific patterns of flow varied across each screen site spatially and through the irrigation season. If more than 10% of approach velocities were greater than 0.4 ft/s during an inspection, the site was considered to be in violation of the NMFS design criterion for approach velocities. Eight sites exceeded this criterion in 2006 at least once (Table 3.1), down from 10 in 2005.

Eighteen sites had bypass velocities slower than average sweep velocities at least once during 2006, an increase of 20% over 2005 (Table 3.2). Sites with slow bypass velocities relative to sweep velocities could result in migration delay.

Underwater Video

All drum screen seals that were classified as in “good condition” fit snugly against the screen and were not cracked, warped, or punctured in any way. In a few cases, bottom seals were buried in debris or aquatic plants and could not be viewed with the underwater video camera. Most screens were properly sealed to prevent fish entrainment and injury. Three sites had seals that were warped below water level or caulking coming loose or missing (Table 3.2); another two sites had warps or poorly fitting side seals above water.

Fish were seen at many of the sites during the year and are mentioned in the discussion of each site. Other organisms have been seen growing along the metal, rubber, and concrete at some sites over the years. Generally, these organisms were not very big and grew from the clean surfaces in May every year. They have been seen consistently at Snipes-Allen and occasionally at Toppenish Pump. In 2006, they were growing also at Taylor for the first time. Samples of these organisms were collected from Snipes-Allen and Taylor and sent, along with pictures (Figure 3.1), to Sally Abella, an aquatic invertebrate specialist with the Water and Resources Division of King County Department of Natural Resources and Parks. Of interest was identification of the organism and whether its presence indicated anything about water quality.

Ms. Abella tentatively identified the organisms as *Spongilla lacustris*, a common freshwater sponge. They live in areas with plenty of algae and diatoms for food. There is little information available to determine if they indicate anything else in particular about water quality. The sponges probably do not pose any danger to the structure, but they will affect water flow and sediment/debris movement if they grow longer than one season and should probably be removed. Some sponges contain minute silica spicules that are an irritant to skin, so care is needed not to touch them with bare skin when they are removed.

Table 3.1. Percentage of Approach Velocity Measurements Exceeding NMFS Approach Velocity Criterion, by Year. Shaded values are those with 10% or more exceeding the criterion.

Screen Type	Screen Site	Percentage of Approach Velocity Measurements ≥ 0.4 ft/s								
		1998	1999	2000	2001(d)	2002	2003	2004	2005	2006
Drum Screens	Bachelor-Hatton	34	0	15	(e)	3	2	10	0	30
	Clark	0	(a)	0	0	0	0	0	0	6
	Congdon	4	8	7	13	11	7	22	53	13
	Fogarty Ditch	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	0
	Huntsville Mill	(c)	(c)	(c)	(c)	(c)	(c)	(c)	10	0
	John Cox	(c)	(c)	39	(e)	28	35	39	20	53
	Kelley-Lowry	0	0	0	20	0	0	4	0	3
	Lindsey	0	0	0	0	0	0	0	0	0
	Lower WIP	(b)	0	0	(e)	39	6	0	(b)	(b)
	Naches-Cowiche	0	13	3	5	2	0	5	0	1
	New Cascade	(a)	0	1	(e)	3	0	2	0	0
	Powell-LaFortune	(c)	(c)	(c)	0	0	2	0	0	0
	Snipes-Allen	0	0	0	0	0	0	0	0	0
	Taylor	0	0	0	0	0	0	0	0	0
	Toppenish Pump	60	25	9	3	31	6	9	11	32
	Upper WIP	9	3	3	(e)	5	8	0	0	8
	Wilson Creek	(c)	(c)	(c)	0	4	0	0	0	0
Vertical Plate Screens	Ellensburg Mill	0	33	26	0	0	0	0	0	0
	Fruitvale	(a)	0	18	0	0	0	0	0	0
	Naches-Selah	3	28	29	8	30	20	46	23	36
	Old Union	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	11
	Packwood	(c)	(c)	(c)	(c)	(c)	(c)	0	0	0
	Selah-Moxee	(c)	(c)	(c)	(c)	(c)	(c)	6	13	0
	Union Gap	5	23	13	4	3	10	43	18	7
	Yakima-Tieton	5	2	1	2	14	3	18	28	4
Vertical Traveling Screen	Younger	(c)	0	8	0	33	0	6	28	39
	Gleed	(a)	14	18	0	17	29	35	29	22
(a) No data; electrical interference prevented velocity measurements. (b) No data; flooded in May and not operating later in the season. (c) Before site was constructed or evaluated. (d) Based on September data only, except Snipes-Allen, Taylor, Toppenish Pump, Naches-Selah, and Union Gap. (e) No data; equipment problems in May and June, and site was dry in September.										

Table 3.2. Summary of Problems at Fish Screens Evaluated from 1999 through 2006

Screen Type		≥10% of Approach Velocities > 0.4 ft/s						Bypass Velocities Slower Than Sweep Velocities At Least Once						Damaged Screen or Seal						Submergence Outside Criterion At Least Once						Excessive Silt or Debris At Least Once						Bypass Outfall < 1 ft At Least Once										
		1999	2000	2001 ^a	2002	2003	2004	2005	2006	1999	2000	2001 ^a	2002	2003	2004	2005	2006	1999	2000	2001 ^a	2002	2003	2004	2005	2006	1999	2000	2001 ^a	2002	2003	2004	2005	2006	1999	2000	2001 ^a	2002	2003	2004	2005	2006	
Drum Screens	Site																																									
	Bachelor-Hatton		■	b			■	■		■	b					■	■		■	■		■					■	■	■	■	■	■	■									■
	Clark														■				■					■													■		■			
	Congdon		■	■	■		■	■	■				■	■	■	■				■																						
	Fogarty Ditch	—	—	—	—	—	—	—	—	—	—	—	—	—	—	■	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	Huntsville Mill	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	John Cox	—	■	b	■	■	■	■	■	—		b	■	■	■	■	■	—		■		■		■		■		■		■		■		■		■		■		■		
	Kelley-Lowry			■									■	■	■	■	■			■				■		■	■	■	■	■	■	■										
	Lindsey												■		■		■			■					■			■											■			
	Lower WIP			b	■			b	b	■		b	■	■	■	b	b					■		b	b	■		■	■	■	■	■	b	b					b	b		
	Naches-Cowiche	■										■	■	■	■	■	■							■				■	■	■	■	■	■									
	New Cascade			b								b	■	■	■	■	■	■		■	■	■	■	■		■	■	■	■	■	■	■	■				■	■				
	Powell-LaFortune	—	—							—	—	■	■	■	■	■	■	—	—		■	■	■	■	■	—	—	■	■	■	■	■	■	■	—	—		■			■	
	Snipes-Allen										■	■	■	■	■	■	■								■																	
	Taylor													■	■	■	■				■	■	■	■	■			■	■	■	■	■	■						■	■		
	Toppenish Pump	■			■			■	■							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■								
	Upper WIP			b								b	■	■	■	■	■	■				■	■	■	■	■	■	■	■	■	■	■	■		■			■				
Wilson Creek	—	—							—	—	■	■	■	■	■	■	—	—		■		■	■	■	—	—	■	■	■	■	■	■	■	—	—							
Vertical Flat-Plate Screens	Ellensburg Mill	■	■						■		■						■		■							■		■	■	■	■	■										
	Fruitvale		■										■		■	■				■						■		■														
	Naches-Selah	■	■		■	■	■	■	■		■	■	■	■	■	■	■							■			■		■		■		■		■	■	■	■		■		
	Old Union	—	—	—	—	—	—	—	—		—	—	—	—	—	■	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
	Packwood	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
	Selah-Moxee	—	—	—	—	—	—		■							■				—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
	Union Gap	■	■				■	■	■	■	■	■	■	■	■	■	■												■													
	Yakima-Tieton				■		■	■	■		■	■		■	■	■	■																									
	Younger				■			■	■							■				■																						
Vertical Traveling Screens																																										
Gleed	■	■		■	■	■	■								■											■																

a) Based on September data only, except Snipes-Allen, Taylor, Toppenish Pump, Naches-Selah, and Union Gap.

b) No data available.

— Before site was constructed or evaluated

Figure 3.1. Sponges Growing on the Snipes-Allen Screen Frame

General Observations at Each Site

The following types of observations are made during each site visit:

- Is the bypass functional, providing unobstructed and safe passage from the forebay to the river?
- Are screens in good condition, and do drums turn smoothly?
- Are seals in good condition?
- Are brushes effective and in good working order?
- Are cheeks caulked to prevent fish from becoming wedged in the gap between the drum screen frame and the cement structure (the cheek)?
- Are there gages?
- Are sediment, vegetation, or other factors affecting the function of the site?
- Does the logbook indicate any problems since the last inspection?

In 2006, most sites were operating in a manner that would be expected to provide safe passage for juvenile salmonids. Some sites, such as New Cascade, are well-maintained, well-designed, and rarely exceed criteria, while others, such as Glead, have had a history of problems. Both the WDFW and USBR typically visited sites every 1 to 2 weeks to perform routine maintenance. An extended period of high run-off in 2006 moved a large amount of sediment and woody debris into sites and kept water levels high. This caused problems at several sites due to obstructed bypass pipes or outfalls, plugged screens, and debris covering bottom seals and parts of drum screens. Four sites had obstructed bypasses for several weeks in 2006. In two of those cases, the blockage was not immediately recognized as such. High river

levels were also backing up water at the outfalls. In 2006, 30% of the sites had problems with excessive debris compared to 17% in 2005 (Table 3.2). The buildup of sediment and debris is a concern because it can create habitat for predators and cause mechanical brushes or drums to become less effective or even cease functioning. The WDFW was usually proactive in removing silt and debris during the season.

Two sites had damaged or worn screens. Cheeks between the cement structure and screen frame were caulked at most sites. Toppenish Pump in particular still needs to have the cheeks caulked, with gaps more than 0.5 in. wide—large enough to entrain fish even though they cannot swim through to the aftbay. Automated cleaning brushes functioned properly in most cases, and chains and other moving parts were well-greased and operated smoothly. Most drum screens turned smoothly.

Phase II rotary drum screens are designed to be operated at submergence levels between 65% and 85%. At higher submergence levels, fish may roll over the top of the screen and enter the canal. Lower submergence levels can prevent the screen from efficiently removing debris from the forebay area. In 2006, 31% of the screen sites had submergence outside the NMFS criterion at least once compared to 36% in 2005. Four of those sites had submergence low enough that rotating drums were not moving debris into the aftbay. Submergence at one drum screen site was high enough to pose a risk of fish rolling over the top. The remaining sites were within one or two percent of the NMFS criterion on submergence.

Flat-plate screen sites do not have the same rollover and debris removal issues to contend with as rotary drum screens. However, should a flat-plate screen become completely submerged, fish can freely enter the irrigation canals by swimming over the top of the screen. Therefore, beginning in 2001, flat-plate screen sites were marked in Table 3.2 only if screens were completely submerged at any point during the irrigation season. According to the logbooks, two flat-plate screen sites (Yakima-Tieton and Naches-Selah) were overtopped in 2006 when debris accumulated on the screens. Screens were cleared, and operations returned to normal within 24 hours.

In 2006, bypass water levels in the bypass pipes were adequate in 85% of the site visits. At four sites, depth of water just downstream of the outfall is of concern rather than right at the outfall pipe. Pools are often dug near the outfall pipe, but fish then have to swim through areas as shallow as 3 in. (e.g., Bachelor-Hatton), making them easy prey for birds and other predators. The outfall pipe at Taylor empties into a long open but very sheltered channel that then empties into the river. Since the main river channel migrated to the opposite shore, the water levels where the channel meets the river is often very shallow and could prevent fish from moving into the river. The area may need to be examined every year after water levels drop and the outfall channel extended to deeper water.

Visual operator control aids, while not required, are important tools that should be used by O&M and irrigation district personnel to document the amount of water diverted to the site and to the canal. Operator aids include marks indicating submergence level on drum screen frames; water depth or elevation gages in the forebay, aftbay, and irrigation canal, and onsite tables relating gage readings to design criteria for the site and allocated canal discharge. At some sites, these tables are kept in the site logbox for quick reference, but many sites do not have this information available. Two sites still do not have gages measuring forebay, aftbay, or canal water elevations. Drum screen submergence marks were present at most sites and had been repainted at many of the sites. Algae covers the marks at many sites later in the season but can be rubbed off easily. These marks provide a quick and easy way to determine if drum screen submergence is within guidelines and should be cleaned and repainted regularly.

Problem Tracking

Two types of problems dominated this year. The more critical problem in 2006 was debris blocking bypass outfalls. Naches-Cowiche and Bachelor-Hatton suffered huge amounts of shifting bedload, which buried the outfall under several feet of gravel. At the same time, river levels were high, and it was impossible to tell which caused the low bypass flow. Woody debris in the bypass entrances were a problem at Toppenish Pump and Naches-Selah.

The second major problem was high approach velocities that occur frequently at various sites. The most critical period is in the spring when juvenile salmonids are out-migrating. Later in the season, most salmonids left in the river are stronger swimmers. In a few cases, the WDFW was able to modify the sites to lower approach values. But both the USBR and WDFW had some sites that seemed to be operating within design criteria for the site and felt they could do nothing to reduce approach velocities.

Agency response by both the WDFW and USBR was good for specific problems with specific remedies, such as removing sticks from seals. When problems were felt to be harder to fix, such as high approach velocities at certain sites, there often was no specific response to correct the problem.

3.2 Rotary Drum Screens

Seventeen of the Phase II fish screen facilities in the Yakima River basin are rotary drum screens. The following provides a description of the evaluations results and plots of velocity data for each of these facilities.

Bachelor-Hatton

The Bachelor-Hatton site was evaluated on May 22, May 31, June 5, and July 6. It also was visited on September 8 when it was dry. High flows starting in May shifted gravel back in front of the bypass outfall and actually buried it beneath 1–2 ft of gravel. There was no flow through the bypass on May 22 or May 31. When notified of the plugged bypass, USBR maintenance personnel quickly came out and partially dug out the outfall pipe to allow at least some movement of water and fish. By July, a small pit had been dug in front of the bypass outfall pipe, but the channel it emptied into was in danger of drying up. Although maintenance personnel had visited the site earlier in the day on May 22 and performed various activities, they had not noticed the outfall pipe was buried. Maintenance personnel may not realize the outfall pipe should be checked for obstructions or channel changes, or there may be confusion about whether that task is the responsibility of the irrigation company or the USBR. But investigating possible problems when bypass flow is poor should be part of the regular maintenance checklist. Excessive sediment accumulations in front of screens 3 and 4 and in the bypass in May had been partly removed in July but were still above the bottom seals along part of screen 3 and all of screen 4.

Velocity measurements were taken on May 31 and July 6, 2006. In May and July, 40% and 20% of measured approach velocities were above the NMFS criterion, respectively (Figures 3.2 and 3.3). This site always has had problems with the angle of water flowing into the forebay causing reversed sweeps past the first two screens (screens 1 and 2 in Figure 3.2). This changed in July (Figure 3.3) when the

Figure 3.2. Water Velocities and Sediment Accumulation, Bachelor-Hatton, May 2006. Error bars represent turbulence.

Figure 3.3. Bachelor-Hatton Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

porosity boards were raised 6 in. behind screen 4 and set on the bottom behind the other three screens. Changes had been made also to the stream bed in front of the headgates, directing more water toward the site. Sweep velocities increased slightly toward the bypass in July but not in May. Bypass flows were lower than sweep velocities during both evaluations. There was a noticeable change in flow at the first position along screen 4, with sharply higher approach and lower sweep velocities in May. Sweep velocities were markedly different again in July. We did not see anything directly responsible for this abrupt spike in velocities, which could be the result of excessive debris in the forebay or some unseen problem near or behind the screen.

Submergence was good in May and June, at 75% and 69%, respectively. Video surveys showed seals that were not covered by debris were generally in good condition. The upstream side seal on screen 4 still has a warp in it above the typical water level. Gaps between the cement cheeks and the drum frame had been caulked the previous year and were still in reasonable condition. Screens were in good condition during all inspections.

Maintenance personnel had been to the site earlier in the day on May 22, but either did not realize they should check the outfall or thought clearing the outfall was someone else's responsibility. Bachelor-Hatton was not able to provide safe passage to juvenile salmonids for a few weeks in May 2007 until the bypass outfall was cleared the second time. Removal of woody debris against the screens and in the bypass should be performed to prevent excessive wear and tear on the screens and seals and provide better flow through the site and the bypass.

Clark

We evaluated the Clark site on May 25, July 19, and September 18, 2006. Submergence was at 75%, 65%, and 68% from May through September, respectively. All approach velocities were below 0.4 ft/s except on July 19, when the first location along the screen was above the criterion (Figures 3.4 through 3.7). Algae had built up on the inside of the drum, where the bottom seal/brush combination could not clean. The plugged drum screen was indicated by the 3 in. of headloss across the screen. Washington Department of Fish and Wildlife personnel were notified and cleaned the screen a few days later. On July 31, flow once again was evenly distributed across the screen, resulting in approach values less than 0.4 ft/s (Figure 3.6).

Sweep velocities increased toward the bypass on May 25 and July 19, but not on July 31 or September 18. Bypass velocity was always higher than the sweep, and sweep was always higher than approach velocities. Water flowed smoothly over the weir and through the bypass during all evaluations. There was minor flooding over the headgates in May, but this was not as serious a problem as in previous years.

Juvenile salmonids were seen in the forebay in September. Demand for water through this site is sporadic, as it provides water for the local fire department's storage pond as needed. This site is generally maintained and operated in such a way as to provide safe passage for juvenile salmonids.

Figure 3.4. Clark Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.5. Clark Water Velocities and Sediment Accumulation, July 19, 2006. Error bars represent turbulence.

Figure 3.6. Clark Water Velocities and Sediment Accumulation, July 31, 2006 After the Screen was Cleaned. Error bars represent turbulence.

Figure 3.7. Clark Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Congdon

The Congdon facility was evaluated on May 30, July 20, and September 15, 2006. Approach velocities met the NMFS criterion in May, with 93% of the measurements below 0.4 ft/s (Figure 3.8). In July and September, only 87% and 80% met the criterion (Figures 3.9 and 3.10). The criterion was typically exceeded at the first location of each screen, where backeddies around the piernoses push water directly toward the screens. Although approach values were high during part of the year, the “hot” spots were not contiguous, and small fish could probably swim away from the screens before tiring.

Sweep velocities always were higher than approach velocities. Bypass velocity was higher than the sweep velocity and flowed smoothly into the outfall channel during each visit. Submergence met the criterion for drum screens at 82%, 80%, and 83% in May, July, and September, respectively. Seals and screens were in good condition during all visits. In July, several species of fish were seen in the forebay, including suckers and some juvenile salmonids.

Stoplogs always were set several inches off the bottom to allow water and sediment to flush through beneath them. Although PNNL hoped to work with WDFW at Congdon to find ways to minimize excessive approach velocities, that work did not occur. It may be possible to try adjusting the stoplogs to control approach velocities if approach velocities are high in spring 2007. Generally, Congdon is operated and maintained to protect juvenile salmonids.

Figure 3.8. Congdon Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.9. Congdon Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.10. Congdon Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Fogarty Ditch

Fogarty Ditch is the last of the Phase II fish screen facilities to be constructed. Completed early in 2006, Fogarty Ditch is located along the Yakima River just west of Ellensburg (Figure 2.1). This site was first evaluated on May 17, 2006. The site contains three perforated-plate drum screens, 10 ft long and 42 in. diameter (Figure 3.11). Water is led to the site through a long canal that has low diked walls. Water levels in the canal frequently exceed the dike level and cause flooding in the adjacent field. Work is planned to raise the dike level. The site is not far from the foot of Manastash Ridge, which may be the source of springs that empty into the channel leading to Fogarty Ditch. The springs contribute to problems with overtopping the dike because they cannot be controlled. Water flow to the forebay is controlled by checkboards just upstream of the site. The bypass pipe runs about 56 ft back to the channel that eventually returns to the river. The water at the site appears to have relatively high organic content based on the dark brown tint to the water.

Figure 3.11. Fogarty Ditch Screens and Aftbay

The bypass weir is controlled by a standard setup with a hand-turned wheel controlling the amount of water moving through the bypass. The stop nut that at most sites marks the fully open weir position is beneath the wheel and frame at this site, instead of above the wheel.

Submergence was 69%, 82%, and 70% on May 17, July 11, and September 6, 2006, respectively. All approach velocities were well below the NMFS criterion and tend to decrease in velocity from upstream to downstream ends of each individual screen. Sweep velocities did not increase as a whole across the site (Figures 3.12 through 3.14) but were greater than approach velocities, except in September. Bypass flows were greater than sweep in July and September. In May, bypass flow was greater than sweep across screen 1 but was considerably lower than sweep across screen 2. Stream levels were high and may have been a factor in the low bypass flow. Stoplogs are set off the bottom behind each screen; it might be possible to smooth out approach and sweep by adjusting these up or down. Seals and drum screens were in good condition. One drum had electrical problems in July and kept tripping the breaker. It had to

Figure 3.12. Fogarty Ditch Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.13. Fogarty Ditch Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.14. Fogarty Ditch Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

be restarted each time. This problem was resolved within two weeks of our evaluation. Water moved smoothly through the bypass, although high water in the outfall channel in May backed up water movement through the bypass.

Overall, this site appears to have been designed, operated, and maintained to provide safe passage to juvenile salmonids. Raising the dike along the channel leading to the site will ensure the dike is not overtopped and keep fish out of the adjacent field.

Huntsville Mill

Huntsville Mill is located along the Touchet River (Figure 2.2). This site was visited on May 16, July 17, and September 5 in 2006. Submergence was 80%, 70%, and 80% in May through September, respectively. Approach values all were below 0.4 ft/s (Figures 3.15 through 3.17). A back eddy was noted in May at the upstream end of the screen where approach was higher than sweep. In September, the middle of the trash rack was plugged with vegetation, and water could enter the forebay only along the sides of the trash rack. This caused more turbulence in water movement through the site and may be partly responsible for higher approach velocities relative to sweep velocities in September (Figure 3.17). Sweep velocities generally were constant or decreased slightly toward the bypass in May and July but increased toward the bypass in September.

Bypass flows were greater than sweep in all cases. Approach velocities exceeded the NMFS criterion only in June. Seals and the drum were in good condition. Water moved smoothly through the bypass. An old beaver dam in the outfall channel was a potential block to adult fish and was removed before the September evaluation. This site still does not have gages, a logbook, any site design or operating criteria, or contact information available onsite.

Figure 3.15. Huntsville Mill Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.16. Huntsville Mill Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.17. Huntsville Mill Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

John Cox

The John Cox site was visited on May 22, May 31, June 5, July 6, and September 8, 2006. High river levels caused a number of problems at this site. On May 22, river levels were still very high and the site had debris blocking the entrance channel causing low submergence (47%), no bypass flow, and most approach velocities exceeding 0.4 ft/s (Figure 3.18). Turbidity prevented videography on this day. As part of the problem-tracking protocol, we notified USBR maintenance personnel of the problems after each of our visits, who responded each time with a plan to immediately start work to resolve the problems.

On the May 31 revisit, submergence had improved to 70% by removing the blockage at the entrance, but the bypass was plugged, preventing any bypass flow (Figure 3.19). Underwater video showed bottom seals obscured by debris. Approach values were not as high as the previous visit, but more than 10% still exceeded 0.4 ft/s. Juvenile salmonids were observed swimming fairly hard in front of the screens with their tails oriented toward the screen face, indicating strong approach values. Most of the debris in front of the screens had been removed by the June 5 revisit (Figure 3.20), and submergence was 75%. However, there was still poor flow through the bypass, indicating either the plug was not removed entirely on June 1 or that a plug had developed again.

On July 6, submergence was low at 58%, although a backhoe had been used to clear rocks and debris from the diversion. Debris had accumulated in front of the screens again, possibly from the backhoe work and may be the cause for 8 of 10 approach values exceeding 0.4 ft/s (Figure 3.21). The only

Figure 3.18. John Cox Water Velocities and Sediment Accumulation, May 22, 2006. Error bars represent turbulence.

Figure 3.19. John Cox Water Velocities and Sediment Accumulation, May 31, 2006. Error bars represent turbulence.

Figure 3.20. John Cox Water Velocities and Sediment Accumulation, June 5, 2006. Error bars represent turbulence.

Figure 3.21. John Cox Water Velocities and Sediment Accumulation, July 6, 2006. Error bars represent turbulence.

locations with low debris also had low approach values. Bypass flow was still poor, apparently due to a plug in the pipe. The site was turned off for the season four days later. No fish were seen during this evaluation, but several were seen on the last visit in September, including some 5- to 8-in. salmonids. The ramp and flushgate were closed, and the fish had to go back through the headgates to get out of the forebay.

Sweep velocities were always greater than bypass values and almost always greater than approach velocities. Screen and seals that could be seen were in good condition. The amount of debris at this site this year could cause increased wear on screen and seal material and extra drag on the motor. This site probably did not provide safe passage for juvenile salmonids in 2006, although USBR personnel were making efforts to correct the problems. High approach velocities in 2006 may be due to excessive debris forcing more flow through a smaller screen cross section when the bypass was blocked. They could also be caused by more water being diverted into the canal than the site was designed for. U.S. Bureau of Reclamation has indicated they are not involved in policing water diversions, but perhaps they could notify WDFW and have someone investigate if too much water is being diverted.

Kelley-Lowry

The Kelley-Lowry site was visited on May 30, July 19, and September 18, 2006. Much of the forebay is still filled with sediment that comes within 18 in. of the water's surface, but WDFW "channelized" flow through the forebay by removing sediment from in front of the screens but leaving the main mound alone. No sediment was found on the sill or near the bottom seals (Figures 3.22 through 3.24). The forebay mound probably affects flow through the site and may be the cause for the very strong difference in sweep and approach velocities between the two screens in May and September (Figures 3.22 and 3.24). No approach velocities exceeded 0.4 ft/s. Sweep values were not greater than approach in September and never increased toward the bypass. The WDFW does not have an agreement with the irrigation district to remove sediment at this site; consequently, it is the irrigation district's responsibility. The irrigation district has not fulfilled this responsibility to date.

Submergence was good, at 73%, 83%, and 80% in May, July, and September, respectively. New side and bottom seals were installed on screen 1 in February 2006. The seals on screen 2 and all screens were in good condition, and the cheeks were caulked. Bypass flows ran freely through the downwell, which has checkboards to make a plunge pool. The outfall is difficult to see from within the facility, and dense vegetation kept us away when we tried to find it from the other side. Salmonids were seen in the forebay in July. Conditions at this site generally provided safe passage to juvenile salmonids, although the channelized flow past the sediment mound restricts movement away from potential predators.

Figure 3.22. Kelley-Lowry Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.23. Kelley-Lowry Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.24. Kelley-Lowry Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Lindsey

The Lindsey site was evaluated on May 25, July 14, and September 20, 2006. During all surveys, 100% of approach velocity values were below the NMFS criterion of 0.4 ft/s (Figures 3.25 through 3.27). Sweep velocities were greater than approach velocities in May and July but not in September. Sweep did not increase toward the bypass during any of our evaluations. Bypass velocity was greater than the sweep velocity during each of the surveys.

The screen and seals were in good condition, and the drum moved leaf matter and other floating debris into the canal effectively. The slight bulge seen in the downstream seal in 2005 was gone. Submergence was 60% in May, below the submergence criterion, but had improved to 67% and 65% in July and September. Flow over the weir was between 4 and 5 in. during each of our visits, and water moved smoothly through the bypass. Water levels at the outfall were deep enough, but became shallower in the main channel when water levels were low. Under those conditions, there is probably not much that can be done other than leave more flow in the channel. Juvenile salmonids were seen in the forebay in June and September. This site generally provided safe passage to juvenile salmonids in 2006.

Figure 3.25. Lindsey Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.26. Lindsey Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.27. Lindsey Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Lower Wapato Irrigation Project

Attempts were made to visit the Lower Wapato Irrigation Project (WIP) site on May 22 and 31, 2006, but water covered the access road. We were able to get to the site on July 6, but the site had been closed the day before due to low water. The logbook indicated backward flow from the bypass into the site on May 8, and the ramp and flushgate were raised to allow this. Mounds of sediment were noticed in the downwell and behind the screens, but it is not clear whether those developed last year or this year. The ramp was still raised, and some water was moving through the bypass, but none appeared to be going through the screens in July. One large log rested across the diversion dam for this site, and another lay across the stream just below the outfall. They were apparently washed in during spring high water.

No underwater video or velocity measurements were made during any of our visits to this site this year.

Naches-Cowiche

The Naches-Cowiche site was evaluated on May 24, July 18, July 31, and September 15, 2006. The bypass was blocked in May, June, and part of July by a huge gravel bar deposited during the high river levels in the spring. A backhoe was required to unblock the outfall, and ecology blocks have now been installed to try to protect the outfall in the future (Figure 3.28). The gravel was moved away from the outfall on July 25–26, and on July 31 bypass flow had improved significantly (Figure 3.28). Because WDFW was not sure if the bypass was blocked or high river levels were backing water up in the bypass, the weir was set low enough to allow fish passage. Construction of a new highway bridge in 2007 will alter the configuration of the channel leading to the forebay as well as the outfall.

Figure 3.28. Naches-Cowiche Outfall After Protective Blocks Were Installed. The actual outfall pipe is approximately 2 ft below the water surface near the center of the picture.

A sediment checkboard had been placed along the bottom from just upstream of screen 1 to wall across the forebay. This board and the sediment that builds up around it affects sweep and approach at the upstream end of screen 1, causing a back eddy with excessive approach values at times and water flowing upstream. Sweep velocities at this site do not smoothly increase toward the bypass. However, sweep was usually greater than approach, and approach was below 0.4 ft/s except for one measurement in September (Figures 3.29 through 3.32).

Submergence was between 65% and 85% in May and July, but shortly after flip-flop in September, (when reservoirs on the Naches River basin upstream of Naches-Cowiche are opened wide while others to the north are closed for the season), it was slightly above at 87%. Water was too turbid for underwater video surveys in May, but surveys were performed in July and September. These surveys showed the seals and screen condition to be good where they could be seen. Debris accumulated in the upstream corner of screen 1 where the back eddy occurs and to a lesser extent along screen 2. One trout (?) was briefly seen in the forebay July 18, and several schools of small non-salmonids were seen July 31. None was seen in May or September.

Figure 3.29. Naches-Cowiche Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.30. Naches-Cowiche Water Velocities and Sediment Accumulation, July 18, 2006. Error bars represent turbulence.

Figure 3.31. Naches-Cowiche Water Velocities and Sediment Accumulation, July 31, 2006. Error bars represent turbulence.

Figure 3.32. Naches-Cowiche Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

New Cascade

We evaluated the New Cascade site on May 17, July 10, and September 6, 2006. Submergence was between 80% and 83% during each of our evaluations, although the logbook indicated a power outage allowed the drums to be overtopped on April 30, 2006. This may explain the small fish we heard jumping in the aftbay in May. Trout and juvenile salmonids were seen in the forebay during each of the evaluations. Approach velocities were below the NMFS criterion 100% of the time during each evaluation (Figures 3.33 through 3.25). Sweep velocities always were greater than approach velocities. Bypass velocities were distinctly greater than sweep in May and September, but in July sweep near the middle of the site was greater than the bypass velocity. Sweep did not increase toward the bypass during any of our surveys.

Turbidity in May was so high that the camera did not have enough light to operate near the bottom. Video of the side seals and screens both that day and during later evaluation showed screens and seals were in good condition, and cheeks were caulked. Sediment and vegetation were partly covering the bottom seals of screens 3, 4, 5, and 6 in July and September. The drums turned smoothly in May, but by July some were turning erratically or had noisy motors. They all were able to move small debris into the canal. Based on the number of juvenile salmonids and trout seen during each visit, this site provides good habitat for fish and is operated in a way that should protect juvenile salmonids.

Figure 3.33. New Cascade Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.34. New Cascade Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.35. New Cascade Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Powell-LaFortune

Powell-LaFortune was evaluated on May 30, July 20, August 7, and September 18, 2006. The site was visited but not evaluated on July 31 because the problems identified on July 20 had not been corrected. All approach measurements met the NMFS criterion, and sweep was higher than approach velocities and increased toward the bypass in May and August (Figures 3.36 through 3.39). Sweep did not increase toward the bypass in July, when there was no bypass flow. In September, bypass flow was slightly greater than sweep.

Submergence was good in May, August, and September at 81%, 82%, and 71%, respectively. In July, the dam operators at Rimrock Lake tested a generator, sending a large slug of water down the river with little warning. This slug of water washed out a number of wing dams, including the one that diverts water to Powell-LaFortune, causing the low submergence on July 20. However, the wing dam had been repaired, and excessive debris on the upper trash rack caused the continuing low submergence found on July 31.

When the trash racks are kept clear, this site normally functions as designed to protect juvenile salmonids. However, when irrigation district personnel do not keep the trash racks clear, submergence drops, which reduces or eliminates bypass flow. The WDFW tried to emphasize to the irrigation district personnel the importance of clearing the trash racks, with moderate success. We still recommend considering alternative trash rack designs as a way to improve overall performance of the site.

Figure 3.36. Powell-LaFortune Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.37. Powell-LaFortune Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.38. Powell-LaFortune Water Velocities and Sediment Accumulation, August 2006. Error bars represent turbulence.

Figure 3.39. Powell-LaFortune Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Screens and seals looked good during all surveys, and all the cheeks were caulked. A number of fish were seen in the forebay this year, including one medium-size trout and juvenile salmonids (including at least one dead on July 20). When flow to the site is good, this site is almost a perfect example of how a site should operate and provides safe passage to fish.

Snipes-Allen

The Snipes-Allen site was inspected on May 18, July 7, and September 11, 2006. All approach velocities were below 0.4 ft/s (Figures 3.40 through 3.42). Sweep velocities were greater than those in the bypass in May and September but not in July, when only 1.5 in. of water spilled over the weir. Bypass flow moved smoothly as well except in July, when there was essentially no bypass flow. Flow through the bypass was backed up in May because of the high water levels in the outfall channel. In May, a strong back eddy caused upstream flow across most of screen 1, causing the approach velocities to be higher than the sweep velocities. Sweep velocities did not increase toward the bypass during any of our evaluations.

Submergence was within the criterion during each of our visits, at 85%, 69%, and 78% from May through September. There was no sediment or debris buildup in front of the screens this year, although the sponges grew back along the seals and frame (Figure 3.1). These sponges do not seem to harm the structures to which they attach, but they should continue to be removed in the winter so they do not cause perturbations in flow. As discussed in Section 2, sponge samples were collected and sent for identification.

Figure 3.40. Snipes-Allen Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.41. Snipes-Allen Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.42. Snipes-Allen Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Seals and screen condition were good, and the cheeks were caulked. A number of small non-salmonid fish were seen in September in the forebay, and one dead sucker was seen in July. Bypass conditions were conducive to safe fish passage in May and September but may not have been in July.

Taylor

The Taylor site functioned much better for most of 2006 than it did in 2005. The site was evaluated on May 19, July 11, and September 21, 2006, and there was bypass flow through the facility until September, when submergence was only 50%. Submergence in May was 76% and in July was 50%. In July, bypass flow was good, even though submergence was below the criterion, because low checkboards in the bypass were used to create submergence instead of the ramp and weir. Seven inches of water flowed over the checkboards in July. In September, however, the checkboards were set 1 in. off the bottom of the bypass, which allowed some water through but did not provide good fish passage for any but the smallest fish, and no water flowed over the top. Conditions at the junction of the outfall and river were not evaluated, but at times in 2005 the river was much less than 12 in. deep at that point.

During all evaluations, approach velocities were below the NMFS criterion (Figures 3.43 through 3.45). Sweep velocities were generally greater than approaches, with a few points in July and September that were lower than approaches. Sweep did not uniformly increase toward the bypass across the site. A number of small, unidentified fish were seen in the forebay in July, and reidside shiners and sculpin were seen in September. The site is kept free of debris by daily visits from the water users. Both drums are losing some of the caulking that smooths the horizontal joint where the perforated plate wraps back onto itself (Figure 3.46). In particular, screen 2 looked slightly misshapen or out-of-round in this same area.

Figure 3.43. Taylor Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.44. Taylor Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.45. Taylor Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Figure 3.46. Screen Edge at Taylor

This is the first time we have found sponges growing at this site. They may have just colonized the area, or algae and diatoms may have recently become abundant enough for the sponges to prosper. They should be removed to prevent any impact on water movement through the site.

Overall, this site does not always provide safe passage for juvenile salmonids due to poor bypass conditions.

Toppenish Pump

Toppenish Pump fish screen facility was evaluated on May 16, July 7, and September 11, 2006. Debris, mostly sticks and vegetation, covered the bottom screen seals throughout the year (Figures 3.47 through 3.49). This prevented visual inspection with the underwater camera and made velocity measurements difficult. Placement of the probe was often not the proper height because the debris would have interfered with the measurement.

Fifty-three, seventy, and ninety percent of approach velocities were below 0.4 ft/s in May, July, and September, respectively (Figures 3.47 through 3.49). Bypass velocities were greater than average sweep velocities in July and September. Sweep increased toward the bypass in July and September, but in May it dropped at the last screen. Sweep velocities were greater than approaches across the last five drums, but the first three screens show a more confused pattern. This confused pattern may be due to a back eddy that is often present at the upstream end of the site and/or to boards placed vertically behind the trash rack on the same side of the facility as the screens. There was no mention of these boards in the logbook, and their purpose was not obvious.

Submergence met the NMFS criterion in May and July (68% and 65%, respectively) but was slightly lower (62%) than the criterion of 65% in September. Screen condition was good, with less algae and periphyton than in previous years, possibly because the woody debris helped scrub them. Seals were generally good, although a warp in the upstream seal of screen 5 had a stick rolling in place between the screen and seal. Cheeks still are not caulked, and sticks were wedged in the gap in at least one place. We would recommend caulking these gaps to prevent impingement of juvenile fish. Sponges were not noted this year in underwater footage; debris may have kept them from growing. A number of redbreast shiners were seen in September, along with at least one adult trout.

Figure 3.47. Toppenish Pump Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.48. Toppenish Pump Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.49. Toppenish Pump Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Upper Wapato Irrigation Project (Upper WIP)

The Upper Wapato Irrigation Project (WIP) site was visited on May 22, June 5, July 6, and September 8, 2006. Velocity measurements were not made in May because large amounts of woody debris in front of the screens and in the bypass prevented access with the ADV probe. Much of the debris was removed in late May. As can be seen in Figures 3.50 through 3.52, sweep velocities were generally greater than approach values but did not increase smoothly toward the bypass. Bypass velocity was greater than sweep velocities in July and September.

In May, the bypass weir was raised high, but a little water was still coming into the forebay from the downwell. By June 5, the plugged bypass pipe had supposedly been cleared of debris, but bypass flow was still low (Figure 3.50). The logbook indicates USBR personnel cleared the bypass again in late June. Bypass flow improved in July and September and was higher than sweep. One hundred percent of approach velocities met the NMFS criterion in July and September, and 85% met the criterion in June.

Cheeks were caulked, and screen and seal condition was good during all visits. A warp seen in September in the upstream seal on screen 3 was above water and does not impact fish. One crawdad was using a drum as a treadmill in June, and one adult trout was seen in September. Submergence was at 63% in June and improved to 83% in July and September.

Once the bypass was cleared, this site was operated in a way that generally protected juvenile salmonids. Locations of excessive approach velocities in June were not adjacent to one another, so young fish could move a short distance away and escape the strong approach flows.

Figure 3.50. Upper WIP Water Velocities and Sediment Accumulation, June 2006. Error bars represent turbulence.

Figure 3.51. Upper WIP Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.52. Upper WIP Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Wilson Creek

The Wilson Creek fish screen site was evaluated on May 17, July 11, and September 6, 2006. Approach velocities met the NMFS criterion during all surveys (Figures 3.53 through 3.55). In May and June, sweep velocities were greater than approach velocities and were less than the bypass velocities. Sweep increased toward the bypass in May but not in July or September. In September, there was a strong back eddy at screen 1, causing upstream flow. Heavy vegetation buildup on the trash rack diverted flow to the sides of the trash rack, which may have caused the back eddy. Submergence was 92% in May, and WDFW was notified. They removed some of the checkboards to keep more flow in the stream, and submergence improved to 83% in both July and September.

Screen and seal condition was good during all surveys. Caulking along the cheeks was also in good condition. Bypass conditions were conducive to the safe passage of fish during all surveys. No fish were seen at this site, but the water is often too turbid here to be able to see far.

This site was operated and maintained to provide safe passage to juvenile salmonids throughout most of the year. High submergence in May was the only problem encountered and was corrected within a couple days.

Figure 3.53. Wilson Creek Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.54. Wilson Creek Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.55. Wilson Creek Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

3.3 Vertical Flat-Plate Screens

Nine of the Phase II fish screen facilities we evaluated in 2006 are vertical flat-plate screens. All of the flat-plate screens evaluated use automated brushes to clean the screen faces. In 2006, we reconfigured the probe at flat-plate screens whenever possible so that the probe would be about 3 in. from the screen face. This was not possible at the sites if the probe position would bump into the rail supporting the sweeper arm, and was impractical at sites with gang brushes (multiple brushes spaced only a couple feet apart, with a stroke that allows some overlap between brushes).

Ellensburg Mill

The Ellensburg Mill site was inspected on May 18, July 10, and September 7, 2006. The probe was positioned within 3 in. of the screen face during all velocity measurements. Approach velocities were well below 0.4 ft/s; in July, water actually moved from the aftbay to the forebay in places (Figures 3.56 through 3.58). Sweep velocities generally increased toward the bypass, and bypass velocities were always greater than the sweep velocities. Sweep velocities were greater than approach in May but gradually drifted through the summer until they were less than approach values at screen 1.

Screens were in good condition. Side seams between panels were not caulked, leaving narrow gaps. The material filling the gap between the screen frame and cement structure is deteriorating. This gap is at least 1 in. wide and could become an entrainment hazard to small fish. Sediment and debris accumulation was minimal in 2006. Hundreds of unidentified 1-in.-long fish were seen in the aftbay in July and September, and two carp were seen in the canal near the weir. A few small fish were seen in the forebay, but poor lighting prevented their identification.

Automated brushes are effective at cleaning the upper three quarters of the screen face but do not keep algae and periphyton from growing along the bottom portion. The brushes appear to sweep across the lower part but apparently without enough force to keep the surface clear. The bypass worked well this year, with water moving freely over the weir and through the bypass pipe. Water depth at the outfall was always 1 ft or more.

Ellensburg Mill provided safe passage to juvenile salmonids in 2006.

Figure 3.56. Ellensburg Mill Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.57. Ellensburg Mill Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.58. Ellensburg Mill Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Fruitvale

The Fruitvale site was inspected on May 24, July 18, and September 13, 2006. The probe was set to measure water velocities within 3 in. of the screen face during each evaluation. Approach velocities always met the NMFS criterion in 2006 (Figures 3.59 through 3.61). Sweep values were less than approach values at the upstream portion of the site in May. Sweep increased toward the bypass in May and September, but not in July, when there almost no bypass flow. As discussed in Chamness (2006), state biologists have determined the channel leading to Fruitvale is relatively safe habitat for fish in the summer and they are not usually endangered by lack of bypass during that time. Bypass velocities were higher than sweep in May and September. A diversion dam was completed on July 18, allowing water levels to remain high enough in 2006 that there was no need to pump supplemental water from the Old Union aftbay as was done in 2005.

Water was very turbid in May, and no video footage was acquired. Screen and seal condition was good during all surveys. According to the logbook, sediment accumulated in the forebay during May's high water but was moved out of the forebay using air bursts. Fruitvale functioned to generally provide safe passage to juvenile salmonids in 2006.

Figure 3.59. Fruitvale Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.60. Fruitvale Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.61. Fruitvale Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Naches-Selah

The Naches-Selah site was evaluated on May 30, July 19, August 8, and September 18, 2006. The probe was positioned to measure within 3 in. of the screen face for all velocity measurements. Sweep velocities always were higher than approach velocities but did not increase toward the bypass during any visits in 2006 (Figures 3.62 through 3.65). Average bypass velocities were greater than average sweep velocities in July and September. In May, the flushgate was opened, the bypass ramp raised, and the fish gate extended about 1 ft into the water in the bypass to try to clear the excess debris flowing through the site. This configuration created velocities of 3.8 ft/s at the lower position and -0.4 ft/s up near the fishgate, where water was moving toward the forebay (Figure 3.62). Woody debris was wedged in beneath the ramp in May and posed a potential hazard for any fish pulled toward the bypass. Washington Department of Fish and Wildlife personnel were notified of the debris beneath the ramp and removed it a day later.

Screen condition was good throughout the year. Seal condition also was good, although there still appears to be significant deterioration of the cement beneath the bottom seal in two places. The WDFW has been notified of these potential problem areas. Juvenile salmonids were abundant in the forebay during each of the surveys this year.

Approaches met the NMFS criterion 58%, 44%, 53%, 47%, and 64% of the time during evaluations in May through September, respectively. Almost all of the excessive approach values occur at the high position. Water velocities are typically higher in the upper portion of the water column, but the differences between the upper and lower approach velocities at Naches-Selah is also influenced by the ecology blocks placed in the forebay to control sediment. These extend from above screen 1 to the end of

Figure 3.62. Naches-Selah Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.63. Naches-Selah Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.64. Naches-Selah Water Velocities and Sediment Accumulation, August 2006. Error bars represent turbulence.

Figure 3.65. Naches-Selah Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

screen 4 and are positioned approximately 18 in. away from the screens. High approach values have been a consistent problem for the Naches-Selah site in the past. We went out with WDFW personnel on June 8 to see whether changes to lower positions can be made to keep the site within criteria.

Louvers at Naches-Selah typically are set to allow more flow at the upstream end, gradually changing to a more closed position at the downstream end of the facility. To facilitate multiple sets of measurements in one day with periods between to adjust the louvers and reach hydrostatic equilibrium, measurements were made at 0.6 depth instead of the usual 0.2 and 0.8. In addition, only two positions were measured at each screen panel instead of the usual three. Using this method, 42% of approaches exceeded 0.4 ft/s (Figure 3.66) compared to 55% when measured at 0.2 and 0.8 depths. Water velocities were made before louver positions were changed and again after louvers behind the downstream half of screen 4, all of screen 5, and the upstream half of screen 6 were closed 10% (two notches in the plate). Overall, however, the number of positions with approaches greater than 0.4 ft/s decreased to 33%. When the same louvers were opened back up by one notch, approach velocities smoothed out even more at the downstream end and increased somewhat at screen 2, with only 17% of approach velocities exceeding 0.4 ft/s (Figure 3.66).

Naches-Selah is a well-maintained site. It has consistently had problems with approach velocities exceeding 0.4 ft/s, which is of particular concern in May when the smallest juvenile salmonids are likely to be present. Fish, particularly juvenile salmonids, are seen near the end of the ecology blocks during almost every video survey.

Figure 3.66. Naches-Selah Water Velocities Before and After Adjustments to Louver Positions, June 2006. All measurements were made at 0.6 forebay depth. Adjusted –1 approach and sweep velocities were measured after the last adjustment was made to the louver positions.

Old Union

May 2006 was the first time PNNL evaluated the Old Union screen site, although the site has been in operation since 1997. The site was evaluated also on July 20 and September 13. Old Union consists of

two 8-ft by 6-ft vertical wedgewire flat-plate screens with cleaning performed by a sweeper arm brush set to run continuously. Louvers have been placed behind the downstream screen but not the upstream screen. A set of checkboards on one side of the forebay controls submergence, and a flushgate weir between the screens and checkboards serves as a bypass (Figure 3.67). Two sets of headgates in the aftbay control flow to the canal. The bypass channel from Fruitvale empties into the channel just above the Old Union trash rack. Excess water can flow over the forebay checkboards into the same bypass channel leading back to the river. A log boom across the forebay directs floating debris over the checkboards and away from the screens and bypass.

The probe was reconfigured to allow it to set within 3 in. of the screen face during all velocity measurements. Sweep velocities were always greater than approach velocities and increased slightly toward the bypass (Figures 3.68 through 3.70). Because the bypass is a vertical flushgate weir, there is a strong divergence in water forced back into the forebay near the forebay floor and the water that moves over the weir to the bypass channel (Figure 3.67). Bypass velocity measurements are not very representative of the conditions. It was difficult to position the probe close to the weir and away from the screen and hold it stable in the current. Bypass velocities were not measured in September due to these difficulties.

Figure 3.67. View of Old Union Forebay, Looking Toward the Bypass. Screens are on the right.

Figure 3.68. Old Union Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.69. Old Union Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence. The last measurement of sweep in the high position at screen 2 is very close to the bypass notch, and the high value reflects that.

Figure 3.70. Old Union Water Velocities and Sediment Accumulation, September 2006. No measurements were made in the bypass. Error bars represent turbulence.

Approach velocities met NMFS criterion 92%, 100%, and 100% of the time in May, July, and September, respectively. Underwater video examinations were performed in July and September. Seals and screen condition were good during all examinations. Sediment and debris accumulation in the forebay were minimal. Brushes generally kept the screens clean. On July 18, the brushes had quit running at Old Union, causing over 5 in. of head loss across the screens. Ditch company personnel were notified and came out immediately to work on the problem. Evaluation of the site was postponed until July 20. In September, the upper trash rack was partly blocked with debris and the adjacent dike was being overtopped and gradually eroded. The irrigation district was notified and indicated they would soon be coming to take out a portion of the wall and reduce water levels at the site in the next few days.

Old Union appears to be designed, maintained, and operated to protect juvenile salmonids.

Packwood

We evaluated the Packwood fish screen site on May 18, July 10, and September 7, 2006. Velocity measurements were taken in front of the screens; bypass flows cannot be measured because the support rail for the sweeper arm blocks access. A paddlewheel powers the brushes and cannot be turned off during measurements, which may cause some fluctuations during velocity measurements. Measurements are typically made with the brace supporting the probe parallel to the screen face, and the rail for the sweeper arm keeps the probe about 8 in. from the screen face. Ideally, measurements should be taken no more than 3 in. from the screen face. In September, we oriented the probe to allow measurements closer to the screen and took three consecutive 10-s measurements between passes of the brushes. These three measurements were added, and the total was used as the approach velocity at that point.

Sweep increased toward the bypass in July, but not in May or September, and was greater than approach in May and July (Figures 3.71 through 3.73). Approach velocities always were below 0.4 ft/s. The bypass was generally clear of debris and had adequate flow over the weir to provide fish passage. The mouth of the outfall channel was kept free of the woody debris that was a problem last year.

Screen condition was good during all surveys. In September, a small gap between the concrete and screen at the downstream corner of screen 2 appeared to show water movement into the aftbay. Although this does not seem likely to occur, WDFW personnel were notified. Gages, a logbox and a logbook were installed late in 2005. Both should help provide better documentation of conditions at the site. Trout, other, juvenile salmonids, and suckers were among the types of fish seen at this site during the year. Overall, Packwood was maintained and operated to protect juvenile salmonids throughout the irrigation season.

Figure 3.71. Packwood Water Velocities and Sediment Accumulation, May 2006. Probe approximately 8 in. from screen face. Error bars represent turbulence.

Figure 3.72. Packwood Water Velocities and Sediment Accumulation, July 2006. Probe approximately 8 in. from screen face. Error bars represent turbulence.

Figure 3.73. Packwood Water Velocities and Sediment Accumulation, September 2006. Probe 3 in. from screen face. Points are averages of three 10-sec bursts between brush passes. Error bars represent turbulence.

Selah-Moxee

This site was inspected on May 19, July 11, and September 21. We attempted to evaluate the site on September 13, but the irrigation district was preparing to apply Acrolein (used to kill “moss” and other organisms) in the canal. The sweeper arm support rail is closer to the screen than at most sites, so the probe was set with the arm parallel to and 4 in. away from the screen face for all velocity measurements. Sweep velocities always were higher than approach values. In May and September, sweep velocities increased toward the bypass and bypass velocities were greater than sweep values (Figures 3.74 through 3.76). All approach velocities met the NMFS criterion during each visit. Water moved smoothly and freely over the weir and through the outfall pipe. In May, a trash boom in the river upstream of the trash rack directed debris away during the high river flows.

Brushes worked effectively to remove large debris. Water was so turbid in May that there was not enough light for the video camera below 4 ft. Video surveys showed some buildup of algae in patches in July and September, indicating the brushes were not hitting the screens with equal pressure throughout. Seals and screens were in good condition. Numerous 1-in.-long fish were seen in the aftbay in July, and one 6-in. trout was seen in the bypass.

Overall, Selah-Moxee was in good operating condition in 2006 and provided safe passage to juvenile salmonids during each visit. There still are no gages at this site. Gages should be installed to make operational measurements consistent among all users.

Figure 3.74. Selah-Moxee Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.75. Selah-Moxee Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.76. Selah-Moxee Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Union Gap

Our evaluations of the Union Gap site took place on May 18, July 7, and September 7, 2006. The sweeper arm support rail is positioned about 8 in. from the screen face, so the probe was reconfigured to sit within 3 in. of the screen. Sweep velocities always were greater than approach values but did not increase toward the bypass. Average sweep velocities were essentially equal to bypass velocities in all three evaluations (Figures 3.77 through 3.79). Approach velocities met the NMFS criterion 100%, 88%, and 100% of the time in May, July, and September, respectively, which is an improvement over last year. Plans had been to work with WDFW at Union Gap to find the optimal settings for the louvers to minimize approach velocities. Approach velocities were better than previous years, and there was no effort made to find the optimal settings. It may be possible to find optimal settings in spring 2007 if approach velocities are excessive.

The seams between screen panels were replaced late in 2005 and were in good condition throughout most of the year. One small area along the bottom seal had started to peel away by September. Screen condition was also good during each of the surveys. There was good bypass flow during each of our inspections, and water moved freely over the weir and into the outfall channel. The brush was effective in cleaning the screens. In July, PNNL noticed water leaking through a small crack in the canal and called the irrigation district person on the callout list in the logbox. The irrigation district was very prompt in fixing the problem. Union Gap was in good operating condition in 2006 and provided safe passage to juvenile salmonids during each evaluation.

Figure 3.77. Union Gap Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.78. Union Gap Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.79. Union Gap Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

Yakima-Tieton

We inspected the Yakima-Tieton site on May 25, July 14, and September 20, 2006. The probe was set about 6 in. from the screen face in May and July and about 3 in. from the face in September. Sweep velocities always were greater than approach velocities but did not gradually increase toward the bypass during any of our inspections (Figures 3.80 through 3.82). Bypass velocities were greater than the average sweep in May and September but not in July. Approach velocities met the NMFS criterion 100%, 96%, and 90% of the time in May, July, and September, respectively. PNNL staff had planned to work with USBR on adjusting the louvers at this site to minimize the frequency of excessive approach values when river levels are high. However, a convenient time for both groups was not found, and this did not happen.

Water flowed freely through the bypass. There is no ramp here, and the flushgate is left up so that all bypass water passes under the flushgate, taking sediment with it. This also allows more water to flow through the bypass than would if the flushgate were used as it is designed. This normally helps keep the forebay near the screens relatively clear of sediment, but in May excessive sediment was building up near the screens (Figure 3.80). It did not impede the operation of the brushes, however, which kept the screens clear of most debris. The logbook noted that pine needles plugged the screens July 4 and caused them to be overtopped. According to the logbook, it took approximately 8 hours for the screens to be cleared and conditions to return to normal.

Figure 3.80. Yakima-Tieton Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.81. Yakima-Tieton Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.82. Yakima-Tieton Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

The video survey was ineffective in May when the water was very turbid. In July and September, caulking was found to be pulling loose in numerous places along the bottom of the screens, leaving long strands of caulk waving in the current. This seems to be getting worse every year as the caulk continues to weaken. It should be replaced. We did not detect any gaps between the frame and cement large enough for fish to get through.

Yakima-Tieton was operated in a way that generally provides safe passage to juvenile salmonids. Approach velocities above 0.4 ft/s in September occur when juvenile salmonids in that area are larger and can swim away. Loose caulking along the screen seals do not appear to expose gaps large enough to entrain fish but may in the future.

Younger

Inspections of the Younger fish screen site occurred on May 17, July 10, and September 6, 2006. The support rail for the sweeper arms extends about 8 in. from the screen faces at Younger, but it is difficult to position the probe any closer to the screen face. Gang brushes (multiple brushes a couple feet apart) move past any given point every 15 sec and create pressure waves in front of each brush. Velocities reported here for May and July are all at least 8 in. in front of the screen face, and approach velocities may not represent conditions closer to the screen face. In September, the probe was placed within 3 in. of the screen face and data were recorded for three consecutive 10-sec bursts (the probe had to be moved away from the brushes between each measurement). The three bursts were then averaged together for the sweep and approach values at that position.

Sweep velocities always were greater than approach velocities, but sweep did not increase toward the bypass (Figures 3.83 through 3.85). Approach velocities met the NMFS criterion 83%, 33%, and 100% of the time in May, July, and September, respectively.

Bypass flow was measured in September by placing the probe in the notch in the checkboards and was greater than the sweep velocities (Figure 3.85). In May, only 4 in. of water were spilling over the checkboards and velocities could not be measured. In July, water was 23 in. deep through the checkboard notch and the probe could not be held stable in the current.

Screen condition was good during all surveys. Caulk is missing around the edges of the screens in several places, but the screens fit snugly to the cement, so there is little chance for fish entrainment. Fish could be impinged, however, and the caulking should be replaced. The brushes effectively kept the screen clear of debris.

The Younger site was usually operated to protect juvenile salmonids in 2006. Approach velocities in July were high enough to potentially impinge even larger juvenile salmonids. River levels at this time were quite high, and some of the checkboards could have been removed to reduce submergence and allow more water to flow back toward the river. The gate at the paddlewheel could also have been raised to reduce the amount of water entering the canal.

Figure 3.83. Younger Water Velocities and Sediment Accumulation, May 2006. Error bars represent turbulence.

Figure 3.84. Younger Water Velocities and Sediment Accumulation, July 2006. Error bars represent turbulence.

Figure 3.85. Younger Water Velocities and Sediment Accumulation, September 2006. Error bars represent turbulence.

3.4 Vertical Traveling Screen

Only one Phase II site evaluated has vertical traveling screens. This site is described in this section.

Gleed

The Gleed site was evaluated on May 31, June 14, July 20, and September 18, 2006. Metal plates are used to protect the screens from debris by being set on the bottom of the forebay in front of the trash rack. Gaps between the plates allow water to flow to the screens. Velocity measurements are made at this site with the probe within 3 in. of the screen faces. During the May evaluation, the two upstream plates were raised so only 18 in. extended into the water. The remaining plates were set on the bottom. Gaps between the plates can cause extreme fluctuations in water velocity and direction (Figure 3.86), but having the upstream two plates raised seemed to improve sweep velocities at the upstream end of the site. A strong back eddy was present in May at the downstream end of the site where water backs up against the checkboards.

In June, debris levels had dropped and all plates were raised, but water levels were so high that 27 in. of the plates still extended into the water. Sweep and approach values smoothed out once the plates were raised (Figure 3.87). Approach values met the NMFS criterion 75%, 92%, 50%, and 96% of the time in May through September (Figures 3.86 through 3.89), with a maximum of 1.2 ft/s in May at screen 2

(Figure 3.86). This same point always has very high approach velocities when the plates are set on the forebay floor. It is apparently related to the gap between the plates and where the main force of the current hits the trash rack and metal plates. We notified the WDFW of the high approach values in May and again in July.

Sweep was not consistently higher than approach and in July was consistently lower. Sweep only increased toward the bypass in June. Bypass flow was always adequate, as was depth of water where the bypass flow spills onto the cement apron. Gaps of up to 0.125 in. noted between vertical sections within screens 1 and 3 exceed the NMFS criterion of 0.06 in. as the maximum opening. The screen material on at least these two screens needs to be either tightened or replaced. Seals were in good condition, although a small warp had developed in the downstream-side seal of screen 1 by September. Sediment was present in places along screens 1 and 2 above the bottom seal in September.

The abrupt fluctuations in flow in early spring may disorient small fish trying to negotiate the site. U.S. Bureau of Reclamation and WDFW personnel are studying ways to provide better flow at this site while protecting it from the heavy debris that frequently occurs in the spring (Figure 3.90).

Figure 3.86. Gleed Water Velocities and Sediment Accumulation, May 2006. Black bars represent the position of metal plates and the gaps between them. Note the location of the gaps relative to the sampling positions.

Figure 3.87. Gleed Water Velocities and Sediment Accumulation, June 2006. Black bars represent the position of metal plates and the gaps between them. Note the location of the gaps relative to the sampling positions.

Figure 3.88. Gleed Water Velocities and Sediment Accumulation, July 2006

Figure 3.89. Gleed Water Velocities and Sediment Accumulation, September 2006

Figure 3.90. Heavy Debris Accumulation at Gleed in February 2006. Screens are located directly below the gantry in the middle of the photo; the main river is off to the right of the photo. (Photo courtesy of Ray Gilmour, WDFW).

4.0 Conclusions and Recommendations

The 2006 evaluation of 27 Phase II fish screen facilities in the Yakima and Touchet river basins by PNNL indicates that the facilities are generally designed, constructed, operated, and maintained to provide juvenile salmonids a safe and efficient return to the river. The Lower WIP site was not operational during any of our evaluations but seemed to be blocked off to prevent access to fish and was not included in further discussions.

In 86% of the 2006 inspections, sweep was greater than approach velocities. In 63% of all inspections, bypass velocities were greater than sweep velocities. Both conditions help move fish through the facility with minimal delays. Eighteen of the twenty-six operating sites had all approach velocities below 0.4 ft/s during 2006. Proportionally, flat-plate screen facilities are more likely to exceed 0.4 ft/s approach velocities than are drum screen sites. This may be related to the fact flat-plate screens are often on canals with larger volumes of water, or there may be some inherent design feature that causes more frequent excessive approach velocities.

Low submergence was noted at six sites during 2006, up slightly from 2005 (Chamness 2006). Debris was a problem at several sites and created significant problems at Bachelor-Hatton, John Cox, Naches-Cowiche, Naches-Selah, Toppenish Pump, and Upper WIP, where either bypass pipes were plugged, bypass entrances were obstructed, or outfalls were blocked for extended periods. When river levels are high, it is difficult to tell if the bypass flow is hydraulically backed up or there is debris in the bypass pipe. Perhaps some simple device or technique could be designed to run down the bypass pipe that would help determine if there is any blockage.

Alternatives to a fish screen facility are being considered for Taylor. Although it functioned better in 2006 than in 2005, it often does not meet safe passage criteria for submergence, bypass flow, and safe outfall conditions.

Screens and seals generally were well-maintained, preventing fish entrainment and injury. A few flat-plate screens had loose or missing caulking (i.e., Yakima-Tieton), and a couple of the drum screens had developed slight bulges in the side seals (i.e., Toppenish Pump and Upper WIP). These situations could entrain or injure salmonid fry. Drums turned smoothly at most sites, and brushes at flat-plate screens were effective in removing most debris. Any problems with brushes and plugged screens were quickly resolved. Operations and maintenance personnel with the WDFW and USBR typically checked sites every 1 to 2 weeks, keeping equipment running smoothly and cleaning those facilities that are their respective responsibility. This schedule seems adequate for most sites, but sites with a history of problems should be visited more frequently. An example is Powell-LaFortune, where blockage of the upstream trash rack can result in rapid and dramatic fluctuations in water levels at the screening facility, causing submergence and bypass flow problems.

The problem-tracking protocol documents problems and O&M personnel accountability for proper operations and maintenance. One problem that may be correctable is consistently high approach velocities at some sites. If time and schedules allow, PNNL personnel will work with WDFW and USBR to identify possible causes for high approach velocities at Congdon, Union Gap, and Yakima-Tieton. PNNL can provide immediate feedback on the effect of changes made to stoplog or louver positions until

optimal settings can be found to keep approach velocities at or below 0.4 ft/s. This process also will identify any circumstances that prevent the site from meeting NMFS criteria.

Gleed continues to have excessive approach velocities, although raising the protective metal plates helped moderate the extreme fluctuations in sweep and approach and may have helped reduce the large back eddy at the downstream end of the site. This site needs to be modified to bring it within NMFS criteria, and USBR and WDFW plan to work on design modifications in 2007. Pacific Northwest National Laboratory researchers will provide support in acquiring data needed for the design.

We recommend each site's logbox have a table showing the design bypass flow and the corresponding depths and settings to maintain good approach and sweep velocities while allowing adequate diversion to the canal. This already is available at some sites.

For the past 10 years, PNNL has evaluated Phase II sites, providing objective feedback to the O&M agencies and to BPA on the screen facilities ability to operate within NMFS design criteria, providing safe passage to juvenile salmonids. Over that time, the effectiveness of fish screen facilities has improved in the Yakima and Touchet river basins as the O&M agencies received feedback on the impact of maintenance and operations issues, such as the effect of excessive sediment or partly plugged screens on water velocities. Underwater videography was particularly helpful in providing important information on performance of parts of the facilities normally seen only in the winter.

This screen evaluation program has collected data that can and should be used as feedback on screen facility structural design (e.g., backeddies should not form around piernoses of drum screen bays) and operation (e.g., position of porosity boards and louvers behind screens to control flow). Inspection of water velocities and screen facility condition by PNNL has given the BPA, USBR, and WDFW monitoring and evaluation data needed to determine that Phase II fish screens are generally providing the necessary safe passage for juvenile salmonids. We recommend monitoring and evaluation of a representative number of new juvenile fish screen facilities throughout the Columbia Basin to ensure design and construction meet NMFS criteria. In addition, we recommend periodic monitoring and evaluation of a representative mix of large and small juvenile fish screen facilities that are operated and maintained by different agencies. This will provide BPA and the O&M agencies with objective data on the ability of these facilities to meet NMFS design criteria.

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