2018 Fish Passage Plan

March 1, 2018 – February 28, 2019

Lower Columbia & Lower Snake River Hydropower Projects
U.S. Army Corps of Engineers, Northwestern Division
CENWD-PDW-R

Lower Granite Dam 2016 – cool water spray at the adult fish ladder exit as part of structural modifications to improve ladder temperatures.

PLEASE NOTE – the FPP is a "living document" and may be updated throughout the year as coordinated with FPOM. *All changes approved after March 1, 2018, are NOT included in this printed copy.*

The most current version of the FPP is available for download online at:
http://pweb.crohms.org/tmt/documents/fpp/

2018 Fish Passage Plan

Chapter 1 – Overview

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Figure OVE-1. Map of the Federal Columbia River Power System (FCRPS).

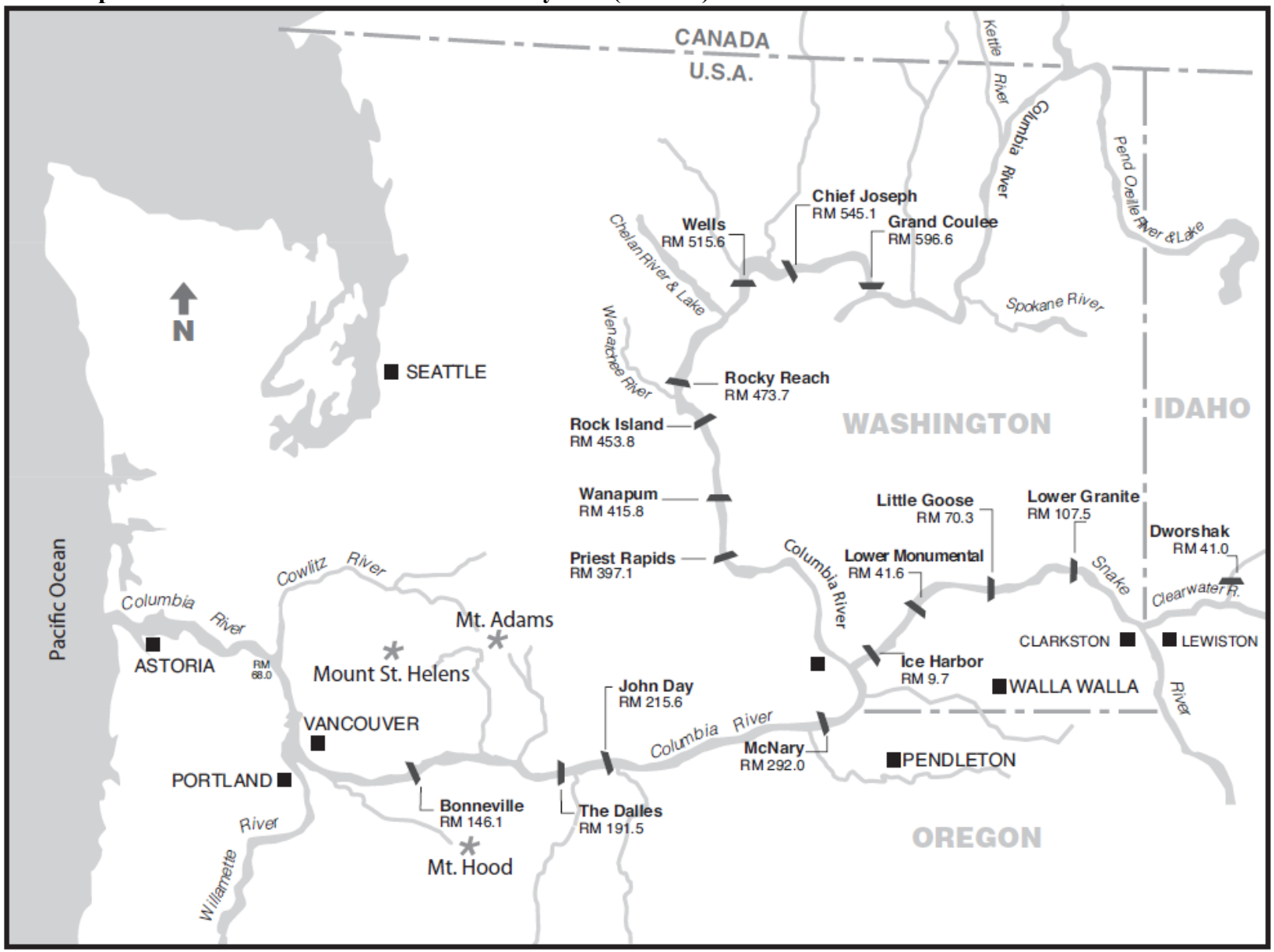

Table OVE-1. Project Information and Operating Criteria for FCRPS Projects on the Lower Columbia and Lower Snake Rivers. [a]

Lower Columbia River				
PROJECT	**Bonneville**	**The Dalles**	**John Day**	**McNary**
Project Acronym [b]	BON	TDA	JDA	MCN
River Mile (RM)	Columbia River – RM 146.1	Columbia River – RM 191.5	Columbia River – RM 215.6	Columbia River – RM 292
Reservoir	Lake Bonneville	Lake Celilo	Lake Umatilla	Lake Wallula
Minimum Instantaneous Flow (kcfs)	80 kcfs	Dec–Feb: 12.5 kcfs Mar–Nov: 50 kcfs	Dec–Feb: 12.5 kcfs Mar–Nov: 50 kcfs	Dec–Feb: 12.5 kcfs Mar–Nov: 50 kcfs
Forebay Normal Operating Range (ft)	71.5’ – 76.5’	155.0’ – 160.0’	Nov–Jun: 260 – 265’ Jul–Oct: 265 – 268’	337’ – 340’
Tailrace Rate of Change Limit (ft)	Apr–Sep: 1.5’/hr, 4’/day Oct–Mar: 3’/hr, 7’/day	3’/hr	3’/hr	1.5’/hr
POWERHOUSE				
Powerhouse Length (ft)	PH1: 1,027’ PH2: 986’	2,089’	1,975’	1,422’
Turbine Units (#)	PH1: 10 PH2: 8 + 2 Fish Units	22 + 2 Fish Units	16	14
Turbine Generating Capacity (MW)	PH1: 535 MW PH2: 558 MW	1,808 MW	2,160 MW	980 MW
Powerhouse Hydraulic Capacity (kcfs)	PH1: 136 kcfs PH2: 152 kcfs	375 kcfs	322 kcfs	232 kcfs
SPILLWAY				
Spillway Length (ft)	1,450’	1,447’	1,228’	1,310’
Spillbays (#)	18	23	20	22
Spillway Weirs (#)	0	0	2 (Bays 18-19)	2 (Bays 19-20)
Spillway Hydraulic Capacity (kcfs)	1,600 kcfs	2,290 kcfs	2,250 kcfs	2,200 kcfs
NAVIGATION LOCK				
Nav. Lock Length x Width (ft)	675’ x 86’	650’ x 86’	650’ x 86’	683’ x 86’
Nav. Lock Maximum Lift (ft)	70’	90’	113’	75’

Lower Snake River				
PROJECT	**Ice Harbor**	**Lower Monumental**	**Little Goose**	**Lower Granite**
Project Acronym [b]	IHR	LMN	LGS	LWG
River Mile (RM)	Snake River – RM 9.7	Snake River – RM 41.6	Snake River – RM 70.3	Snake River – RM 107.5
Reservoir	Lake Sacajawea	Lake Herbert G. West	Lake Bryan	Lake Lower Granite
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 0 kcfs Mar–Jul: 9.5 kcfs / Aug–Nov: 7.5 kcfs	Dec–Feb: 0 kcfs Mar–Nov: 11.5 kcfs	Dec–Feb: 0 kcfs Mar–Nov: 11.5 kcfs	Dec–Feb: 0 kcfs Mar–Nov: 11.5 kcfs
Forebay Normal Operating Range (ft)	437’ – 440’	537’ – 540’	633’ – 638’	733’ – 738’
Tailrace Rate of Change Limit (ft)	1.5’/hr	1.5’/hr	1.5’/hr	1.5’/hr
POWERHOUSE				
Powerhouse Length (ft)	671’	656’	656’	656’
Turbine Units (#)	6	6	6	6
Turbine Generating Capacity (MW)	603 MW	810 MW	810 MW	810 MW
Powerhouse Hydraulic Capacity (kcfs)	106 kcfs	130 kcfs	130 kcfs	130 kcfs
SPILLWAY				
Spillway Length (ft)	590’	498’	512’	512’
Spillbays (#)	10	8	8	8
Spillway Weirs (#)	1 (Bay 2)	1 (Bay 8)	1 (Bay 1)	1 (Bay 1)
Spillway Hydraulic Capacity (kcfs)	850 kcfs	850 kcfs	850 kcfs	850 kcfs
NAVIGATION LOCK				
Nav. Lock Length x Width (ft)	675’ x 86’	666’ x 86’	668’ x 86’	674’ x 86’
Nav. Lock Maximum Lift (ft)	100’	100’	101’	105’

a. Project operating limits and constraints are based on physical plant limitations, legal limits of authorized purposes, and/or to maximize efficiency and benefit of FCRPS reservoir operations. Flexibility of these limits is pursuant to general provisions of the applicable law and any other agreements or contracts. More information is available in the project-specific **FPP Chapters 2-9**, or on the Corps District websites: www.nwp.usace.army.mil/Locations/ColumbiaRiver.aspx (BON, TDA, JDA); www.nww.usace.army.mil/Locations.aspx (MCN, IHR, LMN, LGS, LWG).

b. Project acronym designated by U.S. Army Corps of Engineers Northwestern Division (NWD), Columbia Basin Water Management. Due to the large number of hydropower projects managed by NWD, this acronym may differ from other common regional acronyms. For example, Lower Granite Dam is commonly abbreviated **LGR**; however, this acronym is assigned to another NWD project, so the official Corps NWD acronym is **LWG**.

1. INTRODUCTION

1.1. Fish Passage Plan (FPP)[1]

1.1.1. The annual *Fish Passage Plan* (FPP) is developed by the U.S. Army Corps of Engineers (Corps) in coordination with the Bonneville Power Administration (BPA), regional Federal, State, and Tribal fish agencies, and other partners through the *Fish Passage Operations & Maintenance* (FPOM) workgroup.

1.1.2. The FPP describes year-round (March-February) operations and maintenance (O&M) actions to provide fish passage and protection at the eight Corps projects on the lower Columbia and lower Snake rivers (**Figure OVE-1; Table OVE-1**). The FPP includes appendices for fish protection procedures during turbine maintenance at Chief Joseph Dam on the upper Columbia River and at Dworshak Dam on the North Fork Clearwater River. Other Corps documents and agreements related to fish passage at these projects are consistent with the FPP.

1.1.3. The FPP will be revised as necessary to incorporate changes due to new facilities or modified operational procedures. Revisions will be coordinated with the region as described below in **section 3.3** and with NOAA Fisheries and USFWS as part of ESA Section 7 consultation, Recovery Plan, or Incidental Take permit processes, and through consideration of other regional input and plans. When revising the FPP, the Corps also considers the Northwest Power and Conservation Council's Columbia River Basin Fish & Wildlife Program to the fullest extent practicable.

1.1.4. Comments on the FPP are welcome and may be sent to FPOM and/or the Corps' Northwestern Division, Reservoir Control Center (RCC) Fisheries Section, in Portland, Oregon.

1.2. ESA Consultations (Biological Opinions)[2]

1.2.1. NOAA Fisheries issued a Biological Opinion (BiOp) in May 2008 on the effects of operating the Federal Columbia River Power System (FCRPS) on ESA-listed anadromous fish species. The BiOp included a *Reasonable & Prudent Alternative* (RPA) table of recommended actions and strategies to avoid jeopardizing ESA-listed fish species. The 2008 BiOp was supplemented in 2010 with new information and an *Adaptive Management Integration Plan* (AMIP), and again in 2014 with a review of new and updated scientific reports, data, and analyses, additional project definitions, and amended RPA actions.

1.2.2. The FPP is developed pursuant to RPA 32 (**Figure OVE-2**) as part of the hydropower strategy to operate and maintain fish passage facilities for biological performance.

[1] FPPs from 2000 through present (including all Change Forms) are available on the FPP website at: pweb.crohms.org/tmt/documents/fpp/

[2] FCRPS BiOps, associated decision documents, and other related information are available online at: www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp.aspx

Figure OVE- 2. Fish Passage Plan (FPP), as defined in RPA Action 32 of the 2008 NOAA Fisheries FCRPS Biological Opinion (BiOp) and modified in the 2014 Supplemental BiOp.

RPA No.	Action Description	Implementation Plans, Annual Progress Reporting and Comprehensive RPA Evaluations
Hydropower Strategy 4—Operate and Maintain Facilities at Corps' Mainstem Projects to Maintain Biological Performance		
32	**Fish Passage Plan** The Corps will annually prepare a FPP in coordination with NOAA Fisheries and the Regional Forum through the FPOM. The Corps will operate its projects (including juvenile and adult fish passage facilities) year-round in accordance with the criteria in the FPP. Comments developed by NOAA Fisheries on the draft FPP shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final FPP. Key elements of the plan include: ▪ Operate according to project-specific criteria and dates to operate and maintain fish facilities, turbine operating priorities, and spill patterns; ▪ Operate according to fish transportation criteria; ▪ Maintain turbine operations within the 1% of best efficiency range; ▪ Maintain spillway discharge levels and dates to provide project spill for fish passage; ▪ Implement TDG monitoring plan; ▪ Operate according to protocols for fish trapping and handling; ▪ Take advantage of low river conditions, low reservoir elevations or periods outside the juvenile migration season to accomplish repairs, maintenance, or inspections so there is little or no effect on juvenile fish; ▪ Coordinate routine and non-routine maintenance that affects fish operations or structures to eliminate and/or minimize fish operation impacts; ▪ Schedule routine maintenance during non-fish passage periods; ▪ Conduct non-routine maintenance activities as needed; and ▪ Coordinate criteria changes and emergency operations with FPOM.	**Implementation Plans** ▪ The FPP is prepared annually. **Annual Progress Report** ▪ Not applicable. **2013 and 2016 Comprehensive RPA Evaluation Reports** ▪ Not applicable.

RPA Action No.	Description	Modified RPA Language	Location in 2014 Supplemental Opinion
32	Fish Passage Plan	The Action Agencies will no longer consider transport at McNary Dam in the development of Transportation Strategy Configuration and Operation Plan	Section 3.3.3.4

1.3. Deviations from FPP Criteria

1.3.1. The phrase "*when practicable*" is used in the FPP to describe Project actions for fish that may vary on a case-by-case basis and thus require the exercise of professional judgment by Project staff. These situations may be due to real-time biological and/or other environmental conditions, availability of Project staff and/or equipment, or integrity of fish facility or other dam structures. In these cases, the Project biologist and other Project personnel will consider all relevant factors to determine the best way to proceed and implement appropriate action. These actions will be coordinated with fish agencies and tribes when they deviate from the FPP.

1.3.2. River operational emergencies may occur that require projects to temporarily deviate from the FPP. To the extent practicable, these operations will be coordinated with fish agencies and tribes, and conducted in a manner to avoid or minimize fish impacts. Normally, coordination occurs prior to an action; however, if an emergency situation requires immediate attention, coordination will be completed as soon as practicable afterwards, as described in **section 3**.

1.3.3. In-season decisions on river operations to achieve BiOp biological performance standards for spring and summer out-migrants will be made in coordination with the regional forum *Technical Management Team* (TMT). Special operations identified in the FPP will be coordinated through TMT and included in the annual *Water Management Plan* (WMP) [3], such as maintenance or research activities requiring unit outages that affect other river operations, operation of turbines outside of the ±1% of peak efficiency range, Snake River zero nighttime generation, and implementation of the *Juvenile Fish Transportation Plan* (**Appendix B**).

1.4. Spill for Juvenile Fish Passage

1.4.1. Planned yearly spring and summer spill operations for juvenile fish passage at the eight lower Snake and lower Columbia River projects are defined in the *Fish Operations Plan* (FOP), included in the FPP as **Appendix E**. Spill operations to improve juvenile fish passage are defined in the 2014 NOAA Fisheries Supplemental FCRPS BiOp RPA Action 29 and Table 2.

1.4.2. During spring and summer spill for fish passage, spill at each project will be distributed across the spillway as defined in patterns in the project-specific FPP **Chapters 2-9**, unless otherwise coordinated with FPOM or TMT. If spill occurs outside of spring and summer spill season, projects will typically use the FPP patterns but may modify patterns as necessary to accommodate maintenance, research, navigation, or other constraints.

1.5. Total Dissolved Gas (TDG) Monitoring

1.5.1. The Federal *Clean Water Act* establishes a total dissolved gas (TDG) aquatic life standard of 110% that has been adopted by the states of Washington, Oregon, Idaho, and Montana, and regional tribes.

1.5.2. During spill operations for fish passage, the states of Oregon and Washington have authorized exceptions (standard modification and criteria adjustment, respectively) for the four lower Snake River and four lower Columbia River projects of 120% in the project tailrace (OR and WA) and 115% in the next downstream forebay (WA). The Oregon standard modification applies to spill for fish passage April 1–August 31. The Washington criteria adjustment applies to spill for fish passage year-round. As such, the Corps monitors TDG levels at fixed monitoring stations in the forebay and tailrace of each project to ensure that spill for fish passage is consistent with all applicable State and Tribal standards. For more information, see the FOP (**Appendix E**).

1.5.3. The Corps' annual *TDG Management Plan* (included as Appendix 4 to the WMP[3]) provides the most current information on State water quality standards and includes definitions of spill types (e.g., fish passage, lack of turbine), the process for coordinating and implementing a spill priority list to manage system-wide TDG, the process for setting spill caps, and TDG management policies and monitoring programs. The Corps will coordinate with TMT to develop the spill priority list and to provide ongoing TDG information and reports as necessary.

[3] WMPs from 2001 through present are available online at: pweb.crohms.org/tmt/documents/wmp/

1.6. System Load Shaping

1.6.1. To avoid or minimize impacts of hydropower operations on fish, BPA coordinated the *System Load Shaping Guidelines Regarding Turbine Operation & Peak Efficiency*, included in the FPP as **Appendix C**. The Guidelines define how BPA requests load April 1–October 31 so that the Corps can operate turbine units at fish passage projects within ±1% of peak efficiency (1% range), or as otherwise coordinated through FPOM and/or TMT to enhance fish passage (e.g., Bonneville Dam PH2 mid-range operations).

1.7. Juvenile Fish Transportation Plan (JFTP)

1.7.1. Juvenile fish will be transported in accordance with the FOP, FPP, and ESA Section 10 permit. Protocols and criteria for collection, holding, and transport of juvenile fish are defined in the *Juvenile Fish Transportation Plan* (JFTP), included in the FPP as **Appendix B**. Other operating criteria for juvenile fish bypass facilities are contained in the project-specific **FPP Chapters 2–9**. Additional criteria may be developed as part of the ESA Section 10 permit process and/or in coordination with the TMT. Implementation of the JFTP, including deviation from the plan described in **Appendix B**, will be coordinated through TMT and NOAA Fisheries.

1.8. Turbine Dewatering Fish Protection Protocols at Chief Joseph & Dworshak Dams

1.8.1. The Corps has coordinated and adopted fish protection procedures during turbine dewatering for maintenance at Chief Joseph (**Appendix H**) and Dworshak (**Appendix I**). While these projects do not have fish passage capabilities, ESA-listed salmon and steelhead are present in the tailrace and may become trapped in the turbine unit draft tube during dewatering. The procedures and criteria defined in the Appendices provide fish-protection measures to avoid or minimize impacts on ESA-listed salmonids during turbine dewaterings at these projects.

1.9. Lamprey Passage

1.9.1. The Fish Accords were signed in May 2008 and include actions to protect Pacific lamprey and improve juvenile and adult lamprey passage through the FCRPS. Project operations to improve passage for adult and juvenile lamprey are addressed in FPOM; specific operations for juvenile and adult lamprey are defined in **Appendix D** and in the appropriate project-specific **FPP Chapters 2-9**. In-season conflicts between operations for ESA-listed species and Pacific lamprey that are not addressed in the FPP may be reviewed by FPOM and/or TMT.

2. FISH PASSAGE FACILITIES – INSPECTION & REPORTING CRITERIA

2.1.1. The project-specific **FPP Chapters 2–9** include detailed inspection and reporting criteria for fish passage facilities at Corps projects. An example of a typical fish passage system is illustrated in **Figure OVE-3**. The Corps provides weekly written inspection reports to NOAA Fisheries Hydropower Program in Portland, Oregon, describing out-of-criteria situations, adjustments made to resolve problems, and a detailed account of impacts on project fish passage and survival. The weekly inspection reports also include summaries of equipment calibrations and monitoring of water temperature and adult fish collection channel velocity. Equipment that does not require calibration will not be routinely included in the weekly report. The Corps also

provides an annual report to NOAA Fisheries summarizing project O&M, fish passage facility inspections and monitoring, severity of out-of-criteria conditions, and avian predation abatement actions. In addition, the Corps is developing methods to report hourly individual spillbay and turbine unit operations at mainstem projects as called for in the UPA. An acceptable procedure will be coordinated with NOAA Fisheries and other FPOM participants.

2.2. Annual Reporting

2.2.1. Excursions outside of ±1% peak turbine efficiency range are tracked by BPA for each project during the fish passage season. The Corps determines the cause of each excursion and compiles this information approximately bi-weekly. After the fish passage season, the Corps submits an annual report to NOAA Fisheries that describes instances where turbines at lower Columbia and lower Snake River projects operated outside of ±1% peak efficiency range for significant periods, as defined under the guidelines in **Appendix C**. The intent of excursion reporting is to provide a means for quality assurance for project operations.

2.3. Reporting of Excursions Not Covered by Appendix C

2.3.1. The Corps and BPA will take all reasonable and practicable steps to provide advance notification through the existing interagency coordinating mechanisms prior to departure from the fish-protection measures set out in the 2008 BiOp. If unforeseen circumstances arise that preclude BPA or the Corps from notifying the TMT prior to a variation from required 1% operating criteria and those circumstances are not covered by **Appendix C**, those variations will be reported to the TMT as soon as practicable.

3. FPP IMPLEMENTATION & COORDINATION

3.1. FPP Implementation

3.1.1. FPP implementation requires information exchange and coordination with NOAA Fisheries, BPA, other Federal and state fish agencies, and tribes. The Corps RCC coordinates through TMT for Corps operations that have system-wide effects, such as water management, spill volume, and unit availability. Corps District biologists coordinate through FPOM on spill patterns, unit priority, adult and juvenile fish facilities, and other project-specific operations that do not have system-wide impacts.

3.1.2. The Corps RCC participates in TMT meetings throughout the year to consider recommendations for river operations to implement the FOP, BiOps, and other recommendations from fish interests. As part of this process, TMT may evaluate research data and advice on whether existing operations are consistent with current study results. These meetings are held in the Corps' Northwestern Division office in Portland, Oregon, and are open to the public. Corps representatives are available at these meetings to discuss the latest weather and runoff forecasts, as well as fish, hydrologic, water quality, and power generation information to assist in planning upcoming operations for fish passage. The Corps evaluates fish operation recommendations to determine impact on overall system operations. See section below regarding TMT coordination.

3.1.3. Corps District and RCC biologists attend monthly FPOM meetings dealing with project-specific issues below (see **section 3.3. FPOM Coordination**):

i. Consider recommendations from affected interests;
ii. Provide updates on construction, O&M, research, and other topics;
iii. Develop criteria for the annual FPP;
iv. Coordinate fish passage issues that may require deviation from FPP criteria.

3.2. Agency Responsibilities

3.2.1. U.S. Army Corps of Engineers

i. Coordinate with NOAA Fisheries and USFWS on operations that may impact ESA-listed threatened, endangered, or candidate species;

ii. Prepare annual *Water Management Plan* and seasonal updates in coordination with TMT.

iii. In cooperation with fish agencies and tribes, provide fish passage monitoring, surveillance, and reporting at Corps projects throughout the migration period;

iv. Provide timely information on all proposed and/or scheduled studies or special operations that may negatively impact or otherwise constrain fish passage or energy production. Discuss unforeseen changes in fish passage operations with fish agencies and tribes;

v. Carry out routine and emergency fish passage operations and maintenance procedures in accordance with criteria in **FPP Chapters 2-9** and **Appendix A**;

vi. Conduct the TDG Monitoring Program.

3.2.2. Federal, State and Tribal Fishery Agencies

i. Request spill for fish through TMT to protect ESA-listed species or other species in accordance with the TMT Guidelines;

ii. Via TMT, provide RCC with a spill priority list and recommended modifications;

iii. Provide biological monitoring and surveillance reports throughout the migration period from predetermined locations, such as Smolt Monitoring Program sample sites;

iv. Provide status reports on the timing of the downstream migration, including pertinent marked fish release and recovery data, with weekly written reports estimating percentage of runs past key projects;

v. Where biologically and logistically feasible, coordinate hatchery releases to ensure they are protected by regulated fish flows and spill while minimizing

impacts on ESA-listed species. Provide updated hatchery release schedules weekly;

vi. Provide recommendations to the operating agencies for maintaining acceptable fish passage conditions. This information can be used to maximize other project uses, including power generation;

vii. Provide information on all proposed and scheduled studies or special operations designed to improve fish passage operations that may affect energy production or project operation. Discuss unforeseen changes with the Corps;

viii. Recommend viable methods and procedures to reduce migratory and resident fish mortality (e.g., collection and transport of migrants, use of alternate bypass strategies, or other methods to minimize fish mortality).

3.2.3. Bonneville Power Administration

i. Report to RCC on updated load-resource studies during the April-to-September period to supplement the National Weather Service River Forecast Center's runoff volume forecast for fish passage planning assistance.

ii. Provide to RCC, NOAA Fisheries, other fish agencies, and tribes, the BPA estimate of power market impacts of requested spill operations.

iii. Utilize available flexibility of the Federal Columbia River Power System to shape flow requirements, spill priorities, and plant generation consistent with BPA policies and statutory requirements related to fish protection.

iv. Adjust system generation to provide adequate water for fish operation requirements in accordance with the FOP and relevant FCRPS BiOps.

v. Provide project load requests on a real-time/hourly basis that enable the Corps to implement spill priorities.

vi. Provide information on unit operations outside ±1% peak efficiency, as defined in **Appendix C**.

3.2.4. Mid-Columbia Public Utility Districts

i. Operate projects for spill transfer in accordance with provisions of the FPP with at least 1.5 hours notification to start or stop spill.

3.3. FPOM Coordination

3.3.1. Pursuant to RPA Action 32 (**Figure OVE-2**), project O&M activities in the annual FPP are regionally coordinated through FPOM, which includes representatives from the Corps, BPA, NOAA Fisheries, USFWS, state fish agencies (OR, WA, ID), tribes, and other interested parties. The printed FPP is published annually on or about March 1 and is effective year-round, though

revisions may be approved through FPOM at any time. Proposed revisions are presented to the relevant project's District Operations biologist for consideration by the Corps in an FPP "Change Form" that includes a description and justification for the change. The Corps will submit Change Forms to FPOM for a minimum of two weeks to review and provide feedback to the Corps POC. Approved Change Forms will be finalized with comments received and a record of final action, then amended to the current year's online FPP (if finalized after mid-February) or published in the next printed FPP (if finalized before mid-February). The Corps will provide FPP changes to TMT as necessary for use as part of the overall river operation plan. Sections dealing with special operational requirements will also be included in the annual *Water Management Plan*.

3.3.2. Project activities under the purview of FPOM that may require deviations from FPP criteria will be fully coordinated in a timely manner. All coordination procedures below shall be followed.

3.3.3. Memorandum of Coordination (MOC). For O&M activities within the District's Operations Division, project personnel will compile relevant information into a *Memorandum of Coordination* (MOC) that includes a summary of the activity, location, date, time, analyses of potential impacts to ESA-listed species, and potential alternative actions (see MOC template at the end of this Chapter) and forward to the District Biologist (or other appropriate personnel) for routing to FPOM. The District biologist will submit the MOC to FPOM at the next monthly meeting and/or via email, and if necessary, follow up with appropriate FPOM members via phone or email.

3.3.3.1. For each proposed action requiring an MOC, the analysis of potential impacts will include the following (see MOC template at end of this Chapter for links to data):

i. 10-year average passage of adults and juveniles of each affected listed species during dates of impact.

ii. Statement about the current year's run compared to the 10-year average.

iii. Estimated exposure to impact of adults and/or juveniles, as appropriate, by species (number or percent of 10-year average that occurs during dates of impact).

iv. Type of impact to adults and/or juveniles, as appropriate, by species (e.g., increased delay, exposure to predation, exposure to a route of higher injury/mortality rate, exposure to higher TDG, etc.).

v. Final judgement on scale of potential impact (negligible, minor, significant) on adult and juvenile salmonids (including bull trout) and lamprey (e.g. "As a result of this analysis, we anticipate that the proposed action will result in negligible impact to listed species.").

3.3.3.2. For planned O&M, the MOC should be provided to FPOM for review at least two weeks in advance.

3.3.3.3. For unplanned, non-emergency O&M (e.g., equipment failure), the MOC should be provided to FPOM at least three workdays in advance.

3.3.3.4. Emergency O&M may be performed immediately and an MOC submitted to FPOM as soon as possible, either before or after the activity (see **section 1.3**).

3.3.3.5. FPOM members may submit responses to MOCs by the requested due date via email, phone, or in person; all responses will be documented in the final MOC and distributed to FPOM and posted to the FPOM website. The District biologist will forward the final coordinated operation to project personnel, and if necessary, RCC will issue a teletype.

3.3.3.6. For research and construction activities involving the Planning Division, the Planning Division biologists will coordinate the effort with Operations Division biologists to develop an MOC. Research development is largely carried out and documented through the Corps' Anadromous Fish Evaluation Program (AFEP) in the regional forum Studies Review Work Group (SRWG). New construction or modification of fish facilities is typically carried out and documented through the Fish Facility Design Review Work Group (FFDRWG).

3.3.3.7. If implementation requires assistance from Project staff, temporary equipment installation or facility modification, and/or operational changes, then both Planning and Operations biologists will work closely with Project personnel and any others necessary to ensure all personnel are continually informed and updated throughout the process.

3.3.4. Memorandum for the Record (MFR). Incidents that result in adverse or negative impacts to fish or fishways shall be documented by Project biologists in a *Memorandum for the Record* (MFR; see template at end of this Chapter). The MFR will be sent to FPOM by the next working day and added to the next FPOM meeting agenda for review. FPOM members may submit responses to an MFR by the requested due date via email, phone or in person, and all responses will be documented in the final MFR for posting to the FPOM website.

3.3.5. FPOM Representatives & Participants *(*Chair, **Co-chair*):

- Corps Portland District, Operations – Tammy Mackey**
- Corps Portland District, Planning, Programs & Project Mgmt – Brad Eppard
- Corps Walla Walla District, Operations – Ann Setter*, Chris Peery, Eric Hockersmith
- Corps Walla Walla District, Planning, Programs & Project Mgmt – Marvin Shutters
- Corps Northwestern Division, Reservoir Control Center – Doug Baus, Lisa Wright
- Bonneville Power Administration (BPA) – Scott Bettin, Christine Peterson
- NOAA Fisheries – Trevor Conder, Blane Bellerud, Ed Meyer
- US Fish & Wildlife Service (USFWS) – David Swank
- Columbia River Inter-Tribal Fish Commission (CRITFC) – Tom Lorz
- Colville Confederated Tribes (CCT) – Sheri Sears
- Nez Perce Tribe – Dave Statler
- Confederated Tribes of Warm Springs – Jennifer Graham
- Yakama Nation – Tom Iverson
- Oregon Dept. of Fish & Wildlife (ODFW) – Erick Van Dyke
- Washington Dept. of Fish & Wildlife (WDFW) – Charles Morrill
- Idaho Dept. of Fish & Game (IDFG) – Russ Kiefer
- Fish Passage Center (FPC) – Dave Benner

3.4. TMT Coordination

3.4.1. Actions that may impact fish system-wide will be coordinated and documented through TMT. Actions that may impact fish at a specific project which are a result of actual operations, implementation of FOP/BiOp actions, incidental take, terms and conditions contained in the BiOps, or research projects will be coordinated through the process outlined below. TMT Guidelines are posted as an Appendix to the annual *Water Management Plan*.

3.5. Day-to-Day Coordination of FCRPS

3.5.1. Procedures described in the annual *Water Management Plan* will be used for fish operations. Coordination of system and project operations for flow augmentation and recommended reservoir operations will occur through TMT. This will include operation of turbine units outside of the ±1% peak efficiency range, zero nighttime flow in the Snake River, reservoir operation at minimum operating pool (MOP) or some other specific elevation, and special operations for implementation of approved research projects (see **Appendix A – Special Project Operations & Studies**). When reservoirs are not being operated to provide special protection for fish passage, projects may be operated within the full normal operating range.

3.5.2. Fish Spill Management. The Corps will implement fish spill provisions as described in the *FOP* (**Appendix E**), including special TDG conditions for juvenile fish passage. During spill for fish passage season, TDG levels will be monitored and fish will be evaluated for signs of gas bubble trauma by the Corps, NOAA Fisheries, other fish agencies, Tribes, and/or State water quality agencies. Project spill levels will be adjusted as needed based on daily physical and biological monitoring results, and coordinated with TMT and other relevant agencies and tribes.

3.5.3. Special Operations. Recommendations for special fish operations outside the *Water Management Plan* may be made to RCC and coordinated through TMT. Recommendations related to project O&M activities requiring special operations will be evaluated for fish impacts. Sufficient lead time will be allowed for a planned operation, whenever practical, to allow ESA coordination with TMT, NOAA Fisheries, and USFWS. Preferably, as much lead time as possible will be provided for activities requiring immediate action. After-action coordination will occur when advance notice is not possible, such as in emergency actions. All other special operations will be evaluated for fish impacts and effects on other project O&M requirements, and coordination with NOAA Fisheries, USFWS, fish agencies, and tribes, through TMT. Except as necessary for emergency actions, adequate time will be allowed for evaluation of all project and fish impacts prior to implementation. Coordination of emergencies will occur as identified in the *Emergency Protocols* adopted by TMT (Water Management Plan, Appendix 2).

3.5.4. Non-Corps Activities. All non-Corps personnel intending to conduct activity at a Corps facility (e.g., fish handling; minor facility modifications) must have prior written approval from the Corps. This approval must be requested in writing to the Chief, Operations Division, at the appropriate Corps District office. If the activity may affect ESA-listed fish, proof of consultation with NOAA Fisheries or USFWS (Section 10 permit) must be provided. Appropriate State permits must be provided as well for activities that may impact ESA-listed or non-listed fish.

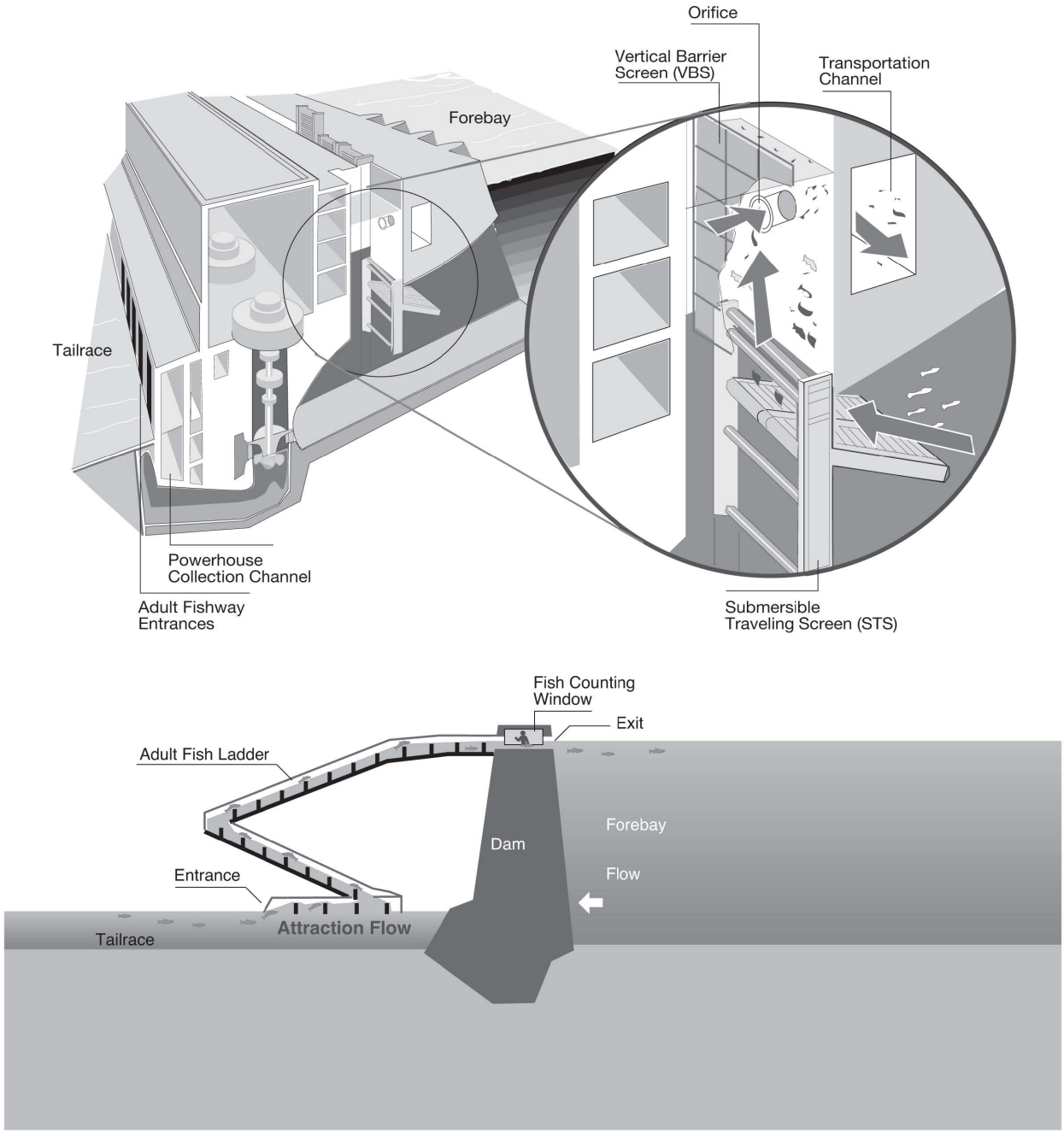

Figure OVE-3. Example Design of Fish Passage Structures at FCRPS Corps Hydropower Projects.

OFFICIAL MEMO of COORDINATION (MOC) FOR NON-ROUTINE OPERATIONS & MAINTENANCE

COORDINATION TITLE- *(filled in by District OD Biologist)*
COORDINATION DATE-
PROJECT-
RESPONSE DATE-

1. Description of problem.

2. Type of outage required *(relate to deviation from FPP).*

3. Dates of impacts/repairs.

4. Length of time for repairs.

5. Impact on fish facility operation *(fishway, JFF, etc.)***.**

6. Impact on project operations (*unit priority, forebay/tailwater operation and/or spill*).

7. Analysis of potential impacts to fish. Include:

a. 10-year average passage of adults and juveniles of each affected listed species during dates of impact.
   i. Adult counts: www.cbr.washington.edu/dart/query/adult_graph_text.
   ii. Adult counts *by ladder*: www.cbr.washington.edu/dart/query/adult_ladder_sum. To calculate 10-year average, download each of the most recent 10 years and copy into a spreadsheet for averaging.
   iii. Smolt index: www.cbr.washington.edu/dart/query/smolt_graph_text. To calculate 10-year average, select the most recent 10 years (hold "ctrl" and select each year) and select download to .CSV spreadsheet.

b. Statement about the current year's run (e.g., higher or lower than 10-year average).
   i. Pre-season – NOAA adult returns forecast: www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/g-forecast.cfm. Or contact the District adult fish passage coordinator.
   ii. Mid-season - current counts to-date vs. 10-year average (see links in section **a.**).

c. Estimated exposure to impact of adults and/or juveniles, as appropriate, by species (number or percentage of 10-year average that occurs during dates of impact).

d. Type of impact to adults and/or juveniles, as appropriate, by species (e.g., increased delay, exposure to predation, exposure to a route of higher injury/mortality rate, exposure to higher TDG, etc.).

e. Final judgement on scale of expected impacts (negligible, minor, significant) on:

   i. Downstream migrants.

   ii. Upstream migrants (including Bull Trout).

   iii. Lamprey.

8. Comments from agencies.

9. Final coordination results.

10. After Action update.

Please email or call with questions or concerns.
Thank you,

Name
Project
Title of person writing MOC
E-mail address of person writing MOC

CENWP-OD-*Project code* ***Date of report***

MEMORANDUM FOR THE RECORD (*include title i.e. 12BON01)*

SUBJECT: *Include species and location*.

Insert explanatory verbiage in this section.

A. Species –
B. Origin –
C. Length –
D. Marks and tags –
E. Marks and injuries found on carcass –
F. Cause and time of death –
G. Future and preventative measures –
H. Regional coordination and responses/comments –
I. Next FPOM meeting (add to agenda for review) –

Include photos if available.

Sincerely,
Project Fisheries

2018 Fish Passage Plan

Chapter 2 – Bonneville Dam

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Bonneville Dam *

River Mile (RM)	Columbia River – RM 146.1
Reservoir	Lake Bonneville
Minimum Instantaneous Flow (kcfs)	80 kcfs
Forebay Normal Operating Range (ft)	71.5 – 76.5 ft
Tailrace Elevation Rate of Change Limit	April – September: 1.5 ft/hour, 4 ft/day October – March: 3 ft/hour, 7 ft/day
Powerhouse Length (ft)	PH1: 1,027 ft PH2: 986 ft
Powerhouse Hydraulic Capacity (kcfs)	PH1: 136 kcfs PH2: 152 kcfs
Turbine Units (#)	PH1: 10 Main Units (1-10 Voith Minimum Gap Runner [MGR] Kaplan) PH2: 8 Main Units (11-18 Allis-Chalmers Kaplan) + 2 Fish Units (Sulzer/Escher-Wyss Kaplan)
Turbine Generating Capacity (MW)	Rated: 1,093 MW (PH1: 535 MW + PH2: 558 MW) Maximum: 1,238 MW (PH1: 600 MW + PH2: 638 MW)
Gatewell Orifice Diameter (in)	12.5" orifices – two per gatewell at Units 11-14 and F2; one per gatewell at Units 15-18 and F1
Spillway Length (ft)	1,450 ft
Spillway Hydraulic Capacity (kcfs)	1,600 kcfs
Spillbays (#)	18
Spillway Weirs (#)	0
Navigation Lock Length x Width (ft)	675 ft x 86 ft
Navigation Lock Max. Lift (ft)	70 ft

* More information is available on the Corps Portland District website for Bonneville Dam at: www.nwp.usace.army.mil/bonneville/

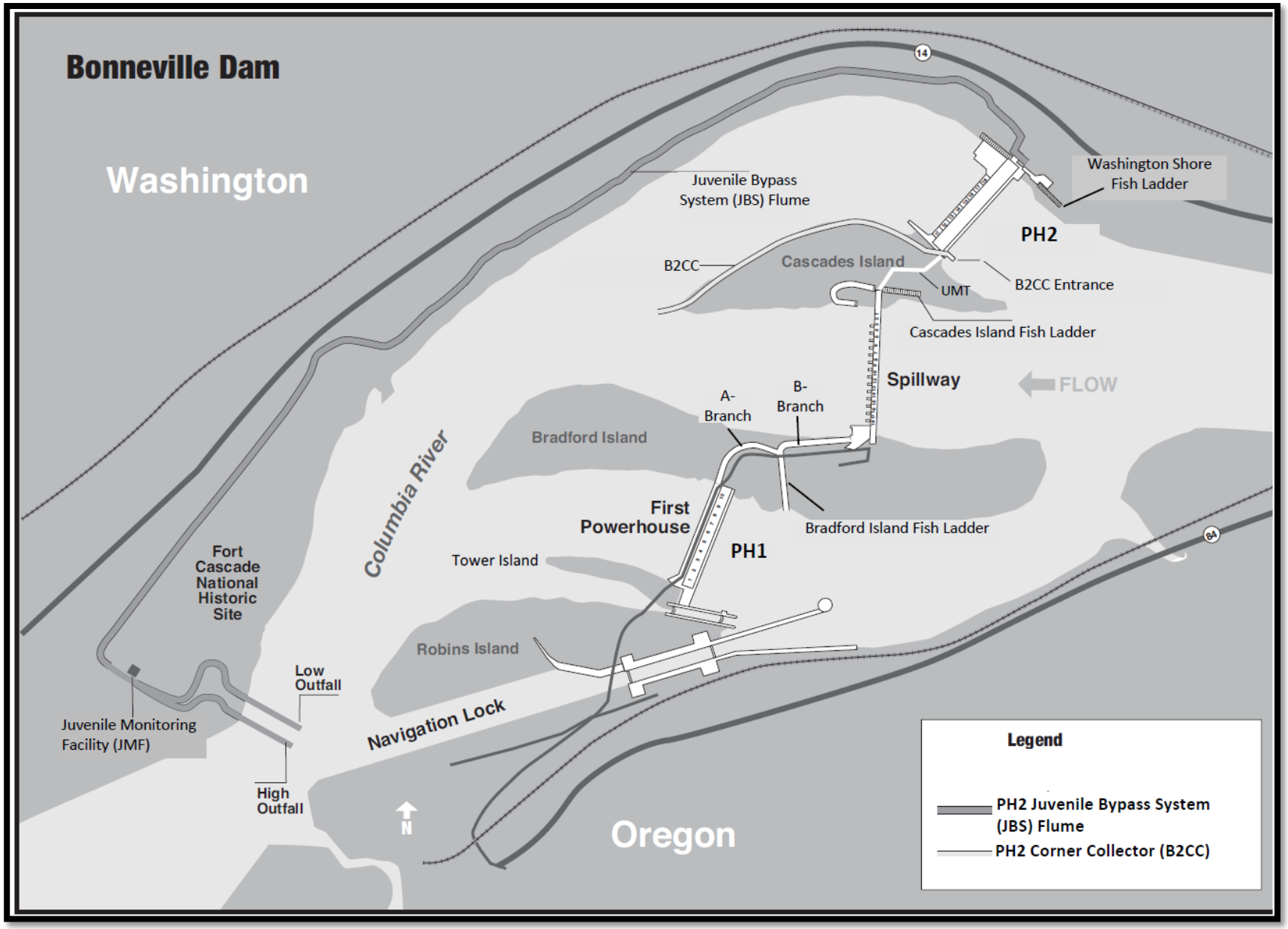


Figure BON-1. Bonneville Dam Overview, including Powerhouse 1 (PH1), Powerhouse 2 (PH2), Spillway, Adult Fish Ladders, PH2 Juvenile Bypass System (JBS), Corner Collector (B2CC), Juvenile Monitoring Facility (JMF) and JBS Outfall.

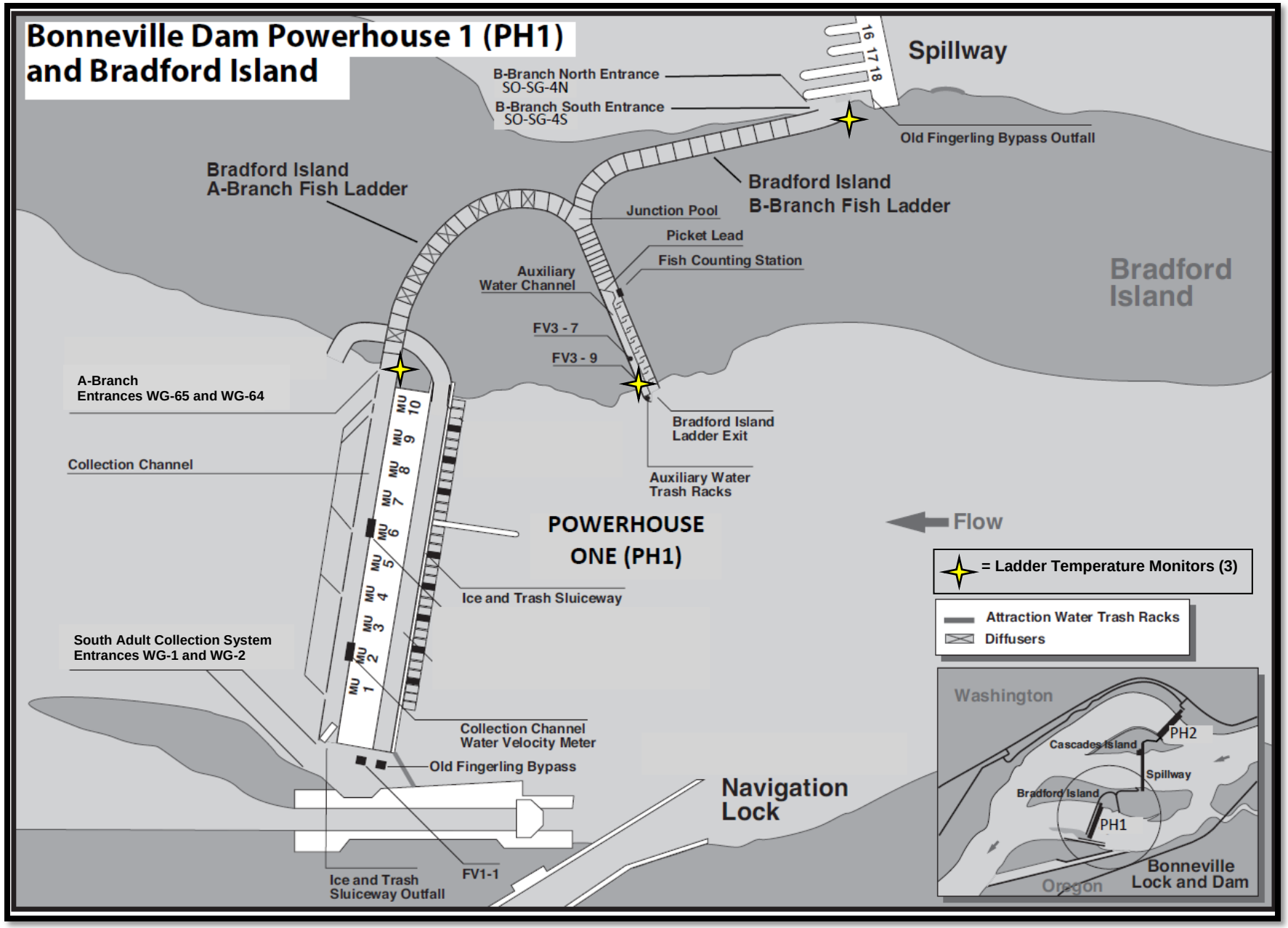


Figure BON-2. Bonneville Dam Powerhouse 1 (PH1) and Bradford Island Adult Fish Ladder A-Branch and B-Branch.

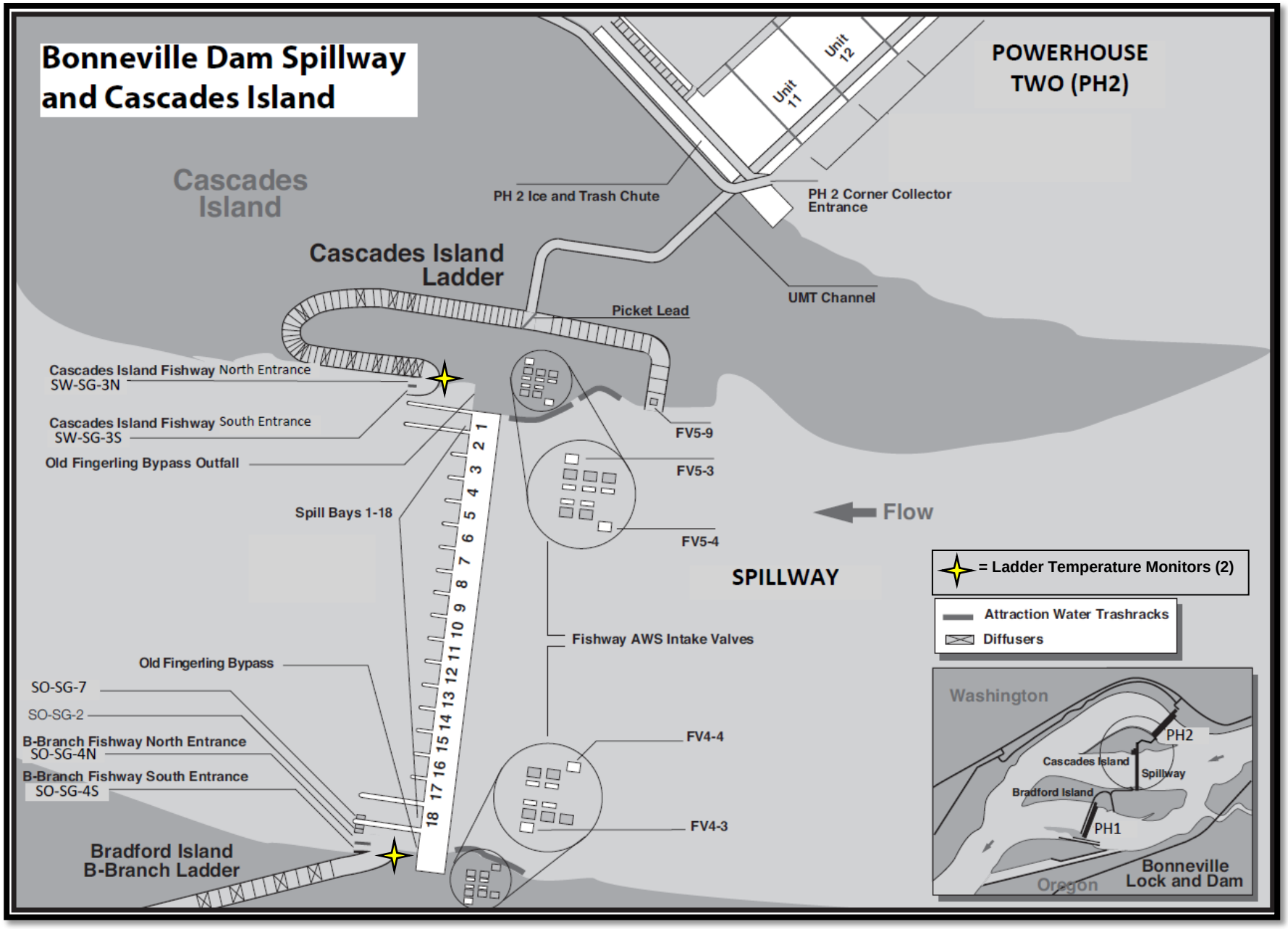


Figure BON-3. Bonneville Dam Spillway, Cascades Island Fish Ladder and Upstream Migrant Transportation (UMT) Channel.

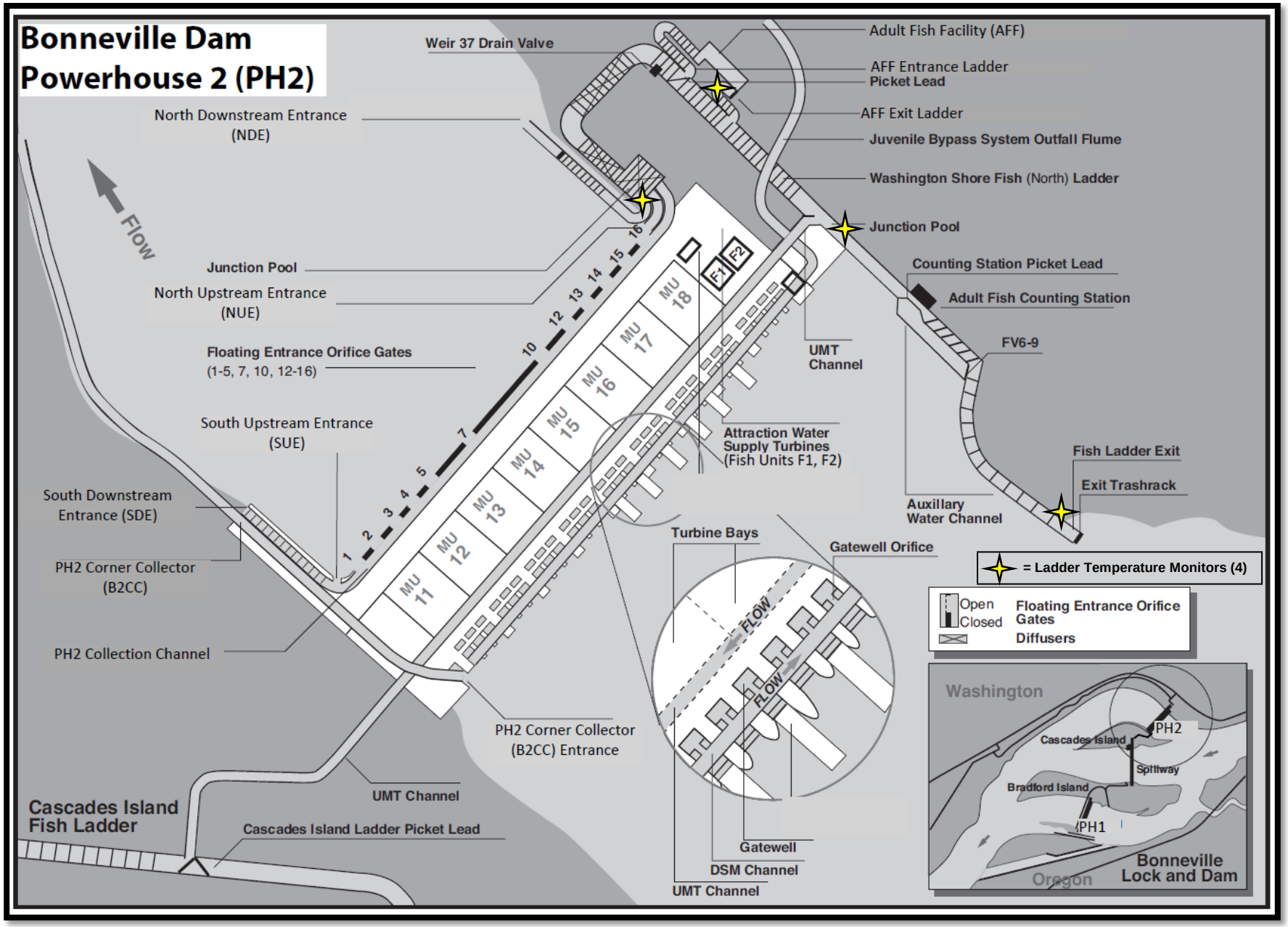


Figure BON-4. Bonneville Dam Powerhouse 2 (PH2) and Washington Shore (WS) North Fish Ladder.

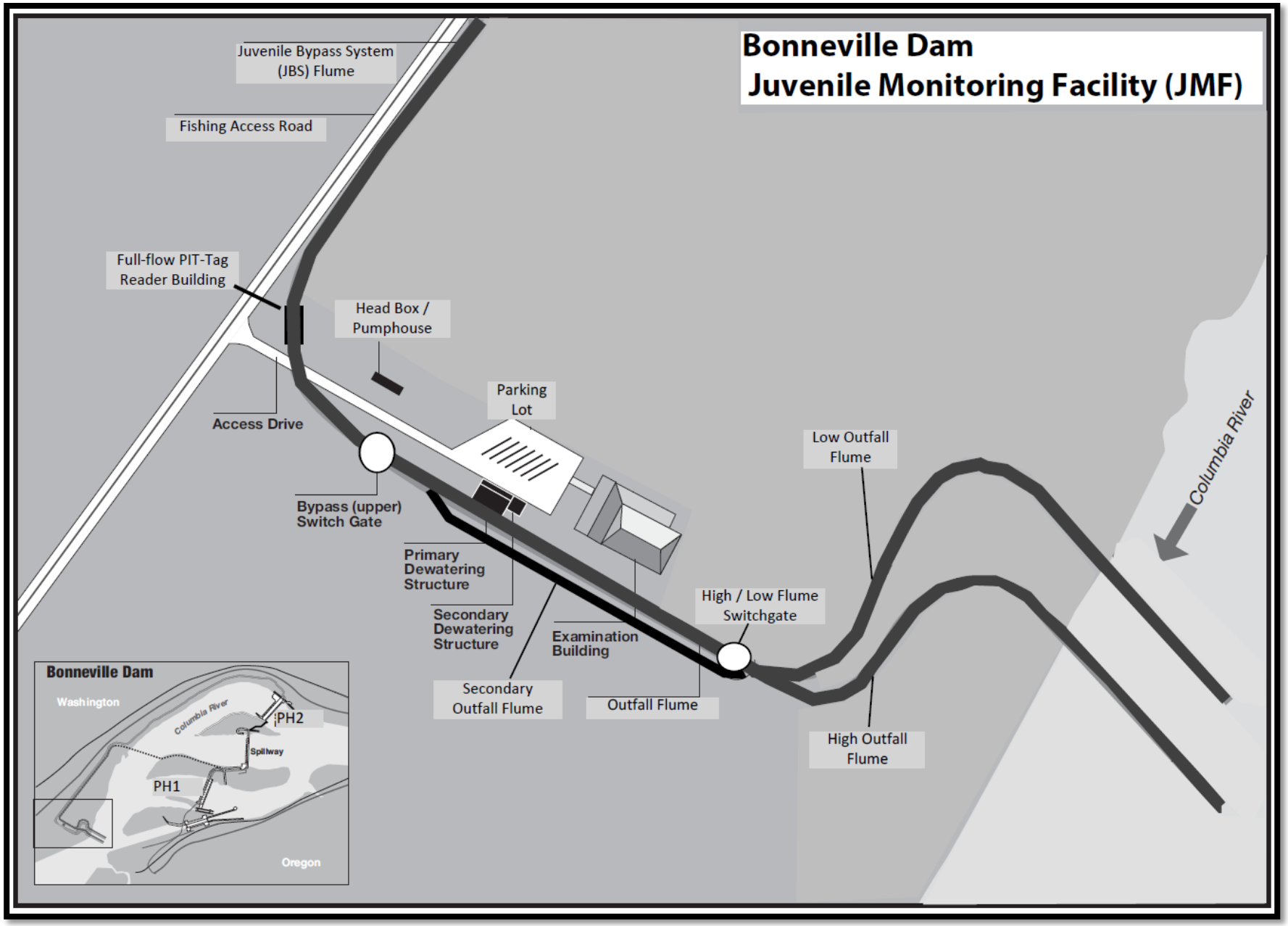
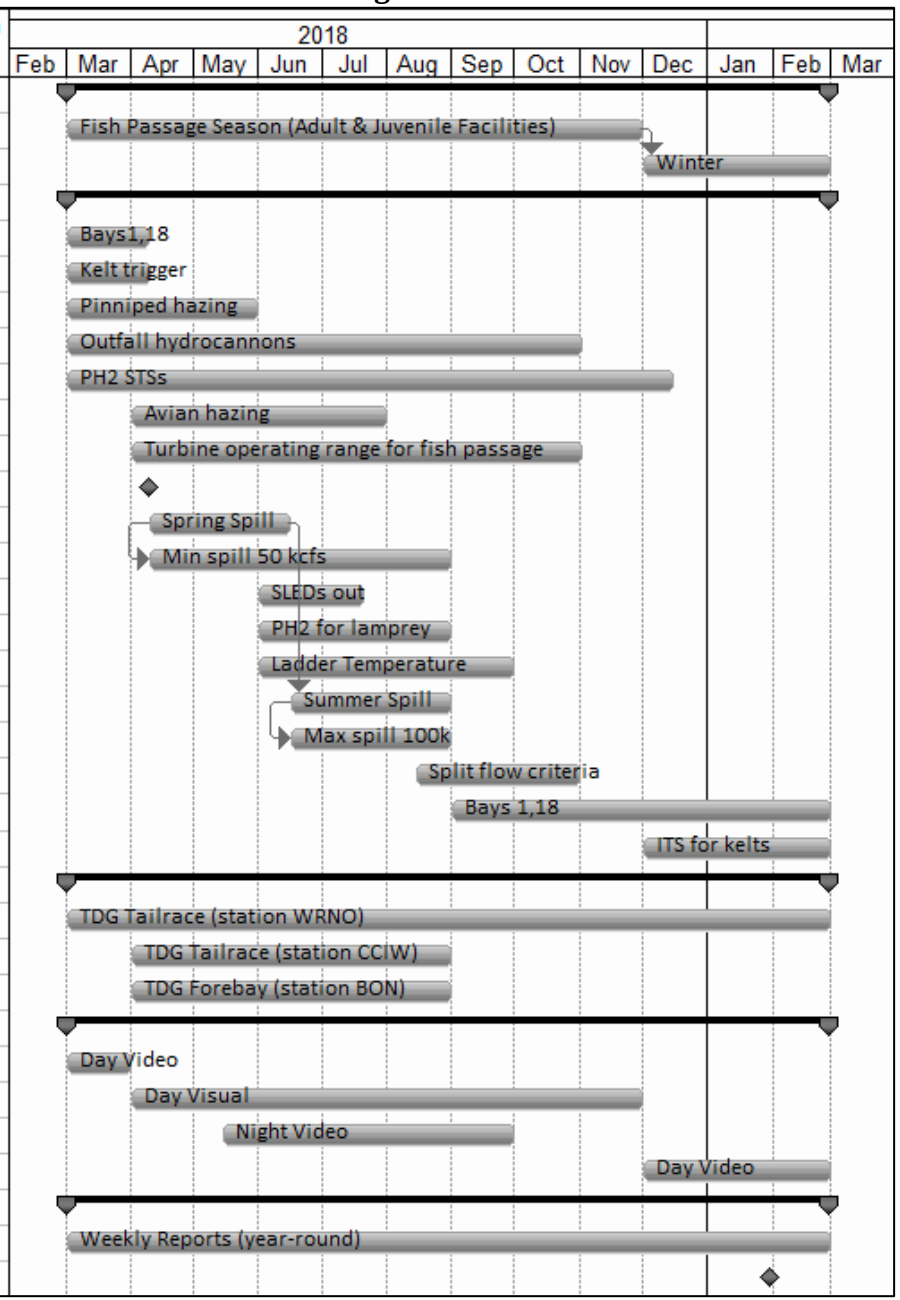


Figure BON-5. Bonneville Dam Juvenile (Smolt) Monitoring Facility (JMF) and Outfall Flumes.

Table BON-1. Bonneville Dam Schedule of Operations and Actions Defined in the 2018 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES (ADULT & JUVENILE)	**3/1/18**	**2/28/19**	
Fish Passage Season	3/1/18	11/30/18	2.3.2, 2.4.2
Winter Maintenance Period	12/1/18	2/28/19	2.3.1, 2.4.1
PROJECT OPERATIONS FOR FISH PASSAGE	**3/1/18**	**2/28/19**	
Spillbays 1,18 for adult attraction	3/1/18	4/9/18	2.2.5
B2CC Kelt trigger	3/1/18	4/10/18	2.3.2.5.t
Pinniped hazing	3/1/18	5/31/18	App L 2.5
Operate outfall hydrocannons	3/1/18	11/1/18	2.3.2.6.e
PH2 STS operation	3/1/18	12/15/18	2.3.2.5.a
Avian hazing	4/1/18	7/31/18	App L 2.2
Turbine operating range for fish passage	4/1/18	10/31/18	5.2
Avian wires installed NLT April 10	4/10/18	4/10/18	App L 1.4
Spring Spill	4/10/18	6/15/18	App E (FOP)
Min spill 50 kcfs for juvenile egress	4/10/18	8/31/18	2.2.1
No Entrance SLEDs 6/1-7/20	6/1/18	7/20/18	2.4.2.11.
Reduced nighttime PH2 FU output for lamprey	6/1/18	8/31/18	2.4.2.13.c
Ladder Temperature Monitoring	6/1/18	9/30/18	2.4.2.2.
Summer Spill	6/16/18	8/31/18	App E (FOP)
Day spill <=100 kcfs when PH1 operating	6/16/18	8/31/18	2.2.4
Split flow criteria	8/15/18	10/31/18	2.1.2
Spill Bays 1 and/or 18 for adult attraction	9/1/18	2/28/19	2.2.5
PH1 ITS gates for kelt passage	12/1/18	2/28/19	2.4.1.12
TDG MONITORING	**3/1/18**	**2/28/19**	
TDG Monitoring - Tailrace (WRNO)	3/1/18	2/28/19	2.2.2
TDG Monitoring - Tailrace (CCIW)	4/1/18	8/31/18	2.2.2
TDG Monitoring - Forebay (BON)	4/1/18	8/31/18	2.2.2
ADULT FISH COUNTING	**3/1/18**	**2/28/19**	
Day Video 0400-2000 PST	3/1/18	3/31/18	Table BON-3
Day Visual 0500-2100 PDT	4/1/18	11/30/18	Table BON-3
Night Video 2100-0500 PDT	5/15/18	9/30/18	Table BON-3
Day Video 0400-2000 PST	12/1/18	2/28/19	Table BON-3
REPORTS	**3/1/18**	**2/28/19**	
Weekly Reports (year-round)	3/1/18	2/28/19	3.3.2
Annual Report due NLT Jan 31	1/31/19	1/31/19	3.3.4



1. FISH PASSAGE INFORMATION

Fish passage facilities at Bonneville Lock & Dam are shown in **Figure BON-1** through **BON-5** and described below. The annual schedule of project operations, maintenance, and other actions described in this Fish Passage Plan (FPP) and Appendices is included in **Table BON-1**.

1.1. Juvenile Fish Passage.

1.1.1. Juvenile Fish Facilities.

1.1.1.1. Powerhouse One (PH1). Juvenile fish passage routes at Bonneville Dam Powerhouse One (PH1) consist of an ice and trash sluiceway (ITS) and minimum gap runner (MGR) turbines.

1.1.1.2. Powerhouse Two (PH2). Juvenile fish passage facilities at Bonneville Dam Powerhouse Two (PH2) consist of: streamlined trash racks; submersible traveling screens (STS); vertical bar screens (VBS); two 12.5" orifices per gatewell in main units 11-14 and fish unit 2; one 12.5" orifice in all other gatewells flowing into the bypass channel; an excess water elimination facility; and a 48" fish transport pipe which connects the bypass channel to the downstream Juvenile Monitoring Facility (JMF) and the tailrace via 48" and 42" transport pipes (high and low outfall, respectively).

i. All eight PH2 main turbine units have STSs, VBSs, and streamlined trashracks.

ii. Two smaller turbines (fish units) supply adult fishway auxiliary water and have a fine trashrack with 0.75" clear opening, but do not have STSs or streamlined trashracks.

iii. The PH2 corner collector (B2CC) on the south side of the PH2 tailrace extends several hundred feet west and empties at the tip of Cascades Island.

1.1.2. Juvenile Fish Migration Timing. The juvenile fish migration season occurs March 1–November 30. The primary passage periods for each species are defined in **Table BON-2**. Bull trout, lamprey, juvenile sturgeon, and other listed salmonids are recorded as by-catch in the Juvenile Monitoring Facility (JMF) reports. Maintenance of juvenile fish facilities is scheduled for December 16 through the end of February to minimize the impact on downstream migrants. These activities will be coordinated to minimize potential impacts on juvenile migrants that may be present at that time.

Table BON-2. Juvenile Salmonid Passage Timing at Bonneville Dam for Most Recent 10 Years Based on Daily & Yearly Collection Data.*

Year	10%	50%	90%	# Days	10%	50%	90%	# Days
	Yearling Chinook				Subyearling Chinook * (Brights only**)			
2008	20-Apr	12-May	27-May	38	22-Jun	6-Jul	23-Jul	32
2009	19-Apr	11-May	26-May	38	20-Jun	30-Jun	19-Jul	30
2010	27-Apr	13-May	1-Jun	36	19-Jun	5-Jul	20-Jul	32
2011	17-Apr	10-May	18-May	32	24-Jun	14-Jul	2-Aug	40
2012	24-Apr	12-May	23-May	30	23-Jun	9-Jul	26-Jul	34
2013	28-Apr	12-May	21-May	24	29-Jun	9-Jul	16-Jul	18
2014	22-Apr	9-May	24-May	33	28-Jun	9-Jul	25-Jul	28
2015	23-Apr	8-May	22-May	30	16-Jun	4-Jul	14-Jul	29
2016	18-Apr	2-May	13-May	26	24-Jun	7-Jul	24-Jul	31
2017	16-Apr	5-May	19-May	33	20-Jun	9-Jul	21-Jul	31
10-Yr MEDIAN	**21-Apr**	**10-May**	**22-May**	**33**	**15-Jun***	**29-Jun***	**19-Jul***	**35***
10-Yr MIN	**16-Apr**	**2-May**	**13-May**	**24**	**6-Jun***	**22-Jun***	**14-Jul***	**30***
10-Yr MAX	**28-Apr**	**13-May**	**1-Jun**	**38**	**21-Jun***	**9-Jul***	**15-Aug***	**70***
	Unclipped Steelhead				Clipped Steelhead			
2008	5-May	14-May	30-May	26	7-May	13-May	25-May	19
2009	30-Apr	13-May	29-May	30	4-May	13-May	26-May	23
2010	1-May	14-May	1-Jun	32	6-May	14-May	7-Jun	33
2011	23-Apr	15-May	31-May	39	24-Apr	12-May	29-May	36
2012	26-Apr	11-May	29-May	34	29-Apr	10-May	28-May	30
2013	22-Apr	12-May	3-Jun	43	28-Apr	9-May	28-May	31
2014	22-Apr	10-May	28-May	37	2-May	12-May	23-May	22
2015	30-Apr	18-May	29-May	30	4-May	11-May	25-May	22
2016	18-Apr	5-May	22-May	35	29-Apr	5-May	19-May	21
2017	24-Apr	10-May	30-May	36	22-Apr	5-May	20-May	28
10-Yr MEDIAN	**25-Apr**	**12-May**	**29-May**	**36**	**30-Apr**	**11-May**	**25-May**	**26**
10-Yr MIN	**18-Apr**	**5-May**	**22-May**	**26**	**22-Apr**	**5-May**	**19-May**	**19**
10-Yr MAX	**5-May**	**18-May**	**3-Jun**	**43**	**7-May**	**14-May**	**7-Jun**	**36**
	Coho				Sockeye (Wild & Hatchery)			
2008	1-May	18-May	30-May	30	24-May	29-May	8-Jun	16
2009	29-Apr	22-May	1-Jun	35	15-May	26-May	5-Jun	22
2010	24-Apr	14-May	5-Jun	43	19-May	1-Jun	10-Jun	23
2011	11-Apr	14-May	24-May	44	4-May	17-May	4-Jun	32
2012	26-Apr	18-May	7-Jun	43	9-May	14-May	23-May	15
2013	16-Apr	14-May	1-Jun	47	14-May	20-May	26-May	13
2014	25-Apr	12-May	28-May	34	15-May	22-May	30-May	16
2015	15-Apr	9-May	28-May	44	14-May	22-May	29-May	16
2016	13-Apr	2-May	19-May	37	5-May	11-May	20-May	16
2017	8-Apr	28-Apr	23-May	45	22-Apr	15-May	25-May	33
10-Yr MEDIAN	**20-Apr**	**14-May**	**29-May**	**40**	**14-May**	**22-May**	**1-Jun**	**17**
10-Yr MIN	**8-Apr**	**28-Apr**	**19-May**	**30**	**4-May**	**11-May**	**20-May**	**13**
10-Yr MAX	**1-May**	**22-May**	**7-Jun**	**47**	**24-May**	**1-Jun**	**10-Jun**	**33**

* Subyearling Chinook **MEDIAN, MIN, MAX** based on 1998-2006 data. Data 2007-present not included due to potential bias from missed sample days during high water temperature sampling protocols (**Appendix K**).

** Includes upriver brights only in order to exclude influence by Spring Creek NFH Tules.

1.2. Adult Fish Passage.

1.2.1. Adult Fish Facilities. Bonneville Dam adult fish passage facilities consist of two main fishway segments, described below. Annual maintenance of adult fish facilities is scheduled during the winter maintenance period (December 1 through the end of February) to minimize impacts on upstream migrants and to minimize fallback of adult fall Chinook and steelhead.

i. Bradford Island (Figure BON-2) is formed by the PH1 collection channel and Bradford Island A-branch ladder that join the B-branch (south spillway) ladder at the Bradford Island junction pool. The PH1 ice & trash sluiceway (ITS) is also used for adult passage year-round (**section 2.4.1**). The Bradford Island fishway has a counting station and auxiliary water supplies for attraction flow.

ii. Washington Shore (Figure BON-3, BON-4) is formed by the PH2 collection channel, and north and south monoliths that join the Washington Shore (North) ladder and Cascades Island (north spillway) ladder at the upstream migrant transportation (UMT) channel. The Washington Shore and Cascades Island fishways have counting stations. The Washington Shore ladder also has an Adult Fish Facility (AFF). All collection systems have auxiliary water supplies for attraction flow.

1.2.2. Adult Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult fish facilities are operated year-round. Adult salmon, steelhead, lamprey, and shad are typically counted year-round (**Table BON-3**) and data are posted daily at: www.fpc.org/adultsalmon_home.html. Fish passage is relatively light November 1–March 31 and counting is done by video, primarily to monitor ESA-listed winter steelhead, and posted online every three days. Sturgeon and bull trout are relatively infrequent and are reported in *Miscellaneous Fish Counts* and in the *Annual Fish Passage Report*.

1.2.2.2. Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage defined in **Table BON-4**. Time-of-day (diel) distributions of adult salmonid activity at Bonneville Dam fishway entrances and exits are shown in **Figure BON-6**.

Table BON-3. Bonneville Dam Adult Fish Count Schedule, 3/1/2018–2/28/2019.

Count Period	Counting Method and Hours*
March 1–31	Video 0400–2000 hours (PST)
April 1 – November 30	Visual 0500–2100 hours (PDT)
May 15 – September 30	Night Video 2100–0500 hours (PDT)
December 1 – end of February	Video 0400–2000 hours (PST)

*PST=Pacific Standard Time. PDT=Pacific Daylight Time (in effect during Daylight Saving Time 3/11/18-11/4/18).

Table BON-4. Bonneville Dam Adult Count Period and Peak Passage Timing (based on yearly counts since 1938, except winter steelhead since 1999 and lamprey since 2001).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Mar 15 – May 31	Apr 15	May 27
Summer Chinook	Jun 1 – Jul 31	Jun 3	Jul 31
Fall Chinook	Aug 1 – Nov 15	Aug 30	Sep 17
Sockeye	Jun 1 – Aug 15	Jun 20	Jul 13
Steelhead	Year-round	Jul 16	Sep 22
Winter Steelhead	Nov 16 – Mar 31	Mar 1	Mar 28
Coho	Jul 15 – Nov 15	Aug 29	Oct 11
Lamprey	Mar 15 – Nov 15	Jun 20	Jul 27

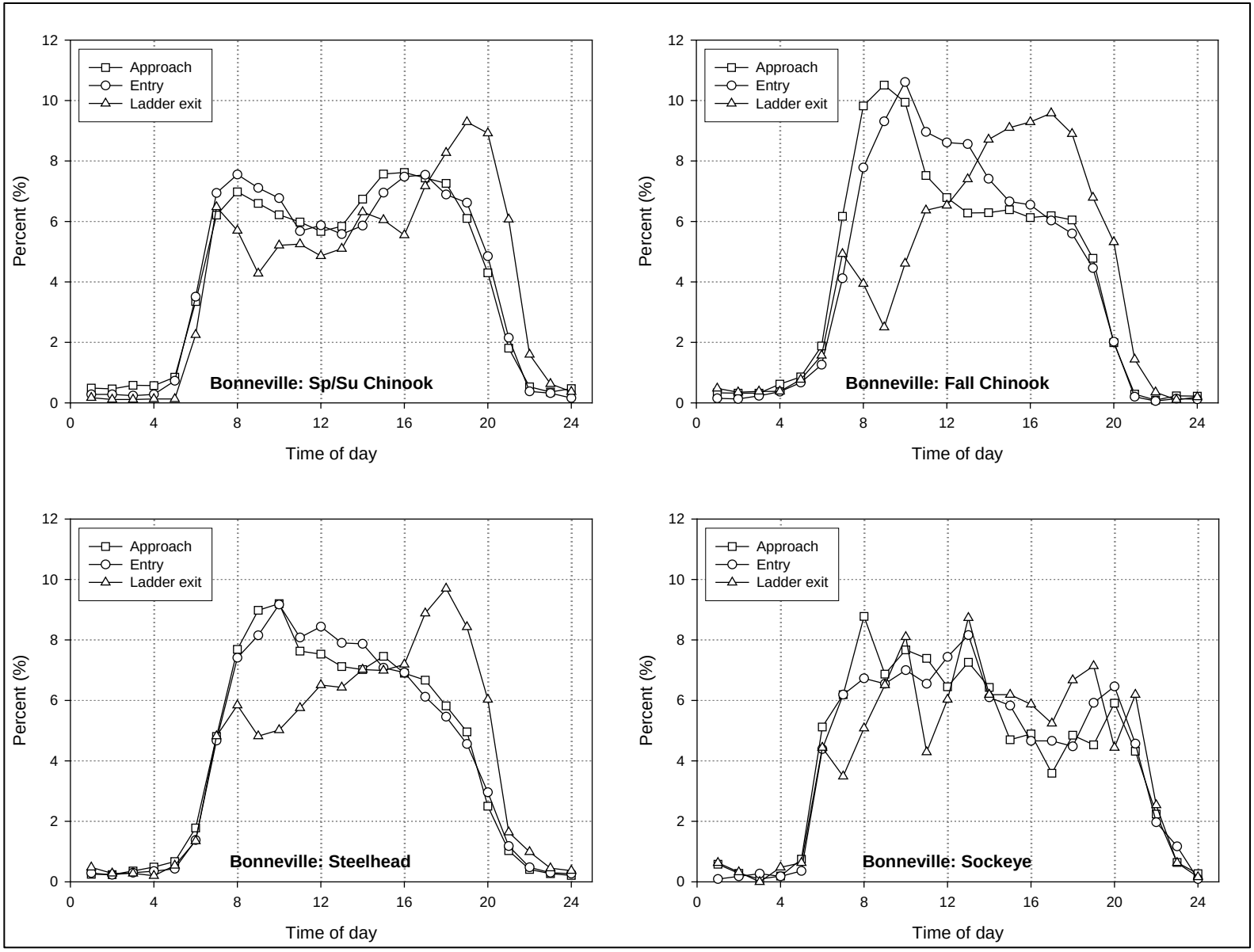


Figure BON-6. Diel Distribution of Adult Salmonids at Bonneville Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*).
pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATION

2.1. General.

2.1.1. Yearling Chinook salmon and most other juvenile salmonids migrate downstream in the spring, whereas sub-yearling Chinook salmon predominantly migrate in the summer after mid-June. Studies specific to Bonneville Dam indicate that juvenile fish survival through various passage routes differ between spring and summer.

2.1.2. Split Flows.

2.1.2.1.a. Before August 31, if adult and jack salmonid counts equal or exceed 30,000 fish/day, Project Fisheries will initiate coordination with the Fish Passage Operations & Maintenance (FPOM) to discuss options for splitting flow between powerhouses to balance attraction flow and adult passage among the project's fishways.

2.1.2.1.b. After August 31, when adult and jack salmonid counts equal or exceed 25,000 fish/day, the Project will operate two or more priority turbines at PH1 in an attempt to balance adult passage between both powerhouses (assuming no PH1 units are already operating). While PH2 is still priority, project fisheries, at their discretion, may shift additional unit flow up to half the combined powerhouse flow, to PH1 as necessary to alleviate adult fishway crowding. This operation will continue until adult and jack salmonid counts fall below 20,000 fish.

2.1.2.1.c. See **section 5** for unit priority order and operating ranges during split flows.

2.1.3. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least two weeks in advance, unless it is deemed an emergency (see coordination guidance in **Chapter 1 - Overview**).

2.1.4. Yearly special operations related to research are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

2.1.5. Research, non-routine maintenance, fish-related activities, and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

2.1.6. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed immediately following the incident of steps taken to correct the situation. On a monthly basis, as necessary, the project biologist will provide FPOM a summary of any emergency actions undertaken.

2.2. Spill Management.

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the FPP as **Appendix E**. Spill patterns are defined in **Table BON-15**. Spill changes will be made through regional coordination at TMT. From April 10–August 31, minimum spill is 50 kcfs to provide acceptable tailrace conditions for juvenile fish egress. However, during extreme low flow conditions, lower spill levels may be considered and coordinated through TMT. There is no minimum spill level September 1–April 9. See the FOP (**Appendix E**) for more information.

2.2.2. Excessive total dissolved gas (TDG) may harm fish and will be controlled to the extent possible, subject to river conditions. Management tools include system-wide spill distribution through the Spill Priority List issued by the Corps Northwestern Division Reservoir Control Center (RCC), night and/or day spill limits, and shaping of spill. Night spill is limited as necessary to control TDG, and adjustments may be granted on a case-by-case basis by the RCC, dependent upon TDG monitoring at stations downstream of the dam, biological monitoring, and fish movement. Monitoring of TDG at Bonneville Dam occurs during the periods defined in **Table BON-1**, pursuant to the Corps' annual *TDG Monitoring Plan* and *Dissolved Gas Monitoring Plan of Action 2015-2018*.[1] Starting March 1, TDG at Cascades Island will be reported every 4 hours, as well as the spill rate and total project outflow.

2.2.3. Hours for "Day" and "Night" spill are defined in **Table BON-5**. The transition between Day and Night spill will normally take 15–20 minutes due to the time required to start, synchronize, and load multiple generators. The transition to Day spill should not start until after the Night period. Frequently, a change in total river flow will occur concurrently with these transitions. The transition to Night spill should begin early enough to minimize the chance of violating the established Night spill maximum for TDG.

2.2.4. From June 16 through August, when PH1 is operating, Day spill will be limited to not exceed 100 kcfs to minimize adult fallback. Normally, this will apply 1 hour before sunrise to ½ hour after sunset (**Table BON-5**). From June 16-July 15, this spill limit will apply until 1 hour after sunset to minimize impacts to adult sockeye.

2.2.5. From September 1 through April 9, during Day hours (**Table BON-5**), spill will occur from Bays 1 and 18, each open 6" (1 stop), to provide attraction flow to the Cascades Island and Bradford Island B-Branch entrances, respectively. From December 1 through the end of February, spill will only occur from the Bay(s) adjacent to an operating ladder entrance.

2.2.6. During spill that occurs September 1–April 9 (outside of fish passage spill season), the B2CC will be operated if available to provide a surface passage route.

[1] TDG Monitoring Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/. TDG Monitoring Plan 2015-2018: pweb.crohms.org/tmt/wqnew/tdg_monitoring/2015-18.pdf

Table BON-5. Day/Night Spill Schedule for Bonneville Dam.

Date Range	Day Start Hour	Day End Hour*	Night Start Hour*	Night End Hour
Jan 1-19	0700	1730	1730	0700
Jan 20 – Feb 14	0630	1800	1800	0630
Feb 15 – Mar 1	0600	1830	1830	0600
Mar 2 – Apr 2	0600	1930	1930	0600
Apr 3-20	0500	2030	2030	0500
Apr 21 – May 16	0500	2100	2100	0500
May 17-31	0430	2130	2130	0430
Jun 1-30	0430	2130	2130	0430
Jul 1-31	0430	2200	2200	0430
Aug 1-15	0500	2145	2145	0500
Aug 16-31	0500	2030	2030	0500
Sep 1-16	0530	2000	2000	0530
Sep 17 – Oct 4	0600	1930	1930	0600
Oct 5-19	0630	1900	1900	0630
Oct 20-29	0630	1830	1830	0630
Oct 30 – Nov 30	0630	1700	1700	0630
Dec 1-31	0630	1700	1700	0630

* Transition to Night spill begins 15-20 minutes before the Night Start Hour.

2.3. Operating Criteria - Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance (December 1 – end of February).

2.3.1.1. Remove debris from forebay, trash racks, and gatewell slots at both powerhouses as necessary to maintain these areas debris-free.

2.3.1.2. See **section 2.4.1** for PH1 ice & trash sluiceway (ITS) operations for adult passage after November 30**.**

2.3.1.3. Avian Lines. See **Appendix L - Avian Monitoring & Deterrence Action Plans**. From September through March, there will be no avian abatement measures other than avian lines. Avian lines will be repaired and/or reinstalled as soon as possible following damage or removal. New avian lines will be installed and maintained in locations determined to have significant avian predation. Avian abatement measures shall be in place by March 1 unless delayed by weather, in which case work will be completed as soon as weather permits.

2.3.1.4. Powerhouse Two (PH2).

2.3.1.4.a. STSs will remain in service through December 15 to prevent adult salmonids from falling back through turbine units, thereby shortening some aspects of the winter maintenance period by two weeks. Unscreened units will be operated on a last-on, first-off basis. Beginning December 16, all STSs may be removed.

2.3.1.4.b. Video or manually inspect VBSs for damage, holes, debris accumulations, protrusions, and proper seating. Clean and repair, as necessary, such that all VBSs in operable units are functional.

2.3.1.4.c. Inspect each STS and operate on trial run (dogged off at deck level). Install STS in each intake of operational units by the end of February.

2.3.1.4.d. The PH2 Downstream Migrant (DSM2) channel may be dewatered only when required for maintenance and will be minimized to the extent practicable.

2.3.1.4.e. Inspect all gatewell orifices, orifice lighting and flushing systems, and clean and/or repair as necessary so that orifices and associated systems are fully functional.

2.3.1.4.f. Inspect dewatering screens and associated equipment. Clean and/or repair as necessary.

2.3.1.4.g. Inspect and correct any deficiencies in DSM channel, conduit outfall walls and floor.

2.3.1.4.h. Flume Pipe (from exit of DSM to outfall). Visually inspect outfall flume pipe and associated switch gates once per year from the transition section leaving the powerhouse to the outfall return to the river for obstructions, protrusions, or structural deficiencies that may affect fish passage.

2.3.1.4.i. Powerhouse 2 Corner Collector (B2CC). During spill that occurs September 1–April 9 (outside of fish passage spill season), the B2CC will be operated if available to provide a surface passage route.

2.3.1.5. Spillway.

2.3.1.5.a. Inspect and repair where necessary spill gates and control systems. The spillway, except for coordinated exceptions, must be able to achieve spill patterns on the first day of the juvenile fish passage season.

2.3.1.5.b. As per *Bonneville Operating Order 14*, raise and lower each spill gate to test for operability and check calibration prior to start of spill season, usually in March.

2.3.1.5.c. Spill guidance during the winter maintenance period is defined in **section 2.2** and the FOP (**Appendix E**).

2.3.2. Juvenile Fish Passage Season (March 1 – November 30).

2.3.2.1. Main unit gatewell drawdown will be measured a minimum of once per week. Remove debris from forebay and trashracks as required to maintain less than 1.5' of total drawdown in gatewells.

2.3.2.2. A slight oily sheen is commonly found in many gatewells, from sources such as lubricated lifting beams, etc. Unusual accumulations of oil (e.g., oil slick) in gate slots will be

removed within 24 hours. Appropriate procedures to remove fish during this situation will be determined in coordination with FPOM. Regardless of unit operating status, oil accumulations will be dealt with promptly.

2.3.2.3. Avian Deterrence. See the *Avian Monitoring & Deterrence Action Plans* in **Appendix L**. From April through August, avian abatement measures other than avian lines will be implemented as necessary. Avian lines will be repaired and/or reinstalled as soon as possible following damage or removal. New avian lines will be installed and maintained in locations determined to have significant avian predation. From September through March, there will be no avian abatement measures other than avian lines.

2.3.2.4. Set PH1 ITS chain gates 1A and 1B at 70' msl. Ensure gates 3B, 6C and 10B are operating according to **Table BON-6**.

2.3.2.4.a. If chain gates for Unit 1 are OOS, set chain gates 2A and 2B at 70' msl. Ensure gates 3B, 6C, and 10B are operating according to **Table BON-6.**

Table BON-6. Bonneville Dam Powerhouse One (PH1) Ice & Trash Sluiceway (ITS) Chain Gate Elevations (ft).

Forebay Elevation (ft)	PH1 ITS Chain Gates			Forebay Elevation (ft)	PH1 ITS Chain Gates		
	3B	6C	10B		3B	6C	10B
<72	70.00	70.00	70.00	**75**	71.75	72.25	73.00
72	70.00	70.00	70.00	**76**	73.50	73.50	74.00
73	70.00	70.25	70.75	**77**	75.00	75.00	75.00
74	70.75	71.50	71.75	**>77**	75.00	75.00	75.00

2.3.2.5. Powerhouse Two (PH2).

2.3.2.5.a. Juvenile fish protection devices (STS, etc.) will be in place prior to the juvenile fish passage season. Screens (STSs, VBSs) will remain in operation through December 15 to prevent adult salmonids from falling back through turbine units.

2.3.2.5.b. Main unit gatewell drawdown will be measured a minimum of once per week. Check more often during times of overwhelming debris, as described in **section 2.3.2.5.p**.

2.3.2.5.c. Remove debris from forebay and trash racks as required to maintain ≤ 1.5' gatewell drawdown, or as indicated by fish condition (e.g., higher than expected descaling), or as determined by the Project Biologist. STSs in units being raked will run continuously during raking. Gatewell orifices of the unit being raked must be closed during the procedure.

2.3.2.5.d. Operate STSs at 60^{o} angle from vertical.

2.3.2.5.e. Turbines without a full complement of STSs will not operate except when in compliance with other coordinated fish measures.

2.3.2.5.f. Observe each STS Watt and/or amp gauge and record reading at least once per day. If an STS failure occurs, then follow procedures in *Fish Facility Maintenance*.

2.3.2.5.g. Video or manually inspect each STS once per month (or 720 hours run time) and each VBS a minimum of once every two months (or 1,440 hours run time). Frequency of monthly inspections may be based on individual turbine unit run time.

2.3.2.5.h. No STS inspections will be scheduled when it may cause excessive TDG due to increased forced spill.

2.3.2.5.i. VBS inspections will occur immediately prior to peaks in juvenile fish migrations, which begin about May 1, mid-July and September 1.

2.3.2.5.j. More frequent inspections may be required by the Project Biologist or under the following conditions: deteriorating fish condition, increased debris in bypass system, and/or other indications of STS or VBS malfunctions or failure.

2.3.2.5.k. If manually inspecting VBSs, shut off units and dip gatewells prior to pulling VBS. It is not necessary to dip gatewells of units that have been off for 48 hours or longer.

2.3.2.5.l. VBSs will be cleaned when drawdowns read 1.1' on any day (including weekends) and when drawdowns reach 0.9' on Thursdays.

2.3.2.5.m. If a screen has reached the cleaning threshold, clean all 3 screens in that unit.

2.3.2.5.n. Unit will be shut down if VBS drawdown equals or exceeds 1.5' in 12-hours.

2.3.2.5.o. Rake trashracks at Units 11, 12 prior to March 1 and at least once/month throughout fish passage season.

2.3.2.5.p. If STS or VBS damage or plugging is detected, follow procedures in *Fish Facilities Maintenance* (**section 4**). In the event of overwhelming debris (as defined below) follow the procedures as follows. Monitor gatewell drawdown daily.

p.1. VBSs will be cleaned by installing the spare VBS in the back slot, pulling the main VBS up and spraying it off with a fire hose, then replace back in slot and pull spare (reverse order).

p.2. If the TIE crane is out of service, the Gantry Crane will be used to pull the main VBS and the spare VBS will not be installed in the back slot.

p.3. If the VBS drawdown criteria of <1.1' CANNOT be maintained during the day due to debris, the spare VBS will not be installed in the back slot and the gatewells will not be dipped. The Project will pull the main screen, spray it off with a fire hose and then re-install.

p.4. If the VBS drawdown criteria of <1.5' over 12-hours CANNOT be maintained due to debris even after performing the above operations, then STSs will be pulled out until the screen re-installation criteria have been met (**p.6** below).

p.5. Once screens have been removed, these units should operate only as necessary to maintain TDG levels below gas cap limits.

p.6. Screen Re-Installation Criteria. At the discretion of the Project Biologist and in consultation with FPOM, the Project will install STSs in the highest priority unit available. When VBS drawdown for that unit remains below 1.1' for 24 hours, the Project will re-install the remaining STSs.

2.3.2.5.q. Gatewell Orifice Systems. All gatewell orifice systems should be operational.

q.1. Orifices automatically flush 3 times/day, one orifice every 10 minutes. Orifices with less than a clear flow jet will be flushed manually during the inspection.

q.2. Manually flush orifices known to have recurring plugging or other problems.

q.3. Orifice jets will be observed through the light tubes during the inspection. Light tubes and orifice tube lenses shall be replaced and kept clean as required so that visual observations of orifice jets are possible during fishway inspections.

2.3.2.5.r. Orifice Lights. Replace all non-operational orifice lights within 24 hours. Orifice lights shall remain lighted 24 hours/day. DSM gallery lights should be off except when there are personnel in the gallery.

2.3.2.5.s. Gatewell Cleaning. The project will clean gatewells before the water surface becomes 50% covered with debris. If due to the volume of debris, it is not possible to keep the gatewell surfaces 50% clear, they will be cleaned at least once daily.

s.1. Turbines with a gatewell fully covered with debris will not be operated except to be in compliance with other coordinated fish measures, and then only on a last-on/first-off basis.

s.2. Gatewell orifices will be closed during the cleaning operations. After cleaning a gatewell, inspect and, if necessary, clean the orifice in that gatewell and then check gatewell drawdown.

s.3. Coordinate gatewell cleaning with JMF personnel operating downstream juvenile sampling facilities.

s.4. A slight oily sheen is commonly found in many gatewells. When unusual accumulations of oil occur in gate slots, it will be removed within 24 hours. When this is not possible, the gatewell orifice will be closed and the turbine unit will be shut down until cleaning is accomplished. Appropriate procedures to remove fish during this situation will be determined in coordination with FPOM. Regardless of unit operating status, oil accumulations will be dealt with promptly.

2.3.2.5.t. Powerhouse Two Corner Collector (B2CC).

t.1. March 1–April 10 (Kelt Trigger): B2CC will be open for downstream migrating steelhead kelts if the following criteria are achieved based on kelt counts at the JMF adult/debris separator. If 2 kelts/day are counted on 2 consecutive days, and the total cumulative count since March 1 is ≥ 20 kelts, JMF personnel will notify Project Fisheries and the Control Room to open the B2CC within 1 hour.

t.2. April 10–August 31 (Spring & Summer Spill): B2CC will be open during spring and summer spill for fish passage, as defined in the FOP (**Appendix E**). The B2CC will be opened within one hour of the start of spring spill on April 10 (unless already open for kelt, as defined above in **t.1**) and closed within one hour of the end of summer spill on August 31.

t.3. September 1–April 9: During spill that occurs outside of fish passage spill season, the B2CC will be opened if available to provide a surface passage route.

2.3.2.5.u. DSM2 Channel.

u.1. Screen Cleaners. The primary screen cleaner will be the airburst system. The system may be set to cycle every 20, 60, or 180 minutes, depending on debris loads.

i. In the event the air system is unable to maintain desired water elevation in the dewatering area, then the cleaning cycle duration will be increased as necessary.

ii. If the system is still unable to accommodate debris loads, then the mechanical brush system will be activated in conjunction with the airburst system to maintain the desired water elevation. The systems will continue to work in tandem until debris loads lessen and the airburst system can maintain a correct water elevation.

iii. Once water elevations can be maintained, the mechanical system will be returned to standby and the airburst system cleaning will be the primary system.

iv. Project biologists shall have the discretion to modify the cleaning system program at any time to maintain FPP criteria.

v. Mechanical screen cleaners will be run once a week to exercise the equipment.

u.2. Operation. Maintain the channel elevation between 64.2'–64.4' as measured at the staff gauge in front of the ERG. DSM channel elevation is maintained by a combination of add-in water, 30 non-regulating orifices and 12 regulating orifices (units 11-14). The add-in water provides a fixed input of 60 cfs and the non-regulating orifices are open at all forebay elevations. If the channel elevation exceeds the range of 64.2-64.4', the regulating orifices will open one at a time from south to north (starting at Unit 11) until proper channel elevation is achieved.

2.3.2.6. Juvenile Monitoring Facility (JMF).

2.3.2.6.a. Project Biologists or JMF personnel will operate the upper switchgate as necessary for sampling requirements.

2.3.2.6.b. The lower switchgate is in automatic control. JMF personnel (PSMFC) will monitor and report any problems with the lower switchgate to Project Biologists.

2.3.2.6.c. On seasonal ascending tailwater elevations, the transition from low to high outfall should be between tailwater elevations at the upper end of 16'–18' range.

2.3.2.6.d. On seasonal descending tailwater elevations, the transition from high to low outfall should be between tailwater elevations at the lower end of 16'–18' range.

2.3.2.6.e. Operate the outfall avian hydrocannons March 1–November 1. The cannons will be operated 24 hours/day during fish passage season.

2.3.2.6.f. For specific monitoring facility guidance, see *Protocols for Juvenile Monitoring Facility Operations at Bonneville Dam* (**Appendix J**).

2.4. Operating Criteria - Adult Fish Facilities.

2.4.1. Adult Facilities - Winter Maintenance (December 1 – end of February).

2.4.1.1. Operate adult fish passage facilities according to fish passage season standards (**section 2.4.2**). Systems may be dewatered or operated out of criteria for repair and maintenance.

2.4.1.2. Outage periods will be minimized to the extent practicable.

2.4.1.3. Only one ladder servicing the powerhouses and the associated powerhouse collection system (including auxiliary water supply system) may be out of service or out of standard operating criteria at one time, unless specifically coordinated.

2.4.1.4. One of the two ladders servicing the spillway will be in full operation at all times unless otherwise coordinated.

2.4.1.5. Operate spillbays 1 and/or 18 for adult attraction (**section 2.2.6**).

2.4.1.6. Adjust fish counting stations crowders to fully open if videotaping is temporarily discontinued due to unscheduled events or during winter maintenance (dewatering) period.

2.4.1.7. Sea Lion Exclusion Devices (SLEDs) will be installed at all adult fishway entrances and all floating orifice gates (FOGs).

2.4.1.8. Inspect and calibrate all staff gauges and water level indicators. Repair and/or clean where necessary.

2.4.1.9. Unless specially coordinated, dewater all ladders and inspect all dewatered sections of fish facilities for projections, debris, or plugged orifices that could injure fish or slow their progress up the ladder. Repair deficiencies.

2.4.1.10. Inspect for and clear debris in the ladder exits.

2.4.1.11. Reinstall counting station picket leads prior to watering up ladders during maintenance.

2.4.1.12. PH1 ITS. Except when closed to facilitate maintenance activities, the PH1 ITS gates 1A, 1B, 3B, 6C, and 10B should remain open from December 1 through the end of February for steelhead kelt passage.

2.4.1.12.a. Set chain gate 1A and 1B at 70' msl. Ensure gates 3B, 6C, and 10B are operating according to **Table BON-6**.

2.4.1.12.b. From December 15 through end of February, the Project may close the ITS endgate or ITS gates for winter maintenance (including researcher equipment O&M). Closures may not exceed six hours per day unless otherwise coordinated with FPOM.

2.4.1.13. In the appropriate year (when fishway is out of service for winter maintenance), dredge AWS intakes to maintain the following elevations:

a.1. PH2 Fish Unit intake: -22' to -24'msl;

a.2. BI exit, FV3-7, FV3-9: +63' msl.

2.4.2. Adult Fish Passage Season (March 1 – November 30).

2.4.2.1. Water depths will be measured at the Bradford Island A- and B-branch staff gauges, at the Washington Shore weirs 37 and 38, and at the UMT staff gauge in the Cascades Island fishway. Maintain water depth over fish ladder weirs at 1.0' ±0.1' during non-shad passage season (< 5,000 shad/day/count station) and at 1.3' ±0.1' during shad passage season (≥ 5,000 shad/day/count station).

2.4.2.2. Temperature Monitoring.

2.4.2.2.a. Water temperature will be measured in an adult fishway at each powerhouse. When water temperature reaches 70°F, all fish handling activities will be coordinated through FPOM prior to any action to verify protocols that will be followed. Fish handling activities in the Adult Fish Facility (AFF) will implement protocols in **Appendix G**.

2.4.2.2.b. From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits (**Figure BON-2, BON-4**).

b.1. Temperature monitors shall be placed within 10 meters of all shore-oriented entrances and exits.

b.2. If possible, the entrance monitor shall be within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers to allow for sufficient mixing with surface water.

b.3. The exit monitor shall be within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

b.4. If an existing temperature monitoring location is proposed for either the exit or entrance, it shall be verified that the site accurately reflects water temperature within 10 meters of the entrance or exit.

b.5. Project Fisheries will submit temperature data to the Fish Passage Center (FPC) on a weekly basis for posting online at: www.fpc.org/river/Q_ladderwatertempgraph.php.

2.4.2.3. Head on all entrances should be 1'–2' (1.5' preferred). Head at the NUE is calculated differently because the collection channel staff gauge is in the junction pool. A head of approximately 1'–2' at the NUE entrance is indicated by a 1.2'–2.2' (1.7' preferred) entrance head calculated using the fishway and tailwater staff gauges closest to NUE. Refer to **Table BON-12** when unable to achieve head criterion.

2.4.2.4. Water velocity shall be maintained between 1.5 feet per second (fps) and 4 fps (2 fps preferred) for the full length of the powerhouse collection channel, and the lower ends of the fish ladders that are below the tailwater. Water velocities will be measured directly, and monitored during fishway inspections to verify channels are operating between 1.5 and 4 fps.

2.4.2.5. Maximum head of 0.5' will be allowed on the PH1 attraction water intakes and trash racks at all the ladder exits, with 4" maximum head on all picket leads. Debris shall be removed when significant amounts accumulate.

2.4.2.6. Staff gauges and water level indicators will be readable at all water levels encountered during the fish passage season, including: PH1 south collection channel, PH1 north collection channel, PH1 north tailwater, PH1 south forebay, BI A- and B-branch ladders, BI weir, B-branch entrance, CI entrance, CI ladder below UMT entrance, NUE/NDE/SUE/SDE collection channel, NUE/SUE tailwater, and PH2 north forebay.

2.4.2.7. Stillwells used in lieu of staff gauges will be checked for calibration once/week.

2.4.2.8. Fish Counting. The current fish counting program is in **Table BON-3**. Count station crowders shall remain in operating position while visual counting and/or videotaping is being conducted. All equipment should be maintained and in good condition. The counting window and backboard should be cleaned as needed to maintain good visibility.

2.4.2.8.a. The crowder shall be opened to full count slot width when not counting. During counting, the crowder shall be open as far as possible to allow accurate counting and shall not be closed to less than 18". This will usually occur during high turbidity conditions to maintain count accuracy. All equipment will be maintained in good condition. The

counting window and backboard will be cleaned as needed to maintain good visibility. The crowder ranges are as follows:

i. Washington Shore = 22.8" – 38.4"
ii. Cascades Island = currently out of service (max. opening approximately 36")
iii. Bradford Island = 20.4" – 36.0"

2.4.2.8.b. If passage is impaired by this condition, the count slot may be widened until proper passage conditions are achieved, even though count accuracy may be compromised to some degree.

2.4.2.8.c. Project biologists, FFU, and the fish count supervisor shall coordinate to achieve optimum count slot passage and/or count accuracy conditions.

2.4.2.8.d. If counting is temporarily discontinued due to unscheduled events, the crowder shall be fully opened.

2.4.2.8.e. The crowder may remain in operating position during the counters' hourly 10-minute break period.

2.4.2.8.f. The fish passage slot lights shall remain on overnight.

2.4.2.8.g. Upstream light banks in both count stations shall remain off to facilitate fish passage through the count slot and to reduce the number of fish impacting the count window framework, unless other passage problems result or count accuracy is compromised as determined by the fish count supervisor and coordinated with FPOM.

2.4.2.8.h. Inspect and ensure that optimum passage conditions are maintained at fishway entrances, exits, and in the count slots.

2.4.2.9. When spilling exclusively for adult attraction, spillbays 1 and/or 18 shall be open 6" during day hours only if adjacent to operating fishway entrances (**section 2.2.6**).

2.4.2.10. Ladder entrances at Cascades Island are labeled "SW-SG" (Washington Sluice Gate) and entrances at Bradford Island are "SO-SG" (Oregon Sluice Gate).

2.4.2.10.a. Side entrances SW-SG-5 and SO-SG-7 shall remain closed.

2.4.2.10.b. Downstream entrances SW-SG-1 and SO-SG-2 shall operate as continuously-open, free-flowing vertical slots.

2.4.2.10.c. Downstream entrances SW-SG-3 and SO-SG-4, adjacent to shorelines, consist of pairs of sluice gates (north and south):

c.1. At Cascades Island, -3N and -3S shall be closed at all tailwater elevations.

c.2. At B-Branch, when tailwater exceeds 17', -4N and -4S shall be closed. When tailwater is between 9' and 17', sluice gate -4N shall be open. When the tailwater is below 9', both sluice gates -4N and -4S shall be open.

2.4.2.11. SLEDs. Sea Lion Exclusion Devices (SLEDs) will be at all adult fishway entrances and all floating orifice gates (FOGs).

i. FOG SLEDs can be left in year-round.

ii. Either the B-Branch or Cascades Island entrance SLED (dependent on crane location) may be left in year-round due to the inability to move the 65-ton crane across the spillway.

iii. All other entrance SLEDs will be raised by June 1 for adult sockeye passage and lowered by July 20, or as soon as possible if a sea lion is observed in the fishway.

2.4.2.12. Powerhouse One (PH1).

2.4.2.12.a. Weir Gates. PH1 weir gates will be operated as shown in **Table BON-10.**

i. Gate Pairing. The four weir gates will be operated in two pairs. Only one gate pair will be allowed to operate at a time. Gates 1 and 65 will operate together as the active pair for tailwater elevations greater than 23' msl, while gates 2 and 64 will operate together as the active pair for tailwater elevations less than 26' msl. For tailwater elevations between 23' and 26', the designated active pair will depend on whether the tailwater elevation has been rising or falling with a “dead band” of 1.5'.

ii. Transition Positioning. During a transition, the former active pair is closed and the new active pair is positioned according to tailwater.

2.4.2.12.b. Fish Valve FV1-1.

i. Emergency Closure. If collection channel/tailwater differential is greater than 2.5', or if pressure differential between the auxiliary water supply conduit and the collection channel becomes excessive, as determined by operators, close FV1-1.

ii. Differential. Low: collection channel/tailwater differential <1'. High: collection channel/tailwater differential >2.0'.

2.4.2.12.c. Fish Valve FV3-7. Maintain the opening concurrent with the charts for valve opening, as set by the forebay and tailwater elevations.

2.4.2.12.d. Bradford Island A-Branch. Bradford Island A-branch diffuser gates FG3-3 through FG3-9 are open according to patterns in **Table BON-7**.

2.4.2.12.e. **PH1 Collection Channel Diffusers.** Diffuser valves are operated according to patterns in **Table BON-11.**

~~2.4.2.12.e.~~2.4.2.12.f. **CAC1 Discharge**. Direct discharge from the PH1 air conditioning into the gatewell of a running unit (8 or 9), when available.

Table BON-7. Bradford Island A-branch Fish Ladder Diffuser Operating Ranges.

Diffuser	Operating Setpoint – Tailwater Elevation (ft)	Position
FG3-3	>8.2	Open
FG3-4	>13.7	Open
FG3-5	>16.7	Open
FG3-6	>19.7	Open
FG3-7	>25.2	Open
FG3-8	>28.2	Open
FG3-9	> 31.2	Open

Table BON-8. Bradford Island B-Branch Fish Ladder Diffuser Operating Ranges.

Diffuser	Operating Range (ft)	Diffuser	Operating Range (ft)	Diffuser	Operating Range (ft)
FG3-18	>34	FG3-23	>19	FG3-28	<25
FG3-19	>31	FG3-24	>16	FG3-29	Manual open
FG3-20	>28	FG3-25	13-34	FG3-30	Manual open
FG3-21	>25	FG3-26	12-31	FG3-31	>25
FG3-22	>22	FG3-27	10.5-28	FG3-32	>26
				FG3-33	>27

Table BON-9. Cascades Island Fish Ladder Diffuser Operating Ranges.

Diffuser	Operating Range (ft)	Diffuser	Operating Range (ft)	Diffuser	Operating Range (ft)
FG6-5	>31	FG6-10	>17	FG6-15	Manual open
FG6-6	>29	FG6-11	>14	FG6-16	Manual open
FG6-7	>25	FG6-12	>11	FG6-17	Manual open
FG6-8	>23	FG6-13	>10	FG6-18	>12
FG6-9	>20	FG6-14	>9	FG6-19	>15
				FG6-20	>19

Table BON-10. Bonneville Dam Powerhouse One (PH1) Weir Gate Requirements.

Weir Gate	Submergence Requirement (ft)	Differential Requirement (ft)	Sill Elevation (ft)
1	>8	1-2	8.5
2	>8	1-2	2
64	8-8.4	1-2	2
65	8-8.4	1-2	8.5

Table BON-11. Bonneville Dam Powerhouse One (PH1) Collection Channel Diffuser Valve Operation. **Any diffusers not listed should be CLOSED.**

Valve	Setting	Valve	Setting
FG2-4	Open	FG2-20	Open
FG2-8	Open	FG2-21	Open
FG2-12	Open	FG2-22A	Open
FG2-19	Open	FG2-22B	Open

2.4.2.13. Powerhouse Two (PH2).

2.4.2.13.a. During day spill (**Table BON-5**), operate all north (NUE, NDE) and south (SUE, SDE) entrances. Operate weir crests at elevation 1' (fully lowered) at tailwater elevation ≤ 14'. At tailwater elevation > 14', operate weir crest ≥ 13' below tailwater.

2.4.2.13.b. Operate all 12 active PH2 floating gate fishway entrances.

2.4.2.13.c. Lamprey Operations June 1–August 31: During night spill (**Table BON-5**), reduce fish unit output to operate all north (NUE, NDE) and south (SUE, SDE) entrances at 0.5' of entrance head. To ensure proper function of fish units, B2 fish unit output can be further reduced or placed on standby to float debris as necessary from 2200-0400 hours.

2.4.2.13.d. Measure fish unit gatewell drawdown at least once per week. When head across trash racks exceeds 1.5', the trash racks will be cleaned that day (may be done by raking late in the workday). However, if head exceeds 3', or if the adult fishway head is reduced, the unit's racks will be raked immediately, even if it is early in the day.

2.4.2.13.e. Take soundings annually at the PH2 Fish Unit intake and the BI exit/AWS intake to determine sediment accumulation and plan for the appropriate dredging need. Fish Unit intake dredging is a key component to maintaining a reliable AWS system and should be prioritized during winter maintenance (**section 2.4.1**).

3. FISH FACILITIES MONITORING & REPORTING

3.1. Inspections.

3.1.1. The results of all inspections and the readiness of the facilities for operation will be reported to the FPOM at the meeting immediately prior to the fish passage season.

3.1.2. During fish passage season, fish passage facilities will be inspected at least three times/day, seven days/week to assure operation according to established criteria. Daily inspections will include at least one by Project Fisheries, one by Project Operators and one modified (PLC check).

3.1.3. During winter maintenance season, fish passage facilities will be inspected at least once/day, seven days/week, with at least three inspections per week performed by Project Fisheries.

3.1.4. More frequent inspections will occur as noted throughout the text.

3.1.5. Project fish biologists and biological staff will conduct at least three inspections per week.

3.2. Zebra Mussel Monitoring.

3.2.1. A zebra mussel monitoring program will continue. These organisms have become a serious problem elsewhere in the country and may become introduced into the Columbia River basin. Inspections should also be made when dewatering all project facilities.

3.3. Reporting.

3.3.1. Project biologists shall prepare weekly reports throughout the year summarizing project operations. The weekly reports will provide an overview of how the project and the fish passage facilities operated during the week and an evaluation of resulting fish passage conditions. The reports shall include:

i. Any out-of-criteria situations observed and subsequent corrective actions taken;

ii. Any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities;

iii. Adult fishway control calibrations;

iv. STS and VBS inspections;

v. AWS closures (i.e., cleaning times);

vi. When trapping is occurring in the AFF;

vii. Any unusual activities at the project that may affect fish passage.

3.3.2. Weekly Reports shall cover Sunday–Saturday and e-mailed to CENWP-OD, CENWD-PDW-R (RCC) and other interested parties as soon as possible the following week.

3.3.3. ***Memorandum for the Record*** **(MFR)** shall be prepared by Project biologists for any adverse or negative impact to fish or fishways. The MFR will be sent to FPOM by the next working day and added to the next FPOM agenda for review. See **FPP Chapter 1 – Overview** for the MFR template.

3.3.4. Annual Reports shall be prepared by Project biologists by January 31 summarizing the operation of the project fish passage facilities for the previous year.

3.3.4.1. The annual report will cover from the beginning of one adult fish facility winter maintenance period to the beginning of the next.

3.3.4.2. The annual report also will include a description of all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities.

3.3.4.3. The annual report will be provided to CENWP-OD in time for distribution to FPOM members at the February meeting.

4. FISH FACILITIES MAINTENANCE

4.1. General.

4.1.1. Routine Maintenance.

4.1.1.1. Staff gauges and other water-level sensors will be installed, cleaned, and/or repaired as required.

4.1.1.2. Scheduled fishway maintenance, to the extent practicable, will be conducted during periods when passage has been documented to be at its lowest during the regular scheduled workday, to minimize impacts to migrating salmonids.

4.1.1.3. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports.

4.2. Maintenance - Juvenile Fish Facilities.

4.2.1. Routine Maintenance.

4.2.1.1. Submersible Traveling Screens (STS). The STS system will receive preventive maintenance or repair at all times of the year, including the winter maintenance period. Whenever a generator malfunctions or is scheduled for maintenance, the three STSs in that turbine may be maintained, repaired, or exchanged for other STSs needing maintenance or repair. One third of the STSs at Bonneville are scheduled for complete overhaul each year resulting in a three-year maintenance cycle unless future developments indicate that longer life expectancy is possible.

4.2.1.2. Juvenile Bypass Systems (JBS). The JBS will receive preventive maintenance throughout the year. During the juvenile fish passage season, this will normally be above-water work such as maintenance of automatic systems, air lines, electrical systems, and monitoring equipment. During the winter maintenance period, the systems may be dewatered downstream of the gatewell orifices. The systems will then be visually inspected in all accessible areas for damaged equipment and in areas that may cause problems to the juvenile fish. Any problem areas identified are to be repaired if the project is able. In extreme cases, the work will be contracted as soon as possible or repaired during the next winter maintenance period. Channel modifications and general maintenance also should be completed at this time.

4.2.1.2.a. Trash racks are to be raked just prior to the juvenile fish passage season and whenever trash accumulations are suspected because of increased head across the trash racks (>1.5') or increased juvenile fish descaling. Additional trash rack raking may be necessary when a storm brings large quantities of debris down river to the project. Gatewell orifices in the unit being raked will be closed during the procedure.

4.2.1.3. Turbines and Spillways. Maintenance and routine repair of project turbines and spillways is a regular and recurring process which requires units to be shut down for extended periods of time.

4.2.1.3.a. The maintenance schedules for turbines and spillways will reflect equal weighting given to fish, power, and water management and will be coordinated with the appropriate fish and resource agencies through FPOM.

4.2.1.3.b. Certain turbine and spillway flows at the projects are secondarily used to attract adult fish to fishway entrances, to keep predator fish from accumulating near juvenile release sites, and/or to move juveniles downstream away from the project. During fish passage season, do not take units F1, F2, 1, 3, 11, and 18 out of service, when practicable.

4.2.1.3.c. Whenever practicable, except during split flows operation, do not take any other PH2 units out of service June 21–September 15, to minimize PH1 operation.

4.2.1.3.d. Fish units may be taken out of service to facilitate cleaning of the fish unit brush rigging. Through trial and error, it has been determined that the rigging should be cleaned twice during the passage season. One cleaning operation is performed in conjunction with the mid-year collection channel diffuser grating inspection, and the second stands alone on the outage schedule.

4.2.1.3.e. Some types of turbine maintenance will require testing the turbine throughout its full operating range before returning it to normal service. These operations will be coordinated with the appropriate resource agencies.

4.2.2. Non-Routine Maintenance. Maintenance of facilities that sometimes break down during fish passage season (e.g., fish screens) will be carried out as described below.

4.2.2.1. Unscheduled maintenance that will have a significant impact on juvenile fish passage shall be coordinated with the Regional fish agencies through FPOM and with RCC on a case-by-case basis by CENWP-OD biologists. See **FPP Chapter 1 - Overview** for the Memo of Coordination (MOC) instructions and template. The CENWP-OD biologists will be notified by the project as soon as possible after it becomes apparent that maintenance repairs are required. The Project Operations Manager has the authority to initiate work prior to notifying CENWP-OD when delay of the work will result in an unsafe situation for people, property, or fish.

4.2.2.2. Screens. If an STS or VBS is found to be damaged or inoperative in an operating unit, the unit will be regarded as an unscreened unit. The screen will be repaired or replaced before returning the unit to normal service.

4.2.2.3. Juvenile Bypass Systems (JBS).

4.2.2.3.a. The JBS is controlled automatically (PLC). When an automatic system fails, it can usually be operated manually. This allows either facility to operate according to criteria while repair of the automatic system is completed.

4.2.2.3.b. Orifices allow fish out of the gatewells into a bypass channel. If an orifice valve system becomes inoperative, it will be repaired expeditiously. When the orifices become plugged with debris they are pneumatically flushed.

4.2.2.3.c. If automatic systems fail and the system is operated manually, facility inspections should increase to a frequency to ensure systems operate within criteria.

4.2.2.3.d. All STS gatewells will be inspected daily and cleaned before they become 50% covered with debris. If due to volume of debris it is not possible to keep the gatewell surfaces at least 50% clear, they will be cleaned at least once daily. Turbines with a gatewell fully covered with debris will not be operated, except on a last-on/first-off basis, if required to be in compliance with other coordinated fish measures. This is to maintain

clean orifices and minimize fish injury. The gatewell orifices will be closed during the cleaning operation. Check gatewell drawdown and clean trashracks if necessary.

4.2.2.3.e. Powerhouse One (PH1). PH1 juvenile passage routes consist of the ITS and MGR turbines. The DSM is no longer in service.

4.2.2.3.f. Powerhouse Two (PH2). If the bypass system fails in the dewatering section or release pipe, fish may be released through the emergency relief conduit. This operation will continue until repairs are accomplished or until the end of the fish passage season. Any decision on whether or not to shut this system down for dewatering and repairs will be made in coordination with the FPOM. During this emergency operating mode, power generation will be minimized at the PH2. Repairs will receive high priority.

4.2.2.3.g. During fishway inspections, VBSs may be found plugged, damaged or not properly seated. In these cases, the associated unit will be taken out of service as if unscreened and repairs will be made before returning the unit to normal service. If screens are pulled and replaced, the underwater video inspection camera will be deployed to check the screens for proper seating.

4.2.2.4. Turbines and Spillways. If a spill gate becomes inoperable, the operator will make the changes necessary to accommodate the spill and then immediately notify the operations supervisor and Project Biologist to determine the best pattern to follow until repairs are completed. This interim operation shall be coordinated with the FPOM through the district biologist who will provide additional guidance to the project.

4.3. Maintenance - Adult Fish Facilities.

4.3.1. Routine Maintenance. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports.

4.3.1.1. Fishway Auxiliary Water Systems. Bonneville Project auxiliary water systems consist of gravity flow and hydroelectric generating systems. Preventive maintenance and normal repair are carried out as needed throughout the year. Trash racks for the AWS intakes will be raked when drawdown exceeds criteria. When practicable, rake trash racks during the time of day when fish passage is least affected.

4.3.1.2. Powerhouse and Spillway Adult Fish Collection Systems. Preventive maintenance and repair occurs throughout the year. During the primary adult fish passage season this maintenance will not involve any operations which will cause failure to comply with the adult fishway criteria except as specially coordinated or as needed for semi-annual maintenance. Inspection of those parts of the adult collection channel systems which require dewatering, such as diffusion gratings, leads, and entrance gates, will be scheduled once per year during the winter maintenance season while the system is dewatered, with one additional inspection during the fish passage season, unless a channel must be dewatered for fishway modifications or to correct observed problems.

4.3.1.2.a. An underwater video system or diver may be used for underwater inspections. This scheduled inspection and any associated maintenance will occur during winter

maintenance period and once during fish passage season unless specially coordinated. Any non-routine maintenance and fishway modifications will be handled individually.

4.3.1.2.b. A Project Biologist will attend all dewatering activities potentially involving fish, as well as inspections, to provide fish related input.

4.3.1.3. Diffuser Gratings: Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to make sure they are in place. These inspections are done by either dewatering the fish passage way and physically inspecting the diffuser gratings, or by using other methods to inspect the gratings. Diffuser gratings may come loose during the fish passage season.

4.3.1.3.a. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings.

4.3.1.3.b. If a diffuser grating is known to or suspected of having moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway.

4.3.1.3.c. If possible, a video inspection should be made ASAP to determine the extent of the problem. If diffusers gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and tribes through the established FPOM coordination procedure.

4.3.1.3.d. Repairs shall be made as quickly as possible unless coordinated differently.

4.3.1.3.e. Clean debris from diffuser pits using a rolling operation. Diffusers are opened for a period of ~5 minutes, one at a time, starting with the furthest diffuser upstream to allow debris in the pits to be flushed down the ladder. This should be done at A-branch, B-branch, Cascades Island, and any other diffuser deemed necessary by Project Fisheries. This should be done in November before the start of winter maintenance, and in summer during the same time as ROV inspections in order to minimize impacts on fish passage.

4.3.1.4. Adult Fish Ladders & Counting Stations. Also see *Adult Fish Trapping Protocols* (**Appendix G**). Adult fish ladders will be dewatered once each year during winter maintenance. During this time, the ladders will be inspected for blocked orifices, projections into the fishway that may injure fish, weir stability, damaged picket leads, exit gate problems, loose diffusion gratings, unreadable or damaged staff gauges, defective diffusion valves, malfunctioning operating equipment at the counting stations, as well as other potential problems. Problems identified throughout the passage year that do not affect fish passage, as well as those identified during the dewatered period, may then be repaired. Trash racks at the ladder exits will be raked when criteria is approached or exceeded. When practicable, rake trash racks during the time of day when fish passage is least affected, usually late morning (**Figure BON-6**). Fish count station windows, light panels, and crowder panels will be cleaned as needed to achieve accurate counts and, when practicable, during the time of day when fish passage is least affected, usually late morning.

4.3.2. Non-Routine Maintenance. Maintenance activities that occur during the fish passage period that may affect fish passage will be reported in the weekly reports. Non-routine maintenance that will significantly affect the operation of a facility, such as repair of displaced diffuser gratings, will be coordinated with RCC and Regional fish agencies through FPOM. Coordination procedures for non-routine maintenance of adult and juvenile facilities are the same. Any non-routine maintenance and fishway modifications will be handled individually.

4.3.2.1. Fishway Auxiliary Water Systems. Most fishway auxiliary water systems are operated automatically. If the automatic system fails, then the system will be manually operated by project personnel to maintain criteria while repair of the automatic system is carried out. When this operation becomes necessary, project personnel will increase the surveillance of the adult system to ensure that criteria are being met. In the event of AWS failure, FPOM will be used in an advisory capacity to assist the project as needed.

4.3.2.1.a. Powerhouse One (PH1). If any valves or other part of the system fails, the project shall attempt to maintain criteria by adjusting functioning valves. Conduit pressure must be monitored and not allowed to exceed the established limits.

4.3.2.1.b. Spillway. Two separate fishway auxiliary water valves add water to each spillway ladder (Cascades Island and B-branch ladders). If one of these valves or any other part of the system malfunctions, the functioning parts of the system are to be adjusted to compensate. If repairs cannot be made in 24 hours, close the sluice gate entrance, if open. This will divert the reduced available water to the entrance slots. If a head of 1' is still not achieved, stop logs are to be added to the entrance slots until the desired head or a weir depth of not less than 6' below the tailwater surface is reached. At this point maintain the gate positions until the auxiliary water system is repaired.

4.3.2.1.c. Powerhouse Two (PH2).

c.1. If either or both fishway auxiliary water turbines do not provide sufficient water to meet full criteria, the adult facilities will be operated according to *Emergency Operations for Bonneville PH2 AWS Systems Operations* (**Table BON-12**) or until a fishway head of 1' is achieved.

c.2. When one of the fish turbines has failed or been taken out of service, refer to **Table BON-12** for turbine operations, floating orifices, diffuser gates, and main gates during emergency situations. **Table BON-12** guidance should be followed to the extent practicable, and shore entrance weirs should be raised in increments or closed as needed to maintain the proper fishway head.

c.3. From September 1–March 31, if both fish unit turbines fail and repairs cannot be made within 8 hours, coordination with FPOM will occur to develop operational guidelines that may include modified powerhouse priority operations.

c.4. PH2 adult fishway diffusion system valves A3, A4 have been removed due to damage. These valves were designed to be closed when tailwater drops below 11' and

9', respectively. Even though the valves cannot be closed, velocity in the channel has remained in criteria.

Table BON-12. Bonneville Dam PH2 Auxiliary Water Supply Emergency Operations.

Tailwater Elevation (ft)	Turbine (MW)	Turbine Q (cfs)	**********CLOSED**********			
			Floating Orifices	South "B" Diffusers	PH "C" Diffusers	Main Entrances
8	13.90	2,950	All	B3-8	C1-5	None
9	13.95	3,010	All	B3-8	C1-5	None
10	14.05	3,090	All	B3-8	C1-5	None
11	14.15	3,165	All	B3-8	C1-5	None
12	14.20	3,230	All	B3-8	C1-5	None
13	14.40	3,340	All	B3-8	C1-5	None
14	14.40	3,400	All	B3-8	C1-5	None
15	14.60	3,520	All	B3-8	C1-5	None
16	14.30	3,515	All	B3-8	C1-5	None
17	14.20	3,560	All	B3-8	C1-5	None
18	14.00	3,575	All	B5-8	None	NU-E
19	13.60	3,535	All	B5-8	None	NU-E
20	13.30	3,520	All	B4-8	None	NU-E
21	13.00	3,510	All	B4-8	None	NU-E
22	12.70	3,505	All	B4-8	None	NU-E
23	12.40	3,505	All	B4-8	None	NU-E
24	12.20	3,535	All	B4-8	None	NU-E
25	11.60	3,535	All	B4-8	None	NU-E
26	11.10	3,365	All	B4-8	None	NU-E
27	10.60	3,285	All	B4-8	None	NU-E
28	10.00	3,160	All	B3-8	None	NU-E

4.3.2.2. Powerhouse & Spillway Adult Fish Collection Systems. Bonneville Project contains several types of fishway entrances. In most cases, if failures occur, the entrance can and will be operated manually by project personnel until repairs are made. If this operation becomes necessary, project personnel will increase the surveillance of the adult system to ensure that criteria are being met. In those cases in which the failure will not allow the entrance to be operated manually, the gate will be maintained, to the extent possible, in an operational position. If this is not possible, the entrance will be repaired expediently and returned to manual or automatic control at the earliest possible date.

4.3.2.3. Adult Fish Ladders & Counting Stations. Ladder components include picket leads, counting stations, fishway exits, and overflow weirs with orifices. Pickets with excessive spacing (greater than 1"), concrete erosion around the leads, or missing pickets can allow fish into areas where escape is difficult. In some instances of picket lead failure, spare leads and spare installation slots are available. In these cases the spare leads are installed and the damaged leads are removed and repaired. In the remaining instances of picket lead failure or concrete erosion, the timing and method of repair will depend upon the severity of the problem. The decision of whether or not to dewater the fishway and repair any problems will be made in coordination with the Regional fish agencies through FPOM.

4.3.2.4. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to make sure they are in place. These inspections are done by either dewatering the fish passage way and physically inspecting the diffuser gratings, or by using other methods to inspect the gratings. Diffuser gratings may come loose during the fish passage season.

4.3.2.4.a. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings.

4.3.2.4.b. If a diffuser grating is known to or suspected of having moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway.

4.3.2.4.c. If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the Regional fish agencies through FPOM.

4.3.2.4.d. Repairs shall be made as quickly as possible unless coordinated differently.

5. TURBINE UNIT OPERATION & MAINTENANCE

5.1. Turbine Unit Priority Order.

5.1.1. Turbine units will be operated in the order of priority defined in **Table BON-13** to optimize fish passage conditions. If a unit is out of service, the next unit in the priority order will be operated. Unit priority order may be coordinated differently for fish research, construction, or project maintenance.

5.1.2. When splitting flows (**section 2.1.3**), the top two available PH1 priority units will be operated first, followed by normal PH2 unit priority. If more units are needed after all available PH2 units are operating, proceed with normal PH1 unit priority.

5.1.3. During high head events (e.g., higher than normal forebay), the top priority unit at PH1 may be operated when necessary to keep PH2 units within the 1% range.

Table BON-13. Bonneville Dam Turbine Unit Priority Order.

PERIOD / OPERATION	UNIT PRIORITY ORDER *
Year-Round: Fish Ladders in service; PH1 Ladder out of service	**PH2**: 11, 18, 12, 17, 13, 14, 15, 16, **Then PH1**: 1, 10, 3, 6, ~~2~~ 9, 4, 5, 8, 7, ~~9~~ 2
PH2 Fish Ladder out of service	**PH1**: 1, 10, 3, 6, ~~2~~ 9, 4, 5, 8, 7, ~~9~~ 2, **Then PH2**: 11, 18, 12, 17, 13, 14, 15, 16
Split Flows (**section 2.1.3**)	**PH1**: 1, 10 (or top two available PH1 priority units), **Then PH2**: 11, 18, 12, 17, 13, 14, 15, 16, **Then PH1:** 3, 6, ~~2~~ 9, 4, 5, 8, 7, ~~9~~ 2
PH1 Unit Priority	1, 10, 3, 6, ~~2~~ 9, 4, 5, 8, 7, ~~9~~ 2
PH2 Unit Priority	11, 18, 12, 17, 13, 14, 15, 16

* Changes in unit priorities may occur and will be authorized in RCC teletypes as needed.

5.2. Turbine Unit Operating Range.

5.2.1. In-Season (April 1–October 31). As defined in the *BPA Load Shaping Guidelines* (**Appendix C**), all units will be operated within ±1% of peak turbine efficiency (1% range) to maximize survival of juvenile fish that pass through the turbines. Turbine units at PH1 may be operated up to the Best Operating Point (BOP). Lower and upper limits of the operating ranges at PH1 and PH2 are defined in **Table BON-14**.

5.2.1.1. From April 10 through June 15, as a soft constraint, PH2 units should not be operated below the 1% mid-range (<13 kcfs) to minimize turbulence that may impact fish that pass through the turbines.

5.2.1.2. If operation outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

i. Meet BPA load requests made pursuant to BPA's policy, statutory requirements, and *Load Shaping Guidelines* (**Appendix C**);

ii. If the draft tube is to be dewatered (**section 6.5**), the unit will be operated at full load >1% (or at speed-no-load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs in order to flush fish from the unit;

iii. Operate a turbine unit solely to provide station service; or

5.2.1.3. Comply with other coordinated fish measures.

5.2.2. Off-Season (November 1–March 31). While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

Table BON-14. Bonneville Dam Turbine Power (MW) and Flow (cfs) at ±1% of Peak Efficiency (Lower and Upper Limits of 1% Range), PH1 Best Operating Point (BOP), and Operating Limits. [a]

Project Head (feet)	PH1 Units 1–10							
	1% Lower Limit		1% Upper Limit		Best Operating Point (BOP)		Operating Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs
35	18.9	7,203	23.6	9,019	27.3	10,527	31.8	12,960
36	19.5	7,205	24.3	8,985	28.3	10,564	33.0	12,997
37	20.1	7,205	25.0	8,951	29.2	10,598	34.1	13,028
38	20.7	7,204	25.6	8,918	30.2	10,627	35.3	13,054
39	21.3	7,202	26.3	8,886	31.2	10,654	36.4	13,076
40	21.9	7,199	26.9	8,854	32.1	10,677	37.6	13,093
41	22.5	7,201	28.0	8,969	33.2	10,759	38.8	13,147
42	23.1	7,202	29.1	9,077	34.3	10,837	40.0	13,197
43	23.6	7,203	30.1	9,180	35.4	10,910	41.1	13,242
44	24.2	7,203	31.2	9,278	36.5	10,979	42.3	13,284
45	24.8	7,203	32.3	9,370	37.6	11,045	43.5	13,322
46	25.4	7,210	33.2	9,416	38.8	11,109	44.6	13,303
47	26.0	7,217	34.1	9,459	39.9	11,170	45.7	13,280
48	26.6	7,223	35.0	9,500	41.0	11,227	46.7	13,253
49	27.3	7,229	36.0	9,539	42.1	11,282	47.8	13,222
50	27.9	7,234	36.9	9,575	43.2	11,333	48.8	13,188
51	28.5	7,241	37.8	9,618	44.2	11,356	49.9	13,207
52	29.1	7,248	38.4	9,577	45.2	11,378	51.0	13,222
53	29.7	7,254	39.0	9,537	46.2	11,398	52.1	13,234
54	30.3	7,260	39.7	9,499	47.2	11,418	53.1	13,242
55	30.9	7,266	41.6	9,768	48.2	11,465	54.2	13,248
56	31.5	7,269	42.5	9,808	49.2	11,478	54.6	13,046
57	32.1	7,272	43.4	9,846	50.3	11,518	54.9	12,841
58	32.7	7,274	44.4	9,883	51.4	11,557	55.3	12,633
59	33.3	7,277	45.3	9,918	52.4	11,594	55.5	12,421
60	33.8	7,279	46.3	9,952	53.5	11,630	55.8	12,206
61	34.5	7,296	46.9	9,930	54.3	11,610	56.1	12,048
62	35.1	7,311	47.6	9,909	55.1	11,591	56.3	11,887
63	35.8	7,326	48.3	9,889	56.0	11,572	56.5	11,721
64	36.5	7,340	49.0	9,868	56.6	11,519	56.7	11,552
65	37.1	7,354	49.7	9,849	56.8	11,388	56.8	11,379
66	37.6	7,341	50.6	9,876	57.1	11,265	57.4	11,328
67	38.1	7,329	51.4	9,902	57.3	11,124	58.1	11,275
68	38.6	7,317	52.3	9,928	57.6	11,021	58.6	11,220
69	39.0	7,305	53.2	9,954	57.8	10,896	59.2	11,161
70	39.5	7,294	54.1	9,979	58.0	10,736	59.8	11,100

Project	PH2 Units 11-18 - With STS						PH2 Units 11-18 - No STS					
Head	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
(ft)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
35	27.6	11,259	44.3	18,068	46.7	19,283	28.2	11,444	45.1	18,277	46.7	19,168
36	28.5	11,271	45.8	18,097	49.0	19,714	29.2	11,455	46.6	18,306	49.0	19,597
37	29.4	11,279	47.3	18,121	51.4	20,146	30.1	11,464	48.1	18,331	51.4	20,026
38	30.3	11,284	48.8	18,139	53.9	20,580	31.0	11,470	49.7	18,350	53.9	20,457
39	31.3	11,287	50.3	18,153	56.4	21,014	32.0	11,473	51.2	18,364	56.4	20,889
40	32.2	11,288	51.8	18,162	59.0	21,450	32.9	11,474	52.7	18,374	59.0	21,321
41	33.0	11,259	53.3	18,197	61.2	21,654	33.7	11,445	54.3	18,409	61.2	21,535
42	33.8	11,230	54.9	18,228	63.4	21,854	34.6	11,415	55.8	18,441	63.4	21,744
43	34.6	11,201	56.4	18,255	65.6	22,049	35.4	11,386	57.4	18,468	65.6	21,949
44	35.4	11,172	57.9	18,278	67.8	22,240	36.2	11,357	58.9	18,493	67.8	22,150
45	36.2	11,144	59.4	18,299	70.1	22,427	37.0	11,328	60.5	18,514	70.1	22,347
46	37.0	11,139	61.0	18,366	72.1	22,441	37.9	11,324	62.1	18,581	72.1	22,390
47	37.8	11,135	61.9	18,200	74.2	22,450	38.7	11,319	63.0	18,415	74.2	22,429
48	38.7	11,129	62.7	18,040	76.3	22,455	39.6	11,314	63.8	18,255	76.3	22,463
49	39.5	11,124	63.5	17,887	76.5	21,994	40.4	11,308	64.7	18,101	76.5	22,040
50	40.3	11,118	67.5	18,598	76.5	21,497	41.3	11,303	68.7	18,817	76.5	21,527
51	41.3	11,154	69.8	18,850	76.5	20,999	42.2	11,339	71.1	19,072	76.5	21,015
52	42.3	11,187	72.1	19,091	76.5	20,502	43.2	11,373	73.4	19,316	76.5	20,502
53	43.2	11,219	74.5	19,323	76.5	20,005	44.2	11,405	75.8	19,551	76.5	19,989
54	44.2	11,249	76.5 [b]	19,536	76.5	19,536	45.2	11,436	76.5 [b]	19,431	76.5	19,431
55	45.2	11,278	76.5 [b]	19,115	76.5	19,115	46.2	11,466	76.5 [b]	18,975	76.5	18,975
56	46.4	11,343	76.5 [b]	18,718	76.5	18,718	47.4	11,531	76.5 [b]	18,581	76.5	18,581
57	47.6	11,404	76.5 [b]	18,336	76.5	18,336	48.6	11,593	76.5 [b]	18,202	76.5	18,202
58	48.8	11,461	76.5 [b]	17,967	76.5	17,967	49.9	11,652	76.5 [b]	17,836	76.5	17,836
59	50.0	11,515	76.5 [b]	17,611	76.5	17,611	51.1	11,707	76.5 [b]	17,483	76.5	17,483
60	51.2	11,567	76.5 [b]	17,267	76.5	17,267	52.3	11,760	76.5 [b]	17,142	76.5	17,142
61	51.8	11,532	76.5 [b]	16,978	76.5	16,978	53.0	11,724	76.5 [b]	16,857	76.5	16,857
62	52.5	11,498	76.5 [b]	16,699	76.5	16,699	53.7	11,690	76.5 [b]	16,582	76.5	16,582
63	53.1	11,466	76.5 [b]	16,428	76.5	16,428	54.3	11,657	76.5 [b]	16,315	76.5	16,315
64	53.7	11,434	76.5 [b]	16,166	76.5	16,166	55.0	11,625	76.5 [b]	16,056	76.5	16,056
65	54.4	11,405	76.5 [b]	15,912	76.5	15,912	55.6	11,595	76.5 [b]	15,806	76.5	15,806
66	55.4	11,448	76.5 [b]	15,671	76.5	15,671	56.7	11,639	76.5 [b]	15,570	76.5	15,570
67	56.5	11,490	76.5 [b]	15,437	76.5	15,437	57.8	11,682	76.5 [b]	15,341	76.5	15,341
68	57.5	11,532	76.5 [b]	15,210	76.5	15,210	58.9	11,724	76.5 [b]	15,119	76.5	15,119
69	58.6	11,571	76.5 [b]	14,990	76.5	14,990	59.9	11,764	76.5 [b]	14,903	76.5	14,903
70	59.6	11,610	76.5 [b]	14,775	76.5	14,775	61.0	11,803	76.5 [b]	14,693	76.5	14,693

a. Table values derived from HDC report (June 2000), except PH1 "Best Operating Point" from Turbine Survival Program (TSP) modeling and analysis (Jan 2013). Flow (cfs) is calculated based on turbine efficiency, head, and power output (MW). “Operating Limit” is the maximum safe operating point, based on the cavitation or generator limit (added Feb 2018).

b. At project head ≥ 54 ft, PH2 units are restricted by the Operating Limit of 76.5 MW and cannot achieve the modeled upper limit of the 1% turbine efficiency range. Power (MW) and flow (cfs) values shown are at the Operating Limit, not the 1% upper limit.

5.3. Turbine Unit Maintenance.

5.3.1. Maintenance Schedules.

5.3.1.1. Turbine unit maintenance schedules will be reviewed by Project and District Operations biologists for fish impacts.

5.3.1.2. Priority unit maintenance will be scheduled for the winter maintenance period or when there are few fish passing the project, to the extent possible. Priority units 1, 3, 11, and 18 will be scheduled for any necessary extended outages between December 1 and April 30. Non-priority units should not be scheduled for routine or extended outages during this time if it will delay or conflict with priority unit maintenance. To maintain the priority importance of Unit 1 when PH1 must be used, long-term outages will be avoided after the beginning of the juvenile fish passage season until after the adult fall Chinook and coho migration ends in late October. Unit 1 provides important attraction flow for adult fish and helps pass juvenile fish downstream when PH1 is operating.

5.3.2. Operational Testing. Operational testing may deviate from priority units and may require water that would otherwise be used for spill if the units operating for reliability are at the 1% lower limit (minimum generation). Water for operational testing will be used from powerhouse allocation when possible, and diverted from spill only to the extent necessary to maintain power system reliability.

5.3.2.1. Pre-Maintenance: Before units go into maintenance status, units may be operationally tested for up to 60 minutes by running at various loads within and outside of the 1% range for pre-maintenance measurements and testing. Units will be run for a minimum of 3 hours to flush fish prior to installing tail logs.

5.3.2.2. Post-Maintenance: After maintenance or repair, units may be operationally tested while remaining in maintenance or forced outage status by running for up to a cumulative time of 60 minutes within and outside of the 1% range before returning to operational status.

5.3.2.3. Units may be operated outside of the 1% range for up to 20 minutes during testing. Unit operations below the 1% range will be minimized to the extent practicable.

5.3.3. Idle Units. When a unit is idle, wicket gates will remain in a closed position unless tail logs are installed and fish salvage has been done in the draft tube, or the project is holding a safety pool below the level of the wicket gates.

5.3.4. Slow Roll. Turbines that have been idle/out-of-service will be started by slow rolling the unit after tipping turbine blades from flat to steep and back to flat.

5.3.5. Long-Term Outages. In the event of long-term powerhouse outages, affected units will be exercised periodically. Each unit will be operated for 4-8 hours every 2 weeks to exercise governor components and clean wetted surfaces of corrosion so that if the unit is needed, fish injury will be minimized and the units will be in good operating condition. Actual runtime will be minimum necessary to keep the unit in good working condition and may be performed at

night, day or whenever unit cycling will have the minimum effect on fish as determined by the Project Biologist.

5.3.6. Head gates[2] at Units 11-18 have been dogged off and the system depressurized. Oil leaks develop frequently when the system operates with normal pressure. Further related instructions are described in a memo from the Project Chief of Operations (*Memorandum for All Operations, dated September 23, 1993. Subject: Powerhouse 2 Hydraulic Head Gate Operation*).

6. DEWATERING PLANS

6.1. General.

6.1.1. *Guidelines for Dewatering and Fish Handling Plans* (**Appendix F**) and project *Dewatering Plans* [3] have been developed by the projects and approved by FPOM, and are followed for most project facility dewaterings. The plans include consideration for fish safety and are consistent with the following general guidance. The appropriate plans are reviewed by participants before each salvage operation.

6.1.2. Whether pumps or drain valves are used, automatic pump shut off devices will be utilized to prevent stranding fish. If automatic pump shut off devices and low water alarms are not used, the dewatering process must be continuously monitored to prevent stranding.

6.1.3. Project Biologist(s) and/or alternate Corps fish personnel will attend all project activities involving fish handling.

6.1.4. The fish agencies and tribes will be notified of any dewaterings and may be invited if additional help is deemed necessary and all safety considerations can be met.

6.1.5. Adult salmonids will be released into the forebay and juvenile salmonids will be released into the tailrace, depending on the age composition of fish in the tank. If a ladder is dewatered in the spring or summer, steelhead kelts will be released into the tailrace. If large numbers of sturgeon are present, it may be necessary to release them into either the forebay or tailrace, depending on the location of the recovery operation.

6.2. Dewatering - Juvenile Bypass Systems (JBS).

6.2.1. See *Guidelines for Dewatering and Fish Handling* (**Appendix F**) and project *Dewatering Plans*[3].

[2] Head gates may also be referred to as "operating" gates at some projects. The terms are interchangeable.
[3] Dewatering Plans are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/

6.3. Dewatering - Adult Fish Ladder.

6.3.1. Routine Maintenance.

6.3.1.1. When possible, operate the ladder to be dewatered at orifice flow for at least 24 hours, and up to 96 hours, prior to dewatering. This operation shall not be initiated prior to 1800 hours on November 30 if a ladder outage is scheduled for December 1.

6.3.1.2. Discontinue all fishway auxiliary water supplies at least 24 hours, but no more than 96 hours, prior to dewatering. This operation shall not be initiated until 1800 hours on November 30 if a ladder outage is scheduled for December 1.

6.3.1.3. A Project Biologist will assure that fish rescue equipment is available and will coordinate to ensure adequate numbers of personnel will be available to move fish out of the dewatered ladder.

6.3.1.4. Project personnel will install head gates to shut down ladder flow. Where possible, a minimum depth of 1"-2" will be maintained in the ladder until fish are rescued.

6.3.1.5. Orifice blocking devices that are placed in the lower-most weirs to prevent fish from re-ascending the dewatered portion of the adult fishway shall have ropes placed on them to be tied to fishway railings. The orifice blocks shall be removed just before the fishway is returned to service. The ropes will help identify and prevent the orifice blocks from being accidentally left in place after fishway water-up. The orifice blocking devices will appear on the pre-water-up checklist maintained by the Project Biologist.

6.3.2. Non-Routine Maintenance.

6.3.2.1. Follow steps in **section 6.3.1** above. When possible, discontinue fishway auxiliary water and operate the ladder at orifice flow as long as possible (prefer 3-24 hours) prior to dewatering.

6.4. Dewatering - Powerhouse Fish Collection System.

6.4.1. Routine Maintenance.

6.4.1.1. During the pumping or draining operation to dewater a portion or the entire collection channel, the water level will not be allowed to drop to a level which strands fish. Personnel shall remain onsite during pumping operations to ensure stranding does not occur, or a water-level sensor that deactivates the dewatering process will be used.

6.4.1.2. Project Fisheries will directly assist fish rescue operations, provide technical guidance, ensure fish safety and ensure rescue equipment/personnel are available if needed.

6.5. Dewatering - Turbine Units.

6.5.1. Immediately before setting the head gates, remove juvenile fish from gatewell(s) that will be drained by use of a special dipping basket. Typically, at least one gatewell is drained to allow ventilation into the draft tube.

6.5.2. If the draft tube is to be dewatered, place head gates and tail logs immediately after the turbine unit is shut down when possible. Bottom tail logs should be placed first. This is necessary for both scheduled and unscheduled outages.

6.5.3. If a turbine unit has been idle and the draft tube is to be dewatered, it will be operated when possible at full load for a minimum of 1 hour, 4 hours preferred. Stop logs will then be placed immediately. It is recommended adjacent units also be operated for a minimum of 1 hour, 4 hours preferred, to flush fish prior to placing tail logs in the unit to be OOS. It is also recommended that units adjacent to OOS units not be voluntarily taken OOS until the adjacent units return to service.

6.5.4. Water levels in the draft tube will not be allowed to drop to a level that strands fish. Adequate inspections will be conducted to ensure that stranding does not occur.

6.5.5. Fish rescue personnel will inspect dewatered turbine draft tubes, scroll cases, and intakes as soon as water levels reach a depth permitting visual inspection and the hatch cover is opened.

6.5.6. A Project Biologist will provide technical guidance for fish safety and will directly participate in fish salvage.

6.5.7. A Project Biologist will invite FPOM members to participate in the dewatering, and will assure that rescue equipment is available if needed.

6.5.8. If the unit is planned to be out of service and partially drained for less than 4 days and low numbers of fish are trapped, then it will not be necessary to remove fish from draft tubes as long as an adequate safety pool is maintained. Adequate inspections will be conducted to ensure the safety pool is maintained and fish are in good condition.

6.6. Dewatering - Navigation Lock.

6.6.1. The navigation lock is frequently dewatered for routine maintenance in late February/early March, in conjunction with navigation lock outages at The Dalles and John Day dams.

6.6.2. The area between the upstream bulkhead and the upstream gate is surveyed for fish as water levels allow. The lateral and pool areas on the floor of the lock are surveyed for fish from above. Most of these areas remain full of water, precluding the ability to implement successful fish salvage operations. Areas where water levels slowly decrease are accessed via crane when pool levels reach a depth of approximately 3 feet. The fill conduits are accessed and checked for fish only if needed and can be done safely. All salvaged fish are removed, transported via bag or tank and released to the river.

7. FOREBAY DEBRIS REMOVAL

7.1.1. Debris can impact fish passage conditions in several ways. It can plug or block trash racks, VBSs, gatewell orifices, dewatering screens, and facility piping, resulting in impingement, injuries, and descaling of fish.

7.1.2. Debris is removed by operating the PH1 ITS, B2CC, or passing it through the spillway with a special spill gate operation.

7.1.3. Special spill operations that don't follow the normal spill schedule or volume limits will be coordinated prior to their execution. Normally, the project shall contact CENWP-OD at least two workdays prior to the day the special operation is required. Using information provided by the project, CENWP-OD will coordinate with FPOM and with RCC, as necessary. Once the coordination is complete, RCC will issue a Teletype detailing the special operations.

8. RESPONSE TO HAZARDOUS MATERIALS SPILLS

8.1.1. Bonneville Project's guidance for responding to hazardous substance spills is contained in its Emergency Spill Response Plan.

8.1.2. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.

8.1.3. Project Fisheries will be contacted as soon as possible after a hazardous material release and prior to any modification to fishway operations. Project biologist(s) will in turn contact the CENWP-OD biologist and FPOM. Attempts should be made to first contact the Project Biologist on duty. During fish passage season, there is a Project Biologist on duty seven days a week. If a Project Biologist cannot be reached by radio or in the office, attempts to contact Project Fisheries will occur in the following order (contact information available in Control Room):

i. Ben Hausmann, Supervisory Fishery Biologist

ii. Ida Royer, Fishery Biologist

iii. Brian Bissell, Fishery Biologist

iv. Andrew Derugin, Fishery Biologist

v. Tammy Mackey, Fisheries Supervisor

Table BON-15. [*pg 1 of 10*] Bonneville Dam Spill Patterns in Vertical Gate Opening (ft) per Spillbay.[a]

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
0.5																	0.5	**1**	**2.3**
0.5	0.5																0.5	**1.5**	**3.4**
0.5	0.5															0.5	0.5	**2**	**4.6**
0.5	0.5														0.5	0.5	0.5	**2.5**	**5.7**
0.5	0.5		0.5												0.5	0.5	0.5	**3**	**6.9**
0.5	0.5		0.5	0.5											0.5	0.5	0.5	**3.5**	**8.0**
0.5	0.5		0.5	0.5									0.5		0.5	0.5	0.5	**4**	**9.2**
0.5	0.5		0.5	0.5							0.5		0.5		0.5	0.5	0.5	**4.5**	**10.3**
0.5	0.5		0.5	0.5					0.5		0.5		0.5		0.5	0.5	0.5	**5**	**11.5**
0.5	0.5		0.5	0.5			0.5		0.5		0.5		0.5		0.5	0.5	0.5	**5.5**	**12.6**
0.5	0.5	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	0.5	0.5	**6**	**13.8**
0.5	0.5	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	1	0.5	**6.5**	**14.9**
0.5	1	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	1	0.5	**7**	**16.0**
0.5	1	0.5	0.5	0.5	0.5		0.5		0.5		0.5		0.5		0.5	1	0.5	**7.5**	**17.2**
0.5	1	0.5	0.5	0.5	0.5		0.5		0.5		0.5		0.5	0.5	0.5	1	0.5	**8**	**18.3**
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5		0.5		0.5		0.5	0.5	0.5	1	0.5	**8.5**	**19.5**
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5		0.5		0.5	0.5	0.5	0.5	0.5	1	0.5	**9**	**20.6**
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5		0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	**9.5**	**21.8**
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	**10**	**22.9**
0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	**10.5**	**24.1**
0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	**11**	**25.2**
1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	**11.5**	**26.3**
1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	**12**	**27.4**
1	1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	**12.5**	**28.6**
1	1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	**13**	**29.7**
1	1	1	1	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	1	1	1	**13.5**	**30.8**
1	1	1	1	0.5	0.5	1	0.5	1	0.5	0.5	0.5	0.5	0.5	1	1	1	1	**14**	**31.9**
1	1	1	1	0.5	0.5	1	0.5	1	0.5	0.5	1	0.5	0.5	1	1	1	1	**14.5**	**33.1**
1	1	1	1	0.5	1	1	0.5	1	0.5	0.5	1	0.5	0.5	1	1	1	1	**15**	**34.2**
1	1	1	1	0.5	1	1	0.5	1	0.5	0.5	1	1	0.5	1	1	1	1	**15.5**	**35.3**
1	1	1	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5	1	1	1	1	**16**	**36.4**
1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	0.5	1	1	1	1	**16.5**	**37.6**
1	1	1	1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	1	1	**17**	**38.7**
1	1	1	1	1	1	1	1	1	1	0.5	1	1	1	1	1	1	1	**17.5**	**39.8**
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**18**	**40.9**
1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**18.5**	**42.0**
1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1	**19**	**43.2**
1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	**19.5**	**44.3**
1	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	**20**	**45.4**
1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	**20.5**	**46.5**
1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1.5	**21**	**47.6**
1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	2	1.5	**21.5**	**48.6**
2	2	2	0	2	0	0	2	0	2	0	0	2	2	0	2	2	2	**22**	**49.0**
2	2	2	0	2	0	0	2	0	2	0	0	2	2	0	2	2.5	2	**22.5**	**50.1**
2	2.5	2	0	2	0	0	2	0	2	0	0	2	2	0	2	2.5	2	**23**	**51.1**
2	2.5	2	0	2	0	0	2	0	2	0	0	2	2	0	2.5	2.5	2	**23.5**	**52.2**
2	2	2	0	2	0	2	2	0	2	0	0	2	2	0	2	2	2	**24**	**53.5**

[a] This table defines spill patterns in increments of ½-ft total gate opening (1 stop) per row. Spill (kcfs) is calculated as a function of total gate opening (ft) at forebay elevation 74.0 ft (updated 2007).

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
2	2	2	0	2	0	2	2	0	2	0	0	2	2	0	2	2.5	2	**24.5**	**54.5**
2	2.5	2	0	2	0	2	2	0	2	0	0	2	2	0	2	2.5	2	**25**	**55.6**
2	2.5	2	0	2	0	2	2	0	2	0	0	2	2	0	2.5	2.5	2	**25.5**	**56.6**
2	2	2	0	2	0	2	2	0	2	2	0	2	2	0	2	2	2	**26**	**57.9**
2	2	2	0	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	**26.5**	**59.0**
2	2.5	2	0	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	**27**	**60.0**
2	2.5	2	0	2	0	2	2	0	2	2	0	2	2	0	2.5	2.5	2	**27.5**	**61.1**
2	2	2	2	2	0	2	2	0	2	2	0	2	2	0	2	2	2	**28**	**62.4**
2	2	2	2	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	**28.5**	**63.4**
2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	**29**	**64.5**
2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	0	2.5	2.5	2	**29.5**	**65.6**
2	2	2	2	2	0	2	2	0	2	2	0	2	2	2	2	2	2	**30**	**66.8**
2	2	2	2	2	0	2	2	0	2	2	0	2	2	2	2	2.5	2	**30.5**	**67.9**
2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	2	2	2.5	2	**31**	**69.0**
2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	2	2.5	2.5	2	**31.5**	**70.0**
2	2	2	2	2	2	2	2	0	2	2	0	2	2	2	2	2	2	**32**	**71.3**
2	2	2	2	2	2	2	2	0	2	2	0	2	2	2	2	2.5	2	**32.5**	**72.4**
2	2.5	2	2	2	2	2	2	0	2	2	0	2	2	2	2	2.5	2	**33**	**73.4**
2	2.5	2	2	2	2	2	2	0	2	2	0	2	2	2	2.5	2.5	2	**33.5**	**74.5**
2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	**34**	**75.8**
2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2.5	2	**34.5**	**76.8**
2	2.5	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2.5	2	**35**	**77.9**
2	2.5	2	2	2	2	2	2	0	2	2	2	2	2	2	2.5	2.5	2	**35.5**	**78.9**
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	**36**	**80.2**
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	**36.5**	**81.3**
2	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	**37**	**82.3**
2	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2	**37.5**	**83.4**
2	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2	**38**	**84.4**
2	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	**38.5**	**85.5**
2.5	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	**39**	**86.6**
2.5	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	2.5	**39.5**	**87.6**
2.5	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	2.5	**40**	**88.6**
2.5	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	3	**40.5**	**89.7**
3	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	3	**41**	**90.7**
3	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	**41.5**	**91.7**
3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	**42**	**92.8**
3	3	3	2	2	2	2	2	2	2	2	2	2	2	2.5	3	3	3	**42.5**	**93.8**
3	3	3	2.5	2	2	2	2	2	2	2	2	2	2	2.5	3	3	3	**43**	**94.9**
3	3	3	2.5	2	2	2	2	2	2	2	2	2	2.5	2.5	3	3	3	**43.5**	**96.0**
3	3	3	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2.5	3	3	3	**44**	**97.0**
3	3	3	2.5	2.5	2	2	2	2	2	2	2.5	2	2.5	2.5	3	3	3	**44.5**	**98.1**
3	3	3	2.5	2.5	2	2	2	2.5	2	2	2.5	2	2.5	2.5	3	3	3	**45**	**99.1**
3	3	3	2.5	2.5	2.5	2	2	2.5	2	2	2.5	2	2.5	2.5	3	3	3	**45.5**	**100.2**
3	3	3	2.5	2.5	2.5	2.5	2.5	2	2	2	2.5	2.5	2.5	2.5	3	3	3	**46.5**	**102.3**
3	3	3	2.5	3	2.5	2.5	2.5	2	2	2	2.5	2.5	2.5	3	3	3	3	**47.5**	**104.4**
3	3	3	3	3	2.5	2.5	2.5	2	2	2	2.5	2.5	2.5	3	3.5	3	3	**48.5**	**106.4**
3	3.5	3	3	3	2.5	2.5	2.5	2	2.5	2	2.5	2.5	2.5	3	3.5	3.5	3	**50**	**109.5**
3	3.5	3.5	3	3	2.5	2.5	2.5	2	2.5	2	2.5	2.5	2.5	3	3.5	3.5	3	**50.5**	**110.5**
3	3.5	3.5	3	3	2.5	2.5	2.5	2	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	**51**	**111.6**
3	3.5	3.5	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	**51.5**	**112.6**
3	3.5	3.5	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	**52**	**113.7**
3	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	**52.5**	**114.7**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
3	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3.5	**53**	**115.7**
3	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	4	3.5	**53.5**	**116.7**
3	3.5	3.5	3	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	4	3.5	**54**	**117.8**
3	3.5	3.5	3	3	3	3	3	2.5	2.5	2.5	2.5	2.5	3	3	3.5	4	3.5	**54.5**	**118.8**
3	3.5	3.5	3	3	3	3	3	2.5	2.5	2.5	2.5	3	3	3	3.5	4	3.5	**55**	**119.8**
3	3.5	3.5	3	3	3	3	3	2.5	2.5	3	2.5	3	3	3	3.5	4	3.5	**55.5**	**120.9**
3	3.5	3.5	3	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	3.5	**56**	**121.9**
3.5	3.5	3.5	3	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	3.5	**56.5**	**122.9**
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	3.5	**57**	**124.0**
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	4	**57.5**	**124.9**
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3.5	3.5	4	4	**58**	**126.0**
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3.5	4	4	4	**58.5**	**127.0**
3.5	3.5	3.5	3.5	3	3	3	3	2.5	3	3	3	3	3	3.5	4	4	4	**59**	**128.0**
3.5	3.5	3.5	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**59.5**	**129.0**
3.5	4	3.5	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**60**	**130.0**
3.5	4	4	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**60.5**	**131.0**
4	4	4	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**61**	**132.0**
4	4	4	4	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**61.5**	**133.0**
4	4	4	4	3	3	3	3	3	3	3	3	3	3	4	4	4	4	**62**	**134.0**
4	4	4	4	3	3.5	3	3	3	3	3	3	3	3	4	4	4	4	**62.5**	**135.0**
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3	3	4	4	4	4	**63**	**136.1**
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3	4	4	4	4	**63.5**	**137.1**
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3.5	4	4	4	4	**64**	**138.1**
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3.5	4	4	4.5	4	**64.5**	**139.1**
4	4	4	4	3.5	3.5	3.5	3	3	3	3	3	3.5	3.5	4	4	4.5	4	**65**	**140.1**
4	4	4	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4	4.5	4	**65.5**	**141.1**
4	4	4	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4.5	4.5	4	**66**	**142.1**
4	4.5	4	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4.5	4.5	4	**66.5**	**143.1**
4	4.5	4.5	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4.5	4.5	4	**67**	**144.0**
4	4.5	4.5	4	3.5	3.5	3.5	3	3	3.5	3	3.5	3.5	3.5	4	4.5	4.5	4	**67.5**	**145.1**
4	4.5	4.5	4	3.5	3.5	3.5	3.5	3	3.5	3	3.5	3.5	3.5	4	4.5	4.5	4	**68**	**146.1**
4	4.5	4.5	4	3.5	3.5	3.5	3.5	3	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	**68.5**	**147.1**
4	4.5	4.5	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	**69**	**148.1**
4	4.5	4.5	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	**69.5**	**149.1**
4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	**70**	**150.1**
4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	4.5	4	**70.5**	**151.1**
4	4.5	4.5	4	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	4.5	4	**71**	**152.1**
4	4.5	4.5	4	4	4	4	3.5	3.5	3.5	3.5	3.5	4	4	4	4.5	4.5	4	**71.5**	**153.1**
4	4.5	4.5	4	4	4	4	3.5	3.5	3.5	3.5	4	4	4	4	4.5	4.5	4	**72**	**154.1**
4	4.5	4.5	4	4	4	4	4	3.5	3.5	3.5	4	4	4	4	4.5	4.5	4	**72.5**	**155.1**
4	4.5	4.5	4	4	4	4	4	3.5	3.5	4	4	4	4	4	4.5	4.5	4	**73**	**156.1**
4	4.5	4.5	4	4	4	4	4	4	3.5	4	4	4	4	4	4.5	4.5	4	**73.5**	**157.1**
4	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4	**74**	**158.1**
4	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4	**74.5**	**159.1**
4	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4	**75**	**160.0**
4	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4	**75.5**	**161.0**
4	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5	4	**76**	**162.0**
4	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5	4	**76.5**	**163.0**
4	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4	**77**	**163.9**
4	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4.5	4.5	4.5	4.5	5	4	**77.5**	**164.9**
4	5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4.5	4.5	4.5	4.5	5	4	**78**	**165.9**
4	5	4.5	4.5	4.5	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	5	4	**78.5**	**166.8**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
4	5	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4.5	4.5	4.5	4.5	4.5	5	4	**79**	**167.8**
4	5	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4.5	4.5	4.5	4.5	5	5	4	**79.5**	**168.8**
4	5	4.5	4.5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	4.5	5	5	4	**80**	**169.8**
4	5	5	4.5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	4.5	5	5	4	**80.5**	**170.7**
4	5	5	4.5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	5	5	5	4	**81**	**171.7**
4	5	5	5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	5	5	5	4	**81.5**	**172.6**
4	5	5	5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	4.5	5	5	5	4	**82**	**173.6**
4	5	5	5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	5	5	5	5	4	**82.5**	**174.6**
4	5	5	5	4.5	4.5	4.5	4.5	4.5	4	4.5	4.5	4.5	5	5	5	5	4	**83**	**175.6**
4	5	5	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	4	**83.5**	**176.5**
4	5	5	5	4.5	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	4	**84**	**177.5**
4	5	5	5	4.5	5	4.5	4.5	4.5	4.5	4.5	5	4.5	5	5	5	5	4	**84.5**	**178.5**
4	5	5	5	4.5	5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	5	4	**85**	**179.4**
4	5	5	5	5	5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	5	4	**85.5**	**180.4**
4	5	5	5	5	5	4.5	5	4.5	4.5	4.5	5	5	5	5	5	5	4	**86**	**181.3**
4	5	5	5	5	5	4.5	5	4.5	5	4.5	5	5	5	5	5	5	4	**86.5**	**182.3**
4	5	5	5	5	5	4.5	5	5	5	4.5	5	5	5	5	5	5	4	**87**	**183.3**
4	5	5	5	5	5	5	5	5	5	4.5	5	5	5	5	5	5	4	**87.5**	**184.2**
4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	**88**	**185.2**
4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	**88.5**	**186.1**
4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	4	**89**	**187.1**
4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	**89.5**	**188.0**
4	5.5	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	**90**	**189.0**
4	5.5	5.5	5	5.5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	**90.5**	**189.9**
4	5.5	5.5	5	5.5	5	5	5	5	5	5	5	5	5	5.5	5.5	5.5	4	**91**	**190.8**
4	5.5	5.5	5.5	5.5	5	5	5	5	5	5	5	5	5	5.5	5.5	5.5	4	**91.5**	**191.8**
4	5.5	5.5	5.5	5.5	5	5	5	5	5.5	5	5	5	5	5.5	5.5	5.5	4	**92**	**192.7**
4	5.5	5.5	5.5	5.5	5	5	5.5	5	5.5	5	5	5	5	5.5	5.5	5.5	4	**92.5**	**193.7**
4	5.5	5.5	5.5	5.5	5	5	5.5	5	5.5	5	5	5.5	5	5.5	5.5	5.5	4	**93**	**194.6**
4	5.5	5.5	5.5	5.5	5	5	5.5	5.5	5.5	5	5	5.5	5	5.5	5.5	5.5	4	**93.5**	**195.6**
4	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5	5	5.5	5	5.5	5.5	5.5	4	**94**	**196.5**
4	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5	5.5	5.5	5	5.5	5.5	5.5	4	**94.5**	**197.5**
4	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5	5.5	5.5	5.5	5.5	5.5	5.5	4	**95**	**198.4**
4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5.5	5.5	5.5	4	**95.5**	**199.3**
4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4	**96**	**200.3**
4	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4	**96.5**	**201.2**
4	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	4	**97**	**202.1**
4	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	4	**97.5**	**203.1**
4	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	4	**98**	**204.0**
4	5.5	5.5	5.5	6	6	5.5	6	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	4	**98.5**	**204.9**
4	5.5	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	5.5	5.5	4	**99**	**205.9**
4	6	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	5.5	5.5	4	**99.5**	**206.8**
4	6	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	5.5	6	4	**100**	**207.7**
4	6	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	6	6	4	**100.5**	**208.6**
4	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	6	6	4	**101**	**209.6**
4	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4	**101.5**	**210.5**
4	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4.5	**102**	**211.5**
4.5	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4.5	**102.5**	**212.4**
4.5	6	6	6	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4.5	**103**	**213.4**
4.5	6	6	6	6	6	5.5	6	5.5	6	5.5	6	6	6	6	6	6	4.5	**103.5**	**214.3**
4.5	6	6	6	6	6	5.5	6	6	6	5.5	6	6	6	6	6	6	4.5	**104**	**215.2**
4.5	6	6	6	6	6	6	6	6	6	5.5	6	6	6	6	6	6	4.5	**104.5**	**216.2**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
4.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	4.5	**105**	**217.1**
4.5	6	6	6	6.5	6	6	6	6	6	6	6	6	6	6	6	6	4.5	**105.5**	**218.0**
4.5	6	6	6	6.5	6	6	6	6	6	6	6	6.5	6	6	6	6	4.5	**106**	**218.9**
4.5	6	6	6	6.5	6	6	6	6	6	6	6.5	6.5	6	6	6	6	4.5	**106.5**	**219.8**
4.5	6	6	6	6.5	6.5	6	6	6	6	6	6.5	6.5	6	6	6	6	4.5	**107**	**220.7**
4.5	6	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6	6	4.5	**107.5**	**221.6**
4.5	6	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6	6.5	4.5	**108**	**222.6**
4.5	6.5	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6	6.5	4.5	**108.5**	**223.5**
4.5	6.5	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6.5	6.5	4.5	**109**	**224.4**
4.5	6.5	6.5	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6.5	6.5	4.5	**109.5**	**225.3**
4.5	6.5	6.5	6	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6	6	6.5	6.5	4.5	**110**	**226.2**
4.5	6.5	6.5	6	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6	6.5	6.5	6.5	4.5	**110.5**	**227.1**
4.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6	6.5	6.5	6.5	4.5	**111**	**228.0**
4.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6.5	6.5	6.5	6.5	4.5	**111.5**	**228.9**
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6.5	6.5	6.5	6.5	6.5	4.5	**112**	**229.9**
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	4.5	**112.5**	**230.8**
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	4.5	**113**	**231.7**
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5	**113.5**	**232.6**
5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5	**114**	**233.6**
5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5	**114.5**	**234.5**
5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	5	**115**	**235.4**
5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	5	**115.5**	**236.3**
5	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	5	**116**	**237.2**
5	6.5	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	5	**116.5**	**238.1**
5	6.5	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	6.5	7	5	**117**	**239.0**
5	7	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	6.5	7	5	**117.5**	**239.9**
5	7	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	7	7	5	**118**	**240.8**
5	7	7	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	7	7	5	**118.5**	**241.7**
5	7	7	6.5	7	7	6.5	7	6.5	7	6.5	7	7	6.5	6.5	7	7	5	**119**	**242.6**
5	7	7	6.5	7	7	6.5	7	6.5	7	6.5	7	7	6.5	7	7	7	5	**119.5**	**243.5**
5	7	7	7	7	7	6.5	7	6.5	7	6.5	7	7	6.5	7	7	7	5	**120**	**244.4**
5	7	7	7	7	7	6.5	7	6.5	7	6.5	7	7	7	7	7	7	5	**120.5**	**245.3**
5	7	7	7	7	7	7	7	6.5	7	6.5	7	7	7	7	7	7	5	**121**	**246.2**
5	7	7	7	7	7	7	7	6.5	7	7	7	7	7	7	7	7	5	**121.5**	**247.1**
5	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	5	**122**	**248.0**
5	7	7	7	7.5	7	7	7	7	7	7	7	7	7	7	7	7	5	**122.5**	**248.8**
5	7	7	7	7.5	7	7	7	7	7	7	7	7.5	7	7	7	7	5	**123**	**249.7**
5	7	7	7	7.5	7	7	7	7	7	7	7.5	7.5	7	7	7	7	5	**123.5**	**250.6**
5	7	7	7	7.5	7.5	7	7	7	7	7	7.5	7.5	7	7	7	7	5	**124**	**251.5**
5	7	7	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7	7	5	**124.5**	**252.4**
5	7	7	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7.5	7	5	**125**	**253.3**
5	7	7.5	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7.5	7	5	**125.5**	**254.1**
5	7	7.5	7	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7	7	7.5	7	5	**126**	**255.0**
5	7	7.5	7	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7	7.5	7.5	7	5	**126.5**	**255.9**
5	7	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7	7.5	7.5	7	5	**127**	**256.8**
5	7	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7.5	7.5	7.5	7	5	**127.5**	**257.7**
5	7	7.5	7.5	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7.5	7.5	7.5	7.5	7	5	**128**	**258.6**
5	7	7.5	7.5	7.5	7.5	7.5	7.5	7	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	5	**128.5**	**259.5**
5	7	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	5	**129**	**260.3**
5	7	7.5	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	5	**129.5**	**261.2**
5	7	7.5	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8	7.5	7.5	7.5	7	5	**130**	**262.1**
5	7	7.5	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7	5	**130.5**	**262.9**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
5	7	7.5	7.5	8	8	7.5	7.5	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7	5	**131**	**263.8**
5	7	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7	5	**131.5**	**264.7**
5	7	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7.5	5	**132**	**265.6**
5	7.5	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7.5	5	**132.5**	**266.5**
5	7.5	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	8	7.5	5	**133**	**267.3**
5	7.5	8	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	8	7.5	5	**133.5**	**268.2**
5	7.5	8	7.5	8	8	7.5	8	7.5	8	7.5	8	8	7.5	7.5	8	7.5	5	**134**	**269.1**
5	7.5	8	7.5	8	8	7.5	8	7.5	8	7.5	8	8	7.5	8	8	7.5	5	**134.5**	**269.9**
5	7.5	8	8	8	8	7.5	8	7.5	8	7.5	8	8	7.5	8	8	7.5	5	**135**	**270.8**
5	7.5	8	8	8	8	7.5	8	7.5	8	7.5	8	8	8	8	8	7.5	5	**135.5**	**271.7**
5	7.5	8	8	8	8	8	8	7.5	8	7.5	8	8	8	8	8	7.5	5	**136**	**272.5**
5	7.5	8	8	8	8	8	8	7.5	8	8	8	8	8	8	8	7.5	5	**136.5**	**273.4**
5	7.5	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7.5	5	**137**	**274.3**
5	7.5	8	8	8.5	8	8	8	8	8	8	8	8	8	8	8	7.5	5	**137.5**	**275.1**
5	7.5	8	8	8.5	8	8	8	8	8	8	8	8.5	8	8	8	7.5	5	**138**	**276.0**
5	7.5	8	8	8.5	8	8	8	8	8	8	8.5	8.5	8	8	8	7.5	5	**138.5**	**276.9**
5	7.5	8	8	8.5	8.5	8	8	8	8	8	8.5	8.5	8	8	8	7.5	5	**139**	**277.7**
5	7.5	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	7.5	5	**139.5**	**278.6**
5	7.5	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	8	5	**140**	**279.5**
5	8	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	8	5	**140.5**	**280.3**
5	8	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8.5	8	5	**141**	**281.2**
5	8	8.5	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8.5	8	5	**141.5**	**282.0**
5	8	8.5	8	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8	8	8.5	8	5	**142**	**282.9**
5	8	8.5	8	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8	8.5	8.5	8	5	**142.5**	**283.8**
5	8	8.5	8.5	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8	8.5	8.5	8	5	**143**	**284.6**
5	8	8.5	8.5	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8.5	8.5	8.5	8	5	**143.5**	**285.5**
5	8	8.5	8.5	8.5	8.5	8.5	8.5	8	8.5	8	8.5	8.5	8.5	8.5	8.5	8	5	**144**	**286.3**
5	8	8.5	8.5	8.5	8.5	8.5	8.5	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8	5	**144.5**	**287.2**
5	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8	5	**145**	**288.1**
5	8	8.5	8.5	9	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8	5	**145.5**	**288.9**
5	8	8.5	8.5	9	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9	8.5	8.5	8.5	8	5	**146**	**289.7**
5	8	8.5	8.5	9	8.5	8.5	8.5	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8	5	**146.5**	**290.6**
5	8	8.5	8.5	9	9	8.5	8.5	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8	5	**147**	**291.4**
5	8	8.5	8.5	9	9	8.5	9	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8	5	**147.5**	**292.3**
5	8	8.5	8.5	9	9	8.5	9	9	8.5	8.5	9	9	8.5	8.5	8.5	8	5	**148**	**293.1**
5	8	8.5	8.5	9	9	8.5	9	9	9	8.5	9	9	8.5	8.5	8.5	8	5	**148.5**	**294.0**
5	8	8.5	8.5	9	9	8.5	9	9	9	9	9	9	8.5	8.5	8.5	8	5	**149**	**294.8**
5	8	8.5	8.5	9	9	9	9	9	9	9	9	9	8.5	8.5	8.5	8	5	**149.5**	**295.7**
5	8	8.5	8.5	9	9	9	9	9	9	9	9	9	9	8.5	8.5	8	5	**150**	**296.5**
5	8	8.5	9	9	9	9	9	9	9	9	9	9	9	9	8.5	8	5	**151**	**298.2**
5	8	8.5	9	9	9	9	9	10	9	9	9	9	9	9	8.5	8	5	**152**	**299.9**
5	8	8.5	9	9	9	9	9	10	10	9	9	9	9	9	8.5	8	5	**153**	**301.5**
5	8	8.5	9	9	9	9	10	10	10	9	9	9	9	9	8.5	8	5	**154**	**303.2**
5	8	8.5	9	9	9	9	10	10	10	10	9	9	9	9	8.5	8	5	**155**	**304.9**
5	8	8.5	9	9	9	9	10	11	10	10	9	9	9	9	8.5	8	5	**156**	**306.5**
5	8	8.5	9	9	9	9	10	11	11	10	9	9	9	9	8.5	8	5	**157**	**308.1**
5	8	8.5	9	9	9	10	10	11	11	10	9	9	9	9	8.5	8	5	**158**	**309.8**
5	8	8.5	9	9	9	10	11	11	11	10	10	9	9	9	8.5	8	5	**160**	**313.1**
5	8	8.5	9	9	9	10	11	11	11	11	10	9	9	9	8.5	8	5	**161**	**314.7**
5	8	8.5	9	9	9	10	11	12	11	11	10	9	9	9	8.5	8	5	**162**	**316.3**
5	8	8.5	9	9	9	10	11	12	12	11	10	9	9	9	8.5	8	5	**163**	**317.9**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
5	8	8.5	9	9	10	10	11	12	12	11	10	9	9	9	8.5	8	5	**164**	**319.6**
5	8	8.5	9	9	10	10	11	12	12	11	10	10	9	9	8.5	8	5	**165**	**321.2**
5	8	8.5	9	9	10	11	11	12	12	11	10	10	9	9	8.5	8	5	**166**	**322.8**
5	8	8.5	9	9	10	11	11	12	12	11	11	10	9	9	8.5	8	5	**167**	**324.5**
5	8	8.5	9	9	10	11	12	12	12	11	11	10	9	9	8.5	8	5	**168**	**326.1**
5	8	8.5	9	9	10	11	12	12	12	12	11	10	9	9	8.5	8	5	**169**	**327.7**
5	8	8.5	9	9	10	11	12	13	12	12	11	10	9	9	8.5	8	5	**170**	**329.2**
5	8	8.5	9	9	10	11	12	13	13	12	11	10	9	9	8.5	8	5	**171**	**330.8**
5	8	8.5	9	10	10	11	12	13	13	12	11	10	9	9	8.5	8	5	**172**	**332.5**
5	8	8.5	9	10	10	11	12	13	13	12	11	10	10	9	8.5	8	5	**173**	**334.1**
5	8	8.5	9	10	11	11	12	13	13	12	11	10	10	9	8.5	8	5	**174**	**335.8**
5	8	8.5	9	10	11	11	12	13	13	12	11	11	10	9	8.5	8	5	**175**	**337.4**
5	8	8.5	9	10	11	12	12	13	13	12	11	11	10	9	8.5	8	5	**176**	**339.0**
5	8	8.5	9	10	11	12	12	13	13	12	12	11	10	9	8.5	8	5	**177**	**340.6**
5	8	8.5	9	10	11	12	13	13	13	12	12	11	10	9	8.5	8	5	**178**	**342.2**
5	8	8.5	9	10	11	12	13	13	13	13	12	11	10	9	8.5	8	5	**179**	**343.7**
5	8	8.5	9	10	11	12	13	14	13	13	12	11	10	9	8.5	8	5	**180**	**345.3**
5	8	8.5	9	10	11	12	13	14	14	13	12	11	10	9	8.5	8	5	**181**	**346.8**
5	8	8.5	9	10	11	12	13	15	14	13	12	11	10	9	8.5	8	5	**182**	**348.4**
5	8	8.5	9	10	11	12	14	15	15	13	12	11	10	9	8.5	8	5	**184**	**351.5**
5	8	8.5	9	10	11	12	14	15	15	14	12	11	10	9	8.5	8	5	**185**	**353.1**
5	8	8.5	9	10	11	13	14	15	15	14	12	11	10	9	8.5	8	5	**186**	**354.6**
5	8	8.5	9	10	11	13	14	15	15	14	13	11	10	9	8.5	8	5	**187**	**356.2**
5	8	8.5	9	10	11	13	14	15	15	14	13	11	10	9	8.5	8	5	**187**	**356.2**
5	8	8.5	9	10	12	13	14	15	15	14	13	11	10	9	8.5	8	5	**188**	**357.8**
5	8	8.5	9	10	12	13	14	15	15	14	13	12	10	9	8.5	8	5	**189**	**359.4**
5	8	8.5	9	10	12	13	14	16	15	14	13	12	10	9	8.5	8	5	**190**	**360.9**
5	8	8.5	9	10	12	13	14	16	16	14	13	12	10	9	8.5	8	5	**191**	**362.5**
5	8	8.5	9	10	12	13	15	16	16	14	13	12	10	9	8.5	8	5	**192**	**364.0**
5	8	8.5	9	10	12	13	15	16	16	15	13	12	10	9	8.5	8	5	**193**	**365.6**
5	8	8.5	9	10	12	14	15	16	16	15	13	12	10	9	8.5	8	5	**194**	**367.1**
5	8	8.5	9	10	12	14	15	16	16	15	14	12	10	9	8.5	8	5	**195**	**368.7**
5	8	8.5	9	10	12	14	15	17	16	15	14	12	10	9	8.5	8	5	**196**	**370.2**
5	8	8.5	9	10	12	14	15	17	17	15	14	12	10	9	8.5	8	5	**197**	**371.8**
5	8	8.5	9	10	12	14	16	17	17	15	14	12	10	9	8.5	8	5	**198**	**373.3**
5	8	8.5	9	10	12	14	16	17	17	16	14	12	10	9	8.5	8	5	**199**	**374.9**
5	8	8.5	9	10	12	14	16	18	17	16	14	12	10	9	8.5	8	5	**200**	**376.4**
5	8	8.5	9	10	12	14	16	18	18	16	14	12	10	9	8.5	8	5	**201**	**378.0**
5	8	8.5	9	11	12	14	16	18	18	16	14	12	10	9	8.5	8	5	**202**	**379.6**
5	8	8.5	9	11	12	14	16	18	18	16	14	12	11	9	8.5	8	5	**203**	**381.2**
5	8	8.5	9	11	13	14	16	18	18	16	14	12	11	9	8.5	8	5	**204**	**382.8**
5	8	8.5	9	11	13	14	16	18	18	16	14	13	11	9	8.5	8	5	**205**	**384.4**
5	8	8.5	9	11	13	15	16	18	18	16	14	13	11	9	8.5	8	5	**206**	**385.9**
5	8	8.5	9	11	13	15	16	18	18	16	15	13	11	9	8.5	8	5	**207**	**387.4**
5	8	8.5	9	11	13	15	17	18	18	16	15	13	11	9	8.5	8	5	**208**	**389.0**
5	8	8.5	9	11	13	15	17	18	18	17	15	13	11	9	8.5	8	5	**209**	**390.5**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
5	8	8.5	9	11	13	15	17	19	18	17	15	13	11	9	8.5	8	5	**210**	**392.1**
5	8	8.5	9	11	13	15	17	19	19	17	15	13	11	9	8.5	8	5	**211**	**393.7**
5	8	8.5	10	11	13	15	17	19	19	17	15	13	11	9	8.5	8	5	**212**	**395.3**
5	8	8.5	10	11	13	15	17	19	19	17	15	13	11	10	8.5	8	5	**213**	**397.0**
5	8	8.5	10	12	13	15	17	19	19	17	15	13	11	10	8.5	8	5	**214**	**398.6**
5	8	8.5	10	12	13	15	17	19	19	17	15	13	12	10	8.5	8	5	**215**	**400.2**
5	8	8.5	10	12	14	15	17	19	19	17	15	13	12	10	8.5	8	5	**216**	**401.7**
5	8	8.5	10	12	14	15	17	19	19	17	15	14	12	10	8.5	8	5	**217**	**403.3**
5	8	8.5	10	12	14	16	17	19	19	17	15	14	12	10	8.5	8	5	**218**	**404.8**
5	8	8.5	10	12	14	16	17	19	19	17	16	14	12	10	8.5	8	5	**219**	**406.4**
5	8	8.5	10	12	14	16	18	19	19	17	16	14	12	10	8.5	8	5	**220**	**407.9**
5	8	8.5	10	12	14	16	18	19	19	18	16	14	12	10	8.5	8	5	**221**	**409.5**
5	8	8.5	10	12	14	16	18	20	19	18	16	14	12	10	8.5	8	5	**222**	**411.1**
5	8	8.5	10	13	14	16	18	20	20	18	16	14	12	10	8.5	8	5	**224**	**414.2**
5	8	8.5	10	13	14	16	18	20	20	18	16	14	13	10	8.5	8	5	**225**	**415.8**
5	8	8.5	10	13	15	16	18	20	20	18	16	14	13	10	8.5	8	5	**226**	**417.4**
5	8	8.5	10	13	15	16	18	20	20	18	16	15	13	10	8.5	8	5	**227**	**418.9**
5	8	8.5	10	13	15	17	18	20	20	18	16	15	13	10	8.5	8	5	**228**	**420.4**
5	8	8.5	10	13	15	17	18	20	20	18	17	15	13	10	8.5	8	5	**229**	**422.0**
5	8	8.5	10	13	15	17	19	20	20	18	17	15	13	10	8.5	8	5	**230**	**423.6**
5	8	8.5	10	13	15	17	19	20	20	19	17	15	13	10	8.5	8	5	**231**	**425.1**
5	8	8.5	10	13	15	17	19	21	20	19	17	15	13	10	8.5	8	5	**232**	**426.7**
5	8	8.5	10	13	15	17	19	21	21	19	17	15	13	10	8.5	8	5	**233**	**428.3**
5	8	8.5	10	13	16	17	19	21	21	19	17	15	13	10	8.5	8	5	**234**	**429.9**
5	8	8.5	10	13	16	17	19	21	21	19	17	16	13	10	8.5	8	5	**235**	**431.4**
5	8	8.5	10	13	16	18	19	21	21	19	17	16	13	10	8.5	8	5	**236**	**433.0**
5	8	8.5	10	13	16	18	19	21	21	19	18	16	13	10	8.5	8	5	**237**	**434.5**
5	8	8.5	10	13	16	18	20	21	21	19	18	16	13	10	8.5	8	5	**238**	**436.1**
5	8	8.5	10	13	16	18	20	21	21	20	18	16	13	10	8.5	8	5	**239**	**437.7**
5	8	8.5	10	13	16	18	20	22	21	20	18	16	13	10	8.5	8	5	**240**	**439.4**
5	8	8.5	10	13	16	18	20	22	22	20	18	16	13	10	8.5	8	5	**241**	**441.0**
5	8	8.5	10	13	16	19	20	22	22	20	18	16	13	10	8.5	8	5	**242**	**442.6**
5	8	8.5	10	13	16	19	20	22	22	20	19	16	13	10	8.5	8	5	**243**	**444.1**
5	8	8.5	10	13	16	19	21	22	22	20	19	16	13	10	8.5	8	5	**244**	**445.8**
5	8	8.5	10	13	16	19	21	22	22	21	19	16	13	10	8.5	8	5	**245**	**447.4**
5	8	8.5	10	13	16	19	21	23	22	21	19	16	13	10	8.5	8	5	**246**	**449.1**
5	8	8.5	10	13	16	19	21	23	23	21	19	16	13	10	8.5	8	5	**247**	**450.7**
5	8	8.5	10	13	16	19	22	23	23	21	19	16	13	10	8.5	8	5	**248**	**452.4**
5	8	8.5	10	13	16	19	22	23	23	22	19	16	13	10	8.5	8	5	**249**	**454.0**
5	8	8.5	10	13	16	19	22	24	23	22	19	16	13	10	8.5	8	5	**250**	**455.8**
5	8	8.5	10	13	16	19	22	24	24	22	19	16	13	10	8.5	8	5	**251**	**457.5**
5	8	8.5	10	13	16	19	22	25	24	22	19	16	13	10	8.5	8	5	**252**	**459.3**
5	8	8.5	10	13	16	19	22	25	25	22	19	16	13	10	8.5	8	5	**253**	**461.1**
5	8	8.5	11	13	16	19	22	25	25	22	19	16	13	10	8.5	8	5	**254**	**462.7**
5	8	8.5	11	13	16	19	22	25	25	22	19	16	13	11	8.5	8	5	**255**	**464.3**
5	8	8.5	11	14	16	19	22	25	25	22	19	16	13	11	8.5	8	5	**256**	**465.9**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
5	8	8.5	11	14	16	19	22	25	25	22	19	16	14	11	8.5	8	5	**257**	**467.5**
5	8	8.5	11	14	17	19	22	25	25	22	19	16	14	11	8.5	8	5	**258**	**469.0**
5	8	8.5	11	14	17	19	22	25	25	22	19	17	14	11	8.5	8	5	**259**	**470.5**
5	8	8.5	11	14	17	20	22	25	25	22	19	17	14	11	8.5	8	5	**260**	**472.1**
5	8	8.5	11	14	17	20	22	25	25	22	20	17	14	11	8.5	8	5	**261**	**473.7**
5	8	8.5	11	14	17	20	23	25	25	22	20	17	14	11	8.5	8	5	**262**	**475.4**
5	8	8.5	11	14	17	20	23	25	25	23	20	17	14	11	8.5	8	5	**263**	**477.1**
5	8	8.5	11	14	17	20	23	26	25	23	20	17	14	11	8.5	8	5	**264**	**478.9**
5	8	8.5	11	14	17	20	23	26	26	23	20	17	14	11	8.5	8	5	**265**	**480.8**
5	8	10	11	14	17	20	23	26	26	23	20	17	14	11	8.5	8	5	**266.5**	**483.3**
5	8	10	11	14	17	20	23	26	26	23	20	17	14	11	10	8	5	**268**	**485.8**
5	8	10	12	14	17	20	23	26	26	23	20	17	14	11	10	8	5	**269**	**487.4**
5	8	10	12	14	17	20	23	26	26	23	20	17	14	12	10	8	5	**270**	**489.0**
5	8	10	12	15	17	20	23	26	26	23	20	17	14	12	10	8	5	**271**	**490.5**
5	8	10	12	15	17	20	23	26	26	23	20	17	15	12	10	8	5	**272**	**492.1**
5	8	10	12	15	18	20	23	26	26	23	20	17	15	12	10	8	5	**273**	**493.6**
5	8	10	12	15	18	20	23	26	26	23	20	18	15	12	10	8	5	**274**	**495.2**
5	8	10	12	15	18	21	23	26	26	23	20	18	15	12	10	8	5	**275**	**496.8**
5	8	10	12	15	18	21	23	26	26	23	21	18	15	12	10	8	5	**276**	**498.4**
5	8	10	12	15	18	21	24	26	26	23	21	18	15	12	10	8	5	**277**	**500.2**
5	8	10	12	15	18	21	24	26	26	24	21	18	15	12	10	8	5	**278**	**501.9**
5	8	11	12	15	18	21	24	26	26	24	21	18	15	12	10	8	5	**279**	**503.5**
5	8	11	12	15	18	21	24	26	26	24	21	18	15	12	11	8	5	**280**	**505.2**
5	8	11	13	15	18	21	24	26	26	24	21	18	15	12	11	8	5	**281**	**506.7**
5	8	11	13	15	18	21	24	26	26	24	21	18	15	13	11	8	5	**282**	**508.3**
5	8	11	13	16	18	21	24	26	26	24	21	18	15	13	11	8	5	**283**	**509.8**
5	8	11	13	16	18	21	24	26	26	24	21	18	16	13	11	8	5	**284**	**511.4**
5	8	11	13	16	19	21	24	26	26	24	21	18	16	13	11	8	5	**285**	**512.9**
5	8	11	13	16	19	21	24	26	26	24	21	19	16	13	11	8	5	**286**	**514.5**
5	8	11	13	16	19	22	24	26	26	24	21	19	16	13	11	8	5	**287**	**516.2**
5	8	11	13	16	19	22	24	26	26	24	22	19	16	13	11	8	5	**288**	**517.8**
5	8	11	13	16	19	22	25	26	26	24	22	19	16	13	11	8	5	**289**	**519.6**
5	8	11	13	16	19	22	25	26	26	25	22	19	16	13	11	8	5	**290**	**521.4**
5	8	11	13	16	20	22	25	26	26	25	22	19	16	13	11	8	5	**291**	**523.0**
5	8	11	13	16	20	22	25	26	26	25	22	20	16	13	11	8	5	**292**	**524.6**
5	8	11	13	16	20	23	25	26	26	25	22	20	16	13	11	8	5	**293**	**526.3**
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6	8	11	13	16	20	23	26	26	26	26	23	20	16	13	11	8	5	**297**	**533.5**
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6	9	11	13	16	20	23	26	26	26	26	23	20	16	13	11	9	6	**300**	**538.8**
6	9	12	13	16	20	23	26	26	26	26	23	20	16	13	11	9	6	**301**	**540.4**
6	9	12	13	16	20	23	26	26	26	26	23	20	16	13	12	9	6	**302**	**542.0**
6	9	12	14	16	20	23	26	26	26	26	23	20	16	13	12	9	6	**303**	**543.5**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
6	9	12	14	16	20	23	26	26	26	26	23	20	16	14	12	9	6	**304**	**545.1**
6	9	12	14	17	20	23	26	26	26	26	23	20	16	14	12	9	6	**305**	**546.6**
6	9	12	14	17	20	23	26	26	26	26	23	20	17	14	12	9	6	**306**	**548.2**
6	9	12	14	17	21	23	26	26	26	26	23	20	17	14	12	9	6	**307**	**549.8**
6	9	12	14	17	21	23	26	26	26	26	23	21	17	14	12	9	6	**308**	**551.4**
6	9	12	14	17	21	24	26	26	26	26	23	21	17	14	12	9	6	**309**	**553.1**
6	9	12	14	17	21	24	26	26	26	26	24	21	17	14	12	9	6	**310**	**554.9**
7	9	12	14	17	21	24	26	26	26	26	24	21	17	14	12	9	6	**311**	**556.7**
7	9	12	14	17	21	24	26	26	26	26	24	21	17	14	12	9	7	**312**	**558.5**
7	10	12	14	17	21	24	26	26	26	26	24	21	17	14	12	9	7	**313**	**560.2**
7	10	12	14	17	21	24	26	26	26	26	24	21	17	14	12	10	7	**314**	**561.8**
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8	10	13	15	18	21	24	26	26	26	26	24	21	18	15	13	10	7	**321**	**572.9**
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8	11	13	15	18	21	24	26	26	26	26	24	21	18	15	13	11	8	**324**	**577.9**
8	11	14	15	18	21	24	26	26	26	26	24	21	18	15	13	11	8	**325**	**579.5**
8	11	14	15	18	21	24	26	26	26	26	24	21	18	15	14	11	8	**326**	**581.0**
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8	11	14	16	18	21	24	26	26	26	26	24	21	18	16	14	11	8	**328**	**584.1**
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8	11	14	16	19	22	24	26	26	26	26	24	21	19	16	14	11	8	**331**	**588.9**
8	11	14	16	19	22	24	26	26	26	26	24	22	19	16	14	11	8	**332**	**590.6**
8	11	14	16	19	22	25	26	26	26	26	25	22	19	16	14	11	8	**334**	**594.1**
8	12	14	16	19	22	25	26	26	26	26	25	22	19	16	14	11	8	**335**	**595.7**
8	12	14	16	19	22	25	26	26	26	26	25	22	19	16	14	12	8	**336**	**597.3**
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8	12	15	16	19	22	25	26	26	26	26	25	22	19	16	15	12	8	**338**	**600.4**
8	12	15	17	19	22	25	26	26	26	26	25	22	19	16	15	12	8	**339**	**602.0**
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8	12	15	17	20	22	25	26	26	26	26	25	22	19	17	15	12	8	**341**	**605.1**
8	12	15	17	20	22	25	26	26	26	26	25	22	20	17	15	12	8	**342**	**606.7**

2018 Fish Passage Plan

Chapter 3 – The Dalles Dam

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The Dalles Dam *

Project Acronym	TDA
River Mile (RM)	Columbia River – RM 191.5
Reservoir	Lake Celilo
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 12.5 kcfs \ Mar–Nov: 50 kcfs
Forebay Normal Operating Range (ft)	155.0’ – 160.0’
Tailrace Rate of Change Limit (ft)	3’/hr
Powerhouse Length (ft)	2,089’
Powerhouse Hydraulic Capacity (kcfs)	375 kcfs
Turbine Units	22 (BLH Kaplan) + 2 Fish Units
Turbine Generating Capacity (MW)	Rated: 1,808 MW (Units 1-14 @ 78 MW/unit + Units 15-22 @ 86 MW/unit) Maximum: 2,080 MW (Units 1-14 @ 90 MW/unit + Units 15-22 @ 99 MW/unit)
Gatewell Orifice Diameter (in)	One 6” orifice per gatewell
Spillway Length (ft)	1,447’
Spillway Hydraulic Capacity (kcfs)	2,290 kcfs
Spillbays (#)	23
Spillway Weirs (#)	0
Navigation Lock Length x Width (ft)	650’ x 86’
Navigation Lock Max. Lift (ft)	90’

***** More information is available on the Corps Portland District website for The Dalles Dam at: www.nwp.usace.army.mil/The-Dalles/

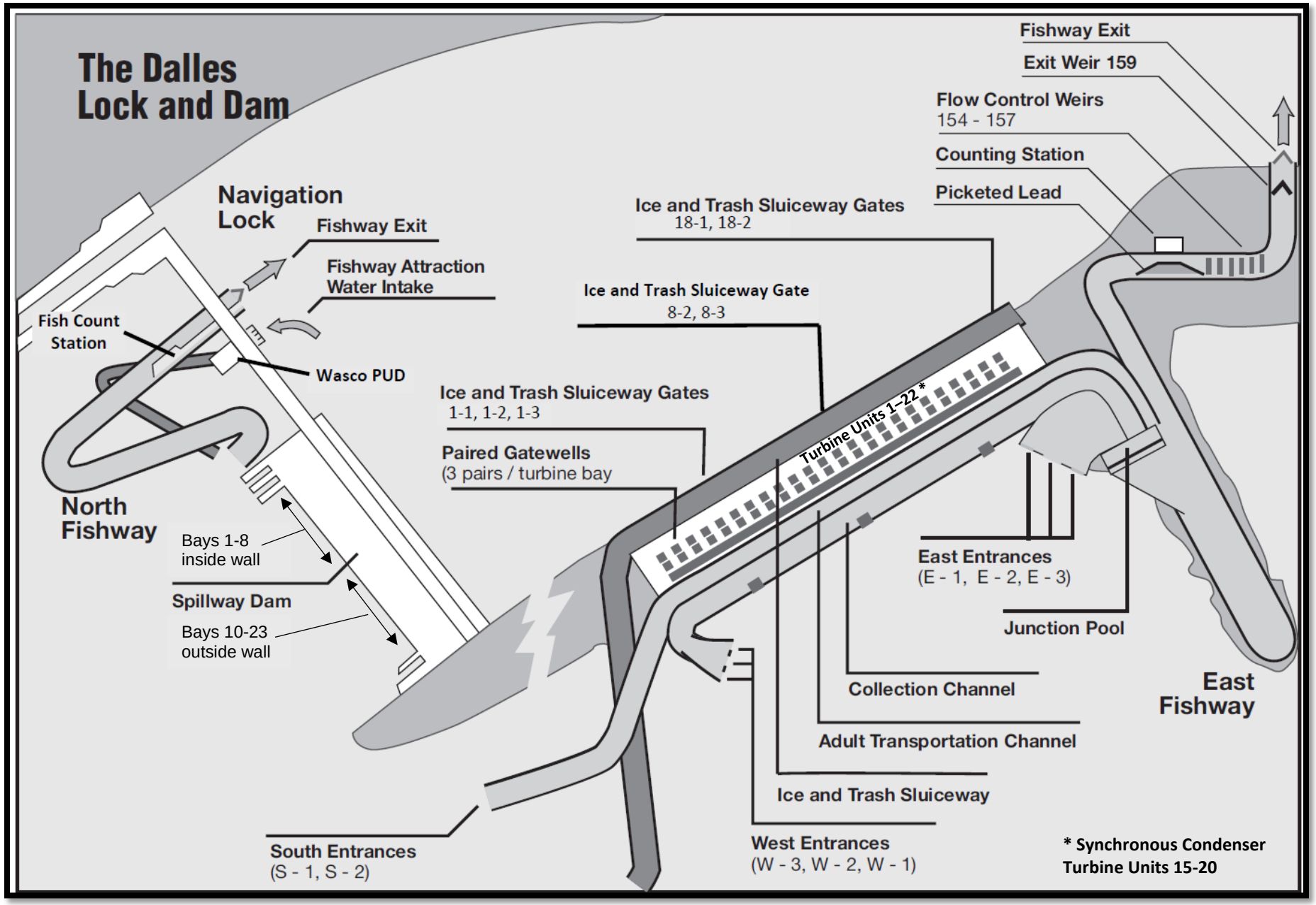


Figure TDA-1. The Dalles Dam General Site Plan.

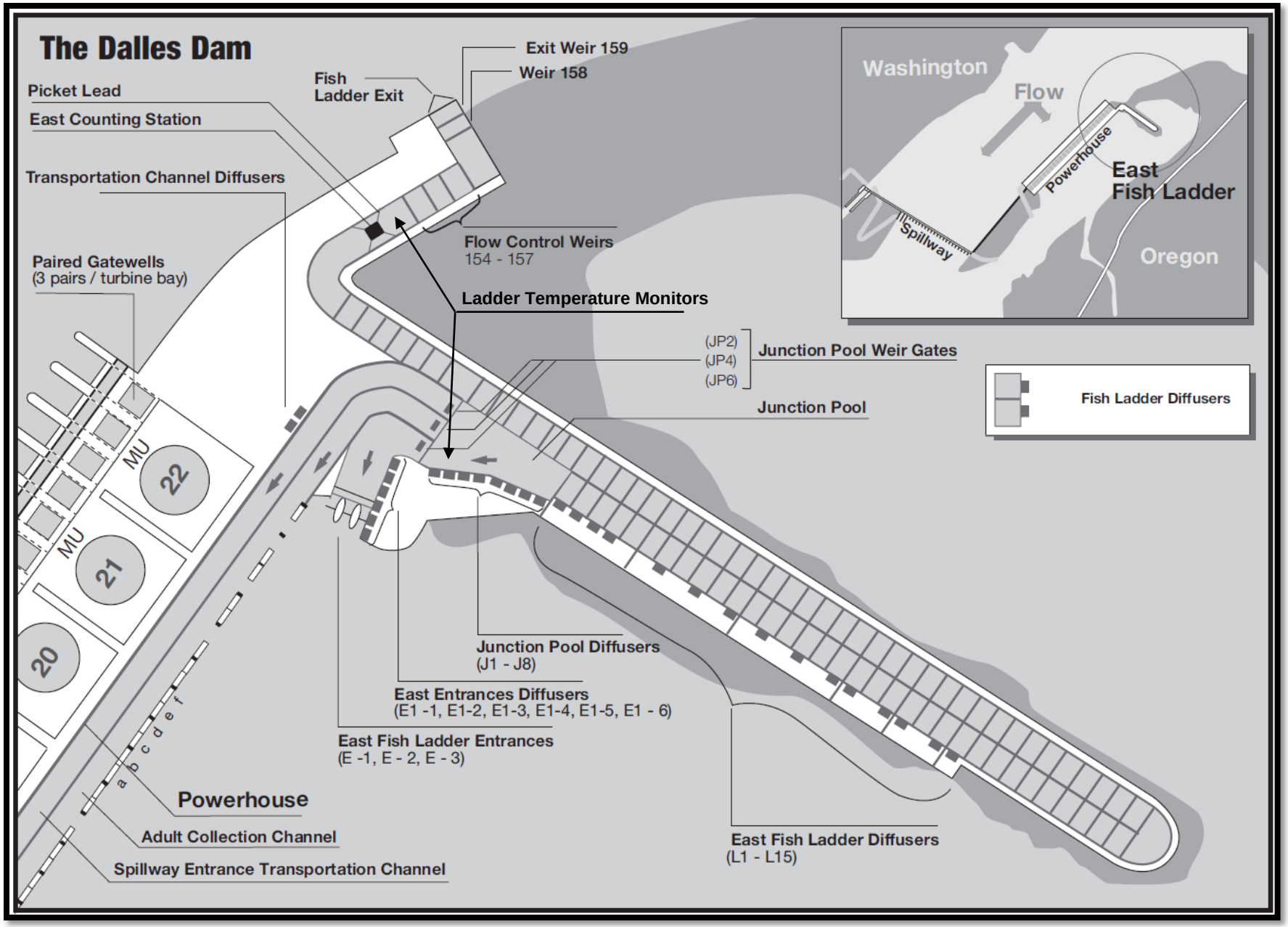


Figure TDA-2. The Dalles Dam East Fish Ladder.

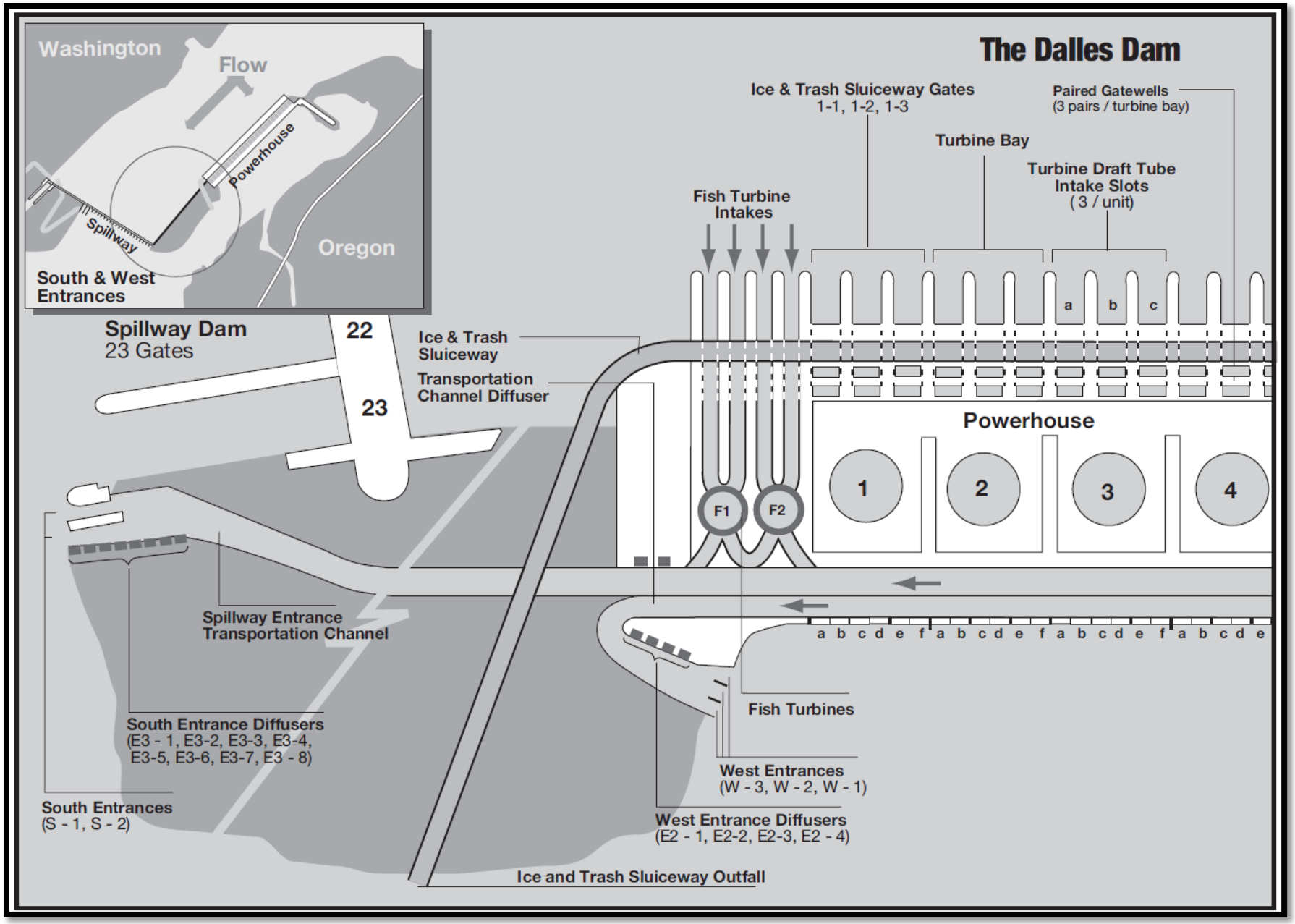


Figure TDA-3. The Dalles Dam South and West Fish Ladder Entrances.

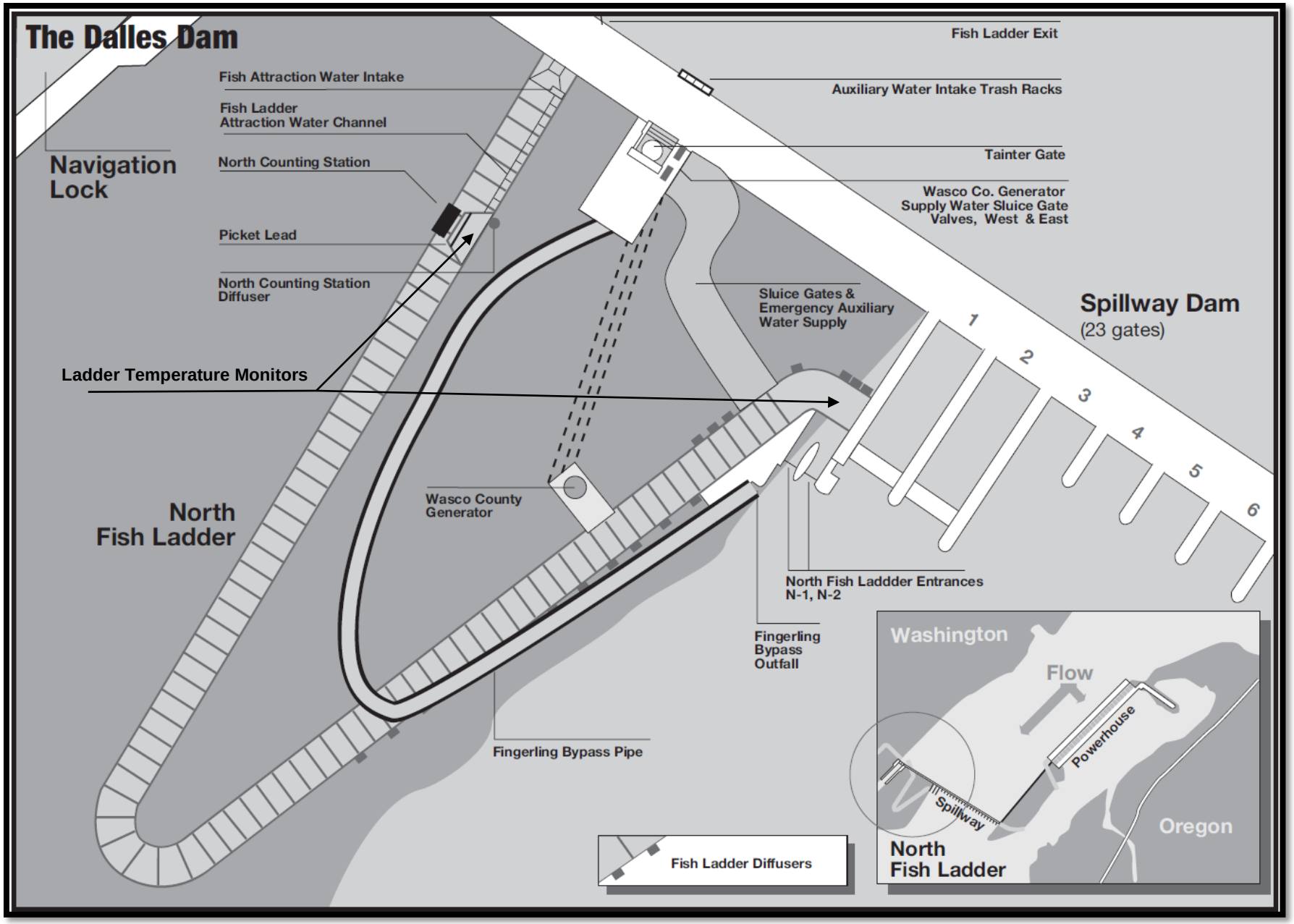
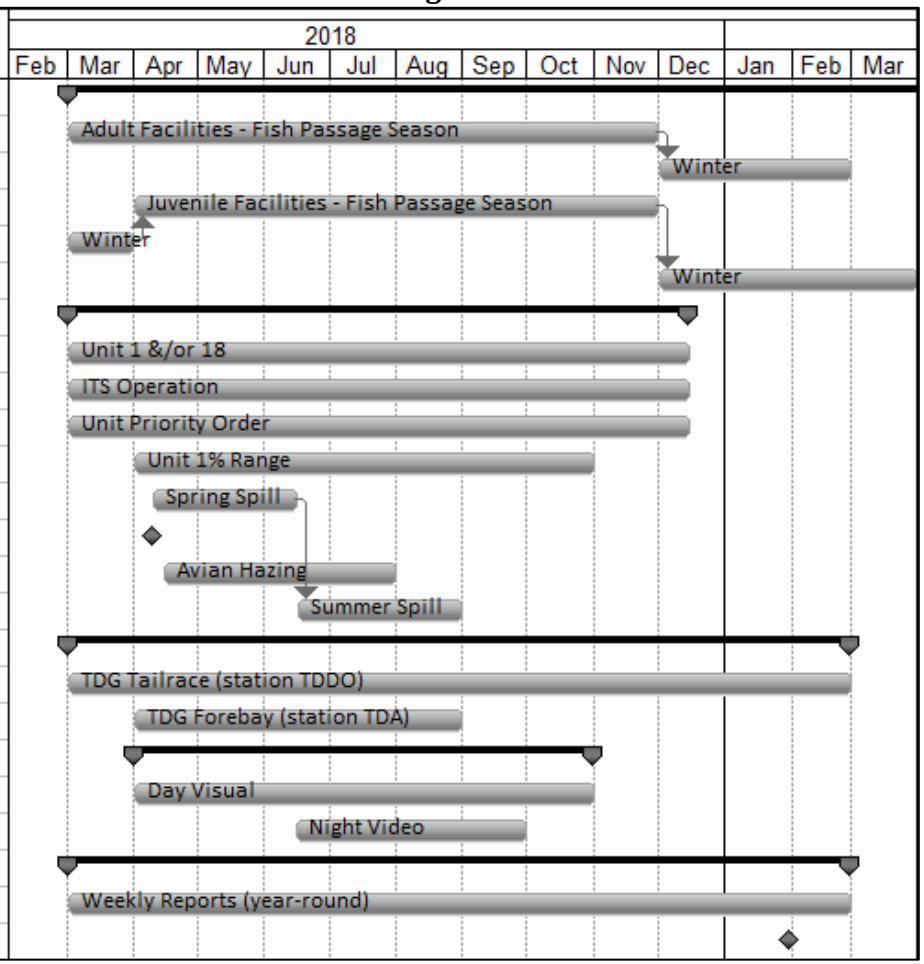


Figure TDA-4. The Dalles Dam North Fish Ladder and Spillway.

Table TDA-1. The Dalles Dam Schedule of Operations and Actions Defined in the 2018 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**3/1/18**	**3/31/19**	
Adult Facilities - Fish Passage Season	3/1/18	11/30/18	2.4.2
Adult Facilities - Winter Maintenance	12/1/18	2/28/19	2.4.1
Juvenile Facilities - Fish Passage Season	4/1/18	11/30/18	2.3.2
Juvenile Facilities - Winter Maintenance	3/1/18	3/31/18	2.3.1
	12/1/18	3/31/19	
PROJECT OPERATIONS FOR FISH PASSAGE	**3/1/18**	**12/15/18**	
Unit 1 &/or 18 operate for fish passage	3/1/18	12/15/18	5.1.1
ITS Operation	3/1/18	12/15/18	Table TDA-4
Turbine unit priority order	3/1/18	12/15/18	Table TDA-5
Turbine unit 1% operating range	4/1/18	10/31/18	5.2
Spring Spill	4/10/18	6/15/18	App E (FOP)
Avian Wires installed NLT April 10	4/10/18	4/10/18	App L 1.4
Avian Hazing	4/15/18	7/31/18	App L 3.2
Summer Spill	6/16/18	8/31/18	App E (FOP)
TDG MONITORING	**3/1/18**	**2/28/19**	
TDG Monitoring - Tailrace (year-round)	3/1/18	2/28/19	2.2.2
TDG Monitoring - Forebay	4/1/18	8/31/18	2.2.2
ADULT FISH COUNTING	**4/1/18**	**10/31/18**	
Day Visual 0500-2100 PDT	4/1/18	10/31/18	Table TDA-2
Night Video 2100-0500 PDT	6/15/18	9/30/18	Table TDA-2
REPORTS	**3/1/18**	**2/28/19**	
Weekly Reports (year-round)	3/1/18	2/28/19	3.3
Annual Report due NLT Jan 31	1/31/19	1/31/19	3.3.4



1. FISH PASSAGE INFORMATION

Fish passage facilities at The Dalles Lock & Dam are shown in **Figure TDA-1** through **TDA-4** and described below. The schedule for project operations described in the Fish Passage Plan (FPP) and Appendices is included in **Table TDA-1**.

1.1. Juvenile Fish Passage.

1.1.1. Juvenile Fish Facilities. Turbine units at The Dalles Dam are not screened. Juvenile fish passage consists of the Ice & Trash Sluiceway (ITS) and one 6"orifice in each gatewell. All 6" orifices will be closed as units are dewatered. The ITS is a rectangular channel extending along the total length of the 22-unit powerhouse and is located in the forebay side of the powerhouse. When any of the sluiceway gates (located in the forebay side of the sluiceway) are opened, water and juvenile migrants are skimmed from the forebay into the sluiceway and deposited in the tailrace downstream of the project.

1.1.2. Juvenile Fish Migration Timing.

1.1.2.1. There is no juvenile monitoring at The Dalles Dam. The primary juvenile fish passage period at The Dalles Dam is April–November, based on monitoring at the John Day Dam Smolt Monitoring Facility (see **FPP Chapter 4 - John Day Dam, Table JDA-2**). Juvenile fish arrival at The Dalles Dam is approximately one day later than JDA.

1.1.2.2. Diel passage of juvenile fish at The Dalles Dam sluiceway is affected by spill and flow conditions. In years of consistently high flow and spill, fish may be distributed higher in the water column and daytime passage may increase.

1.2. Adult Fish Passage.

1.2.1. Adult Fish Facilities.

1.2.1.1. Adult fish passage facilities at The Dalles Dam are composed of a north shore ladder that passes fish collected at the north end of the spillway, and an east ladder that passes fish collected at the south end of the spillway and across the downstream face of the powerhouse.

1.2.1.2. North Wasco PUD operates a small hydropower facility constructed in 1991 that utilizes the north fishway ladder auxiliary water supply. Adult fishway criteria associated with this facility are monitored and maintained during daily fishway inspections. A backup auxiliary water supply system has been upgraded to facilitate its use if needed. The backup system is the originally-constructed water supply to the north fish ladder and does not provide juvenile screening. Survival through this system is unknown.

1.2.1.3. Annual maintenance of adult facilities is scheduled during the winter maintenance period (December 1 through the end of February) to minimize impacts on upstream migrants. One ladder is dewatered at a time unless otherwise coordinated through FPOM.

1.2.2. Adult Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult passage facilities are operated year-round. Adult salmon, steelhead, lamprey, and shad are typically counted April through October (**Table TDA-2**) and data are posted daily at: www.fpc.org/adultsalmon_home.html. Sturgeon and bull trout are relatively infrequent and counts are reported in *Miscellaneous Fish Counts* and in the *Annual Fish Passage Report*.

1.2.2.2. Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage defined in **Table TDA-3**. Time-of-day (diel) distributions of adult salmonid activity at The Dalles Dam fishway entrances and exits are summarized in **Figure TDA-5**.

Table TDA-2. The Dalles Dam Adult Fish Count Schedule, 3/1/2018 – 2/28/2019.

Count Period	Counting Method and Hours *
April 1 – October 31	Visual 0500–2100 hours (PDT)
June 15 – September 30	Night Video 2100–0500 hours (PDT)

*PST=Pacific Standard Time. PDT=Pacific Daylight Time (in effect during Daylight Saving Time 3/11/18-11/4/18).

Table TDA-3. The Dalles Dam Adult Fish Count Period and Peak Passage Timing (based on yearly counts since 1957, except lamprey since 2000).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Apr 1 – Jun 3	Apr 13	May 23
Summer Chinook	Jun 4 – Aug 3	Jun 6	Aug 1
Fall Chinook	Aug 4 – Oct 31	Sep 2	Sep 23
Sockeye	Apr 1 – Oct 31	Jun 20	Jul 10
Steelhead	Apr 1 – Oct 31	Jul 9	Sep 23
Coho	Apr 1 – Oct 31	Sep 3	Oct 25
Lamprey	Apr 1 – Oct 31	Jul 11	Aug 1

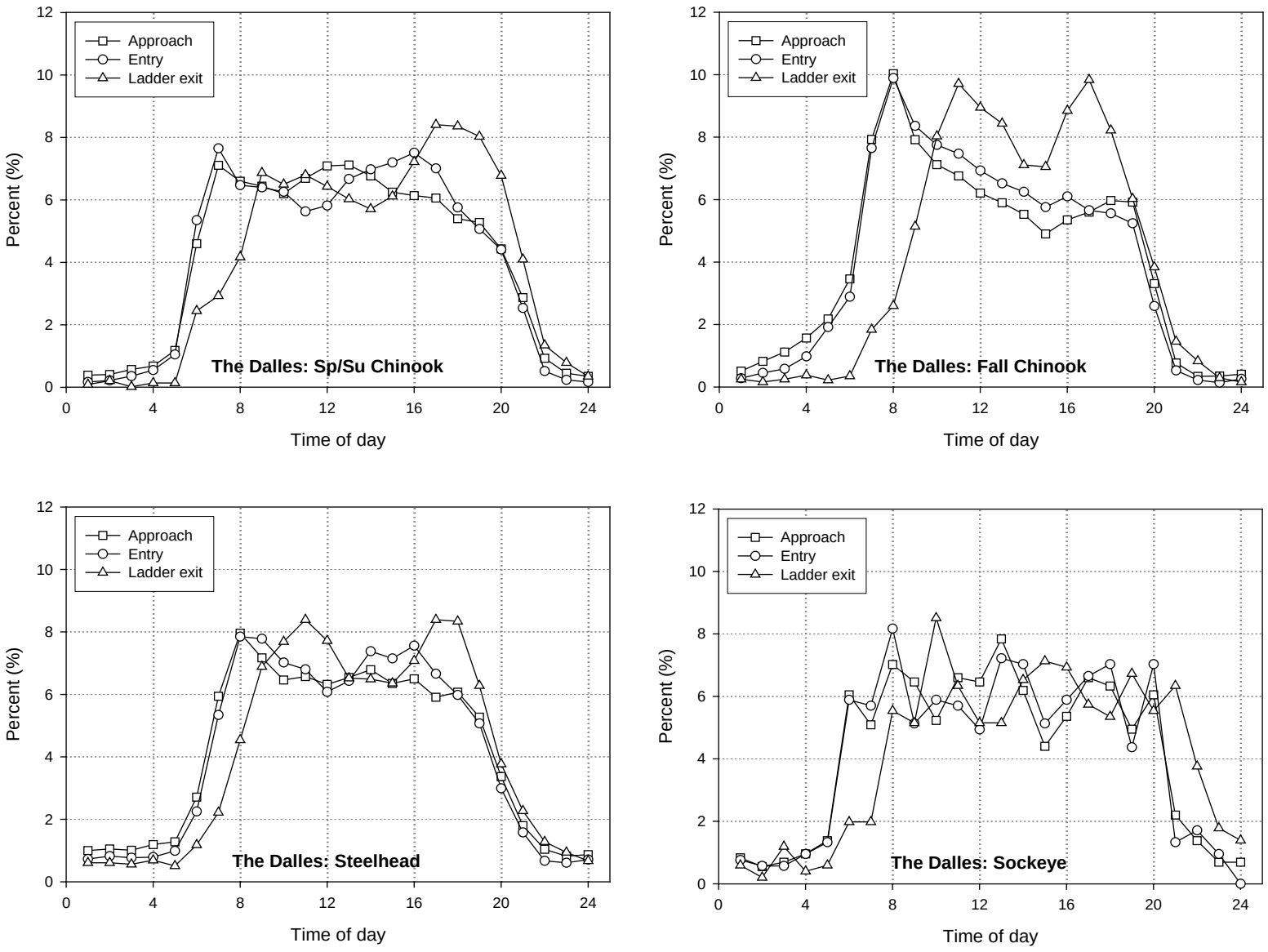


Figure TDA-5. Diel Distribution of Adult Salmonids at The Dalles Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*).
pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATION

2.1. General.

2.1.1. Research, non-routine maintenance, fish-related activities, and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

2.1.2. Yearly special operations related to research are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

2.1.3. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed immediately following the incident of steps taken to correct the situation. On a monthly basis, as necessary, the project biologist will provide FPOM a summary of any emergency actions undertaken.

2.1.4. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least two weeks in advance, unless it is deemed an emergency (see coordination guidance in **Chapter 1 - Overview**).

2.1.5. All fish passage related equipment and operations will be inspected twice daily. Additionally, entrance differential and weir depth 12-hour trends will be monitored daily from the data logging system to track operational changes and included in weekly status reports.

2.2. Spill Management.

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the FPP as **Appendix E**. Spill patterns are defined in **Table TDA-7**.

2.2.2. Excessive total dissolved gas (TDG) may harm fish and will be controlled to the extent possible, subject to river conditions. Management tools include system-wide spill distribution through the Spill Priority List issued by the Corps Northwestern Division Reservoir Control Center (RCC), night and/or day spill limits, and shaping of spill. Monitoring of TDG at The Dalles Dam occurs during the periods defined in **Table TDA-1**, pursuant to the Corps' annual *TDG Monitoring Plan* and *Dissolved Gas Monitoring Plan of Action 2015-2018.*[1]

2.2.3. During spill that occurs December 16 through the end of February, the Ice & Trash Sluiceway (ITS) will be operated if available to provide a surface passage route. Operate three gates on Unit 1 and three gates on Unit 18.

[1] TDG Monitoring Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/. TDG Monitoring Plan 2015-2018: pweb.crohms.org/tmt/wqnew/tdg_monitoring/2015-18.pdf

2.3. Operating Criteria - Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance (December 1 – March 31).

2.3.1.1. An ROV will be used to inspect trashracks and main unit intakes. If necessary, remove debris from forebay, trashracks, gatewell slots, and gatewell orifices such that these areas are free of debris on April 1.

2.3.1.2. Inspect, lubricate, and test hoist-operated chain gates, end gates, and hoists for operation as needed.

2.3.1.3. Inspect and correct any epoxy or concrete deficiencies on the Ice & Trash Sluiceway (ITS) walls and floors, where accessible.

2.3.1.4. Inspect and repair spill gates and control systems where necessary. Except for coordinated changes, the spillway must be able to achieve spill patterns on April 1.

2.3.1.5. Avian Lines. See the *Avian Monitoring & Deterrence Action Plans* for all projects in **Appendix L**. From August through mid-April, there will be no avian abatement measures other than avian lines. Avian lines will be repaired and/or reinstalled as soon as possible following damage or removal. New avian lines will be installed and maintained in locations determined to have significant avian predation. Avian abatement measures shall be in place by April 1 unless delayed by inclement weather, in which case work will be completed as soon as weather permits.

2.3.1.6. Ice & Trash Sluiceway (ITS). The ITS will be operated as defined in **Table TDA-4**.

Table TDA-4. The Dalles Dam Ice & Trash Sluiceway (ITS) Schedule of Operations.

DATES	SLUICEWAY OPERATION (24 hrs/day)	PURPOSE	FPP Section
March 1–31; December 1–15	OPEN End gate OPEN Sluice gates 1-2, 1-3 / 18-1, 18-2	Adult fallback; kelt passage	2.4.1.6; 2.4.2.9
April 1– November 30	OPEN End gate OPEN Sluice gates 1-1, 1-2, 1-3 / 8-2, 8-3 / 18-2	Juvenile passage	2.3.2.5
*December 16– end of February	*CLOSE End gate OPEN Sluice gates 1-1 / 18-3	*No passage; allows egress when equalized w/forebay	2.3.1.6, 2.4.1.6

*Except during periods of spill when the ITS will be operated if available, as defined in **section 2.2.2** (3 gates on Unit 1 and 3 gates on Unit 18).

2.3.2. Juvenile Fish Passage Season (April 1 – November 30).

2.3.2.1. Measure gatewell drawdown a minimum of once per week, and more frequently, three times per week or more, as needed during high debris periods. Clean trashracks as flow conditions dictate, or when drawdown in gatewell slots exceeds 1.5'. To determine if there is debris buildup on the trashracks between June 1 and June 15, inspect three units across the powerhouse that have the most prior operation and will not interfere with sluiceway operation. If so, trashracks will be raked. All trashracks can be raked using the Hammerhead crane.

2.3.2.2. Remove debris from the forebay as needed by operating sluiceway.

2.3.2.3. Inspect all gatewells daily. Clean gatewells before the gatewell water surface becomes 50% covered with debris. If due to the debris volume it is not possible to keep the gatewell surfaces at least 50% clear, they will be cleaned at least once daily. Turbines with a gatewell fully covered with debris will not be operated except to be in compliance with other coordinated fish measures, and then only on a last-on/first-off basis.

2.3.2.4. Project maintenance will permanently close the gate slot orifices as the unit intakes are serviced over the next few years, utilizing orifice plates as covers.

2.3.2.5. Ice & Trash Sluiceway (ITS).

2.3.2.5.a. April 1-November 30: operate ITS 24 hrs/day for juvenile fish passage (**Table TDA-4**). Open gates 1-1, 1-2, 1-3 over operating Main Unit (MU)-1; gates 8-2, 8-3 over operating MU-8; and gate 18-2 over operating MU-18. If any these MUs are out of service for more than 6 hours, operate the next available MU and associated gates adjacent to the unit (i.e., if MU-1 is OOS, then operate MU-2 w/gates; if MU-18 is OOS, then operate MU-17 w/gates or MU-19 w/gates).

2.3.2.6. When units are being dewatered, leave endgate open and close sluice gates to expose gatewell orifices, and then install orifice blocker. After orifice-sealing devices are installed, sluice gates should be returned to the open position. Installation time should be approximately 1 hour.

2.3.2.7. Efforts should be made to keep all petroleum out of gatewells. Project environmental section will determine cleanup efforts if needed. Regardless of unit operating status, oil accumulations will be dealt with promptly.

2.3.2.8. Avian Deterrence. See the *Avian Monitoring & Deterrence Action Plans* for all projects in **Appendix L**. Avian abatement measures shall be in place by April 1 unless delayed by inclement weather, in which case work will be completed as soon as weather permits. Avian hazing shall occur April 15–July 31. From August through mid-April, there will be no avian abatement measures other than avian lines. Avian lines will be repaired and/or reinstalled as soon as possible following damage or removal. New avian lines will be installed and maintained in locations determined to have significant avian predation.

2.3.2.9. Follow the spill patterns in **Table TDA-7** for juvenile fish passage.

2.4. Operating Criteria - Adult Fish Facilities.

2.4.1. Adult Fish Facilities - Winter Maintenance (December 1 – end of February).

2.4.1.1. Inspect and calibrate all staff gauges and water level indicators. Repair and/or clean where necessary.

2.4.1.2. Dewater all ladders and inspect for projections, debris, or plugged orifices that could injure fish or slow their progress up the ladder. Make necessary repairs and complete preventative maintenance.

2.4.1.3. Pull exit trashracks and/or inspect and clear debris from the ladder exits.

2.4.1.4. Inspect count station equipment and assure operational. Reinstall picket leads at counting stations prior to watering up ladders. Ensure the leads are properly seated.

2.4.1.5. Only one of the two adult fish facilities may be out of service at any one time unless coordinated through FPOM. The operating facility shall be operated at full fish passage season criteria unless specially coordinated. Outage periods will be minimized to the extent practicable.

2.4.1.6. Ice & Trash Sluiceway (ITS).

2.4.1.6.a. December 1–15: operate ITS 24 hrs/day for adult fallback and steelhead kelt passage (**Table TDA-4**). Open gates 1-2, 1-3 over operating MU-1, and gates 18-1, 18-2 over operating MU-18. If either of these MUs are out of service, operate the next available MU and associated adjacent gates (i.e., if MU-1 is OOS, then operate MU-2 w/gates; if MU-18 is OOS, then operate MU-17 w/gates or MU-19 w/gates).

2.4.1.6.b. December 16–end of February: discontinue ITS operation on a 24-hour basis, close the endgate and open sluice gates 1-1, 18-3 to allow fish egress from the ITS when equalized with the forebay (except during periods of spill when the ITS will be operated if available; see **section 2.2.2**).

2.4.2. Adult Fish Passage Season (March 1 – November 30).

2.4.2.1. Water depth over fish ladder weirs = 1.0’ ±0.1'. During shad passage season (>5,000 shad/day per at Bonneville Dam count station) = 1.3’ ±0.1’. See **section 2.4.2** for exceptions.

2.4.2.2. Temperature Monitoring.

2.4.2.2.a. Water temperatures will be measured in count station of each adult fishway and will be recorded in the fishway status report. When water temperature reaches 70°F, all fish handling activities will be coordinated through FPOM prior to any action to verify protocols that will be followed.

2.4.2.2.b. From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits.

b.1. Temperature monitors shall be placed within 10 meters of all shore-oriented entrances and exits.

b.2. If possible, the entrance monitor shall be within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers to allow for sufficient mixing with surface water.

b.3. The exit monitor shall be within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

b.4. If an existing temperature monitoring location is proposed for either the exit or entrance, it shall be verified that the site accurately reflects water temperature within 10 meters of the entrance or exit.

b.5. Project Fisheries will submit temperature data to the Fish Passage Center (FPC) on a weekly basis for posting online at: www.fpc.org/river/Q_ladderwatertempgraph.php.

2.4.2.3. Head on all entrances: 1'–2' (1.5' optimum). Refer to **section 4.3.1** when unable to achieve head criteria.

2.4.2.4. Water velocity of 1.5–4.0 fps (2 fps optimum) shall be maintained for full length of the powerhouse collection channel and the lower ends of fish ladders that are below the tailwater. Fishway channel water velocities will be measured three times weekly, daily preferred, during adult fish passage (Mar 1 – Dec 1) part of the fishway inspection program. Floats will be timed through all fishway channels that are supplemented by auxiliary water. Results will be provided in the project weekly fishway status report.

2.4.2.5. Remove debris as required to maintain head below 0.5' on attraction water intakes and trash racks at all the ladder exits, with a 0.3' maximum head on all picket leads. Debris shall be removed when significant amounts accumulate.

2.4.2.6. Necessary staff gauges and water level indicators will be readable at all water levels encountered during the fish passage period and accuracy checked weekly. Instruments will be cleaned and/or recalibrated when necessary and ASAP.

2.4.2.7. Main entrance weir depths at 8' or greater below tailwater. Maintain a minimum tailwater at 70' msl to remain in entrance weir criteria operating range (regulated by RCC).

2.4.2.8. Adult Fish Counts. The current fish counting program schedule is in **Table TDA-2**. Count station crowders and picket leads shall remain in operating position while visual counting, videotaping and/or PIT-tag antenna operation is being conducted.

2.4.2.8.a. The crowder shall be opened to full count slot width when not counting. During counting, the crowder shall be open as far as possible to allow accurate counting and shall not be closed to less than 18". This will usually occur during high turbidity conditions to allow count accuracy criteria to be achieved. Crowder ranges are:

i. TDA-East = 20–34"

ii. TDA-North = 18–38"

2.4.2.8.b. If passage is impaired by this condition, the count slot may be widened until proper passage conditions are achieved, even though count accuracy may be compromised to some degree.

2.4.2.8.c. Project biologists, FFU, and the fish count supervisor shall coordinate to achieve optimum count slot passage and/or count accuracy conditions.

2.4.2.8.d. If counting is temporarily discontinued due to unscheduled events, the crowder shall be fully opened.

2.4.2.8.e. The crowder may remain in operating position during the counters' hourly ten-minute break period.

2.4.2.9. Ice & Trash Sluiceway (ITS). March 1–31: operate ITS 24 hrs/day for adult fallback and steelhead kelt passage (**Table TDA-4**). Open ITS gates 1-2, 1-3 over operating MU-1, and gates 18-1, 18-2 over operating MU-18. If either of these MUs are out of service, operate the next available MU and associated adjacent gates (i.e., if MU-1 is OOS, operate MU-2 w/gates; if MU-18 is OOS, operate MU-17 w/gates or MU-19 w/gates).

2.4.2.10. East Fishway.

2.4.2.10.a. Removable weirs #154 -#157 will drop into the ladder at a differential (water surface at respective weir location relative to the forebay) of 1.0' ±0.1'.

2.4.2.10.b. Telescoping weir #159 will adjust to maintain 1.1' ±0.1' depth over the weirs, measured below the counting station.

2.4.2.10.c. Telescoping weir #158 will track 1.0' ±0.1' below weir #159 at all times during fishway operation.

2.4.2.11. North Fishway Entrance. Operate one entrance weir, N1. Project biologists will work in conjunction with Wasco County to maintain fishway entrances within criteria.

2.4.2.12. Powerhouse.

2.4.2.12.a. West PH Entrance. Operate entrance weirs W1 and W2 to maintain a gate crest of 8' or greater below tailwater. W3 will be closed at 81'msl, but remain operational as backup to W1 and W2.

2.4.2.12.b. East PH Entrance. Operate entrance weirs E2 and E3 to maintain a gate crest of 8'or greater below tailwater, currently operated at 13'below tailwater. Weir E1 to be closed at 81' msl but will remain operational. At lower range of tailwater elevation, E1 may be operated manually at any depth to provide criteria entrance differential.

2.4.2.12.c. Operate east ladder junction pool weirs at the following minimum depths in relation to east entrance tailwater surface elevation: JP6..... >7'

2.4.2.12.d. South Spillway Entrance. Operate entrance weirs S1 and S2 to maintain a gate crest at 8' or greater below tailwater.

2.4.2.12.e. Discharge from the two operating fish units will be adjusted to maintain criteria at all associated fishway entrances. Discharge volume is dependent on criteria levels at entrances.

2.4.2.13. Ladder Crowding. Beginning September 1 (after spill for juvenile fish passage has ended), Project personnel should assess ladder crowding daily during peak seasonal passage periods. If daily East Fishway passage count exceeds 25,000 combined adult salmonids per day (20,000 if ladder temperatures are above 70°F), the following guidance will apply:

i. Inspectors shall walk entire East Fishway ladder, exit to east entrance, twice daily. Observations and picture recording will be made at the pool between 157 and 158, the pool downstream of count station, and the pool at the 180° bend in the ladder.

ii. During East Fishway passage exceeding 35,000 combined adult salmonids per day (30,000 if ladder temperatures are above 70°F), if Project Biologists identify a fish crowding emergency, or if any adult salmonid mortality is observed anywhere in the fishway, attempt to alleviate crowding by immediately notifying the control room to coordinate with BPA and implement an emergency spill operation as soon as possible: currently 15 kcfs total = 6 kcfs (4 stops) from bay 1 and 4.5 kcfs (3 stops) each from bays 7 and 8. This operation and daily coordination with FPOM will continue as long as fish passage counts are greater than or equal to project passage (both ladders) when the operation started, or unless otherwise determined by FPOM.

iii. If inspectors see crowding that is not an emergency but is cause for concern, FPOM will be consulted to evaluate the situation. If the team determines the crowding situation is severe enough, the spill operation will be implemented as defined above.

3. FISH FACILITIES MONITORING & REPORTING

3.1. Inspections.

3.1.1. The results of all inspections and the readiness of the facilities for operation will be reported to the FPOM at the meeting immediately prior to the fish passage season.

3.1.2. During fish passage season, fish passage facilities will be inspected at least twice/day, seven days/week to assure operation according to established criteria. A third inspection will be made using the data logging system. Entrance conditions for the previous 24 hours will be checked daily for entrance criteria.

3.1.3. During winter maintenance, fish passage facilities will be inspected once/day, seven days/week.

3.1.4. More frequent inspections of some facility components will occur as noted in the text.

3.1.5. Additional fishway inspections may be performed by FFU and fish agencies.

3.2. Zebra Mussel Monitoring.

3.2.1. A zebra mussel monitoring program will continue. These organisms have become a serious problem elsewhere in the country and may become introduced into the Columbia River basin. Inspections should also be made when dewatering all project facilities.

3.3. Reporting.

3.3.1. Project biologists shall prepare weekly reports throughout the year summarizing project operations. The weekly reports will provide an overview of how the project and the fish passage facilities operated during the week and an evaluation of resulting fish passage conditions. The reports shall include:

i. Any out-of-criteria situations observed and subsequent corrective actions taken;

ii. Any maintenance or equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities;

iii. Adult fishway control calibrations;

iv. AWS closures (i.e. cleaning times);

v. Any unusual activities at the project that may affect fish passage.

3.3.2. The weekly reports shall cover Sunday through Saturday and they shall be e-mailed to CENWP-OD and other interested parties as soon as possible the following week, with a copy to CENWD-PDW-R (RCC).

3.3.3. ***Memorandum for the Record*** **(MFR)** shall be prepared by Project biologists for any adverse or negative impact to fish or fishways. See **FPP Chapter 1 – Overview** for the MFR template. The MFR will be sent to FPOM by the next working day and added to the next FPOM agenda for review.

3.3.4. The project biologists shall prepare an annual report by January 31, summarizing the operation of the project fish passage facilities for the previous year.

3.3.4.1. The report will cover from the beginning of one adult fish facility winter maintenance period to the beginning of the next.

3.3.4.2. The annual report also will include a description of all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities in discouraging avian predation.

3.3.4.3. The annual report will be provided to CENWP-OD in time for distribution to FPOM members at the February meeting.

4. FISH FACILITIES MAINTENANCE

4.1. General.

4.1.1. Routine Maintenance.

4.1.1.1. Staff gauges will be installed, cleaned, and/or repaired as required**.**

4.1.1.2. The zebra mussel monitoring program will continue. This includes veliger sampling, colonization sample units, and dewatering inspections. These organisms have become a serious problem elsewhere in the country and may become introduced into the Columbia River basin.

4.1.1.3. Routine fishway maintenance, to the extent practicable, will be conducted during periods when passage has been documented to be at its lowest to minimize impacts to migrating salmonids. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports.

4.2. Maintenance - Juvenile Fish Facilities.

4.2.1. Routine Maintenance.

4.2.1.1. Collection and Transportation Systems. The Dalles Dam Ice & Trash Sluiceway (ITS) will receive preventive maintenance throughout the year. During the juvenile fish passage season, this will normally be above water work, such as maintenance of automatic systems, air lines, electrical systems, and monitoring equipment. The system is visually inspected in all accessible areas for damaged equipment and areas that may cause problems to the juvenile fish. Any problem areas identified are repaired and modifications to the channel and general maintenance are completed.

4.2.1.2. Turbines and Spillways. Maintenance and routine repair of project turbines and spillways is a regular and recurring process that requires units to be shut down for extended periods (see **Appendix F, Dewatering Plans**). Maintenance schedules are reviewed by Project and District biologists and coordinated within NWP, NWD, BPA, and among fish agencies and tribes through FPOM. Certain turbine and spillway discharges at the projects are secondarily used to attract adult fish to the fishway entrance areas, thus maintenance schedules for these turbines and spillways will reflect equal weight given to fish, power and water management, and will be coordinated with the appropriate resource agencies. No other fish-related restrictions regarding maintenance will be placed on any units at this project, except to coordinate research activities. Some types of turbine maintenance will require testing the turbine operation throughout its full range before returning it to normal service. Units which should receive low priority for scheduling maintenance during the fish passage season are: F1, F2, 1, 2, 3, 4, 8, and 18 (during ITS operation). The trash racks are raked if necessary as determined by ROV inspection just prior to the juvenile fish passage season (April 1), between June 1 and June 15, and whenever trash accumulations are suspected because of increased head across the trash racks.

4.2.2. Non-Routine Maintenance. Maintenance of all fish-related facilities will be carried out as described below. Unscheduled maintenance that will have a significant impact on juvenile fish passage shall be coordinated through FPOM on a case-by-case basis by Project and CENWP-OD biologists. See **FPP Chapter 1 - Overview** for *Memo of Coordination* (MOC) instructions and template. The CENWP-OD biologists will be notified as soon as possible after it becomes apparent that maintenance and/or repairs are required. The Operations Project Manager has the authority to initiate work prior to notifying CENWP-OD when delay of work will result in unsafe situations for people, property, or fish.

4.2.2.1. Collection and Transportation Systems. The Ice & Trash Sluiceway (ITS) is now being used as a juvenile surface passage route.

4.2.2.1.a. The chain/hoist gates are fully opened during normal operation. If a chain gate fails, an adjacent gate can be operated until repairs can be made.

4.2.2.1.b. If a gate hoist fails, it will be repaired promptly. The gate will be removed when there are problems with the seal and the difficulty cannot be repaired promptly. If the epoxy- lined section of the sluiceway is damaged, it will be repaired.

4.2.2.1.c. To prepare a turbine for dewatering, the ice/trash sluiceway can be temporarily closed to install a gatewell orifice plug.

4.2.2.2. Turbines and Spillways - Spill Gate Failure. If a spill gate becomes inoperable, the operators will make necessary changes to accommodate spill and then immediately notify the Project Operations supervisor and the project biologist to determine the best pattern to follow until repairs can be made. This interim operation shall be coordinated with FPOM and FFDRWG through the CENWP-OD biologist, who will, depending on coordination, provide additional guidance to the project (see also section **2.2.**).

4.3. Maintenance - Adult Fish Facilities.

4.3.1. Routine Maintenance. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports.

4.3.1.1. Fishway Auxiliary Water Systems. The Dalles Project fishway auxiliary water is provided by discharge from hydroelectric turbine systems. Preventive maintenance and normal repair occur throughout the year. Trashracks for the AWS intakes will be raked when drawdown exceeds criteria. When practicable, rake trashracks during the time of day when fish passage is least affected.

4.3.1.2. Powerhouse and Spillway Adult Collection Systems. Preventive maintenance and repair occurs throughout the year. During the adult fish passage season the maintenance will not involve any operations that will cause a failure to comply with the fishway criteria, unless specially coordinated. Inspection of those parts of the adult collection channel systems, such as diffusion gratings, picket leads, and entrance gates, will be scheduled once per year during the winter maintenance period while the system is dewatered. An inspection during the first week of August with the system watered up will also be conducted (see **section 5**). A diver or

underwater video system may be used for underwater inspections. Any non-routine maintenance and fishway modification will be handled on a case-by-case basis.

4.3.1.2.a. The project fish biologist or alternate Corps fish personnel will attend all dewatering activities potentially involving fish, as well as inspections to provide fish input.

4.3.1.3. Adult Fish Ladders and Counting Stations. The adult fish ladders will be dewatered once each year during the winter maintenance period. Unless specially coordinated, only one ladder will be dewatered at a time, with the other ladder capable of operating within criteria. During this time, the ladders are inspected for blocked orifices, projections into the fishway that may injure fish, stability of the weirs, damaged picket leads, exit gate problems, loose diffuser valves, ladder orifice reduction plates, malfunctioning equipment at the counting stations, and other potential problems. Problems identified throughout the passage year that do not affect fish passage, as well as those identified during the dewatered period are then repaired. Trashracks at the ladder exits and the north AWS intake will be raked when criteria are exceeded. Rake trashracks between 1100 and one hour prior to sunset. Fish count station windows will be cleaned when necessary, and when practicable.

4.3.2. Non-Routine Maintenance. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports. Non-routine maintenance that will significantly affect the operation of a facility, such as repair of displaced diffuser gratings, will be coordinated with the Region, through FPOM. Coordination procedures for non-routine maintenance of adult facilities are the same as for juvenile facilities (**section 4.2.2** and **FPP Chapter 1 - Overview**).

4.3.2.1. Fishway Auxiliary Water Systems. Most fishway auxiliary water systems operate automatically. If the automatic system fails, the system will be manually operated by the project personnel until the system is repaired. When this operation becomes necessary, project personnel will increase surveillance on the adult system to ensure that criteria are being met. In the event of AWS failure, FPOM will work with the project to determine the best operating procedure.

4.3.2.1.a. Powerhouse. If one of the two fishway auxiliary water turbines fails or malfunctions for any duration, use the following sequential procedure until a fishway entrance head of 1' is achieved:

i. Increase discharge of remaining operating fish unit to maximum capacity.

ii. Close entrance weir S1.

iii. Set junction pool weirs 4 and 6 to no less than 4’ below junction pool elevation.

iv. Raise entrance weir E2 and E3 to 8’ depth below tailwater.

v. Close 2 to 3 south entrance diffuser valves.

vi. Close entrance weir S2 in 1’ increments.

vii. Close entrance weir W2 in 1' increments.

viii. Close entrance weir W1 in 1' increments.

ix. Differentials for open entrances should be checked between each of the steps above.

4.3.2.1.b. If both of the fishway auxiliary water turbines fail or malfunction, regardless of fish passage season, the adult fish passage facility will be operated as follows:

i. Raise the south entrance weirs to elevation 81'msl (closed position).

ii. Close west entrance.

iii. Close entrance weir E1 and E2 and keep E3 at 6' depth.

iv. Open two available fish lock valves and associated four diffusers to provide most possible water to the east auxiliary water system.

4.3.2.1.c. North Ladder. If the North Wasco County power unit auxiliary water system fails, the backup auxiliary water system will be started and the system operated ~~at~~ to maintain north fish ladder entrance criteria. Scheduled unit outages will be within October 1 through March 15. If the backup auxiliary water system fails, N1 will remain open with a weir depth of 6' below the tailwater surface.

4.3.2.2. Powerhouse and Spillway Adult Fish Collection Systems. The Dalles Dam contains several types of fishway entrances. In most cases, if failures occur, the entrance will be operated manually by project personnel until repairs are made. If this operation becomes necessary, project personnel will increase surveillance on the adult system to ensure criteria are being met. In those cases in which the failure will not allow the entrance to be operated manually, the gate will be maintained, to the extent possible, in an operational position. If this is not possible, the entrance will be repaired expediently, and it will be returned to manual or automatic control at the earliest possible date.

4.3.2.3. Adult Fish Ladders and Counting Stations. The ladder structures include picket leads, counting stations, fishway exits, and overflow weirs with orifices. Picket leads with excessive spacing (greater than 1") erosion of concrete around the picket leads, or missing pickets can allow fish into areas where escape is not likely. If picket lead failure or concrete erosion occurs, then the timing and method of repair will depend upon the severity of the problem. The decision of whether or not to dewater the fishway and repair any problem will be made in coordination with the fish agencies and tribes through the FPOM.

4.3.2.4. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to make sure they are in place. These inspections are done by either dewatering the fish passage system and physically inspecting the diffuser gratings, or using underwater video cameras and divers or other methods to inspect the gratings. Diffuser gratings may come loose during the fish passage season due to a variety of reasons. If a diffuser grating is known to or suspected of

having moved, creating an opening into a diffuser chamber, close associated diffuser valve ASAP. Efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway. If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and tribes through the established FPOM coordination procedure. Repairs shall be made as quickly as possible unless coordinated differently.

5. TURBINE UNIT OPERATION & MAINTENANCE

5.1. Turbine Unit Priority Order.

5.1.1. Turbine units will be operated in the order of priority defined in **Table TDA-5** to optimize fish passage conditions (excluding synchronous condenser unit operation at Units 15-20). Either Unit 1 and/or 18 will operate during daylight hours from April 1–November 30 for juvenile fish passage *and* from March 1–31 and December 1–15 for adult steelhead fallbacks or kelts. If a unit is out of service, the next unit in the priority order will be operated. Unit priority order may be coordinated differently for fish research, construction, or project maintenance.

Table TDA-5. The Dalles Dam Turbine Unit Priority Order.

PERIOD	UNIT PRIORITY ORDER
Fish Passage Season: April 1–November 30 If additional units needed, operate one unit from each block moving west to east. Repeat as necessary.	**1, 8, 18*** block 2-4, block 5-7, block 9-12, block 13-16, block 17-22
December 1 – December 15	1 and/or 18†
December 16 – end of February	Any Order
March 1 – March 31	1 and/or 18†

***April–November priority order for juvenile fish passage: Units under open sluice gates 1, 8, 18 (**Table TDA-4**).

†March and December priority order for adult fallbacks and kelt passage: Units 1 & 18 must be operated with two open sluice gates per unit (**Table TDA-4**).

5.2. Turbine Unit Operating Range.

5.2.1. In-Season (April 1–October 31). As defined in the *BPA Load Shaping Guidelines* (**Appendix C**), all units will be operated within ±1% of peak turbine efficiency (1% range) to maximize survival of juvenile fish that pass through the turbines. Turbine unit flow and power output at the lower and upper limits of the 1% range are defined in **Table TDA-6.**

5.2.1.1. If necessary to operate turbines outside of the 1% range, units will be selected according to the following guidance: Units 7–14 first, spacing by at least one unit (e.g., 7, 9, 11, 13, 15, 5, 2, 1, 8, etc.). Since each successive unit in this order is thought to pass more fish, this order is intended to minimize fish impacts during turbine passage. If operation

outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

i. Meet BPA load requests made pursuant to BPA's policy, statutory requirements, and *Load Shaping Guidelines* (**Appendix C**);

ii. If the draft tube is to be dewatered (**section 6.5**), the unit will be operated at full load >1% (or at speed-no-load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs in order to flush fish from the unit;

iii. Operate a turbine unit solely to provide station service; or

iv. Comply with other coordinated fish measures.

5.2.1.2. Off-Season (November 1–March 31). While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

Table TDA-6. The Dalles Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Turbine Efficiency (Lower and Upper Limits of 1% Range) and Operating Limits. [a]

Project Head	TDA Units 1–14						TDA Units 15–22					
	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
(feet)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
55	35.1	8,854	44.1	11,108	61.3	16,600	38.5	9,643	49.3	12,346	71.7	18,942
56	35.9	8,875	45.1	11,147	62.8	16,639	39.0	9,554	50.6	12,402	73.5	18,997
57	36.7	8,894	46.2	11,184	64.2	16,675	39.4	9,468	51.9	12,454	75.2	19,049
58	37.5	8,912	47.2	11,219	65.7	16,709	39.9	9,384	53.2	12,503	76.9	19,098
59	38.3	8,929	48.3	11,252	67.1	16,740	40.4	9,302	54.4	12,548	78.7	19,145
60	39.1	8,945	49.4	11,282	68.6	16,769	40.8	9,223	55.7	12,590	80.5	19,189
61	39.5	8,870	50.8	11,415	70.0	16,803	41.6	9,219	56.8	12,599	82.2	19,254
62	39.9	8,798	52.3	11,543	71.4	16,834	42.3	9,215	57.9	12,607	83.9	19,316
63	40.3	8,728	53.8	11,665	72.9	16,862	43.0	9,211	58.9	12,613	85.6	19,376
64	40.7	8,660	55.3	11,783	74.3	16,889	43.8	9,207	60.0	12,619	87.3	19,433
65	41.0	8,593	56.8	11,896	75.7	16,913	44.5	9,202	61.1	12,624	89.0	19,488
66	41.8	8,614	58.0	11,939	77.2	16,953	45.1	9,164	62.5	12,719	90.8	19,528
67	42.6	8,633	59.2	11,980	78.7	16,992	45.6	9,127	64.0	12,810	92.5	19,566
68	43.4	8,652	60.3	12,019	80.2	17,029	46.1	9,091	65.5	12,899	94.2	19,602
69	44.2	8,670	61.5	12,056	81.7	17,063	46.7	9,056	66.9	12,984	95.9	19,636
70	45.0	8,686	62.7	12,092	83.2	17,096	47.2	9,021	68.4	13,066	97.6	19,667
71	45.8	8,693	63.7	12,111	84.2	17,009	47.9	9,019	70.0	13,168	98.7	19,501
72	46.5	8,700	64.5	12,067	85.1	16,920	48.6	9,016	70.6	13,105	98.7	19,141
73	47.2	8,706	65.2	12,024	86.1	16,827	49.3	9,014	71.3	13,043	98.7	18,792
74	47.9	8,712	65.9	11,982	87.0	16,733	50.0	9,011	72.0	12,983	98.7	18,453
75	48.6	8,717	68.0	12,179	87.9	16,635	50.7	9,008	76.2	13,542	98.7	18,123
76	49.1	8,673	69.2	12,226	88.9	16,526	51.3	8,984	77.8	13,638	98.7	17,824
77	49.5	8,629	70.4	12,270	89.7	16,379	51.8	8,960	79.4	13,731	98.7	17,533
78	49.9	8,587	71.6	12,314	89.7	16,091	52.4	8,936	81.0	13,821	98.7	17,249
79	50.4	8,545	72.8	12,356	89.7	15,810	53.0	8,913	82.6	13,908	98.7	16,973
80	50.8	8,505	74.0	12,396	89.7	15,537	53.5	8,891	84.3	13,993	98.7	16,704
81	51.4	8,493	75.4	12,471	89.7	15,285	54.2	8,896	85.9	14,092	98.7	16,465
82	52.0	8,482	76.8	12,543	89.7	15,040	54.9	8,902	87.5	14,188	98.7	16,231
83	52.5	8,471	78.2	12,613	89.7	14,802	55.6	8,908	89.2	14,283	98.7	16,004
84	53.1	8,460	79.6	12,681	89.7	14,569	56.3	8,914	90.8	14,375	98.7	15,781
85	53.7	8,449	81.0	12,748	89.7	14,343	57.0	8,919	92.4	14,465	98.7	15,564
86	54.3	8,441	82.5	12,833	89.7	14,134	57.5	8,898	94.1	14,564	98.7	15,363
87	54.9	8,433	84.0	12,916	89.7	13,931	58.0	8,877	95.8	14,660	98.7	15,166
88	55.5	8,425	85.6	12,997	89.7	13,733	58.5	8,856	97.4	14,755	98.7	14,974
89	56.0	8,417	87.1	13,076	89.7	13,539	59.0	8,836	98.7 [b]	14,786	98.7	14,786
90	56.6	8,409	88.6	13,154	89.7	13,350	59.5	8,817	98.7 [b]	14,602	98.7	14,602
91	57.3	8,411	89.7 [b]	13,236	89.7	13,192	60.1	8,815	98.7 [b]	14,429	98.7	14,429
92	57.9	8,414	89.7 [b]	13,080	89.7	13,037	60.8	8,813	98.7 [b]	14,260	98.7	14,260
93	58.6	8,416	89.7 [b]	12,928	89.7	12,885	61.4	8,811	98.7 [b]	14,094	98.7	14,094
94	59.2	8,418	89.7 [b]	12,779	89.7	12,737	62.1	8,809	98.7 [b]	13,932	98.7	13,932
95	59.8	8,420	89.7 [b]	12,634	89.7	12,592	62.7	8,808	98.7 [b]	13,773	98.7	13,773

a. Table values derived from HDC reports for Units 1-14 (Jan 2001) and Units 15-22 (Oct 2002). Flow (cfs) is calculated based on turbine efficiency, head, and power output (MW). "Operating Limit" is the maximum safe operating point, based on cavitation or generator limit (added Feb 2018).

b. At project head ≥ 91 ft (TDA Units 1-14) and ≥ 89 ft (TDA Units 15-22), units are restricted by the Operating Limit and cannot achieve the modeled upper limit of the 1% turbine efficiency range. Power (MW) and flow (cfs) values shown are at the Operating Limit, not the 1% upper limit.

5.3. Turbine Unit Maintenance

5.3.1. Maintenance Schedule. The project turbine unit maintenance schedules will be reviewed by project and district biologists for fish impacts and be coordinated with FPOM.

5.3.2. Operational Testing.

5.3.2.1. Pre-Maintenance: Units may be operationally tested for up to 30 minutes before going into maintenance status by running the unit at speed-no-load and various loads within the 1% range to allow pre-maintenance measurements and testing and to allow all fish to move through the unit.

5.3.2.2. Post-Maintenance: Units may be operationally tested after maintenance or repair while remaining in maintenance or forced outage status. Operational testing may consist of running the unit for up to a cumulative time of 30 minutes (within 1% range) before it is returned to operational status.

5.3.2.3. Operational testing of a unit under maintenance is in addition to a unit in run status required for power plant reliability. Operational testing may deviate from FPP priority order and may require water that would otherwise be used for spill if the unit running for reliability is at its 1% lower limit (i.e., minimum generation). Water for operational testing will be used from powerhouse allocation when possible, and diverted from spill only to the extent necessary to maintain generation system reliability.

5.3.3. To reduce the chance of debris washing onto the tail log sill during tail log installation in units 19 through 22, fish unit loading may be reduced to about 8 MW for 30-60 minutes. Entrance weir E1 may be closed for the same duration.

5.3.4. Wicket gate opening for functional testing on a watered-up unit will be no longer than 15 minutes total open time.

6. DEWATERING PLANS

6.1. General.

6.1.1. *Guidelines for Dewatering and Fish Handling* (**Appendix F**) and project *Dewatering Plans*[2] have been developed by the projects and approved by FPOM, and are followed for most project facility dewaterings. The appropriate plans are reviewed by participants before each salvage operation. The plans include consideration for fish safety and are consistent with the following general guidance.

6.1.2. The project biologist and/or alternate Corps fish personnel will attend all project activities involving fish handling. The fish agencies and tribes are encouraged to participate in all ladder dewaterings.

[2] Project Dewatering Plans are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/

6.2. Dewatering - Juvenile Bypass Systems. [*not applicable for TDA*]

6.3. Dewatering - Adult Fish Ladder.

6.3.1. Routine Maintenance.

6.3.1.1. When possible, operate the ladder to be dewatered at orifice flow with the AWS off for at least 24 hours, but not more than 96 hours prior to dewatering.

6.3.1.2. A project biologist will assure that fish rescue equipment is available, and will coordinate to ensure adequate numbers of personnel will be available to move fish out of the dewatered ladder.

6.3.1.3. Project personnel will install exit bulkheads to shut down ladder flow. Where possible, a minimum flow of 1"-2" will be maintained in the ladder until fish are rescued.

6.3.1.4. The project biologist or alternate Corps fish personnel will oversee fish rescue when the ladders are dewatered. The fish are then transported to the forebay or tailwater, depending on the fish life stage (adults to forebay, juveniles to tailrace), for release. If a ladder is dewatered in the spring or summer, identifiable steelhead kelts should be released into the tailrace.

6.3.1.5. Orifice blocking devices, with attachment ropes tied to handrails may be placed in the lower-most weirs to prevent fish from re-ascending the dewatered portion of the adult fishway. Use of orifice blocking devices will be at the discretion of the project biologist. The fishway return-to-service checklist is as follows:

i. Remove orifice blocking devices if used.

ii. Activate automation for systems.

iii. Assure all count station lighting is operational.

iv. Open count station crowder

v. Close picket leads.

vi. Remove all tools, equipment, and debris from inside ladder.

6.3.2. Non-Routine Maintenance.

6.3.2.1. Follow steps in **section 6.3.1** above. When possible, discontinue fishway auxiliary water and operate ladder at reduced flow as long as possible (prefer 3-24 hours) prior to dewatering.

6.4. Dewatering - Powerhouse Collection System Routine Maintenance.

6.4.1. During the pumping or draining operation to dewater a portion or the entire collection channel, the water level will not be allowed to drop so low it strands fish. Personnel shall remain present onsite during pumping operations to ensure stranding does not occur or a water level sensor that de-activates the dewatering process will be used.

6.4.2. The project biologist will ensure that rescue equipment is available if needed.

6.4.3. The project biologist or alternate Corps fish personnel will provide technical guidance on fish safety and will assist directly in rescue operations.

6.5. Dewatering – Turbine Units.

6.5.1. Gatewells need not be dipped as is required at other projects due to the lack of VBSs. Immediately before draining it will be operated at speed/no load briefly to flush fish out of the draft tube.

6.5.2. If the turbine unit draft tube is dewatered, operate unit with full load for a minimum 15 minutes prior to immediately installing tail logs. If not possible to load, run unit at speed-no-load for minimum 15 minutes. Install bottom two tail logs side-by-side first before stacking the remainder to minimize sturgeon from entering the draft tube before dewatering. This is necessary for both scheduled and unscheduled outages.

6.5.3. If a turbine unit is idle and partially dewatered, and tail logs are put into place, an adequate safety pool may be maintained for up to 4 days to accommodate fish trapped in the draft tube (If longer timeframes are needed for the safety pool, project fisheries will coordinate with FPOM on a case-by-case basis). The safety pool will be maintained at an appropriate level which will be determined by the project biologist.

6.5.4. Fish rescue personnel will inspect dewatered turbine draft tubes and intakes as soon as the water levels reach a depth permitting visual inspection and the hatch cover is opened. The project biologist or alternate Corps fish personnel will provide technical guidance on fish safety, will assure that rescue equipment is available if needed, and will directly participate in fish salvage.

6.6. Dewatering - Navigation Lock.

6.6.1. The navigation lock is frequently dewatered for routine maintenance in late February/early March, in conjunction with navigation lock outages at Bonneville and John Day dams.

6.6.2. The area between the upstream bulkhead and the upstream gate is surveyed for fish as water levels allow. The lateral and pool areas on the floor of the lock are surveyed for fish from above. Most of these areas remain full of water, precluding the ability to implement successful fish salvage operations. Areas where water levels slowly decrease are accessed via crane when pool levels reach a depth of approximately 3 feet. The fill conduits are accessed and checked for fish only if needed and can be done safely. All salvaged fish are removed, transported via bag or tank and released to the river.

7. FOREBAY DEBRIS REMOVAL

7.1.1. Debris at projects can impact fish passage conditions. It can plug or block trashracks, gatewell orifices, dewatering screens, separators, and facility piping resulting in impingement, injuries, and descaling of fish. The preferred option is to remove debris at each project when possible to avoid passing a debris problem on to the next project downstream. This is not always

possible at each project as some projects do not have forebay debris removal capability. In this case, the only viable alternative is to spill to pass the debris.

7.1.2. Special spill operations that don't follow the normal spill schedule or volume limits will be coordinated prior to their execution. Normally, the project shall contact CENWP-OD at least two workdays prior to the day the special operation is required. Using information provided by the project, CENWP-OD will coordinate with FPOM and with RCC, as necessary. Once the coordination is complete, RCC will issue a teletype detailing the special operations.

8. RESPONSE TO HAZARDOUS MATERIALS SPILLS

8.1.1. The Dalles Project's guidance for responding to hazardous substance spills is contained in the Emergency Spill Response Plan.

8.1.2. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.

8.1.3. Project Fisheries will be contacted as soon as possible after a hazardous material release and prior to any modification to fishway operations. The project biologist will in turn contact the CENWP-OD biologist and FPOM. Attempts should be made to first contact the project biologist on duty. During fish passage season there is a project biologist on duty seven days a week. If a project biologist cannot be reached by radio or in the office, attempts to contact Project Fisheries will occur in the following order (home & mobile #s available in Control Room):

i. Bob Cordie

ii. Jeff Randall

iii. Gabriel Forrester

iv. Tammy Mackey

Table TDA-7. [*pg 1 of 5*] The Dalles Dam Spill Patterns for Juvenile Fish Passage at 40% of Total Project Outflow. *See notes at end of table.*

PROJECT OUTFLOW			SPILL			TDA 40% Spill Patterns Vertical Gate Opening (ft) per Spillbay [a, b]																				Total Open	
Total	Range (kcfs)		Total	% Range [c]																							
(kcfs)	Low	High	(kcfs)	Low	High	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	(ft)	Note
61.7	61.7	62.5	11.7	18.7%	19.0%							4	4																8	c, d
63.2	62.5	63.9	13.2	20.7%	21.1%							4.5	4.5																9	c, d
64.6	63.9	65.4	14.6	22.3%	22.8%							5	5																10	c, d
66.1	65.4	66.9	16.1	24.1%	24.6%							5.5	5.5																11	c, d
67.6	66.9	68.3	17.6	25.8%	26.3%							6	6																12	c, d
69.0	68.3	69.8	19.0	27.2%	27.8%							6.5	6.5																13	c, d
70.5	69.8	71.2	20.5	28.8%	29.4%							7	7																14	c, d
71.9	71.2	72.6	21.9	30.2%	30.8%							7.5	7.5																15	c, d
73.3	72.6	74.1	23.3	31.5%	32.1%							8	8																16	c, d
74.8	74.1	75.5	24.8	32.8%	33.5%							8.5	8.5																17	c, d
76.2	75.5	77.0	26.2	34.0%	34.7%							9	9																18	c, d
77.7	77.0	78.4	27.7	35.3%	36.0%							9.5	9.5																19	c, d
79.1	78.4	79.8	29.1	36.5%	37.1%							10	10																20	c, d
80.5	79.8	81.2	30.5	37.6%	38.2%							10.5	10.5																21	c, d
81.9	81.2	82.6	31.9	38.6%	39.3%							11	11																22	c, d
83.3	82.6	85.2	33.3	39.1%	40.3%							11.5	11.5																23	c, d
87.0	85.2	87.4	34.8	39.8%	40.9%							12	12																24	c
87.8	87.4	90.0	35.1	39.0%	40.2%			4	4	4	4	4	4																24	c
92.3	90.0	95.5	36.9	38.6%	41.0%			4.2	4.2	4.2	4.2	4.2	4.2																25.2	c, e
98.8	95.5	100.6	39.5	39.3%	41.4%			4.5	4.5	4.5	4.5	4.5	4.5																27	c, e
102.5	100.6	105.0	41.0	39.0%	40.7%		4	4	4	4	4	4	4																28	c
107.5	105.0	111.4	43.0	38.6%	41.0%		4.2	4.2	4.2	4.2	4.2	4.2	4.2																29.4	c, e
115.3	111.4	116.1	46.1	39.7%	41.4%		4.5	4.5	4.5	4.5	4.5	4.5	4.5																31.5	c, e
117.0	116.1	120.0	46.8	39.0%	40.3%	4	4	4	4	4	4	4	4																32	c
123.0	120.0	127.4	49.2	38.6%	41.0%	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2																33.6	c, e
131.8	127.4	134.8	52.7	39.1%	41.4%	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5																36	c, e
137.8	134.8	142.0	55.1	38.8%	40.9%	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7																37.6	c, e
146.3	142.0	149.3	58.5	39.2%	41.2%	5	5	5	5	5	5	5	5																40	c, e
152.3	149.3	156.6	60.9	38.9%	40.8%	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2																41.6	c, e
161.0	156.6	163.9	64.4	39.3%	41.1%	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5																44	c, e
166.8	163.9	171.1	66.7	39.0%	40.7%	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7																45.6	c
175.5	171.1	178.4	70.2	39.4%	41.0%	6	6	6	6	6	6	6	6																48	c

PROJECT OUTFLOW			SPILL			TDA 40% Spill Patterns																				Total	
Total	Range (kcfs)		Total	% Range [c]		Vertical Gate Opening (ft) per Spillbay [a, b]																				Open	
(kcfs)	Low	High	(kcfs)	Low	High	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	(ft)	Note
181.3	178.4	185.6	72.5	39.1%	40.6%	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2																49.6	c
190.0	185.6	193.0	76.0	39.4%	40.9%	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5																52	c
196.0	193.0	200.4	78.4	39.1%	40.6%	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7																53.6	c
204.8	200.4	207.6	81.9	39.4%	40.9%	7	7	7	7	7	7	7	7																56	c
210.5	207.6	214.8	84.2	39.2%	40.6%	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2																57.6	c
219.0	214.8	221.9	87.6	39.5%	40.8%	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5																60	c
224.8	221.9	229.0	89.9	39.3%	40.5%	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7																61.6	c
233.3	229.0	236.1	93.3	39.5%	40.7%	8	8	8	8	8	8	8	8																64	c
239.0	236.1	243.4	95.6	39.3%	40.5%	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2																65.6	c
247.8	243.4	250.6	99.1	39.5%	40.7%	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5																68	c
253.5	250.6	257.9	101.4	39.3%	40.5%	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7																69.6	c
262.3	257.9	265.1	104.9	39.6%	40.7%	9	9	9	9	9	9	9	9																72	c
268.0	265.1	272.4	107.2	39.4%	40.4%	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2																73.6	c
276.8	272.4	279.6	110.7	39.6%	40.6%	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5																76	c
282.5	279.6	286.6	113.0	39.4%	40.4%	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7																77.6	c
290.8	286.6	293.6	116.3	39.6%	40.6%	10	10	10	10	10	10	10	10																80	c
296.5	293.6	300.6	118.6	39.5%	40.4%	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2																81.6	c
304.8	300.6	307.6	121.9	39.6%	40.5%	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5																84	c
310.5	307.6	314.9	124.2	39.4%	40.4%	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7																85.6	c
319.3	314.9	322.0	127.7	39.7%	40.6%	11	11	11	11	11	11	11	11																88	c
324.8	322.0	329.1	129.9	39.5%	40.3%	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2																89.6	c
333.5	329.1	336.4	133.4	39.7%	40.5%	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5																92	c
339.3	336.4	343.5	135.7	39.5%	40.3%	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7																93.6	c
347.8	343.5	350.5	139.1	39.7%	40.5%	12	12	12	12	12	12	12	12																96	c
353.3	350.5	357.4	141.3	39.5%	40.3%	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2																97.6	c
361.5	357.4	364.3	144.6	39.7%	40.5%	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5																100	c
367.0	364.3	371.3	146.8	39.5%	40.3%	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7																102	c
375.5	371.3	378.4	150.2	39.7%	40.5%	13	13	13	13	13	13	13	13																104	c
381.3	378.4	385.4	152.5	39.6%	40.3%	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2																106	c
389.5	385.4	392.3	155.8	39.7%	40.4%	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5																108	c
395.0	392.3	399.1	158.0	39.6%	40.3%	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7																110	c
403.3	399.1	406.0	161.3	39.7%	40.4%	14	14	14	14	14	14	14	14																112	c, f
408.8	406.0	413.0	163.5	39.6%	40.3%	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2																114	c

PROJECT OUTFLOW			SPILL			TDA 40% Spill Patterns Vertical Gate Opening (ft) per Spillbay [a, b]																				Total Open	
Total (kcfs)	Range (kcfs) Low	High	Total (kcfs)	% Range [c] Low	High	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	(ft)	Note
417.3	413.0	420.0	166.9	39.7%	40.4%	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5																116	c
422.8	420.0	433.9	169.1	39.0%	40.3%	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7																118	c
445.0			175.0	39.3%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				4												122	
450.8			180.8	40.1%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				4		4										126	
456.7			186.7	40.9%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				4		4	4									130	
462.5			192.5	41.6%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				4		4	4		4							134	
468.4			198.4	42.4%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				4		4	4		4			4				138	
474.2			204.2	43.1%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				4		4	4		4			4	4			142	
480.1			210.1	43.8%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				4		4	4		4			4	4	4		146	
485.9			215.9	44.4%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				8		4	4		4			4	4	4		150	
491.7			221.7	45.1%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				8		8	4		4			4	4	4		154	
497.5			227.5	45.7%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				8		8	8		4			4	4	4		158	
503.3			233.3	46.4%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				8		8	8		8			4	4	4		162	
509.1			239.1	47.0%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				8		8	8		8			8	4	4		166	
515.0			245.0	47.6%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				8		8	8		8			8	8	4		170	
520.8			250.8	48.2%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				8		8	8		8			8	8	8		174	
526.5			256.5	48.7%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				12		8	8		8			8	8	8		178	
532.2			262.2	49.3%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				12		12	8		8			8	8	8		182	
537.9			267.9	49.8%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				12		12	12		8			8	8	8		186	
543.7			273.7	50.3%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				12		12	12		12			8	8	8		190	
549.4			279.4	50.9%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				12		12	12		12			12	8	8		194	
555.1			285.1	51.4%		14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7				12		12	12		12			12	12	8		198	
563.3			293.3	52.1%		14.7	14.7	15	15	15	15	15	15				12		12	12		12			12	12	12		203	
568.2			298.2	52.5%		15	15	15.5	15.5	15.5	15.5	15.5	15.5				12		12	12		12			12	12	12		207	
572.5			302.5	52.8%		15	15	16	16	16	16	16	16				12		12	12		12			12	12	12		210	
576.7			306.7	53.2%		15	15	16.5	16.5	16.5	16.5	16.5	16.5				12		12	12		12			12	12	12		213	
580.6			310.6	53.5%		15	15	17	17	17	17	17	17				12		12	12		12			12	12	12		216	
590.5			320.5	54.3%		15	16	18	18	18	18	18	18				12		12	12		12			12	12	12		223	g
595.6			325.6	54.7%		15	16	18	18	18	18	18	18				16		12	12		12			12	12	12		227	
601.1			331.1	55.1%		15	16	18	18	18	18	18	18				16		16	12		12			12	12	12		231	
606.6			336.6	55.5%		15	16	18	18	18	18	18	18				16		16	16		12			12	12	12		235	
612.1			342.1	55.9%		15	16	18	18	18	18	18	18				16		16	16		16			12	12	12		239	
617.6			347.6	56.3%		15	16	18	18	18	18	18	18				16		16	16		16			16	12	12		243	

PROJECT OUTFLOW		SPILL		TDA 40% Spill Patterns																					Total	
Total	Range (kcfs)	Total	% Range [c]	Vertical Gate Opening (ft) per Spillbay [a, b]																					Open	
(kcfs)	Low High	(kcfs)	Low High	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	(ft)	Note
623.1		353.1	56.7%	15	16	18	18	18	18	18	18				16		16	16		16			16	16	12		247	
625.8		355.8	56.9%	15	16	18	18	18	18	18	18				18		16	16		16			16	16	12		249	
628.5		358.5	57.0%	15	16	18	18	18	18	18	18				18		18	16		16			16	16	12		251	
631.2		361.2	57.2%	15	16	18	18	18	18	18	18				18		18	18		16			16	16	12		253	
633.9		363.9	57.4%	15	16	18	18	18	18	18	18				18		18	18		18			16	16	12		255	
636.6		366.6	57.6%	15	16	18	18	18	18	18	18				18		18	18		18			18	16	12		257	
639.2		369.2	57.8%	15	16	18	18	18	18	18	18				20		18	18		18			18	16	12		259	
641.9		371.9	57.9%	15	16	18	18	18	18	18	18				20		20	18		18			18	16	12		261	
644.5		374.5	58.1%	15	16	18	18	18	18	18	18				20		20	20		18			18	16	12		263	
647.2		377.2	58.3%	15	16	18	18	18	18	18	18				20		20	20		20			18	16	12		265	
649.9		379.9	58.5%	15	16	18	18	18	18	18	18				20		20	20		20			20	16	12		267	
656.4		386.4	58.9%	15	16	18	18	18	18	18	18				21		21	21		21			21	16	12		272	
664.4		394.4	59.4%	15	16	19	19	19	19	19	19				21		21	21		21			21	16	12		278	
672.4		402.4	59.8%	15	16	20	20	20	20	20	20				21		21	21		21			21	16	12		284	
680.3		410.3	60.3%	15	16	21	21	21	21	21	21				21		21	21		21			21	16	12		290	
686.2		416.2	60.7%	15	16	21	21	21	21	21	21		4		21		21	21		21			21	16	12		294	
692.0		422.0	61.0%	15	16	21	21	21	21	21	21		8		21		21	21		21			21	16	12		298	
697.7		427.7	61.3%	15	16	21	21	21	21	21	21		12		21		21	21		21			21	16	12		302	
703.2		433.2	61.6%	15	16	21	21	21	21	21	21		16		21		21	21		21			21	16	12		306	
708.6		438.6	61.9%	15	16	21	21	21	21	21	21		20		21		21	21		21			21	16	12		310	
715.8		445.8	62.3%	15	16	21	21	21	21	21	21		21	4	21		21	21		21			21	16	12		315	
721.6		451.6	62.6%	15	16	21	21	21	21	21	21		21	8	21		21	21		21			21	16	12		319	
727.3		457.3	62.9%	15	16	21	21	21	21	21	21		21	12	21		21	21		21			21	16	12		323	
732.8		462.8	63.2%	15	16	21	21	21	21	21	21		21	16	21		21	21		21			21	16	12		327	
738.1		468.1	63.4%	15	16	21	21	21	21	21	21		21	20	21		21	21		21			21	16	12		331	
745.4		475.4	63.8%	15	16	21	21	21	21	21	21		21	21	21	4	21	21		21			21	16	12		336	
751.2		481.2	64.1%	15	16	21	21	21	21	21	21		21	21	21	8	21	21		21			21	16	12		340	
756.9		486.9	64.3%	15	16	21	21	21	21	21	21		21	21	21	12	21	21		21			21	16	12		344	
762.4		492.4	64.6%	15	16	21	21	21	21	21	21		21	21	21	16	21	21		21			21	16	12		348	
767.7		497.7	64.8%	15	16	21	21	21	21	21	21		21	21	21	20	21	21		21			21	16	12		352	
775.0		505.0	65.2%	15	16	21	21	21	21	21	21		21	21	21	21	21	21	4	21			21	16	12		357	
780.8		510.8	65.4%	15	16	21	21	21	21	21	21		21	21	21	21	21	21	8	21			21	16	12		361	
786.5		516.5	65.7%	15	16	21	21	21	21	21	21		21	21	21	21	21	21	12	21			21	16	12		365	

PROJECT OUTFLOW			SPILL			TDA 40% Spill Patterns																					Total	
Total	Range (kcfs)		Total	% Range [c]		Vertical Gate Opening (ft) per Spillbay [a, b]																					Open	
(kcfs)	Low	High	(kcfs)	Low	High	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	(ft)	Note
792.0			**522.0**	**65.9%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	16	21			21	16	12		**369**	
797.3			**527.3**	**66.1%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	20	21			21	16	12		**373**	
804.6			**534.6**	**66.4%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	4		21	16	12		**378**	
810.4			**540.4**	**66.7%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	8		21	16	12		**382**	
816.0			**546.0**	**66.9%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	12		21	16	12		**386**	
821.6			**551.6**	**67.1%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	16		21	16	12		**390**	
826.9			**556.9**	**67.3%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	20		21	16	12		**394**	
834.2			**564.2**	**67.6%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	21	4	21	16	12		**399**	
840.0			**570.0**	**67.9%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	21	8	21	16	12		**403**	
845.6			**575.6**	**68.1%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	21	12	21	16	12		**407**	
851.1			**581.1**	**68.3%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	21	16	21	16	12		**411**	
856.5			**586.5**	**68.5%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	21	20	21	16	12		**415**	
863.8			**593.8**	**68.7%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	21	21	21	16	12	4	**420**	
869.6			**599.6**	**69.0%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	21	21	21	16	12	8	**424**	
875.2			**605.2**	**69.1%**		15	16	21	21	21	21	21	21		21	21	21	21	21	21	21	21	21	21	21	16	12	12	**428**	

a. Spill (kcfs) is calculated as a function of total gate opening (ft) at forebay elevation 158.5 feet (revised July 2012).

b. Highlighted spillbays operationally restricted because of structural or wire rope issues, and will be used only if needed for dam safety.

c. Uniform spill patterns are critical to increasing juvenile fish survival through the tailrace. Uniform pattern fixed spill rates will result in hourly spill % within ranges in table.

d. TDA minimum generation requirement = 50 kcfs. Therefore, 40% spill is not achievable at total river flow <84 kcfs (i.e., minimum generation operation).

e. At certain flow ranges, spill could exceed ±1% of target spill of 40%. At total river flow 92,250–161,000 cfs, spill may range from 38.6–41.4% (up to ±1.4% of the 40% rate).

f. Minimum gate opening is 4 ft. At forebay elevation 160 ft, maximum gate opening through bays 1-8 is 14 ft, thus higher bays will be utilized prior to opening any of bays 1-8 more than 14.0 ft. At lower forebay elevations, gate openings can be increased up to 14.7 feet before utilizing higher bays.

g. If gate openings greater than shown in table are needed, to the extent feasible, incrementally increase gate openings. If all available spillbays are fully open and more flow is needed to limit pool surcharge, use restricted spillbays in following priority order: 10, 11, 13, 16, 18, 19, and 23. Fully open each bay as needed before moving to next.

Table TDA-8. Spillway Configuration at Various Flow Ranges.

Min Flow (cfs)	Max Flow (cfs)	Spillbay Gates	Gate Opening per Bay (ft)	Total Gate Opening (ft)	Total Spill (cfs)
62,000	65,000	7,8	4	8	12,000
65,000	71,000	7,8	6	12	18,000
71,000	77,000	7,8	8	16	24,000
77,000	85,000	7,8	10	20	30,000
85,000	97,500	7,8	12	24	36,000
85,000	97,500	1-8	4	24	36,000
97,500	112,500	1-8	4	28	42,000
112,500	127,500	1-8	4	32	48,000
127,500	142,500	1-8	4.5	36	54,000
142,500	157,500	1-8	5	40	60,000
157,500	172,500	1-8	5.5	44	66,000
172,500	187,500	1-8	6	48	72,000
187,500	202,500	1-8	6.5	52	78,000
202,500	217,500	1-8	7	56	84,000
217,500	232,500	1-8	7.5	60	90,000
232,500	247,500	1-8	8	64	96,000
247,500	262,500	1-8	8.5	68	102,000
262,500	277,500	1-8	9	72	108,000
277,500	292,500	1-8	9.5	76	114,000
292,500	307,500	1-8	10	80	120,000
307,500	322,500	1-8	10.5	84	126,000
322,500	337,500	1-8	11	88	132,000
337,500	352,500	1-8	11.5	92	138,000
352,500	367,500	1-8	12	96	144,000
367,500	382,500	1-8	12.5	100	150,000
382,500	397,500	1-8	13	104	156,000
397,500	412,500	1-8	13.5	108	162,000
412,500	438,000	1-8	14	112	168,000

2018 Fish Passage Plan

Chapter 4 – John Day Dam

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John Day Dam *	
Project Acronym	JDA
River Mile (RM)	Columbia River – RM 215.6
Reservoir	Lake Umatilla
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 12.5 kcfs \ Mar–Nov: 50 kcfs
Forebay Normal Operating Range (ft)	Nov–Jun: 260'–265' \ Jul–Oct: 265'–268'
Tailrace Rate of Change Limit (ft)	3'/hr
Powerhouse Length (ft)	1,975'
Powerhouse Hydraulic Capacity (kcfs)	322 kcfs
Turbine Units (#)	16 (Units 1-16 BLH Kaplan)
Turbine Generating Capacity (MW)	Rated: 2,160 MW (135 MW/unit) \ Maximum: 2,480 MW (155 MW/unit)
Gatewell Orifice Diameter (in)	One 14" orifice per gatewell (3 per unit) = 48 total
Spillway Length (ft)	1,228'
Spillway Hydraulic Capacity (kcfs)	2,250 kcfs
Spillbays (#)	20
Spillway Weirs (#)	2 Temporary Spillway Weirs (TSW) Bays 18, 19
Navigation Lock Length x Width (ft)	650' x 86'
Navigation Lock Max. Lift (ft)	113'

* More information is available on the Corps Portland District website for John Day Dam at: www.nwp.usace.army.mil/Locations/Columbia-River/John-Day/

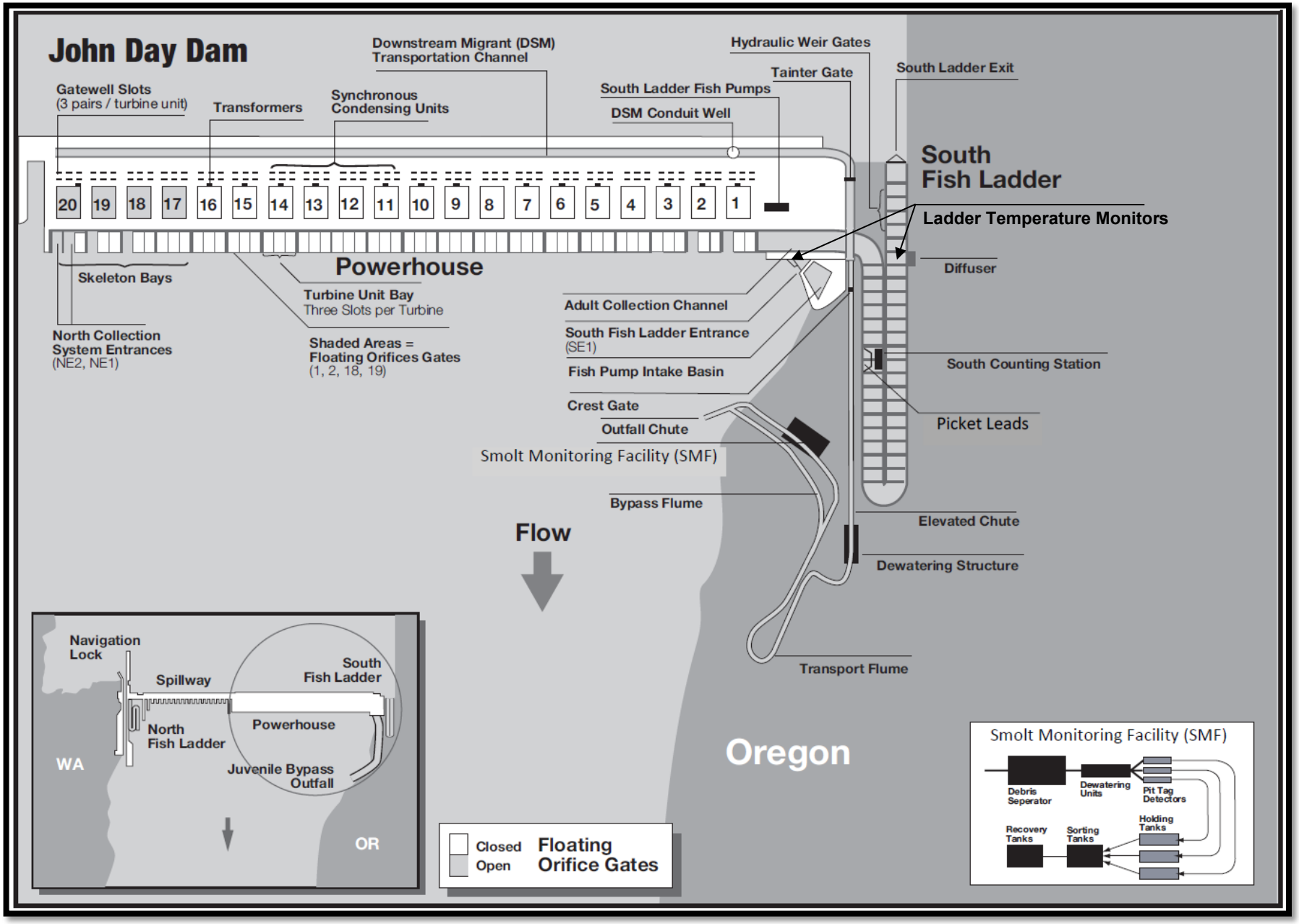


Figure JDA-1. John Day Dam South Fish Ladder, Powerhouse Collection System, and Juvenile Bypass System.

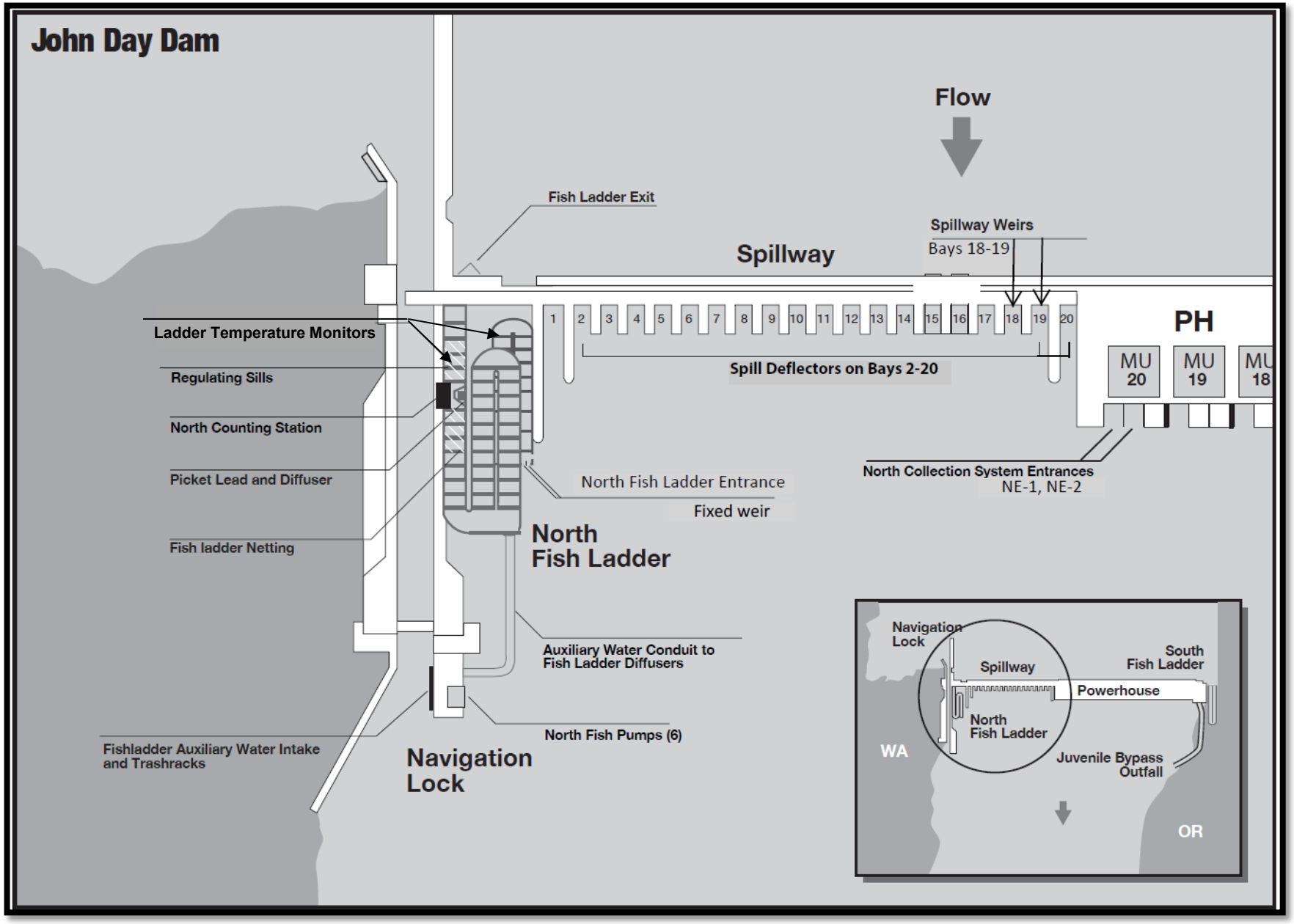
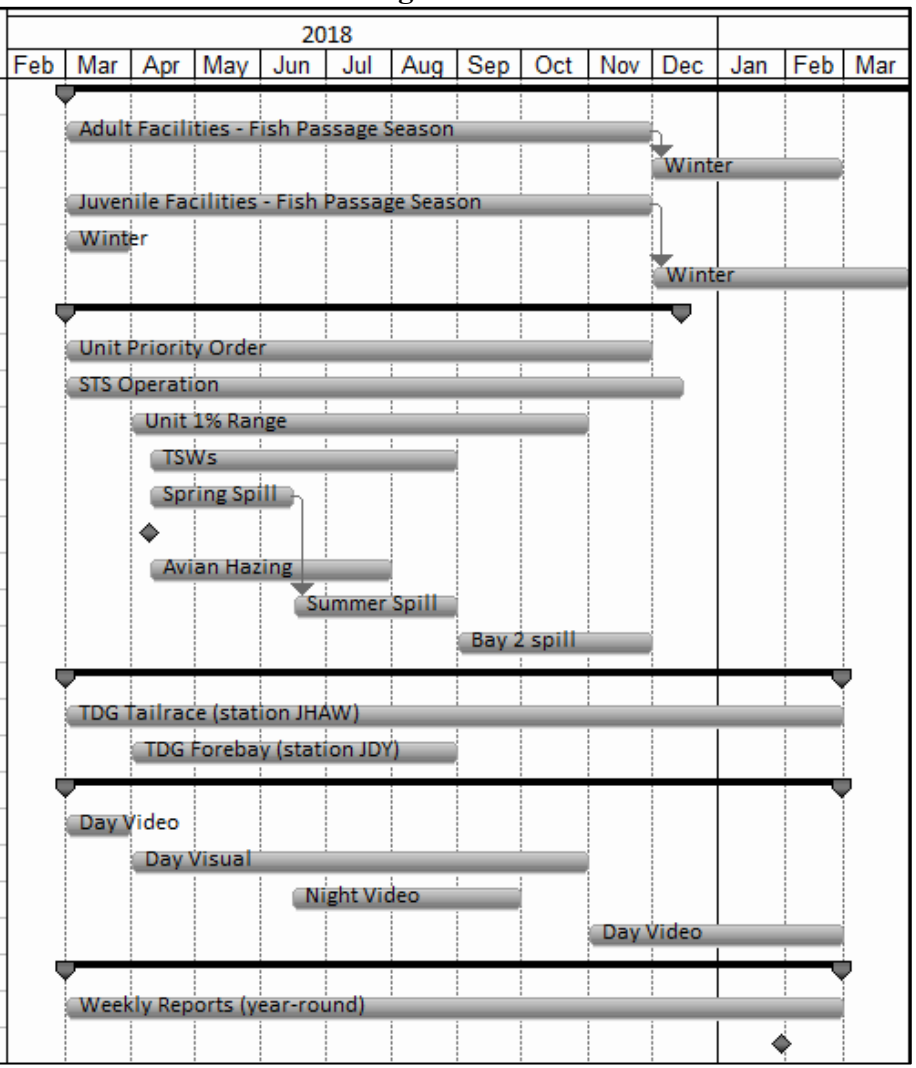


Figure JDA-2. John Day Dam Spillway and North Fish Ladder.

Table JDA-1. John Day Dam Schedule of Operations and Actions Defined in the 2018 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**3/1/18**	**3/31/19**	
Adult Facilities - Fish Passage Season	3/1/18	11/30/18	2.4.2
Adult Facilities - Winter Maintenance	11/30/18	2/27/19	2.4.1
Juvenile Facilities - Fish Passage Season	3/1/18	11/30/18	2.3.2
Juvenile Facilities - Winter Maintenance	3/1/18	3/31/18	2.3.1
	12/1/18	3/31/19	
PROJECT OPERATIONS FOR FISH PASSAGE	**3/1/18**	**12/15/18**	
Turbine unit priority order	3/1/18	11/30/18	Table JDA-6
STS Operation	3/1/18	12/15/18	2.3.2.1
Turbine unit 1% operating range	4/1/18	10/31/18	5.2
TSW Operation	4/10/18	8/31/18	2.3.2.16
Spring Spill	4/10/18	6/15/18	App E (FOP)
Avian Wires installed NLT April 10	4/10/18	4/10/18	App L 1.4
Avian Hazing	4/10/18	7/31/18	App L 4.2
Summer Spill	6/16/18	8/31/18	App E (FOP)
Spill Bay 2 for adult attraction	9/1/18	11/30/18	2.2.3
TDG MONITORING	**3/1/18**	**2/28/19**	
TDG Monitoring - Tailrace (year-round)	3/1/18	2/28/19	2.2.2
TDG Monitoring - Forebay	4/1/18	8/31/18	2.2.2
ADULT FISH COUNTING	**3/1/18**	**2/28/19**	
Day Video 0400-2000 PST	3/1/18	3/31/18	Table JDA-3
Day Visual 0500-2100 PDT	4/1/18	10/31/18	Table JDA-3
Night Video 2100-0500 PDT	6/15/18	9/30/18	Table JDA-3
Day Video 0400-2000 PST	11/1/18	2/28/19	Table JDA-3
REPORTS	**3/1/18**	**2/28/19**	
Weekly Reports (year-round)	3/1/18	2/28/19	3.3
Annual Report due NLT Jan 31	1/31/19	1/31/19	3.3.4



1. FISH PASSAGE INFORMATION

Fish passage facilities at John Day Lock & Dam are shown on the general site plans in **Figures JDA-1** and **JDA-2**. The annual schedule of project operations, maintenance, and other actions that are described in this Fish Passage Plan (FPP) and appendices is in **Table JDA-1**.

1.1. Juvenile Fish Passage.

1.1.1. Juvenile Fish Facilities.

1.1.1.1. The Juvenile Bypass System (JBS) at John Day Dam was completed in 1987 and the Smolt Monitoring Facility (SMF) was completed in 1998. Each of the project's 16 turbine units includes one vertical barrier screen (VBS), one submersible traveling screen (STS), and three 14"-diameter orifices (one per gatewell).

1.1.1.2. During juvenile fish sampling at the SMF, flow with collected fish from the SMF is sent over the crest gate and down an elevated chute to the dewatering structure that reduces the flow to 30 cubic feet per second (cfs) before entering the transport flume. A switch gate diverts fish to either the SMF or directly to the outfall (emergency bypass only). Fish diverted for sampling pass a fish/debris separator that directs debris and adult fish into a separate flume to the outfall. Juvenile fish are interrogated by PIT-tag detectors and diverted either to the SMF for sampling or the outfall. When the SMF is not in operation, the bypass collection conduit connects to a transport channel that carries fish to the river below the dam (bypass mode). The differential between the forebay and bypass conduit is controlled by the tainter gate.

1.1.1.3. Maintenance of juvenile fish facilities is scheduled from approximately December 16 through March 31 to minimize impact on downstream migrants and reduce the possibility of adult fallbacks through turbine units. During this time, the JBS will be dewatered.

1.1.2. Juvenile Migration Timing.

1.1.2.1. Juvenile passage timing at John Day Dam has been determined by gatewell and SMF sampling (**Table JDA-2**). Results to-date of ongoing research show significant daytime passage during daytime operations. Bull trout, lamprey, juvenile sturgeon, and other listed salmonids are recorded as by-catch in the SMF report. Sample collection will continue through September 15 and PIT-tag interrogation will continue through November 30 (weather permitting). The JBS will operate through December 15.

1.1.2.2. Juvenile fish passage increases dramatically at dusk and peaks around 2300–2400 hours with a long period of elevated passage until dawn when passage decreases. Gatewell sampling data* indicate that roughly 80% of juvenile migrants pass John Day Dam between 2100 and 0600 hours. During the peak spring juvenile migration period at John Day Dam, 40% of spring Chinook and steelhead passage occurred between 0700 and 2200 hours. *[*Data are for powerhouse passage only. More recent radio-tracking and hydroacoustic data indicate different passage patterns for the spillway and project when spill is occurring 24 hours/day.]*

Table JDA-2. Juvenile Salmonid Passage Timing at John Day Dam for Most Recent 10 Years (based on daily & yearly collection data).

Year	10%	50%	90%	# Days	10%	50%	90%	# Days
	Yearling Chinook				Subyearling Chinook *			
2008	4-May	22-May	1-Jun	29	24-Jun	9-Jul	5-Aug	43
2009	27-Apr	17-May	1-Jun	36	17-Jun	1-Jul	17-Jul	31
2010	1-May	18-May	6-Jun	37	14-Jun	1-Jul	20-Jul	37
2011	2-May	17-May	28-May	27	16-Jun	14-Jul	3-Aug	49
2012	27-Apr	6-May	22-May	26	27-Jun	13-Jul	29-Jul	33
2013	27-Apr	12-May	24-May	28	20-Jun	3-Jul	15-Jul	26
2014	28-Apr	9-May	24-May	27	21-Jun	5-Jul	20-Jul	30
2015	20-Apr	13-May	24-May	35	10-Jun	23-Jun	30-Jun	21
2016	18-Apr	30-Apr	10-May	23	10-Jun	23-Jun	30-Jun	21
2017	24-Apr	8-May	18-May	25	9-Jun	1-Jul	15-Jul	37
10-Yr MEDIAN	**27-Apr**	**12-May**	**24-May**	**28**	**16-Jun ***	**29-Jun ***	**28-Jul ***	**43 ***
10-Yr MIN	**18-Apr**	**30-Apr**	**10-May**	**23**	**6-Jun ***	**27-Jun ***	**20-Jul ***	**31 ***
10-Yr MAX	**4-May**	**22-May**	**6-Jun**	**37**	**27-Jun ***	**30-Jul ***	**22-Aug ***	**59 ***
	Unclipped Steelhead				Clipped Steelhead			
2008	6-May	21-May	1-Jun	27	7-May	16-May	30-May	24
2009	26-Apr	11-May	28-May	33	29-Apr	10-May	27-May	29
2010	27-Apr	12-May	8-Jun	43	3-May	11-May	9-Jun	38
2011	25-Apr	19-May	31-May	37	19-Apr	19-May	30-May	42
2012	25-Apr	1-May	19-May	25	25-Apr	3-May	15-May	21
2013	21-Apr	13-May	27-May	37	29-Apr	8-May	21-May	23
2014	23-Apr	9-May	27-May	35	30-Apr	8-May	21-May	22
2015	16-Apr	18-May	28-May	43	28-Apr	14-May	28-May	31
2016	18-Apr	28-Apr	12-May	25	22-Apr	30-Apr	10-May	19
2017	24-Apr	6-May	28-May	35	24-Apr	4-May	22-May	29
10-Yr MEDIAN	**24-Apr**	**11-May**	**28-May**	**35**	**28-Apr**	**9-May**	**24-May**	**27**
10-Yr MIN	**16-Apr**	**28-Apr**	**12-May**	**25**	**19-Apr**	**30-Apr**	**10-May**	**19**
10-Yr MAX	**6-May**	**21-May**	**8-Jun**	**43**	**7-May**	**19-May**	**9-Jun**	**42**
	Coho				Sockeye (Wild & Hatchery)			
2008	11-May	25-May	6-Jun	27	22-May	29-May	6-Jun	16
2009	16-May	29-May	13-Jun	29	10-May	25-May	7-Jun	29
2010	9-May	3-Jun	16-Jun	39	11-May	29-May	9-Jun	30
2011	10-May	23-May	6-Jun	28	10-May	22-May	2-Jun	24
2012	6-May	21-May	5-Jun	31	2-May	11-May	25-May	24
2013	6-May	19-May	1-Jun	27	10-May	19-May	28-May	19
2014	3-May	17-May	31-May	29	14-May	22-May	31-May	18
2015	23-Apr	20-May	4-Jun	43	11-May	20-May	27-May	17
2016	26-Apr	8-May	24-May	29	30-Apr	10-May	22-May	23
2017	2-May	18-May	1-Jun	31	30-Apr	14-May	24-May	25
10-Yr MEDIAN	**6-May**	**20-May**	**4-Jun**	**31**	**10-May**	**21-May**	**29-May**	**21**
10-Yr MIN	**23-Apr**	**8-May**	**24-May**	**27**	**30-Apr**	**10-May**	**22-May**	**16**
10-Yr MAX	**16-May**	**3-Jun**	**16-Jun**	**43**	**22-May**	**29-May**	**9-Jun**	**30**

*Subyearling Chinook **MEDIAN, MIN, MAX** based on 1998-2005 data. Data from 2006-present not included due to potential bias from missed sample days during high water temperature sampling protocols (**Appendix K**).

1.2. Adult Fish Passage.

1.2.1. Adult Fish Facilities. The John Day Dam adult fish facilities include a north shore ladder to pass fish from entrances at the north end of the spillway, and a south shore ladder to pass fish from entrances along a collection channel extending the full length of the powerhouse. Auxiliary water is pumped from the tailrace to all collection systems. South auxiliary water also includes forebay water from the fish turbines. Counting stations are provided in both fishways. Annual maintenance of adult fish facilities is scheduled December 1 through the end of February (winter maintenance period) to minimize impacts on upstream migrants.

1.2.2. Adult Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult fish facilities are operated year-round. Adult salmon, steelhead, lamprey, and shad are typically counted April through October (**Table JDA-3**) and data are posted daily at: www.fpc.org/adultsalmon_home.html. Sturgeon and bull trout are relatively infrequent and are reported in *Miscellaneous Fish Counts* and in the *Annual Fish Passage Report*.

1.2.2.2. Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage defined in **Table JDA-4**. Time-of-day (diel) distributions of adult salmonid activity at John Day Dam fishway entrances and exits are shown in **Figure JDA-2**.

Table JDA-3. John Day Dam Adult Fish Count Schedule, 3/1/2018 – 2/28/2019.

Count Period	Counting Method and Hours *
March 1 – 31	Day Video 0400–2000 (PST)
April 1 – October 31	Visual 0500–2100 hours (PDT)
June 15 – September 30	Night Video 2100–0500 hours (PDT)
November 1 – end of February	Day Video 0400–2000 (PST)

*PST=Pacific Standard Time. PDT=Pacific Daylight Time (in effect during Daylight Saving Time 3/11/18-11/4/18).

Table JDA-4. John Day Dam Adult Count Period and Peak Passage Timing (based on yearly counts since 1968, except lamprey since 2000).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Apr 1 – Jun 5	Apr 14	May 24
Summer Chinook	Jun 6 – Aug 5	Jun 7	Aug 2
Fall Chinook	Aug 6 – Oct 31	Sep 2	Sep 25
Steelhead	Apr 1 – Oct 31	Aug 25	Oct 6
Sockeye	Apr 1 – Oct 31	Jun 21	Jul 10
Coho	Apr 1 – Oct 31	Sep 4	Oct 26
Lamprey	Apr 1 – Oct 31	Jun 30	Aug 12

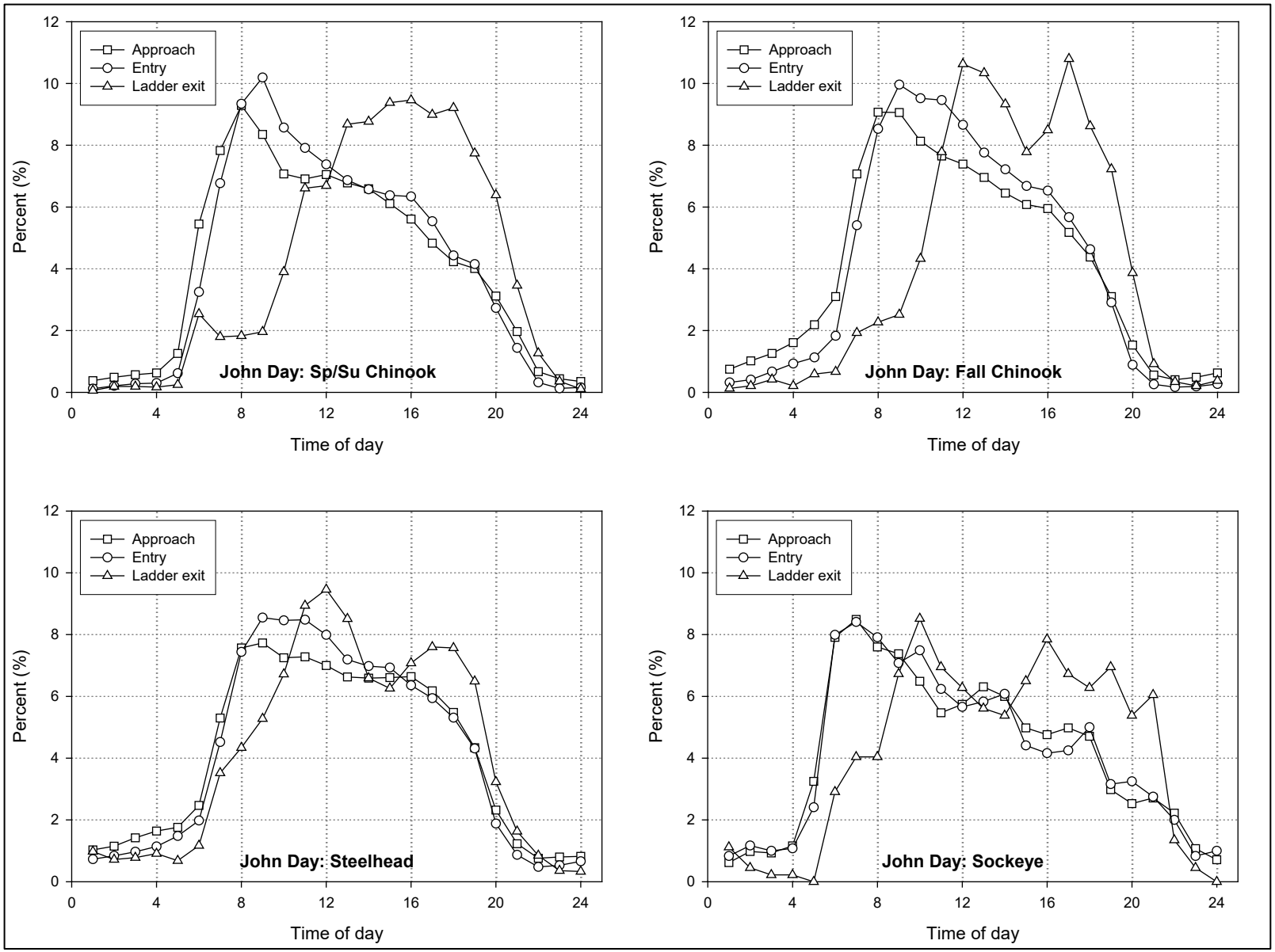


Figure JDA-3. Diel Distribution of Adult Salmonids at John Day Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*).
pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATION

2.1. General.

2.1.1. Research, non-routine maintenance, fish-related activities, and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

2.1.2. Yearly special operations related to research are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

2.1.3. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed immediately following the incident of steps taken to correct the situation. On a monthly basis, as necessary, the Project Biologist will provide FPOM a summary of any emergency actions undertaken.

2.1.4. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least two weeks in advance, unless deemed an emergency (see **Chapter 1 - Overview**).

2.2. Spill Management.

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the Fish Passage Plan as **Appendix E**. Spill patterns formulated with spillway deflectors in place for both adult and juvenile passage are defined in **Tables JDA-8, JDA-9**. Spill pattern modifications for barge traffic entering the navigation lock have been coordinated with the fish agencies and tribes through the proper regional fish forums (e.g., TMT, FPOM, FFDRWG). Minimum spill is 30% April 10–August 31 to provide adequate conditions in the tailrace for juvenile egress.

2.2.2. Excessive total dissolved gas (TDG) may harm fish and will be controlled to the extent possible, subject to river conditions. Management tools include system-wide spill distribution through the Spill Priority List issued by the Corps Northwestern Division Reservoir Control Center (RCC), night and/or day spill limits, and shaping of spill. Monitoring of TDG at John Day Dam occurs during the periods defined in **Table JDA-1**, pursuant to the Corps' annual *TDG Monitoring Plan* and *Dissolved Gas Monitoring Plan of Action 2015-2018*.[1]

2.2.3. From September 1 through November 30, adult fish attraction flow will be provided by spilling through Bay 2 open one stop (approximately 1.6 kcfs) during daylight hours defined in **Table JDA-5**.

[1] TDG Monitoring Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/. TDG Monitoring Plan 2015-2018: pweb.crohms.org/tmt/wqnew/tdg_monitoring/2015-18.pdf

Table JDA-5. Daytime Spill Hours for Adult Attraction at John Day Dam, September 1–November 30.

Date Range	Daytime Spill Hours	
	Begin	End
January 1–19	0700	1730
January 20 – February 14	0630	1800
February 15 – March 1	0600	1830
March 2 – April 2	0600	1930
April 3–20	0500	2030
April 21 – May 16	0500	2100
May 17–31	0430	2130
June 1–30	0430	2130
July 1–31	0430	2200
August 1–15	0500	2145
August 16–31	0500	2030
September 1–16	0530	2000
September 17 – October 4	0600	1930
October 5–19	0630	1900
October 20–29	0630	1830
October 30 – November 30	0630	1700
December 1–31	0630	1700

2.3. Operating Criteria - Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance (December 1 – March 31*).

**In 2018, the JBS and SMF will begin operations on March 1, as described below.*

2.3.1.1. Submersible traveling screens (STS) will remain in place and the juvenile bypass system (JBS) channel will operate through December 15 to prevent adult salmonids from falling back through turbine units, thereby shortening some aspects of the winter maintenance period by two weeks. Priority units will be screened during this period to the extent practicable (barring operational failure); STSs will only be removed from non-priority units when necessary to begin maintenance. After December 15, all STSs may be removed.

2.3.1.2. Dewater DSM channel only when required for inspection, maintenance, or structural modifications (**section 5**). Minimize the outage period to the extent practicable.

2.3.1.3. All units are available to meet power demands.

2.3.1.4. Remove debris from the forebay, all trash racks, and gatewell slots so these areas are debris-free by April 1, *except in 2018 when this is in effect March 1 due to early JBS start*.

2.3.1.5. Inspect all VBSs for damage, holes, debris accumulations, or protrusions (video inspection acceptable). Clean and repair when necessary.

2.3.1.6. Inspect and operate each STS.

2.3.1.7. *In 2018, install STSs by March 1 in at least the first four operational units in the priority order (**Table JDA-6**). Additional units may be screened prior to April 1 if maintenance schedules allow.* By April 1, install STSs in each intake slot of all operational units unless otherwise coordinated with the fish agencies and tribes.

2.3.1.8. Inspect all gatewell orifices and orifice lighting systems. Clean and/or repair where necessary such that these systems are debris-free and operable on April 1, *except in 2018 when this is in effect March 1 due to early JBS start*.

2.3.1.9. Check automatic control calibration/operation for the DSM tainter gate and other necessary sensors weekly. Recalibrate as necessary and report summaries of equipment recalibration in the weekly SMF operation monitoring reports.

2.3.1.10. Inspect and maintain DSM conduit tainter gate. Repair where necessary.

2.3.1.11. Inspect walls and floor of DSM conduit, raceway, and outfall. Correct any deficiencies.

2.3.1.12. Inspect spillbay gates and associated control system. Repair where necessary. Spillbays must be able to achieve FPP spill patterns on April 10, unless otherwise coordinated.

2.3.1.13. Avian Lines. See the *Avian Monitoring & Deterrence Action Plans* in **Appendix L**. Avian abatement measures shall be in place by April 1, or as soon as weather permits.

2.3.1.14. Smolt Monitoring Facility (SMF). Ensure all following items are fully operational. *In 2018, the SMF will begin operations on March 1.*

2.3.1.14.a. Dewatering facilities, including weir gates, perforated plates, screens (free of holes or gaps), and screen cleaner brush system;

2.3.1.14.b. All valves and auxiliary water systems;

2.3.1.14.c. Flushing water valves and their perforated plates;

2.3.1.14.d. All gates, including the crest, tainter, switch, and rotating gates;

2.3.1.14.e. Fish/debris separator, including perforated plates and adult passage chamber;

2.3.1.14.f. PIT-tag detectors;

2.3.1.14.g. All sampling building systems, including holding tanks, valves, and conduits (see specific list in the *SMF Operation & Maintenance Manual*).

2.3.2. Juvenile Facilities - Fish Passage Season (April 1* – November 30).

**In 2018, the JBS and SMF will begin operations on March 1, as described below.*

2.3.2.1. *In 2018, STSs will be installed by March 1 in at least the first four operational units in the priority order (**Table JDA-6**). Additional units may be screened prior to April 1 if maintenance schedules allow.* STSs will be in place prior to the beginning of the juvenile fish passage season and will remain in operation through December 15 for adult fallbacks, even though the juvenile passage season officially ends November 30.

2.3.2.2. Units without a full complement of rotating STSs will not operate except to be in compliance with other coordinated fish measures.

2.3.2.3. Inspect each STS, VBS, and orifice once per month or every 720 hours run-time. Video inspections are acceptable. More frequent inspections may be required under the following conditions: deterioration of fish condition, increased debris load in JBS, or other indications of STS or VBS malfunction or failure. If STS or VBS damage or plugging is detected, follow procedures in **section 3** below**.** Inspection records will be reported in weekly fishway status reports and provided to FPOM. Unit 2 will operate when Unit 1 is out of service for STS inspections.

2.3.2.4. Observe each STS amp and/or watt meter readings at least once per shift. If an STS failure occurs, then follow procedures in **section 3** below.

2.3.2.5. Inspect all STS gatewells daily. Clean gatewells before the gatewell water surface becomes 50% covered with debris. If due to the volume of debris it is not possible to keep the gatewell surfaces at least 50% clear, clean gatewells at least once daily. Do not operate turbines that have a gatewell fully covered with debris except to be in compliance with other coordinated fish measures, and then only on a "last-on/first-off" basis. Close the powerhouse gatewell orifices during cleaning. After gatewell de-barking, cycle the orifice in that gatewell. Check gatewell drawdown.

2.3.2.6. Measure gatewell drawdown across trashrack a minimum of once per week. Remove debris from forebay and trashracks as required to maintain gatewell drawdown <1.5 ft. If VBS drawdown reaches 1.2 ft, inspect the screen and prepare to clean as necessary.

2.3.2.7. Open all gatewell orifices April 1–December 15*, except in 2018 when this is in effect beginning March 1 due to early start of the JBS*. Inspect orifice lights daily to ensure lights are operating. Replace all burned out orifice lights within 24 hours. Close and open each orifice three times daily, or more frequently as determined by the Project Biologist due to heavy debris accumulation in gatewells. If a unit goes out of service, orifices are to remain open in associated gatewells unless that gatewell is dewatered.

2.3.2.8. From April 1 through August 1, rake Units 1–5 monthly and Units 6–10 *or* 11–16 every other month*, except in 2018 when this is in effect beginning March 1 due to early start of the JBS*. After August 1, rake units as determined necessary by ROV inspection, or as needed to maintain gatewell drawdown in criteria.

2.3.2.9. Debris accumulations in the forebay of 300 ft or more in any direction from the face of the dam will be removed within 48 hours. Debris removal efforts should continue until the debris load has been removed.

2.3.2.10. If debris loads are obvious in the forebay, trash will be raked in front of the affected units weekly until the debris load has been removed.

2.3.2.11. Additional raking will occur whenever trash accumulations are suspected because of increased differential (≥ 1.5 ft) across the trash racks, or as determined by the Project Biologist in response to increased juvenile fish descaling at the dam, deteriorating fish condition observed at the SMF, or increased accumulation of tumbleweeds in the forebay. Gatewell orifices of the unit being raked must be closed during the raking operation.

2.3.2.12. When using a dip basket for gatewell cleaning, coordinate with SMF personnel.

2.3.2.13. Make best efforts to keep all petroleum out of gatewells. Project environmental section will determine cleanup efforts if needed. Regardless of unit operating status, oil accumulations will be dealt with promptly.

2.3.2.14. Maintain water level in bypass conduit between 4.0'–5.0' as measured at Unit 16.

2.3.2.15. Smolt Monitoring Facility (SMF). From April 1–September 15 *(except in 2018 when the SMF will begin operations March 1)*, the SMF will be monitored 24 hours/day, 7 days/week by Project fish personnel to ensure proper functioning and to provide quick response to an emergency. On-duty staff will perform a walking inspection of the entire SMF system every two hours to ensure safe passage conditions. The system will be fully staffed while the SMF is in operation (i.e., crest gate deployed and secondary dewatering structure receiving fish-laden flow). To ensure proper function of sampling systems, particular attention will be directed to the following:

i. Dewatering facilities, including screens, being free of holes or gaps, and the screen cleaner brush system;

ii. All valves and auxiliary water systems;

iii. Flushing water valves and perforated plates;

iv. All gates, including crest, tainter, switch, and rotating gates;

v. Fish/debris separator (FDS), including perforated plates and adult passage chamber;

vi. PIT-tag detectors;

vii. All sampling building systems, including holding tanks, valves, and conduits;

viii. During low to normal debris loads, cycle the Primary Dewatering Screen (PDS) sweepers twice per shift (six times per day). If higher debris loads, increase

frequency of screen sweeper cycling as determined by the Project Fisheries inspection.

ix. Pay particular attention to the fish/debris separator (FDS) that needs to be visually inspected every 30 minutes to prevent injury and/or mortality to fish. During high debris loading periods (likely during spring runoff), additional personnel may be required to keep the FDS free of any obstruction to fish passage. The Project Biologist will decide to assign a person to remove debris from the FDS on a shift basis (possibly 24 hours/day presence) for as long as necessary to assure the safety of passing fish.

x. When river temperatures are ≥ 70°F, all fish handling to remove adult fish from the PDS area will be coordinated through FPOM.

2.3.2.16. Temporary Spillway Weirs (TSWs). [2]

2.3.2.16.a. Both TSWs will be installed as early as possible on the first day of spring spill and operated throughout the spring and summer spill seasons. Both TSWs will be removed from service as late as possible on the last normal work day of the summer spill season (no later than August 31). Spill for juvenile fish passage will be maintained through August 31, pursuant to the FOP (**Appendix E**).

2.3.2.16.b. During high flow events, TSW removal is recommended prior to river flows exceeding 685 kcfs.

2.3.2.17. Avian Lines. See the *Avian Monitoring & Deterrence Action Plans* in **Appendix L**. Reinstall or repair avian predation control lines as soon as possible following damage or removal. Install and maintain new avian predation control lines in locations determined to be significantly impacted by avian predators. Implement other avian abatement (hazing) as necessary from April through August only.

2.4. Operating Criteria - Adult Fish Facilities.

2.4.1. Adult Facilities - Winter Maintenance (December 1 – end of February).

2.4.1.1. Operate according to criteria for adult fish passage season (see **section 2.4.2**) except facilities may be dewatered or operated out of criteria for maintenance or repair. Outage periods will be minimized to the extent practicable. Only one of the two adult fish passage facilities may be out of service at a time. The other facility must be operated within passage season criteria unless otherwise coordinated with FPOM. However, Unit 2 may be operated in place of Unit 1 without special coordination when the south fishway is in service.

[2] Spillway weirs provide surface passage routes via spillbay(s). Temporary, or Top, Spillway Weirs (*TSW*s) at Little Goose, McNary and John Day dams can be installed, uninstalled, and moved between bays using the gantry crane. Removable Spillway Weirs (*RSW*s) at Lower Granite, Lower Monumental, and Ice Harbor dams are "removed" by controlled descent to the bottom of the forebay.

2.4.1.2. Inspect and calibrate all staff gauges, water level sensors, and indicators. Repair and/or clean where necessary.

2.4.1.3. Dewater and inspect all ladders and other dewatered sections of fish facilities for projections, debris, or plugged orifices that could injure or delay fish. Repair as needed.

2.4.1.4. Inspect ladder exits for debris and clean when necessary.

2.4.1.5. At the end of the adult fish counting season (see **Table JDA-3**), pull picket leads at counting stations and adjust crowders so that the counting slots are fully opened (this will be done shortly after adult fish counting ends). Reinstall picket leads at counting stations prior to watering up ladders during maintenance.

2.4.1.6. Repair or, when necessary, upgrade netting and padding at top of north fish ladders to address the fish jumping problem in this area.

2.4.1.7. Maximum head of 0.5' on attraction water intakes and trash racks at all ladder exits. Debris shall be removed when significant amounts accumulate.

2.4.2. Adult Facilities - Fish Passage Season (March 1 – November 30).

2.4.2.1. Water depth over fish ladder weirs 1.0' ±0.1'. When shad numbers exceed 5,000 per day per count station at Bonneville Dam, water depth should be increased to 1.3' ±0.1'.

2.4.2.2. Temperature Monitoring.

2.4.2.2.a. Measure water temperatures at the count stations of each ladder and include the weekly means in the status report. When water temperature reaches 70°F all fish handling activities will be coordinated with the Regional fish agencies through FPOM prior to any action to verify protocols that will be followed.

2.4.2.2.b. From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits.

b.1. Temperature monitors shall be placed within 10 meters of all shore-oriented entrances and exits.

b.2. If possible, the entrance monitor shall be within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers to allow for sufficient mixing with surface water.

b.3. The exit monitor shall be within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

b.4. If an existing temperature monitoring location is proposed for either the exit or entrance, it shall be verified that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.4.2.2.c. Project Fisheries will submit temperature data to the Fish Passage Center (FPC) weekly for posting online at: www.fpc.org/river/Q_ladderwatertempgraph.php.

2.4.2.3. Head on all entrances: 1'–2' (1.5' optimum). Refer to **section 3.3** when unable to achieve head criteria.

2.4.2.4. Maintain water velocity at 1.5–4.0 feet per second (2 fps optimum) in all channels and the lower ends of fish ladders that are below the tailwater. Open floating orifice gates 1, 2, 18 and 19, and operate three fish pumps to maintain fishway criteria. The entrance gate should be submerged 8' deep or greater to be in criteria. Fishway channel water velocities will be measured a minimum of three times weekly (daily preferred) during adult fish passage season (Mar 1 – Dec 1) as part of the fishway inspection program. Floats will be timed through all fishway channels that are supplemented by auxiliary water, and results reported in the project weekly fishway status report.

2.4.2.5. Maximum head of 0.5' on attraction water intakes and trashracks at all ladder exits, with a 0.3' maximum on all picket leads. Remove debris when significant amounts build up.

2.4.2.6. Staff gauges and water level indicators will be readable at all water levels encountered during the fish passage period, and calibration checked weekly. Instruments will be cleaned and/or recalibrated when necessary as soon as practicable.

2.4.2.7. Main entrance weir depths: 8' or greater below tailwater. Maintain tailwater elevation above 158'msl to stay within criteria operation range for entrance weirs.

2.4.2.8. Fish Counting. The current fish counting schedule is in **Table JDA-3**. The crowder shall be opened to full count slot width when not counting. The crowder shall be open as far as possible to allow accurate counting and shall not be closed to less than 18 inches while counting. This will usually occur during high turbidity conditions to maintain count accuracy.

2.4.2.8.a. Count station crowders shall be at maximum width that allows count or video accuracy. The minimum count slot width shall be ≥18". Crowder ranges are as follows:

i. JDA-North = 18"–28"

ii. JDA-South = 18"–30"

2.4.2.8.b. If passage is impaired by narrow count slot conditions, the count slot will be widened until proper passage conditions are achieved, despite count accuracy.

2.4.2.8.c. Project biologists, FFU, and the fish count supervisor shall coordinate to achieve optimum count slot passage and/or count accuracy conditions.

2.4.2.8.d. If counting is temporarily discontinued due to unscheduled events, the crowder shall be fully opened.

2.4.2.8.e. The crowder may remain in the operating position during the counters' hourly 10-minute break.

2.4.2.9. North Fishway.

2.4.2.9.a. Starting September 1, spill from Bay 2 (1 stop = 1.5k) for adult attraction during daylight hours through November (**Table JDA-5**).

2.4.2.9.b. Maintain netting and padding for the North fishway to address the adult salmonid jumping problem. All holes in the netting large enough to catch or allow escapement of an adult salmonid must be closed.

2.4.2.10. South Fishway. Operate entrance weir SE-1.

2.4.2.11. Powerhouse.

2.4.2.11.a. Operate entrances NE-1 and NE-2.

2.4.2.11.b. Operate four powerhouse floating orifices (1, 2, 18, 19) and open associated auxiliary water diffusers (see also **section 2.4.2.4**).

2.4.2.11.c. From 0400–2000 hours, operate Unit 1 near 100 megawatts (±10) to provide best entrance conditions. If additional load is required by BPA, Unit 1 may be operated above 100MW, but it should be the last brought up to full load when demand increases and the first to reduce when demand decreases (**Appendix C - Load Shaping Guidelines**).

3. FISH FACILITIES MONITORING & REPORTING

3.1. Inspections.

3.1.1. The results of all inspections and the readiness of the facilities for operation will be reported to the FPOM at the meeting immediately prior to the fish passage season.

3.1.2. During fish passage season, fish passage facilities will be inspected at least twice/day, seven days/week to assure operation according to established criteria.

3.1.3. During winter maintenance, fish facilities will be inspected once/day, seven days/week.

3.1.4. More frequent inspections of some facility components will occur as described throughout this document.

3.1.5. Additional fishway inspections may be performed by FFU and fish agencies.

3.2. Zebra Mussel Monitoring.

3.2.1. A zebra mussel monitoring program will continue. These organisms are a serious problem elsewhere in the country and may become introduced into the Columbia River basin. Inspections should also be made when dewatering all project facilities.

3.3. Reporting.

3.3.1. Project biologists shall prepare weekly reports throughout the year summarizing project operations. The weekly reports will provide an overview of how the project and the fish passage facilities operated during the week and an evaluation of resulting fish passage conditions. The reports shall include:

i. Any out-of-criteria situations observed and subsequent corrective actions taken;

ii. Any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities;

iii. Adult fishway control calibrations;

iv. STS and VBS inspections;

v. AWS closures (i.e. cleaning times);

vi. Any unusual activities that occurred at the project that may affect fish passage.

3.3.2. Weekly reports shall cover Sunday–Saturday period and shall be e-mailed to CENWP-OD, CENWD-PDW-RCC, and other interested parties as soon as possible the following week.

3.3.3. ***Memorandum for the Record*** **(MFR)** shall be prepared by Project biologists for any adverse or negative impact to fish or fishways. See **FPP Chapter 1 – Overview** for the MFR instructions and template. The MFR will be sent to FPOM by the next working day and added to the next FPOM agenda for review.

3.3.4. Project biologists shall prepare an annual report by January 31, summarizing the operation of the project fish passage facilities for the previous year.

3.3.4.1. The report will cover from the beginning of one adult fish facility winter maintenance period to the beginning of the next.

3.3.4.2. The annual report also will include a description of all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities in discouraging avian predation.

3.3.4.3. The annual report will be provided to CENWP-OD in time for distribution to FPOM members at the February meeting.

4. FISH FACILITIES MAINTENANCE

4.1. General.

4.1.1. Routine Maintenance. Scheduled fishway maintenance, to the extent practicable, will be conducted during periods when passage has been documented to be at its lowest to minimize impacts to migrating salmonids. Maintenance activities that occur during the fish passage period, and that may affect fish passage, will be reported in the weekly reports (**section 3.3**).

4.1.1.1. Staff gauges will be installed, cleaned, and/or repaired as required.

4.2. Maintenance - Juvenile Fish Facilities.

4.2.1. Routine Maintenance.

4.2.1.1. Submersible Traveling Screens (STS). The STS system may receive preventive maintenance or repair any time of the year as necessary. Most maintenance will occur during the winter maintenance period when all STSs may be removed from intakes. From April 1–December 15, a turbine unit cannot operate without a full complement of functioning STSs, *except in 2018 when at least the first four available priority units must have a full complement of STSs installed by March 1*.

4.2.1.2. Juvenile Bypass System (JBS). The JBS facilities may receive preventive maintenance at any time of the year as necessary in coordination with FPOM. During the juvenile fish passage season, this will normally be out-of-water work (e.g., maintenance of automatic systems, air lines, electrical systems, and monitoring equipment). During the winter maintenance period, the system is dewatered and visually inspected in all accessible areas for damaged equipment and areas that may cause potential problems to juvenile fish. Identified problems will be repaired by project maintenance or the contractor as soon as possible. Extended repair projects will be coordinated through FPOM.

4.2.1.3. Turbines and Spillway. Maintenance and routine repair of project turbines and spillways is a regular and recurring process that requires units shut down for extended periods of time (see **section 5**). Maintenance schedules for these turbines and spillways will be coordinated through FPOM. Certain turbine and spillway discharges at the projects are secondarily used to attract adult fish near fishway entrances to keep predator fish from accumulating in the area of juvenile release sites and to move juveniles downstream away from the project. The maintenance schedules for these turbines and spillways will reflect equal weight given to fish, power, and water management and will be coordinated with the appropriate fish agencies. Units that should not be scheduled for maintenance during the fish passage season are 1, 2, and 5. Some types of turbine maintenance will require testing turbine operation throughout the full operating range before returning it to normal service.

4.2.2. Non-Routine Maintenance. Non-routine maintenance of facilities will occur as described below. Activities that will significantly impact juvenile fish passage shall be coordinated through FPOM on a case-by-case basis by project and CENWP-OD biologists. See **FPP Chapter 1 – Overview** for the *Memo of Coordination* (MOC) instructions and template. CENWP-OD biologists will be notified as soon as possible after it becomes apparent that maintenance repairs are required. The Project Operations Manager has the authority to initiate work prior to notifying CENWP-OD when delay will result in an unsafe situation for people, property, or fish.

4.2.2.1. Submersible Traveling Screens (STS). If an STS or VBS is damaged or inoperative in an operating unit, the unit will be regarded as an unscreened unit. The screen will be repaired or replaced before returning the unit to service.

4.2.2.2. Juvenile Bypass System (JBS).

4.2.2.2.a. The JBS is automatically controlled. If the automatic system fails, it will be operated manually until automation repairs are made. If the orifices become plugged with debris, the turbine will not be operated until it has been cleaned.

4.2.2.2.b. Inspect all STS gatewells daily. Clean gatewells before the water surface becomes 50% covered with debris. If due to the volume of debris it is not possible to keep the gatewell surfaces at least 50% clear, they will be cleaned at least daily. Turbines with a gatewell fully covered with debris will not be operated except on a last-on/first-off basis if required to be in compliance with other coordinated fish measures. The gatewell orifices must be closed during the cleaning process. Juvenile mortality numbers will be monitored in all gatewells, as potential indicators of gatewell environment problems. Mortality estimates will be recorded and reported in the weekly status reports.

4.2.2.2.c. If the bypass system fails in the powerhouse conduit, tainter gate, or transportation outfall making the system unsafe for fish, a decision will be made in coordination with FPOM. During this emergency operating mode, power generation will be minimized to the extent practicable. If this operating mode is expected to last longer than four days, then all units required for generation will be shut down sequentially, fish salvaged from gatewells, STSs removed, and the unit restarted. Orifice gates will be closed during this process.

4.2.2.2.d. During fishway inspection activities, VBSs may be found plugged with debris, damaged or not properly seated. In these cases, the associated unit will be regarded as if unscreened and repairs will be made before returning the unit to operation.

4.2.2.3. Turbines and Spillways.

4.2.2.3.a. If a spill gate becomes inoperable, the operators will make the changes necessary to accommodate the spill and then immediately notify the operations supervisor and Project Biologist to determine the best pattern to follow until repairs can be made. This interim operation shall be coordinated with the FPOM through the district biologist who will provide additional guidance to the project.

4.2.2.3.b. Unit 2 will replace Unit 1 for adult attraction whenever Unit 1 is not operating.

4.2.2.3.c. From September 15 through end of February, spillbay 2 may be closed for up to one work day for maintenance activities. During the outage, spillbay 3 will be opened for attraction flow.

4.3. Maintenance - Adult Fish Facilities.

4.3.2. Routine Maintenance. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports (**section 3.3**).

4.3.2.1. Fishway Auxiliary Water Systems. John Day Dam has tailwater pump auxiliary water systems. Preventive maintenance and normal repair are carried out throughout the year.

Trash racks for the AWS intakes will be raked when drawdown exceeds criteria. When practicable, rake trash racks during the time of day when fish passage is least affected. During the annual navigation lock maintenance outage, the north fish ladder auxiliary water is shut off for about half a day. This is required to allow divers to clean off the navigation lock discharge sill so that a bulkhead can be placed.

4.3.2.2. Powerhouse and Spillway Fish Collection Systems. Preventive maintenance and repair occurs throughout the year as needed. During the adult fish passage season, this maintenance will not result in failing to achieve fishway criteria, unless coordinated through FPOM. During the winter maintenance period, an inspection will occur through dewatering or divers per discretion of the Project Biologists. One additional underwater diver/ROV will occur during August 1 - 15. Timing of this inspection will be coordinated through FPOM. The Project Biologist or alternate Corps fish personnel will attend all dewatering and inspection activities potentially involving fish (**section 5**).

4.3.2.3. Adult Fish Ladders and Counting Stations. Adult fish ladders will be dewatered once per year during the winter maintenance period. Unless specially coordinated, only one ladder will be dewatered at a time with the other ladder operating within criteria. During this time, the ladders are inspected for necessary maintenance needs and potential fish passage problems (e.g., blocked orifices, projections into the fishway that may injure fish, unstable weirs, damaged picket leads, exit gate problems, loose diffuser gratings, unreadable or damaged staff gauges, defective diffuser valves, and malfunctioning equipment at the counting stations). Potential problems identified throughout the passage year that do not impact fish passage, as well as those identified during the dewatered period, are then repaired. Trash racks at ladder exits will be raked when criteria are exceeded. When practicable, rake trash racks during the time of day when fish passage would be least impacted. Fish count station windows, light panels, and crowder panels will be cleaned as needed to achieve accurate counts and, when practicable, during the time of day when fish passage is least impacted. North netting installed on ladders to prevent fish leaping will be inspected daily and maintained as necessary. Inspection summaries will be included in the weekly activity report.

4.3.3. Non-Routine Maintenance. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports (**section 3.3**). Non-routine maintenance that will significantly affect the operation of a facility, such as repair of displaced diffuser gratings, will be coordinated through FPOM. Coordination procedures for non-routine maintenance of adult facilities are the same as for juvenile facilities (**section 4.2.2**).

4.3.3.1. Fishway Auxiliary Water Systems. The fishway auxiliary water systems are mostly automated. If the automatic system fails, the system will be operated manually by project personnel. This will allow the fish facility to operate according to criteria while the automatic system is repaired. When this operation becomes necessary, project personnel will increase the surveillance of the adult system to ensure that criteria are being met. The FPOM will work with the project to determine the best operation in the event of an AWS failure during the adult passage season.

4.3.3.1.a. South Ladder. If one of the three auxiliary water turbines fails, assuming all three turbines are being used to meet criteria, the output of the two remaining turbines will be increased to meet adult fishway criteria. If a second turbine unit fails, the adult fish facility will be operated as follows until a fishway head of 1' is achieved:

i. Increase discharge of remaining unit to maximum capacity;

ii. Close NE-1;

iii. Leave NE-2 at a depth of 8';

iv. Close remaining floating submerged orifice gate entrances starting at north end;

v. Leave south powerhouse entrance weir (SE-1) at 8' depth below tailwater surface.

vi. If criteria are still not achieved, reduce entrance weirs depth to 6', then to 4' if necessary, until more auxiliary water is available. Then reverse the above procedure.

vii. If all three turbine units fail, operate as follows until repairs can be made:

- Open SE-1 with the weir crest 6' below the tailwater surface;
- Close NE1 and NE2;
- Place cross-channel bulkheads in powerhouse collection channel between Units 2 and 3;
- Close floating orifice gate in front of Unit 2, leaving the floating orifice gate in front of Unit 1 open.

4.3.3.1.b. North Ladder. The 6 AWS pumps installed in 2011 are capable of achieving the optimal attraction criteria of 1.5' at all tailrace elevations. There is a built-in contingency as 1 of the 6 pumps is always spare and will be automatically started by PLC in case of another pump's failure.

4.3.3.2. Powerhouse and Spillway Fish Collection Systems. John Day Dam contains several types of fishway entrances. If failures occur, in most cases the entrance can be operated manually by project personnel until repaired. When this operation becomes necessary, project personnel will increase the surveillance of the adult system to ensure criteria are being met. In those cases in which the failure will not allow the entrance to be operated manually, the gate will be maintained, to the extent possible, in an operational position. If this is not possible, the entrance will be repaired expediently and the entrance will be returned to manual or automatic control at the earliest possible date.

4.3.3.3. Adult Fish Ladders and Counting Stations. Pickets with excessive spacing (>1"), erosion of concrete around the picket leads, or missing pickets can allow fish into areas where they cannot escape. The north count station upstream picket leads have an exit hatch that can be opened to allow fish to escape. Repair will be required for picket lead failure at the south count station. In the instances of picket lead failure or concrete erosion, the timing

and method of repair will depend upon the severity of the problem. The decision of whether or not to dewater the fishway for repairs will be made in coordination with FPOM.

4.3.3.4. Diffuser Gratings. Diffuser chambers for adding auxiliary water to ladders and collection channels are covered by gratings attached by several methods. Diffuser gratings are normally inspected during winter maintenance to ensure integrity. Inspections are done by either dewatering the fishway and/or collection channel, or by using video cameras and divers or other methods to inspect the gratings underwater. Diffuser gratings may come loose during fish passage season due to a variety of reasons. Daily inspections of the ladders and collection systems should include looking for flow changes that may indicate problems with diffuser gratings. If a diffuser grating is known to or suspected of having moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway. If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffusers gratings are found to be missing or displaced, close associated diffuser and develop a method of repair as coordinated with FPOM. Repair as quickly as possible unless coordinated differently.

5. TURBINE UNIT OPERATION & MAINTENANCE

5.1. Turbine Unit Priority Order.

5.1.1. Units will be operated in the order of priority defined in **Table JDA-6**, including time during synchronous condensing. If a unit is out of service for maintenance or repair, the next unit in the priority order shall be operated. Unit priority order may be coordinated differently for fish research, construction, or project maintenance.

Table JDA-6. John Day Dam Turbine Unit Priority Order.

Season	TSWs	Unit Priority Order*
March 1 – November 30 Fish Passage Season	With TSWs	5, 1, 3, 16, 14, 12, 10, 8, 15, 2, 11, 7, 4, 13, 9, 6
	No TSWs	1–4 any order, then 5–16 any order
December 1 – end of February Winter Maintenance Period	n/a	Any Order

*When a main unit is not available, the paired adjacent unit will be used to comply with requested priority.

5.2. Turbine Unit Operating Range.

5.2.1. In-Season (April 1–October 31). As defined in the *BPA Load Shaping Guidelines* (**Appendix C**), all units will be operated within ±1% of peak turbine efficiency (1% range) to maximize survival of juvenile fish that pass through the turbines. Turbine unit flow and power output at the lower and upper limits of the 1% range are defined in **Table JDA-7**.

5.2.1.1. If necessary to operate turbines outside the 1% range, they will be operated in sequence from north to south since juvenile passage through turbines decreases from south to north, making inefficient operation of Unit 16 least likely to impact fish. However, allowance will also be given to special project requirements for stable voltage control that requires load

distribution between transformer banks. If operation outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

i. Meet BPA load requests made pursuant to BPA's policy, statutory requirements, and *Load Shaping Guidelines* (**Appendix C**);

ii. If the draft tube is to be dewatered (**section 4.3.4**), the unit will be operated at full load >1% (or at speed-no-load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs in order to flush fish from the unit;

iii. Operate a turbine unit solely to provide station service; or

iv. Comply with other coordinated fish measures.

5.2.2. Off-Season (November 1–March 31). While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

Table JDA-7. John Day Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Turbine Efficiency (Lower and Upper Limits of 1% Range) and Operating Limits. [a]

Project Head (feet)	JDA Units 1-16 [b] - With STS						JDA Units 1-16 [b] - No STS					
	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
80	65.4	11,338	118.0	20,472	129.9	23,194	71.7	12,305	122.8	21,074	129.9	22,684
81	66.7	11,416	120.8	20,671	132.1	23,228	73.2	12,391	125.7	21,290	132.1	22,697
82	68.1	11,492	123.6	20,864	134.3	23,261	74.7	12,473	128.7	21,500	134.3	22,710
83	69.4	11,566	126.4	21,052	136.5	23,292	76.1	12,554	131.6	21,703	136.5	22,720
84	70.8	11,638	129.1	21,234	138.7	23,321	77.6	12,631	134.6	21,901	138.7	22,730
85	72.1	11,707	131.9	21,411	140.9	23,349	79.1	12,707	137.5	22,093	140.9	22,738
86	72.9	11,692	134.7	21,593	142.7	23,282	80.0	12,690	140.1	22,223	142.7	22,722
87	73.7	11,676	137.5	21,770	144.5	23,214	80.9	12,674	142.6	22,349	144.5	22,704
88	74.5	11,661	140.2	21,942	146.2	23,145	81.7	12,657	145.1	22,471	146.2	22,684
89	75.3	11,646	143.0	22,110	148.0	23,074	82.6	12,641	147.6	22,591	148.0	22,662
90	76.1	11,632	145.8	22,274	149.7	23,001	83.5	12,625	150.2	22,707	149.7	22,638
91	77.0	11,622	146.9	22,164	151.1	22,917	84.5	12,616	151.7	22,656	151.1	22,562
92	77.9	11,613	148.0	22,057	152.5	22,831	85.5	12,606	153.2	22,606	152.5	22,484
93	78.8	11,604	149.1	21,951	153.8	22,743	86.4	12,596	154.8	22,556	153.8	22,403
94	79.7	11,595	150.2	21,848	155.1	22,652	87.4	12,586	155.2 [c]	22,321	155.1	22,321
95	80.6	11,585	151.3	21,746	155.2	22,383	88.4	12,576	155.2 [c]	22,062	155.2	22,062
96	81.7	11,604	151.6	21,532	155.2	22,115	89.6	12,597	155.2 [c]	21,797	155.2	21,797
97	82.8	11,623	151.8	21,323	155.2	21,852	90.8	12,617	155.2 [c]	21,538	155.2	21,538
98	83.8	11,640	152.1	21,118	155.2	21,595	92.0	12,636	155.2 [c]	21,284	155.2	21,284
99	84.9	11,657	152.4	20,917	155.2	21,343	93.1	12,655	155.2 [c]	21,035	155.2	21,035
100	86.0	11,674	152.7	20,720	155.2	21,096	94.3	12,673	155.2 [c]	20,792	155.2	20,792
101	86.9	11,675	154.9	20,800	155.2	20,852	95.3	12,675	155.2 [c]	20,554	155.2	20,554
102	87.9	11,677	155.2 [c]	20,613	155.2	20,613	96.4	12,676	155.2 [c]	20,321	155.2	20,321
103	88.8	11,678	155.2 [c]	20,378	155.2	20,378	97.4	12,678	155.2 [c]	20,092	155.2	20,092
104	89.7	11,679	155.2 [c]	20,149	155.2	20,149	98.4	12,679	155.2 [c]	19,868	155.2	19,868
105	90.6	11,680	155.2 [c]	19,923	155.2	19,923	99.4	12,680	155.2 [c]	19,649	155.2	19,649
106	91.4	11,658	155.2 [c]	19,711	155.2	19,711	100.2	12,656	155.2 [c]	19,442	155.2	19,442
107	92.1	11,637	155.2 [c]	19,503	155.2	19,503	101.0	12,633	155.2 [c]	19,239	155.2	19,239
108	92.8	11,615	155.2 [c]	19,299	155.2	19,299	101.8	12,610	155.2 [c]	19,040	155.2	19,040
109	93.6	11,594	155.2 [c]	19,098	155.2	19,098	102.6	12,587	155.2 [c]	18,845	155.2	18,845
110	94.3	11,574	155.2 [c]	18,901	155.2	18,901	103.5	12,565	155.2 [c]	18,653	155.2	18,653

a. Table values derived from HDC report (Nov 2002). Flow (cfs) is calculated based on turbine efficiency, head, and power output (MW). "Operating Limit" is the maximum safe operating point, based on cavitation or generator limit (added Feb 2018).

b. As of Feb 2018, Units 4, 8, 9, 11, and 12 have fixed blades and restricted operating range of approximately 17-19 kcfs.

c. At project head ≥ 102 ft (with STS) and ≥ 94 ft (no STS), JDA units are restricted by the Operating Limit and cannot achieve the modeled upper limit of the 1% turbine efficiency range. Power (MW) and flow (cfs) values shown are at the Operating Limit, not the 1% upper limit.

5.3. Turbine Unit Maintenance.

5.3.1. Maintenance Schedules. Turbine unit maintenance schedules will be reviewed by Project and District biologists for fish impacts.

5.3.2. Operational Testing. Operational testing of a unit under maintenance is in addition to a unit in run status required for power plant reliability. Operational testing may deviate from FPP priority order and may require water that would otherwise be used for spill if the unit running for reliability is at its 1% lower limit (i.e., minimum generation). Water for operational testing will be used from powerhouse allocation when possible, and diverted from spill only to the extent necessary to maintain generation system reliability.

5.3.2.1. Pre-Maintenance: Before units go into maintenance status, units may be operationally tested for up to 30 minutes by running at speed-no-load and various loads within the 1% range for pre-maintenance measurements and testing, and to allow all fish to move through the unit as defined in **section 6.5.2**.

5.3.2.2. Post-Maintenance: After maintenance or repair, units may be operationally tested while remaining in maintenance or forced outage status for up to a cumulative time of 30 minutes (within 1% range) before returning to operational status.

5.3.3. Wicket gate opening for functional testing of a watered-up unit will be less than 15 minutes total open time.

6. DEWATERING PLANS

6.1. General.

6.1.1. *Guidelines for Dewatering and Fish Handling* (**Appendix F**) and project *Dewatering Plans*[3] have been developed by the projects and approved by FPOM, and are followed for most project facility dewaterings. The appropriate plans are reviewed by participants before each salvage operation. The plans include consideration for fish safety and are consistent with the following general guidance.

6.1.2. The project biologist and/or alternate Corps fish personnel will attend all project activities involving fish handling. Personnel shall remain present onsite during pumping operations to ensure stranding does not occur or a water level sensor that deactivates the dewatering process will be used. The fish agencies and tribes will be encouraged to participate in all ladder dewaterings.

6.1.3. During the pumping or draining operation to dewater a portion or all, the water level will not be allowed to drop so low it strands fish.

[3] Dewatering Plans are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/

6.2. Dewatering – Adult Fish Ladders.

6.2.1. Routine Maintenance.

6.2.1.1. When possible, operate ladders to be dewatered at orifice flow, with the AWS off, for at least 24 hours, but not more than 96 hours prior to dewatering.

6.2.1.2. The Project Biologist will ensure that fish rescue equipment is available and will coordinate to provide adequate personnel to move fish out of the dewatered ladder.

6.2.1.3. Project personnel will install head gates[4] to shut down ladder flow. Where possible, a flushing flow of 1"–2" will be maintained in the ladder until fish are rescued.

6.2.1.4. The Project Biologist or alternate Corps fish personnel will oversee fish rescue when the ladders are dewatered. The Project Biologist will invite fish agency and/or tribal biologists to participate in the dewatering activities. Captured fish will then be transported to the forebay or tailwater, depending on the fish life stage (adults to forebay, juveniles to tailrace), for release. If a ladder is dewatered in the spring or summer, steelhead kelts should be released into the tailrace.

6.2.1.5. Orifice blocking devices, which are placed in the lower-most weirs to prevent fish from re-ascending the dewatered portion of the adult fishway, shall have ropes attached to them by project operations and be tied off to fishway railings. The blocking devices shall be removed just before the fishway is returned to service. These devices will be noted on the pre-water-up checklist maintained by project fish biologists. This will prevent the orifice blocks from being unintentionally left in place following fishway water-up.

6.2.2. Non-Routine Maintenance. When possible, discontinue auxiliary water and operate ladder at reduced flow as long as possible for up to 72 hours prior to dewatering. Follow guidance in **section 6.4**.

6.3. Dewatering – Powerhouse Fish Collection System.

6.3.1. Routine Maintenance. During the pumping or draining operation to dewater a portion or the entire collection channel, the water will not be allowed to drop to a level which strands fish. Personnel shall remain present onsite during pumping operations to ensure that stranding does not occur. The Project Biologist will assure that all necessary rescue equipment is available. The Project Biologist or alternate Corps fish personnel will provide technical guidance on fish safety and will assist directly in rescue operations.

[4] Head gates may also be referred to as "operating" gates at some projects. The terms are interchangeable.

6.4. Dewatering – Juvenile Bypass System (JBS).

6.4.1. Routine Maintenance. When draining the juvenile bypass channel, it is typical to flush the channel with only bay 16 bypass orifices open. Bay 16 gatewells will be dipped in advance to minimize the number of fish contained in this flushing water during fish passage season.

6.5. Dewatering – Turbine Units.

6.5.1. Gatewell Dipping: Remove juvenile fish from gatewell(s) that will be drained by use of a special dipping basket. During fish passage season, April 1–December 15, gatewell dipping is mandatory whether or not fish screens are installed, *except in 2018 when this goes into effect starting March 1 for units that have screens installed for the early JBS start-up (see **section 2.3.2**)*. Dipping is not required during winter maintenance, December 16–March 31, when fish screens have been removed, *except in 2018 when screens will be installed by March 1 in at least the first four priority units*. To minimize the number of fish contained in the gatewell:

i. Shut down the turbine the previous evening/night and leave idle with all orifices open overnight if power demand allows;

ii. Keep orifices open during the removal of screens/STSs, during turbine spinning, and while gatewell dipping is performed;

iii. Close orifices only after gatewell dipping/fish removal has been completed and immediately before installing the bulkhead;

iv. It is strongly preferred that, if possible, two roller gates and one bulkhead are deployed to isolate a turbine for dewatering.

6.5.2. If the turbine draft tube is dewatered, operate unit at full load for a minimum of 15 minutes immediately prior to installing tail logs. If not possible to load, run unit at speed-no-load for a minimum of 15 minutes. Install the bottom two tail logs side-by-side prior to stacking the remainder to minimize risk of sturgeon entering the draft tube before dewatering. This is necessary for both scheduled and unscheduled outages.

6.5.3. If a turbine unit is idle and partially dewatered, and tail logs are to be put into place, an adequate safety pool may be maintained for up to 4 days to accommodate fish trapped in the draft tube. If longer timeframes are needed for the safety pool, project fisheries will coordinate with FPOM on a case-by-case basis. Adequate inspections will need to be conducted to ensure that the safety pool is maintained and fish are in good condition. Water levels in the draft tube will not be allowed to drop to a level that strands fish.

6.5.4. Fish rescue personnel will inspect dewatered turbine draft tubes, scroll cases, and intakes as soon as they can gain access and the water levels reach a depth permitting visual inspection. The Project Biologist or alternate fish personnel will provide technical guidance on fish safety and will directly participate in fish salvage.

6.5.5. The Project Biologist will assure that all necessary rescue equipment is available.

6.6. Dewatering – Navigation Lock.

6.6.1. The navigation lock is frequently dewatered for routine maintenance in late February/early March, in conjunction with navigation lock outages at The Dalles and Bonneville dams.

6.6.2. The area between the upstream bulkhead and the upstream gate is surveyed for fish as water levels allow. The lateral and pool areas on the floor of the lock are surveyed for fish from above. Most of these areas remain full of water, precluding the ability to implement successful fish salvage operations. Areas where water levels slowly decrease are accessed via crane when pool levels reach a depth of approximately 3 feet. The fill conduits are accessed and checked for fish only if needed and can be done safely. All salvaged fish are removed, transported via bag or tank and released to the river.

7. FOREBAY DEBRIS REMOVAL

7.1.1. Debris at projects can impact fish passage conditions. It can plug or block trash racks, VBSs, gatewell orifices, dewatering screens, separators, and facility piping resulting in impingement, injuries, and descaling of fish. Removing debris at its source in the forebay is sometimes necessary to maintain safe and efficient fish passage conditions, navigation, and other project activities. In this case, the only viable alternative is to spill to pass the debris.

7.1.2. Special spill operations that don't follow the normal spill schedule or volume limits will be coordinated prior to their execution. Normally, the project shall contact CENWP-OD at least two workdays prior to the day the special operation is required. Using information provided by the project, CENWP-OD will coordinate with FPOM and with RCC, as necessary. Once the coordination is complete, RCC will issue a teletype detailing the special operations.

8. RESPONSE TO HAZARDOUS MATERIALS SPILLS

8.1.1. John Day Project's guidance for responding to hazardous substance spills is contained in its *Emergency Spill Response Plan*. This guidance will be followed in case of a spill.

8.1.2. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.

8.1.3. Project Fisheries will be contacted as soon as possible after a hazardous material release and prior to any modification to fishway operations. Project Fisheries will then contact the CENWP-OD biologist and FPOM. Attempts should be made to first contact the Project Biologist on duty. During fish passage season there is a Project Biologist on duty 7 days/week. If a Project Biologist cannot be reached by radio or in the office, attempts to contact Project Fisheries will occur in the following order:

i. Miro Zyndol (541) 506-7860 or 980-9958. Home # available in Control Room.
ii. Tammy Mackey (503) 961-5733.

Table JDA-8. [*pg 1 of 11*] John Day Dam Spill Patterns with TSWs in Bays 18-19.

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
																	TSW	TSW		**0**	**19.4**
																	TSW	TSW	1	**1**	**21**
																	TSW	TSW	1.5	**1.5**	**21.8**
	1																TSW	TSW	1.5	**2.5**	**23.4**
	1	1															TSW	TSW	1.5	**3.5**	**25**
	1	1														1	TSW	TSW	1.5	**4.5**	**26.6**
	1	1													1	1	TSW	TSW	1.5	**5.5**	**28.2**
	1	1												1	1	1	TSW	TSW	1.5	**6.5**	**29.8**
	1	1											1	1	1	1	TSW	TSW	1.5	**7.5**	**31.4**
	1	1										1	1	1	1	1	TSW	TSW	1.5	**8.5**	**33**
	1	1									1	1	1	1	1	1	TSW	TSW	1.5	**9.5**	**34.6**
	1	1								1	1	1	1	1	1	1	TSW	TSW	1.5	**10.5**	**36.2**
	1	1							1	1	1	1	1	1	1	1	TSW	TSW	1.5	**11.5**	**37.8**
	1	1						1	1	1	1	1	1	1	1	1	TSW	TSW	1.5	**12.5**	**39.4**
	1	1					1	1	1	1	1	1	1	1	1	1	TSW	TSW	1.5	**13.5**	**41**
	1	1				1	1	1	1	1	1	1	1	1	1	1	TSW	TSW	1.5	**14.5**	**42.6**
	1	1	1			1	1	1	1	1	1	1	1	1	1	1	TSW	TSW	1.5	**15.5**	**44.2**
	1	1	1			1	1	1	1	1	1	1	1	1	1	1.5	TSW	TSW	1.5	**16**	**45**
	2	1	1			1	1	1	1	1	1	1	1	1	1	1.5	TSW	TSW	1.5	**16.5**	**45.8**
	2	1.5	1			1	1	1	1	1	1	1	1	1	1	1.5	TSW	TSW	1.5	**17**	**46.6**
	2	1.5	1	1		1	1	1	1	1	1	1	1	1	1	1.5	TSW	TSW	1.5	**18**	**48.2**
	2	1.5	1	1		1	1	1	1	1	1	1	1	1	1.5	1.5	TSW	TSW	1.5	**18.5**	**49**
	2	1.5	1.5	1		1	1	1	1	1	1	1	1	1	1.5	1.5	TSW	TSW	1.5	**19**	**49.8**
	2	1.5	1.5	1		1	1	1	1	1	1	1	1	1	1.5	1.5	TSW	TSW	2	**19.5**	**50.6**
	2	1.5	1.5	1		1	1	1	1	1	1	1	1	1	1.5	2	TSW	TSW	2	**20**	**51.4**
	2	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1.5	2	TSW	TSW	2	**21**	**53**
	2	1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1.5	2	TSW	TSW	2	**21.5**	**53.8**
	2	1.5	1	1.5	1	1	1	1.5	1	1	1	1	1	1	1.5	2	TSW	TSW	2	**22**	**54.6**
	2	1.5	1	1.5	1	1.5	1	1.5	1	1	1	1	1	1	1.5	2	TSW	TSW	2	**22.5**	**55.4**
	2	1.5	1	1.5	1	1.5	1	1.5	1	1	1	1	1	1.5	1.5	2	TSW	TSW	2	**23**	**56.2**
	2	1.5	1	1.5	1	1.5	1	1.5	1	1	1	1	1	1.5	2	2	TSW	TSW	2	**23.5**	**57**
	3	1.5	1	1.5	1	1.5	1	1.5	1	1	1	1	1	1.5	2	2	TSW	TSW	2	**24**	**57.8**
	3	1.5	1	1.5	1	1.5	1	1.5	1.5	1	1	1	1	1.5	2	2	TSW	TSW	2	**24.5**	**58.6**
	3	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1	1	1	1	1.5	2	2	TSW	TSW	2	**25**	**59.4**
	3	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1	1	1	1.5	1.5	2	2	TSW	TSW	2	**25.5**	**60.2**
	3	1.5	1	1.5	1	1.5	1.5	2	1.5	1	1	1	1.5	1.5	2	2	TSW	TSW	2	**26**	**61**
	3	1.5	1	1.5	1.5	1.5	1.5	2	1.5	1	1	1	1.5	1.5	2	2	TSW	TSW	2	**26.5**	**61.8**
	3	1.5	1	1.5	1.5	1.5	1.5	2	1.5	1	1	1.5	1.5	1.5	2	2	TSW	TSW	2	**27**	**62.6**
	3	1.5	1	1.5	1.5	1.5	1.5	2	1.5	1	1.5	1.5	1.5	1.5	2	2	TSW	TSW	2	**27.5**	**63.4**
	3	1.5	1	1.5	1.5	2	1.5	2	1.5	1	1.5	1.5	1.5	1.5	2	2	TSW	TSW	2	**28**	**64.2**
	3	1.5	1	1.5	1.5	2	1.5	2	1.5	1	1.5	1.5	1.5	1.5	2	2.5	TSW	TSW	2	**28.5**	**65**
	3	1.5	1	1.5	1.5	2	1.5	2	1.5	1	1.5	1.5	1.5	2	2	2.5	TSW	TSW	2	**29**	**65.8**
	3	1.5	1	1.5	1.5	2	1.5	2	1.5	1.5	1.5	1.5	1.5	2	2	2.5	TSW	TSW	2	**29.5**	**66.6**

[a] Spill (kcfs) is calculated as a function of total stops + TSW spill. At Spill >305 kcfs, transition from pattern for juvenile fish to flood.
[b] Gates 1 & 20 blocked at 11 stops (10.3 ft opening).
[c] TSWs in Bays 18-19 = fixed spill of ~19.4 kcfs (~9.7 kcfs/bay). TSW removal recommended for flow > 685 kcfs. TSW does not affect spillway flood capacity until flow ≥ 1,492 kcfs.

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
	3	1.5	1.5	1.5	1.5	2	1.5	2	1.5	1.5	1.5	1.5	1.5	2	2	2.5	TSW	TSW	2	**30**	**67.4**
	3	1.5	1.5	1.5	1.5	2	2	2	1.5	1.5	1.5	1.5	1.5	2	2	2.5	TSW	TSW	2	**30.5**	**68.2**
	3	1.5	1.5	1.5	1.5	2	2	2	1.5	1.5	1.5	1.5	2	2	2	2.5	TSW	TSW	2	**31**	**69**
	3	1.5	1.5	1.5	1.5	2	2	2	1.5	1.5	1.5	1.5	2	2	2.5	2.5	TSW	TSW	2	**31.5**	**69.8**
	3	2	1.5	1.5	1.5	2	2	2	1.5	1.5	1.5	1.5	2	2	2.5	2.5	TSW	TSW	2	**32**	**70.6**
	3	2	1.5	1.5	1.5	2	2	2	1.5	1.5	1.5	1.5	2	2	2.5	2.5	TSW	TSW	2.5	**32.5**	**71.4**
	3	2	1.5	1.5	1.5	2	2	2	1.5	1.5	1.5	2	2	2	2.5	2.5	TSW	TSW	2.5	**33**	**72.2**
	3	2	1.5	1.5	1.5	2	2	2	1.5	1.5	1.5	2	2	2	2.5	2.5	TSW	TSW	2.5	**33.5**	**73**
	3	2	1.5	2	1.5	2	2	2	1.5	1.5	1.5	2	2	2	2.5	2.5	TSW	TSW	2.5	**34**	**73.8**
	3	2	1.5	2	1.5	2	2	2	1.5	1.5	2	2	2	2	2.5	2.5	TSW	TSW	2.5	**34.5**	**74.6**
	3	2	1.5	2	1.5	2	2	2	2	1.5	2	2	2	2	2.5	2.5	TSW	TSW	2.5	**35**	**75.4**
	3	2	1.5	2	1.5	2	2	2	2	2	2	2	2	2	2.5	2.5	TSW	TSW	2.5	**35.5**	**76.2**
	3	2	1.5	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	TSW	TSW	2.5	**36**	**77**
	3	2	1.5	2	2	2.5	2	2	2	2	2	2	2	2	2.5	2.5	TSW	TSW	2.5	**36.5**	**77.8**
	3	2	2	2	2	2.5	2	2	2	2	2	2	2	2	2.5	2.5	TSW	TSW	2.5	**37**	**78.6**
	3	2.5	2	2	2	2.5	2	2	2	2	2	2	2	2	2.5	2.5	TSW	TSW	2.5	**37.5**	**79.4**
	3	2.5	2	2	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2.5	TSW	TSW	2.5	**38**	**80.2**
	4	2.5	2	2	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2.5	TSW	TSW	2.5	**38.5**	**81**
	4	2.5	2	2	2.5	2.5	2	2	2	2	2	2	2	2.5	2.5	2.5	TSW	TSW	2.5	**39**	**81.8**
	4	2.5	2	2	2.5	2.5	2.5	2	2	2	2	2	2	2.5	2.5	2.5	TSW	TSW	2.5	**39.5**	**82.6**
	4	2.5	2	2	2.5	2.5	2.5	2	2	2	2	2	2.5	2.5	2.5	2.5	TSW	TSW	2.5	**40**	**83.4**
	4	2.5	1.5	2	2.5	2.5	2.5	2.5	2	2	2	2.5	2.5	2.5	2.5	2.5	TSW	TSW	2.5	**40.5**	**84.2**
	4	2.5	1.5	2	2.5	2.5	2.5	2.5	2.5	2	2	2.5	2.5	2.5	2.5	2.5	TSW	TSW	2.5	**41**	**85**
	4	2.5	1.5	2	2.5	2.5	2.5	2.5	2.5	2	2	2.5	2.5	2.5	3	2.5	TSW	TSW	2.5	**41.5**	**85.8**
	4	2.5	1.5	2	2.5	2.5	2.5	2.5	2.5	2	2	2.5	2.5	3	3	2.5	TSW	TSW	2.5	**42**	**86.6**
	4	2.5	1.5	2	2.5	2.5	2.5	2.5	2.5	2	2.5	2.5	2.5	3	3	2.5	TSW	TSW	2.5	**42.5**	**87.4**
	4	3	1.5	2	2.5	2.5	2.5	2.5	2.5	2	2.5	2.5	2.5	3	3	2.5	TSW	TSW	2.5	**43**	**88.2**
	4	3	1.5	2	2.5	2.5	2.5	2.5	2.5	2	2.5	2.5	3	3	3	2.5	TSW	TSW	2.5	**43.5**	**89**
	4	3	1.5	2	2.5	3	2.5	2.5	2.5	2	2.5	2.5	3	3	3	2.5	TSW	TSW	2.5	**44**	**89.8**
	4	3	1.5	2	2.5	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	2.5	TSW	TSW	2.5	**44.5**	**90.6**
	4	3	2	2	2.5	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	2.5	TSW	TSW	2.5	**45**	**91.4**
	4	3	2	2	2.5	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	TSW	TSW	2.5	**45.5**	**92.2**
	4	3	2	2.5	2.5	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	TSW	TSW	2.5	**46**	**93**
	4	3	2	2.5	2.5	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3.5	3	TSW	TSW	2.5	**46.5**	**93.8**
	4	3.5	2	2.5	2.5	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3.5	3	TSW	TSW	2.5	**47**	**94.6**
	4	3.5	2	2.5	2.5	3	3	2.5	2.5	2.5	2.5	2.5	3	3	3.5	3	TSW	TSW	2.5	**47.5**	**95.4**
	4	3.5	2	2.5	2.5	3	3	2.5	2.5	2.5	2.5	2.5	3	3	3.5	3.5	TSW	TSW	2.5	**48**	**96.2**
	4	3.5	2	3	2.5	3	3	2.5	2.5	2.5	2.5	2.5	3	3	3.5	3.5	TSW	TSW	2.5	**48.5**	**97**
	4	3.5	2.5	3	2.5	3	3	2.5	2.5	2.5	2.5	2.5	3	3	3.5	3.5	TSW	TSW	2.5	**49**	**97.8**
	4	3.5	2.5	3	2.5	3	3	2.5	2.5	2.5	3	2.5	3	3	3.5	3.5	TSW	TSW	2.5	**49.5**	**98.6**
	4	3.5	2.5	3	2.5	3	3	3	2.5	2.5	3	2.5	3	3	3.5	3.5	TSW	TSW	2.5	**50**	**99.4**
	4	3.5	2.5	3	2.5	3	3	3	3	2.5	3	2.5	3	3	3.5	3.5	TSW	TSW	2.5	**50.5**	**100.2**
	4	3.5	2.5	3	2.5	3	3	3	3	2.5	3	3	3	3	3.5	3.5	TSW	TSW	2.5	**51**	**101**
	4	3.5	2.5	3.5	2.5	3	3	3	3	2.5	3	3	3	3	3.5	3.5	TSW	TSW	2.5	**51.5**	**101.8**
	4	3.5	3	3.5	2.5	3	3	3	3	2.5	3	3	3	3	3.5	3.5	TSW	TSW	2.5	**52**	**102.6**
	4	3.5	3	3.5	2.5	3	3	3	3	2.5	3	3	3	3	3.5	4	TSW	TSW	2.5	**52.5**	**103.4**
	4	3.5	3	3.5	2.5	3	3	3	3	2.5	3	3	3	3.5	3.5	4	TSW	TSW	2.5	**53**	**104.2**
	4	3.5	3	3.5	2.5	3	3	3	3	2.5	3	3	3	3.5	3.5	4	TSW	TSW	2.5	**53.5**	**105**
	4	3.5	3	3.5	2.5	3	3	3	3	3	3	3	3	3.5	3.5	4	TSW	TSW	2.5	**54**	**105.8**
	4	3.5	3	3.5	3	3	3	3	3	3	3	3	3	3.5	3.5	4	TSW	TSW	2.5	**54.5**	**106.6**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
	4	3.5	3	3.5	3	3	3	3	3	3	3	3	3	3.5	4	4	TSW	TSW	2.5	**55**	**107.4**
	4	3.5	3	3.5	3	3	3	3	3	3	3	3	3.5	3.5	4	4	TSW	TSW	2.5	**55.5**	**108.2**
	4	4	3	3.5	3	3	3	3	3	3	3	3	3.5	3.5	4	4	TSW	TSW	2.5	**56**	**109**
	4	4	3	3.5	3	3	3	3	3	3	3.5	3	3.5	3.5	4	4	TSW	TSW	2.5	**56.5**	**109.8**
	4	4	3	3.5	3	3.5	3	3	3	3	3.5	3	3.5	3.5	4	4	TSW	TSW	2.5	**57**	**110.6**
	4	4	3	3.5	3	3.5	3	3	3	3.5	3.5	3	3.5	3.5	4	4	TSW	TSW	2.5	**57.5**	**111.4**
	4	4	3	3.5	3	3.5	3	3	3	3.5	3.5	3.5	3.5	3.5	4	4	TSW	TSW	2.5	**58**	**112.2**
	4	4	3	3.5	3.5	3.5	3	3	3	3.5	3.5	3.5	3.5	3.5	4	4	TSW	TSW	2.5	**58.5**	**113**
	4	4	3	3.5	3.5	3.5	3	3.5	3	3.5	3.5	3.5	3.5	3.5	4	4	TSW	TSW	2.5	**59**	**113.8**
	4	4	3	3.5	3.5	3.5	3	3.5	3	3.5	3.5	3.5	3.5	3.5	4	4.5	TSW	TSW	2.5	**59.5**	**114.6**
	4	4	3	3.5	3.5	3.5	3	3.5	3	3.5	3.5	3.5	3.5	3.5	4	4.5	TSW	TSW	3	**60**	**115.4**
	4	4	3	3.5	3.5	3.5	3	3.5	3	3.5	3.5	3.5	3.5	4	4	4.5	TSW	TSW	3	**60.5**	**116.2**
	4	4	3.5	3.5	3.5	3.5	3	3.5	3	3.5	3.5	3.5	3.5	4	4	4.5	TSW	TSW	3	**61**	**117**
	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3	3.5	3.5	3.5	3.5	4	4	4.5	TSW	TSW	3	**61.5**	**117.8**
	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	TSW	TSW	3	**62**	**118.6**
	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	TSW	TSW	3	**62.5**	**119.4**
	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	4.5	TSW	TSW	3	**63**	**120.2**
	4	4.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	4.5	TSW	TSW	3	**63.5**	**121**
	4	4.5	3.5	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	4.5	TSW	TSW	3	**64**	**121.8**
	4	4.5	3.5	4	3.5	3.5	3.5	3.5	3.5	3.5	4	3.5	4	4	4.5	4.5	TSW	TSW	3	**64.5**	**122.6**
	4	4.5	3.5	4	3.5	4	3.5	3.5	3.5	3.5	4	3.5	4	4	4.5	4.5	TSW	TSW	3	**65**	**123.4**
	4	4.5	3.5	4	3.5	4	3.5	3.5	3.5	4	4	3.5	4	4	4.5	4.5	TSW	TSW	3	**65.5**	**124.2**
	4	4.5	3.5	4	3.5	4	3.5	3.5	3.5	4	4	4	4	4	4.5	4.5	TSW	TSW	3	**66**	**125**
	4	4.5	3.5	4	4	4	3.5	3.5	3.5	4	4	4	4	4	4.5	4.5	TSW	TSW	3	**66.5**	**125.8**
	4	4.5	3.5	4	4	4	3.5	4	3.5	4	4	4	4	4	4.5	4.5	TSW	TSW	3	**67**	**126.6**
	4	4.5	3.5	4	4	4	3.5	4	3.5	4	4	4	4	4	4.5	5	TSW	TSW	3	**67.5**	**127.4**
	4	4.5	3.5	4	4	4	3.5	4	3.5	4	4	4	4	4	4.5	5	TSW	TSW	3.5	**68**	**128.2**
	4	4.5	3.5	4	4	4	3.5	4	3.5	4	4	4	4	4.5	4.5	5	TSW	TSW	3.5	**68.5**	**129**
	4	4.5	4	4	4	4	3.5	4	3.5	4	4	4	4	4.5	4.5	5	TSW	TSW	3.5	**69**	**129.8**
	4	4.5	4	4	4	4	4	4	3.5	4	4	4	4	4.5	4.5	5	TSW	TSW	3.5	**69.5**	**130.6**
	4	4.5	4	4	4	4	4	4	4	4	4	4	4	4.5	4.5	5	TSW	TSW	3.5	**70**	**131.4**
	4	4.5	4	4	4	4	4	4	4	4	4	4	4	4.5	5	5	TSW	TSW	3.5	**70.5**	**132.2**
	4	4.5	4	4	4	4	4	4	4	4	4	4	4.5	4.5	5	5	TSW	TSW	3.5	**71**	**133**
	4	5	4	4	4	4	4	4	4	4	4	4	4.5	4.5	5	5	TSW	TSW	3.5	**71.5**	**133.8**
	4	5	4	4.5	4	4	4	4	4	4	4	4	4.5	4.5	5	5	TSW	TSW	3.5	**72**	**134.6**
	4	5	4	4.5	4	4	4	4	4	4	4.5	4	4.5	4.5	5	5	TSW	TSW	3.5	**72.5**	**135.4**
	4	5	4	4.5	4	4.5	4	4	4	4	4.5	4	4.5	4.5	5	5	TSW	TSW	3.5	**73**	**136.2**
	4	5	4	4.5	4	4.5	4	4	4	4.5	4.5	4	4.5	4.5	5	5	TSW	TSW	3.5	**73.5**	**137**
	4	5	4	4.5	4	4.5	4	4	4	4.5	4.5	4.5	4.5	4.5	5	5	TSW	TSW	3.5	**74**	**137.8**
	4	5	4	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	4.5	5	5	TSW	TSW	3.5	**74.5**	**138.6**
	4	5	4	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	4.5	4.5	5	5	TSW	TSW	3.5	**75**	**139.4**
	4	5	4	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	4.5	4.5	5	5.5	TSW	TSW	3.5	**75.5**	**140.2**
	4	5	4	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	4.5	4.5	5	5.5	TSW	TSW	4	**76**	**141**
	4	5	4	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	4.5	5	5	5.5	TSW	TSW	4	**76.5**	**141.8**
	4	5	4.5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	4.5	5	5	5.5	TSW	TSW	4	**77**	**142.6**
	4	5	4.5	4.5	4.5	4.5	4.5	4.5	4	4.5	4.5	4.5	4.5	5	5	5.5	TSW	TSW	4	**77.5**	**143.4**
	4	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5.5	TSW	TSW	4	**78**	**144.2**
	4	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5.5	5.5	TSW	TSW	4	**78.5**	**145**
	4	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5.5	5.5	TSW	TSW	4	**79**	**145.8**
	4	5.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5.5	5.5	TSW	TSW	4	**79.5**	**146.6**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
	4	5.5	4.5	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5.5	5.5	TSW	TSW	4	**80**	**147.4**
	4	5.5	4.5	5	4.5	4.5	4.5	4.5	4.5	4.5	5	4.5	5	5	5.5	5.5	TSW	TSW	4	**80.5**	**148.2**
	4	5.5	4.5	5	4.5	5	4.5	4.5	4.5	4.5	5	4.5	5	5	5.5	5.5	TSW	TSW	4	**81**	**149**
	4	5.5	4.5	5	4.5	5	4.5	4.5	4.5	5	5	4.5	5	5	5.5	5.5	TSW	TSW	4	**81.5**	**149.8**
	4	5.5	4.5	5	4.5	5	4.5	4.5	4.5	5	5	5	5	5	5.5	5.5	TSW	TSW	4	**82**	**150.6**
	4	5.5	4.5	5	5	5	4.5	4.5	4.5	5	5	5	5	5	5.5	5.5	TSW	TSW	4	**82.5**	**151.4**
	4	5.5	4.5	5	5	5	4.5	5	4.5	5	5	5	5	5	5.5	5.5	TSW	TSW	4	**83**	**152.2**
	4	5.5	4.5	5	5	5	4.5	5	4.5	5	5	5	5	5	5.5	6	TSW	TSW	4	**83.5**	**153**
	4	5.5	4.5	5	5	5	4.5	5	4.5	5	5	5	5	5	5.5	6	TSW	TSW	4.5	**84**	**153.8**
	4	5.5	4.5	5	5	5	4.5	5	4.5	5	5	5	5	5.5	5.5	6	TSW	TSW	4.5	**84.5**	**154.6**
	4	5.5	5	5	5	5	4.5	5	4.5	5	5	5	5	5.5	5.5	6	TSW	TSW	4.5	**85**	**155.4**
	4	5.5	5	5	5	5	5	5	4.5	5	5	5	5	5.5	5.5	6	TSW	TSW	4.5	**85.5**	**156.2**
	4	5.5	5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	6	TSW	TSW	4.5	**86**	**157**
	4	5.5	5	5	5	5	5	5	5	5	5	5	5	5.5	6	6	TSW	TSW	4.5	**86.5**	**157.8**
	4	5.5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	6	6	TSW	TSW	4.5	**87**	**158.6**
	4	6	5	5	5	5	5	5	5	5	5	5	5.5	5.5	6	6	TSW	TSW	4.5	**87.5**	**159.4**
	4	6	5	5.5	5	5	5	5	5	5	5	5	5.5	5.5	6	6	TSW	TSW	4.5	**88**	**160.2**
	4	6	5	5.5	5	5	5	5	5	5	5.5	5	5.5	5.5	6	6	TSW	TSW	4.5	**88.5**	**161**
	4	6	5	5.5	5	5.5	5	5	5	5	5.5	5	5.5	5.5	6	6	TSW	TSW	4.5	**89**	**161.8**
	4	6	5	5.5	5	5.5	5	5	5	5.5	5.5	5	5.5	5.5	6	6	TSW	TSW	4.5	**89.5**	**162.6**
	4	6	5	5.5	5	5.5	5	5	5	5.5	5.5	5.5	5.5	5.5	6	6	TSW	TSW	4.5	**90**	**163.4**
	4	6	5	5.5	5.5	5.5	5	5	5	5.5	5.5	5.5	5.5	5.5	6	6	TSW	TSW	4.5	**90.5**	**164.2**
	4	6	5	5.5	5.5	5.5	5	5.5	5	5.5	5.5	5.5	5.5	5.5	6	6	TSW	TSW	4.5	**91**	**165**
	4	6	5	5.5	5.5	5.5	5	5.5	5	5.5	5.5	5.5	5.5	5.5	6	6.5	TSW	TSW	4.5	**91.5**	**165.8**
	4	6	5	5.5	5.5	5.5	5	5.5	5	5.5	5.5	5.5	5.5	5.5	6	6.5	TSW	TSW	5	**92**	**166.6**
	4	6	5	5.5	5.5	5.5	5	5.5	5	5.5	5.5	5.5	5.5	6	6	6.5	TSW	TSW	5	**92.5**	**167.4**
	4	6	5.5	5.5	5.5	5.5	5	5.5	5	5.5	5.5	5.5	5.5	6	6	6.5	TSW	TSW	5	**93**	**168.2**
	4	6	5.5	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5.5	6	6	6.5	TSW	TSW	5	**93.5**	**169**
	4	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	6	6.5	TSW	TSW	5	**94**	**169.8**
	4	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	6.5	6.5	TSW	TSW	5	**94.5**	**170.6**
	4	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	6	6.5	6.5	TSW	TSW	5	**95**	**171.4**
	4	6	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	6	6.5	6.5	TSW	TSW	5	**95.5**	**172.2**
	4	6	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	6	5.5	6	6	6.5	6.5	TSW	TSW	5	**96**	**173**
	4	6	5.5	6	5.5	6	5.5	5.5	5.5	5.5	6	5.5	6	6	6.5	6.5	TSW	TSW	5	**96.5**	**173.8**
	4	6	5.5	6	5.5	6	5.5	5.5	5.5	6	6	5.5	6	6	6.5	6.5	TSW	TSW	5	**97**	**174.6**
	4	6	5.5	6	5.5	6	5.5	5.5	5.5	6	6	6	6	6	6.5	6.5	TSW	TSW	5	**97.5**	**175.4**
	4	6	5.5	6	6	6	5.5	5.5	5.5	6	6	6	6	6	6.5	6.5	TSW	TSW	5	**98**	**176.2**
	4	6	5.5	6	6	6	5.5	6	5.5	6	6	6	6	6	6.5	6.5	TSW	TSW	5	**98.5**	**177**
	4	6	5.5	6	6	6	5.5	6	5.5	6	6	6	6	6	6.5	7	TSW	TSW	5	**99**	**177.8**
	4	6	5.5	6	6	6	5.5	6	5.5	6	6	6	6	6	6.5	7	TSW	TSW	5.5	**99.5**	**178.6**
	4	6	5.5	6	6	6	5.5	6	5.5	6	6	6	6	6.5	6.5	7	TSW	TSW	5.5	**100**	**179.4**
	4	6	6	6	6	6	5.5	6	5.5	6	6	6	6	6.5	6.5	7	TSW	TSW	5.5	**100.5**	**180.2**
	4	6	6	6	6	6	6	6	5.5	6	6	6	6	6.5	6.5	7	TSW	TSW	5.5	**101**	**181**
	4	6	6	6	6	6	6	6	6	6	6	6	6	6.5	6.5	7	TSW	TSW	5.5	**101.5**	**181.8**
	4	6	6	6	6	6	6	6	6	6	6	6	6	6.5	7	7	TSW	TSW	5.5	**102**	**182.6**
	4	6	6	6	6	6	6	6	6	6	6	6	6.5	6.5	7	7	TSW	TSW	5.5	**102.5**	**183.4**
	4	6	6	6.5	6	6	6	6	6	6	6	6	6.5	6.5	7	7	TSW	TSW	5.5	**103**	**184.2**
	4	6	6	6.5	6	6	6	6	6	6	6.5	6	6.5	6.5	7	7	TSW	TSW	5.5	**103.5**	**185**
	4	6	6	6.5	6	6.5	6	6	6	6	6.5	6	6.5	6.5	7	7	TSW	TSW	5.5	**104**	**185.8**
	4	6	6	6.5	6	6.5	6	6	6	6.5	6.5	6	6.5	6.5	7	7	TSW	TSW	5.5	**104.5**	**186.6**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
	4	6	6	6.5	6	6.5	6	6	6	6.5	6.5	6.5	6.5	6.5	7	7	TSW	TSW	5.5	**105**	**187.4**
	4	6	6	6.5	6.5	6.5	6	6	6	6.5	6.5	6.5	6.5	6.5	7	7	TSW	TSW	5.5	**105.5**	**188.2**
	4	6	6	6.5	6.5	6.5	6	6.5	6	6.5	6.5	6.5	6.5	6.5	7	7	TSW	TSW	5.5	**106**	**189**
	4	6	6	6.5	6.5	6.5	6	6.5	6	6.5	6.5	6.5	6.5	6.5	7	7.5	TSW	TSW	5.5	**106.5**	**189.8**
	4	6	6	6.5	6.5	6.5	6	6.5	6	6.5	6.5	6.5	6.5	6.5	7	7.5	TSW	TSW	6	**107**	**190.6**
	4	6	6	6.5	6.5	6.5	6	6.5	6	6.5	6.5	6.5	6.5	7	7	7.5	TSW	TSW	6	**107.5**	**191.4**
	4	6	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6.5	6.5	6.5	7	7	7.5	TSW	TSW	6	**108**	**192.2**
	4	6	6.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6.5	6.5	6.5	7	7	7.5	TSW	TSW	6	**108.5**	**193**
	4	6	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7	7	7.5	TSW	TSW	6	**109**	**193.8**
	4	6	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7	7.5	7.5	TSW	TSW	6	**109.5**	**194.6**
	4	6	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7	7	7.5	7.5	TSW	TSW	6	**110**	**195.4**
	4	6	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7	7	7.5	7.5	TSW	TSW	6	**110.5**	**196.2**
	4	6	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	7	6.5	7	7	7.5	7.5	TSW	TSW	6	**111**	**197**
	4	6	6.5	7	6.5	7	6.5	6.5	6.5	6.5	7	6.5	7	7	7.5	7.5	TSW	TSW	6	**111.5**	**197.8**
	4	6	6.5	7	6.5	7	6.5	6.5	6.5	7	7	6.5	7	7	7.5	7.5	TSW	TSW	6	**112**	**198.6**
	4	6	6.5	7	6.5	7	6.5	6.5	6.5	7	7	7	7	7	7.5	7.5	TSW	TSW	6	**112.5**	**199.4**
	4	6	6.5	7	7	7	6.5	6.5	6.5	7	7	7	7	7	7.5	7.5	TSW	TSW	6	**113**	**200.2**
	4	6	6.5	7	7	7	6.5	7	6.5	7	7	7	7	7	7.5	7.5	TSW	TSW	6	**113.5**	**201**
	4	6	6.5	7	7	7	6.5	7	6.5	7	7	7	7	7	7.5	8	TSW	TSW	6	**114**	**201.8**
	4	6	6.5	7	7	7	6.5	7	6.5	7	7	7	7	7	7.5	8	TSW	TSW	6.5	**114.5**	**202.6**
	4	6	6.5	7	7	7	6.5	7	6.5	7	7	7	7	7.5	7.5	8	TSW	TSW	6.5	**115**	**203.4**
	4	6	7	7	7	7	6.5	7	6.5	7	7	7	7	7.5	7.5	8	TSW	TSW	6.5	**115.5**	**204.2**
	4	6	7	7	7	7	7	7	6.5	7	7	7	7	7.5	7.5	8	TSW	TSW	6.5	**116**	**205**
	4	6	7	7	7	7	7	7	7	7	7	7	7	7.5	7.5	8	TSW	TSW	6.5	**116.5**	**205.8**
	4	6	7	7	7	7	7	7	7	7	7	7	7	7.5	8	8	TSW	TSW	6.5	**117**	**206.6**
	4	6	7	7	7	7	7	7	7	7	7	7	7.5	7.5	8	8	TSW	TSW	6.5	**117.5**	**207.4**
	4	6	7	7.5	7	7	7	7	7	7	7	7	7.5	7.5	8	8	TSW	TSW	6.5	**118**	**208.2**
	4	6	7	7.5	7	7	7	7	7	7	7.5	7	7.5	7.5	8	8	TSW	TSW	6.5	**118.5**	**209**
	4	6	7	7.5	7	7.5	7	7	7	7	7.5	7	7.5	7.5	8	8	TSW	TSW	6.5	**119**	**209.8**
	4	6	7	7.5	7	7.5	7	7	7	7.5	7.5	7	7.5	7.5	8	8	TSW	TSW	6.5	**119.5**	**210.6**
	4	6	7	7.5	7	7.5	7	7	7	7.5	7.5	7.5	7.5	7.5	8	8	TSW	TSW	6.5	**120**	**211.4**
	4	6	7	7.5	7.5	7.5	7	7	7	7.5	7.5	7.5	7.5	7.5	8	8	TSW	TSW	6.5	**120.5**	**212.2**
	4	6	7	7.5	7.5	7.5	7	7.5	7	7.5	7.5	7.5	7.5	7.5	8	8	TSW	TSW	6.5	**121**	**213**
	4	6	7	7.5	7.5	7.5	7	7.5	7	7.5	7.5	7.5	7.5	7.5	8	8.5	TSW	TSW	6.5	**121.5**	**213.8**
	4	6	7	7.5	7.5	7.5	7	7.5	7	7.5	7.5	7.5	7.5	7.5	8	8.5	TSW	TSW	7	**122**	**214.6**
	4	6	7	7.5	7.5	7.5	7	7.5	7	7.5	7.5	7.5	7.5	8	8	8.5	TSW	TSW	7	**122.5**	**215.4**
	4	6	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7.5	7.5	7.5	8	8	8.5	TSW	TSW	7	**123**	**216.2**
	4	6	7.5	7.5	7.5	7.5	7.5	7.5	7	7.5	7.5	7.5	7.5	8	8	8.5	TSW	TSW	7	**123.5**	**217**
	4	6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8	8	8.5	TSW	TSW	7	**124**	**217.8**
	4	6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8	8.5	8.5	TSW	TSW	7	**124.5**	**218.6**
	4	6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8	8	8.5	8.5	TSW	TSW	7	**125**	**219.4**
	4	6	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8	8	8.5	8.5	TSW	TSW	7	**125.5**	**220.2**
	4	6	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	8	7.5	8	8	8.5	8.5	TSW	TSW	7	**126**	**221**
	4	6	7.5	8	7.5	8	7.5	7.5	7.5	7.5	8	7.5	8	8	8.5	8.5	TSW	TSW	7	**126.5**	**221.8**
	4	6	7.5	8	7.5	8	7.5	7.5	7.5	8	8	7.5	8	8	8.5	8.5	TSW	TSW	7	**127**	**222.6**
	4	6	7.5	8	7.5	8	7.5	7.5	7.5	8	8	8	8	8	8.5	8.5	TSW	TSW	7	**127.5**	**223.4**
	4	6	7.5	8	8	8	7.5	7.5	7.5	8	8	8	8	8	8.5	8.5	TSW	TSW	7	**128**	**224.2**
	4	6	7.5	8	8	8	7.5	8	7.5	8	8	8	8	8	8.5	8.5	TSW	TSW	7	**128.5**	**225**
	4	6	7.5	8	8	8	7.5	8	7.5	8	8	8	8	8	8.5	9	TSW	TSW	7	**129**	**225.8**
	4	6	7.5	8	8	8	7.5	8	7.5	8	8	8	8	8	8.5	9	TSW	TSW	7.5	**129.5**	**226.6**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
	4	6	7.5	8	8	8	7.5	8	7.5	8	8	8	8	8.5	8.5	9	TSW	TSW	7.5	**130**	**227.4**
	4	6	8	8	8	8	7.5	8	7.5	8	8	8	8	8.5	8.5	9	TSW	TSW	7.5	**130.5**	**228.2**
	4	6	8	8	8	8	8	8	7.5	8	8	8	8	8.5	8.5	9	TSW	TSW	7.5	**131**	**229**
	4	6	8	8	8	8	8	8	8	8	8	8	8	8.5	8.5	9	TSW	TSW	7.5	**131.5**	**229.8**
	4	6	8	8	8	8	8	8	8	8	8	8	8	8.5	9	9	TSW	TSW	7.5	**132**	**230.6**
	4	6	8	8	8	8	8	8	8	8	8	8	8.5	8.5	9	9	TSW	TSW	7.5	**132.5**	**231.4**
	4	6	8	8.5	8	8	8	8	8	8	8	8	8.5	8.5	9	9	TSW	TSW	7.5	**133**	**232.2**
	4	6	8	8.5	8	8	8	8	8	8	8.5	8	8.5	8.5	9	9	TSW	TSW	7.5	**133.5**	**233**
	4	6	8	8.5	8	8.5	8	8	8	8	8.5	8	8.5	8.5	9	9	TSW	TSW	7.5	**134**	**233.8**
	4	6	8	8.5	8	8.5	8	8	8	8.5	8.5	8	8.5	8.5	9	9	TSW	TSW	7.5	**134.5**	**234.6**
	4	6	8	8.5	8	8.5	8	8	8	8.5	8.5	8.5	8.5	8.5	9	9	TSW	TSW	7.5	**135**	**235.4**
	4	6	8	8.5	8.5	8.5	8	8	8	8.5	8.5	8.5	8.5	8.5	9	9	TSW	TSW	7.5	**135.5**	**236.2**
	4	6	8	8.5	8.5	8.5	8	8.5	8	8.5	8.5	8.5	8.5	8.5	9	9	TSW	TSW	7.5	**136**	**237**
	4	6	8	8.5	8.5	8.5	8	8.5	8	8.5	8.5	8.5	8.5	8.5	9	9.5	TSW	TSW	7.5	**136.5**	**237.8**
	4	6	8	8.5	8.5	8.5	8	8.5	8	8.5	8.5	8.5	8.5	8.5	9	9.5	TSW	TSW	8	**137**	**238.6**
	4	6	8	8.5	8.5	8.5	8	8.5	8	8.5	8.5	8.5	8.5	9	9	9.5	TSW	TSW	8	**137.5**	**239.4**
	4	6	8	8.5	8.5	8.5	8.5	8.5	8	8.5	8.5	8.5	8.5	9	9	9.5	TSW	TSW	8	**138**	**240.2**
	4	6	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9	9	9.5	TSW	TSW	8	**138.5**	**241**
	4	6	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9	9.5	9.5	TSW	TSW	8	**139**	**241.8**
	4	6	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9	9	9.5	9.5	TSW	TSW	8	**139.5**	**242.6**
	4	6	8	9	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9	9	9.5	9.5	TSW	TSW	8	**140**	**243.4**
	4	6	8	9	8.5	8.5	8.5	8.5	8.5	8.5	9	8.5	9	9	9.5	9.5	TSW	TSW	8	**140.5**	**244.2**
	4	6	8	9	8.5	9	8.5	8.5	8.5	8.5	9	8.5	9	9	9.5	9.5	TSW	TSW	8	**141**	**245**
	4	6	8	9	8.5	9	8.5	8.5	8.5	9	9	8.5	9	9	9.5	9.5	TSW	TSW	8	**141.5**	**245.8**
	4	6	8	9	8.5	9	8.5	8.5	8.5	9	9	9	9	9	9.5	9.5	TSW	TSW	8	**142**	**246.6**
	4	6	8	9	9	9	8.5	8.5	8.5	9	9	9	9	9	9.5	9.5	TSW	TSW	8	**142.5**	**247.4**
	4	6	8	9	9	9	8.5	9	8.5	9	9	9	9	9	9.5	9.5	TSW	TSW	8	**143**	**248.2**
	4	6	8	9	9	9	8.5	9	8.5	9	9	9	9	9	9.5	10	TSW	TSW	8	**143.5**	**249**
	4	6	8	9	9	9	8.5	9	8.5	9	9	9	9	9	9.5	10	TSW	TSW	8.5	**144**	**249.8**
	4	6	8	9	9	9	8.5	9	8.5	9	9	9	9	9.5	9.5	10	TSW	TSW	8.5	**144.5**	**250.6**
	4	6	8	9	9	9	9	9	8.5	9	9	9	9	9.5	9.5	10	TSW	TSW	8.5	**145**	**251.4**
	4	6	8	9	9	9	9	9	9	9	9	9	9	9.5	9.5	10	TSW	TSW	8.5	**145.5**	**252.2**
	4	6	8	9	9	9	9	9	9	9	9	9	9	9.5	10	10	TSW	TSW	8.5	**146**	**253**
	4	6	8	9	9	9	9	9	9	9	9	9	9.5	9.5	10	10	TSW	TSW	8.5	**146.5**	**253.8**
	4	6	8	9.5	9	9	9	9	9	9	9	9	9.5	9.5	10	10	TSW	TSW	8.5	**147**	**254.6**
	4	6	8	9.5	9	9	9	9	9	9	9.5	9	9.5	9.5	10	10	TSW	TSW	8.5	**147.5**	**255.4**
	4	6	8	9.5	9	9.5	9	9	9	9	9.5	9	9.5	9.5	10	10	TSW	TSW	8.5	**148**	**256.2**
	4	6	8	9.5	9	9.5	9	9	9	9.5	9.5	9	9.5	9.5	10	10	TSW	TSW	8.5	**148.5**	**257**
	4	6	8	9.5	9	9.5	9	9	9	9.5	9.5	9.5	9.5	9.5	10	10	TSW	TSW	8.5	**149**	**257.8**
	4	6	8	9.5	9.5	9.5	9	9	9	9.5	9.5	9.5	9.5	9.5	10	10	TSW	TSW	8.5	**149.5**	**258.6**
	4	6	8	9.5	9.5	9.5	9	9.5	9	9.5	9.5	9.5	9.5	9.5	10	10	TSW	TSW	8.5	**150**	**259.4**
	4	6	8	9.5	9.5	9.5	9	9.5	9	9.5	9.5	9.5	9.5	9.5	10	11	TSW	TSW	8.5	**151**	**260.2**
	4	6	8	9.5	9.5	9.5	9	9.5	9	9.5	9.5	9.5	9.5	9.5	10	11	TSW	TSW	9	**151.5**	**261**
	4	6	8	9.5	9.5	9.5	9	9.5	9	9.5	9.5	9.5	9.5	10	10	11	TSW	TSW	9	**152**	**261.8**
	4	6	8	9.5	9.5	9.5	9.5	9.5	9	9.5	9.5	9.5	9.5	10	10	11	TSW	TSW	9	**152.5**	**262.6**
	4	6	8	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	10	10	11	TSW	TSW	9	**153**	**263.4**
	4	6	8	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	10	11	11	TSW	TSW	9	**154**	**264.2**
	4	6	8	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	10	10	11	11	TSW	TSW	9	**154.5**	**265**
	4	6	8	10	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	10	10	11	11	TSW	TSW	9	**155**	**265.8**
	4	6	8	10	9.5	9.5	9.5	9.5	9.5	9.5	10	9.5	10	10	11	11	TSW	TSW	9	**155.5**	**266.6**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
	4	6	8	10	9.5	10	9.5	9.5	9.5	9.5	10	9.5	10	10	11	11	TSW	TSW	9	**156**	**267.4**
	4	6	8	10	9.5	10	9.5	9.5	9.5	10	10	9.5	10	10	11	11	TSW	TSW	9	**156.5**	**268.2**
	4	6	8	10	9.5	10	9.5	9.5	9.5	10	10	10	10	10	11	11	TSW	TSW	9	**157**	**269**
	4	6	8	10	10	10	9.5	9.5	9.5	10	10	10	10	10	11	11	TSW	TSW	9	**157.5**	**269.8**
	4	6	8	10	10	10	9.5	10	9.5	10	10	10	10	10	11	11	TSW	TSW	9	**158**	**270.6**
	4	6	8	10	10	10	9.5	10	9.5	10	10	10	10	10	11	11	TSW	TSW	9	**158**	**271.4**
	4	6	8	10	10	10	9.5	10	9.5	10	10	10	10	10	11	11	TSW	TSW	9.5	**158.5**	**272.2**
	4	6	8	10	10	10	9.5	10	9.5	10	10	10	10	11	11	11	TSW	TSW	9.5	**159.5**	**273**
	4	6	8	10	10	10	10	10	9.5	10	10	10	10	11	11	11	TSW	TSW	9.5	**160**	**273.8**
	4	6	8	10	10	10	10	10	10	10	10	10	10	11	11	11	TSW	TSW	9.5	**160.5**	**274.6**
	4	6	8	10	10	10	10	10	10	10	10	10	10	11	11	11	TSW	TSW	9.5	**160.5**	**275.4**
	4	6	8	10	10	10	10	10	10	10	10	10	11	11	11	11	TSW	TSW	9.5	**161.5**	**276.2**
	4	6	8	11	10	10	10	10	10	10	10	10	11	11	11	11	TSW	TSW	9.5	**162.5**	**277**
	4	6	8	11	10	10	10	10	10	10	11	10	11	11	11	11	TSW	TSW	9.5	**163.5**	**277.8**
	4	6	8	11	10	11	10	10	10	10	11	10	11	11	11	11	TSW	TSW	9.5	**164.5**	**278.6**
	4	6	8	11	10	11	10	10	10	11	11	10	11	11	11	11	TSW	TSW	9.5	**165.5**	**279.4**
	4	6	8	11	10	11	10	10	10	11	11	11	11	11	11	11	TSW	TSW	9.5	**166.5**	**280.2**
	4	6	8	11	11	11	10	10	10	11	11	11	11	11	11	11	TSW	TSW	9.5	**167.5**	**281**
	4	6	8	11	11	11	10	11	10	11	11	11	11	11	11	11	TSW	TSW	9.5	**168.5**	**281.8**
	4	6	8	11	11	11	10	11	10	11	11	11	11	11	11	12	TSW	TSW	9.5	**169.5**	**282.6**
	4	6	8	11	11	11	10	11	10	11	11	11	11	11	11	12	TSW	TSW	10	**170**	**283.4**
	4	6	8	11	11	11	10	11	10	11	11	11	11	11	11	12	TSW	TSW	10	**170**	**284.2**
	4	6	8	11	11	11	11	11	10	11	11	11	11	11	11	12	TSW	TSW	10	**171**	**285**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	11	12	TSW	TSW	10	**172**	**285.8**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**286.6**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**287.4**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**288.2**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**289**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**289.8**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**290.6**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**291.4**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**292.2**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**293**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10	**173**	**293.8**
	4	6	8	11	11	11	11	11	11	11	11	11	11	11	12	12	TSW	TSW	10.5	**173.5**	**294.6**
	4	6	8	11	11	11	11	11	11	11	11	11	11	12	12	12	TSW	TSW	10.5	**174.5**	**295.4**
	4	6	8	11	11	11	11	11	11	11	11	11	11	12	12	12	TSW	TSW	10.5	**174.5**	**296.2**
	4	6	8	11	11	11	11	11	11	11	11	11	11	12	12	12	TSW	TSW	10.5	**174.5**	**297**
	4	6	8	11	11	11	11	11	11	11	11	11	11	12	12	12	TSW	TSW	10.5	**174.5**	**297.8**
	4	6	8	11	11	11	11	11	11	11	11	11	12	12	12	12	TSW	TSW	10.5	**175.5**	**298.6**
	4	6	8	12	11	11	11	11	11	11	11	11	12	12	12	12	TSW	TSW	10.5	**176.5**	**299.4**
	4	6	8	12	11	11	11	11	11	11	12	11	12	12	12	12	TSW	TSW	10.5	**177.5**	**300.2**
	4	6	8	12	11	12	11	11	11	11	12	11	12	12	12	12	TSW	TSW	10.5	**178.5**	**301**
	4	6	8	12	11	12	11	11	11	12	12	11	12	12	12	12	TSW	TSW	10.5	**179.5**	**301.8**
	4	6	8	12	11	12	11	11	11	12	12	12	12	12	12	12	TSW	TSW	10.5	**180.5**	**302.6**
	4	6	8	12	12	12	11	11	11	12	12	12	12	12	12	12	TSW	TSW	10.5	**181.5**	**303.4**
	4	6	8	12	12	12	11	12	11	12	12	12	12	12	12	12	TSW	TSW	10.5	**182.5**	**304.2**
	4	6	8	12	12	12	11	12	11	12	12	12	12	12	12	12	TSW	TSW	11	**183**	**305**
	4	6	8	12	12	12	12	12	11	12	12	12	12	12	12	12	TSW	TSW	11	**184**	**305.8**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
	4	6	8	12	12	12	12	12	11	12	12	12	12	12	12	12	TSW	TSW	11	**184**	**306.6**
	4	6	8	12	12	12	12	12	11	12	12	12	12	12	12	12	TSW	TSW	11	**184**	**307.4**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**308.2**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**309**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**309.8**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**310.6**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**311.4**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**312.2**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**313**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**313.8**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**314.6**
	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**185**	**315.4**
1	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**186**	**317**
2	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**187**	**318.6**
3	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**188**	**320.2**
3	4	6	9	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**189**	**321.8**
4	4	6	9	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**190**	**323.4**
4	5	6	9	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**191**	**325**
4	5	7	9	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**192**	**326.6**
4	5	7	10	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**193**	**328.2**
5	5	7	10	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**194**	**329.8**
5	6	7	10	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**195**	**331.4**
5	6	8	10	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**196**	**333**
5	6	8	11	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**197**	**334.6**
6	6	8	11	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**198**	**336.2**
6	7	8	11	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**199**	**337.8**
6	7	9	11	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**200**	**339.4**
6	7	9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**201**	**341**
7	7	9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**202**	**342.6**
7	8	9	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**203**	**344.2**
7	8	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**204**	**345.8**
8	8	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**205**	**347.4**
8	9	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**206**	**349**
8	9	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**207**	**350.6**
9	9	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**208**	**352.2**
9	10	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**209**	**353.8**
10	10	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**210**	**355.4**
10	11	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**211**	**357**
10	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**212**	**358.6**
11	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**213**	**360.2**
11	11	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	TSW	TSW	11	**214**	**361.8**
11	11	13	12	12	12	12	12	12	12	12	12	12	12	12	12	13	TSW	TSW	11	**215**	**363.4**
11	11	13	13	12	12	12	12	12	12	12	12	12	12	12	12	13	TSW	TSW	11	**216**	**365**
11	11	13	13	12	12	12	12	12	12	12	12	12	12	13	12	13	TSW	TSW	11	**217**	**366.6**
11	11	13	13	13	12	12	12	12	12	12	12	12	12	13	12	13	TSW	TSW	11	**218**	**368.2**
11	11	13	13	13	12	12	13	12	12	12	12	12	12	13	12	13	TSW	TSW	11	**219**	**369.8**
11	11	13	13	13	12	12	13	12	13	12	12	12	12	13	12	13	TSW	TSW	11	**220**	**371.4**
11	11	13	13	13	12	12	13	12	13	12	13	12	12	13	12	13	TSW	TSW	11	**221**	**373**
11	11	13	13	13	13	12	13	12	13	12	13	12	12	13	12	13	TSW	TSW	11	**222**	**374.6**
11	11	13	13	13	13	12	13	12	13	12	13	12	12	13	13	13	TSW	TSW	11	**223**	**376.2**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
11	11	13	13	13	13	13	13	12	13	12	13	12	12	13	13	13	TSW	TSW	11	**224**	**377.8**
11	11	13	13	13	13	13	13	12	13	12	13	12	13	13	13	13	TSW	TSW	11	**225**	**379.4**
11	11	13	13	13	13	13	13	13	13	12	13	12	13	13	13	13	TSW	TSW	11	**226**	**381**
11	11	13	13	13	13	13	13	13	13	13	13	12	13	13	13	13	TSW	TSW	11	**227**	**382.6**
11	11	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	TSW	TSW	11	**228**	**384.2**
11	11	14	13	13	13	13	13	13	13	13	13	13	13	13	13	13	TSW	TSW	11	**229**	**385.8**
11	11	14	13	13	13	13	13	13	13	13	13	13	13	13	13	14	TSW	TSW	11	**230**	**387.4**
11	11	14	14	13	13	13	13	13	13	13	13	13	13	13	13	14	TSW	TSW	11	**231**	**389**
11	11	14	14	13	13	13	13	13	13	13	13	13	13	14	13	14	TSW	TSW	11	**232**	**390.6**
11	11	14	14	14	13	13	13	13	13	13	13	13	13	14	13	14	TSW	TSW	11	**233**	**392.2**
11	11	14	14	14	13	13	14	13	13	13	13	13	13	14	13	14	TSW	TSW	11	**234**	**393.8**
11	11	14	14	14	13	13	14	13	14	13	13	13	13	14	13	14	TSW	TSW	11	**235**	**395.4**
11	11	14	14	14	13	13	14	13	14	13	14	13	13	14	13	14	TSW	TSW	11	**236**	**397**
11	11	14	14	14	14	13	14	13	14	13	14	13	13	14	13	14	TSW	TSW	11	**237**	**398.6**
11	11	14	14	14	14	13	14	13	14	13	14	13	13	14	14	14	TSW	TSW	11	**238**	**400.2**
11	11	14	14	14	14	14	14	13	14	13	14	13	13	14	14	14	TSW	TSW	11	**239**	**401.8**
11	11	14	14	14	14	14	14	13	14	13	14	13	14	14	14	14	TSW	TSW	11	**240**	**403.4**
11	11	14	14	14	14	14	14	14	14	13	14	13	14	14	14	14	TSW	TSW	11	**241**	**405**
11	11	14	14	14	14	14	14	14	14	14	14	13	14	14	14	14	TSW	TSW	11	**242**	**406.6**
11	11	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	TSW	TSW	11	**243**	**408.2**
11	11	15	14	14	14	14	14	14	14	14	14	14	14	14	14	14	TSW	TSW	11	**244**	**409.8**
11	11	15	14	14	14	14	14	14	14	14	14	14	14	14	14	15	TSW	TSW	11	**245**	**411.4**
11	11	15	15	14	14	14	14	14	14	14	14	14	14	14	14	15	TSW	TSW	11	**246**	**413**
11	11	15	15	14	14	14	14	14	14	14	14	14	14	15	14	15	TSW	TSW	11	**247**	**414.6**
11	11	15	15	15	14	14	14	14	14	14	14	14	14	15	14	15	TSW	TSW	11	**248**	**416.2**
11	11	15	15	15	14	14	15	14	14	14	14	14	14	15	14	15	TSW	TSW	11	**249**	**417.8**
11	11	15	15	15	14	14	15	14	15	14	14	14	14	15	14	15	TSW	TSW	11	**250**	**419.4**
11	11	15	15	15	14	14	15	14	15	14	15	14	14	15	14	15	TSW	TSW	11	**251**	**421**
11	11	15	15	15	15	14	15	14	15	14	15	14	14	15	14	15	TSW	TSW	11	**252**	**422.6**
11	11	15	15	15	15	14	15	14	15	14	15	14	14	15	15	15	TSW	TSW	11	**253**	**424.2**
11	11	15	15	15	15	15	15	14	15	14	15	14	14	15	15	15	TSW	TSW	11	**254**	**425.8**
11	11	15	15	15	15	15	15	14	15	14	15	14	15	15	15	15	TSW	TSW	11	**255**	**427.4**
11	11	15	15	15	15	15	15	15	15	14	15	14	15	15	15	15	TSW	TSW	11	**256**	**429**
11	11	15	15	15	15	15	15	15	15	15	15	14	15	15	15	15	TSW	TSW	11	**257**	**430.6**
11	11	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	TSW	TSW	11	**258**	**432.2**
11	11	16	15	15	15	15	15	15	15	15	15	15	15	15	15	15	TSW	TSW	11	**259**	**433.8**
11	11	16	15	15	15	15	15	15	15	15	15	15	15	15	15	16	TSW	TSW	11	**260**	**435.4**
11	11	16	16	15	15	15	15	15	15	15	15	15	15	15	15	16	TSW	TSW	11	**261**	**437**
11	11	16	16	15	15	15	15	15	15	15	15	15	15	16	15	16	TSW	TSW	11	**262**	**438.6**
11	11	16	16	16	15	15	15	15	15	15	15	15	15	16	15	16	TSW	TSW	11	**263**	**440.2**
11	11	16	16	16	15	15	16	15	15	15	15	15	15	16	15	16	TSW	TSW	11	**264**	**441.8**
11	11	16	16	16	15	15	16	15	16	15	15	15	15	16	15	16	TSW	TSW	11	**265**	**443.4**
11	11	16	16	16	15	15	16	15	16	15	16	15	15	16	15	16	TSW	TSW	11	**266**	**445**
11	11	16	16	16	16	15	16	15	16	15	16	15	15	16	15	16	TSW	TSW	11	**267**	**446.6**
11	11	16	16	16	16	15	16	15	16	15	16	15	15	16	16	16	TSW	TSW	11	**268**	**448.2**
11	11	16	16	16	16	16	16	15	16	15	16	15	15	16	16	16	TSW	TSW	11	**269**	**449.8**
11	11	16	16	16	16	16	16	15	16	15	16	15	16	16	16	16	TSW	TSW	11	**270**	**451.4**
11	11	16	16	16	16	16	16	16	16	15	16	15	16	16	16	16	TSW	TSW	11	**271**	**453**
11	11	16	16	16	16	16	16	16	16	16	16	15	16	16	16	16	TSW	TSW	11	**272**	**454.6**
11	11	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	TSW	TSW	11	**273**	**456.2**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1[b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
11	11	17	16	16	16	16	16	16	16	16	16	16	16	16	16	16	TSW	TSW	11	**274**	**457.8**
11	11	17	16	16	16	16	16	16	16	16	16	16	16	16	16	17	TSW	TSW	11	**275**	**459.4**
11	11	17	17	16	16	16	16	16	16	16	16	16	16	16	16	17	TSW	TSW	11	**276**	**461**
11	11	17	17	16	16	16	16	16	16	16	16	16	16	17	16	17	TSW	TSW	11	**277**	**462.6**
11	11	17	17	17	16	16	16	16	16	16	16	16	16	17	16	17	TSW	TSW	11	**278**	**464.2**
11	11	17	17	17	16	16	17	16	16	16	16	16	16	17	16	17	TSW	TSW	11	**279**	**465.8**
11	11	17	17	17	16	16	17	16	17	16	16	16	16	17	16	17	TSW	TSW	11	**280**	**467.4**
11	11	17	17	17	16	16	17	16	17	16	17	16	16	17	16	17	TSW	TSW	11	**281**	**469**
11	11	17	17	17	17	16	17	16	17	16	17	16	16	17	16	17	TSW	TSW	11	**282**	**470.6**
11	11	17	17	17	17	16	17	16	17	16	17	16	16	17	17	17	TSW	TSW	11	**283**	**472.2**
11	11	17	17	17	17	17	17	16	17	16	17	16	16	17	17	17	TSW	TSW	11	**284**	**473.8**
11	11	17	17	17	17	17	17	16	17	16	17	16	17	17	17	17	TSW	TSW	11	**285**	**475.4**
11	11	17	17	17	17	17	17	17	17	16	17	16	17	17	17	17	TSW	TSW	11	**286**	**477**
11	11	17	17	17	17	17	17	17	17	17	17	16	17	17	17	17	TSW	TSW	11	**287**	**478.6**
11	11	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	TSW	TSW	11	**288**	**480.2**
11	11	18	17	17	17	17	17	17	17	17	17	17	17	17	17	17	TSW	TSW	11	**289**	**481.8**
11	11	18	17	17	17	17	17	17	17	17	17	17	17	17	17	18	TSW	TSW	11	**290**	**483.4**
11	11	18	18	17	17	17	17	17	17	17	17	17	17	17	17	18	TSW	TSW	11	**291**	**485**
11	11	18	18	17	17	17	17	17	17	17	17	17	17	18	17	18	TSW	TSW	11	**292**	**486.6**
11	11	18	18	18	17	17	17	17	17	17	17	17	17	18	17	18	TSW	TSW	11	**293**	**488.2**
11	11	18	18	18	17	17	18	17	17	17	17	17	17	18	17	18	TSW	TSW	11	**294**	**489.8**
11	11	18	18	18	17	17	18	17	18	17	17	17	17	18	17	18	TSW	TSW	11	**295**	**491.4**
11	11	18	18	18	17	17	18	17	18	17	18	17	17	18	17	18	TSW	TSW	11	**296**	**493**
11	11	18	18	18	18	17	18	17	18	17	18	17	17	18	17	18	TSW	TSW	11	**297**	**494.6**
11	11	18	18	18	18	17	18	17	18	17	18	17	17	18	18	18	TSW	TSW	11	**298**	**496.2**
11	11	18	18	18	18	18	18	17	18	17	18	17	17	18	18	18	TSW	TSW	11	**299**	**497.8**
11	11	18	18	18	18	18	18	17	18	17	18	17	18	18	18	18	TSW	TSW	11	**300**	**499.4**
11	11	18	18	18	18	18	18	18	18	17	18	17	18	18	18	18	TSW	TSW	11	**301**	**501**
11	11	18	18	18	18	18	18	18	18	18	18	17	18	18	18	18	TSW	TSW	11	**302**	**502.6**
11	11	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	TSW	TSW	11	**303**	**504.2**
11	11	19	18	18	18	18	18	18	18	18	18	18	18	18	18	18	TSW	TSW	11	**304**	**505.8**
11	11	19	18	18	18	18	18	18	18	18	18	18	18	18	18	19	TSW	TSW	11	**305**	**507.4**
11	11	19	19	18	18	18	18	18	18	18	18	18	18	18	18	19	TSW	TSW	11	**306**	**509**
11	11	19	19	18	18	18	18	18	18	18	18	18	18	19	18	19	TSW	TSW	11	**307**	**510.6**
11	11	19	19	19	18	18	18	18	18	18	18	18	18	19	18	19	TSW	TSW	11	**308**	**512.2**
11	11	19	19	19	18	18	19	18	18	18	18	18	18	19	18	19	TSW	TSW	11	**309**	**513.8**
11	11	19	19	19	18	18	19	18	19	18	18	18	18	19	18	19	TSW	TSW	11	**310**	**515.4**
11	11	19	19	19	18	18	19	18	19	18	19	18	18	19	18	19	TSW	TSW	11	**311**	**517**
11	11	19	19	19	19	18	19	18	19	18	19	18	18	19	18	19	TSW	TSW	11	**312**	**518.6**
11	11	19	19	19	19	18	19	18	19	18	19	18	18	19	19	19	TSW	TSW	11	**313**	**520.2**
11	11	19	19	19	19	19	19	18	19	18	19	18	18	19	19	19	TSW	TSW	11	**314**	**521.8**
11	11	19	19	19	19	19	19	18	19	18	19	18	19	19	19	19	TSW	TSW	11	**315**	**523.4**
11	11	19	19	19	19	19	19	19	19	18	19	18	19	19	19	19	TSW	TSW	11	**316**	**525**
11	11	19	19	19	19	19	19	19	19	19	19	18	19	19	19	19	TSW	TSW	11	**317**	**526.6**
11	11	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	TSW	TSW	11	**318**	**528.2**
11	11	20	19	19	19	19	19	19	19	19	19	19	19	19	19	19	TSW	TSW	11	**319**	**529.8**
11	11	20	19	19	19	19	19	19	19	19	19	19	19	19	19	20	TSW	TSW	11	**320**	**531.4**
11	11	20	20	19	19	19	19	19	19	19	19	19	19	19	19	20	TSW	TSW	11	**321**	**533**
11	11	20	20	19	19	19	19	19	19	19	19	19	19	20	19	20	TSW	TSW	11	**322**	**534.6**
11	11	20	20	20	19	19	19	19	19	19	19	19	19	20	19	20	TSW	TSW	11	**323**	**536.2**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]	Stops (#)	(kcfs)
11	11	20	20	20	19	19	20	19	19	19	19	19	19	20	19	20	TSW	TSW	11	**324**	**537.8**
11	11	20	20	20	19	19	20	19	20	19	19	19	19	20	19	20	TSW	TSW	11	**325**	**539.4**
11	11	20	20	20	19	19	20	19	20	19	20	19	19	20	19	20	TSW	TSW	11	**326**	**541**
11	11	20	20	20	20	19	20	19	20	19	20	19	19	20	19	20	TSW	TSW	11	**327**	**542.6**
11	11	20	20	20	20	19	20	19	20	19	20	19	19	20	20	20	TSW	TSW	11	**328**	**544.2**
11	11	20	20	20	20	20	20	19	20	19	20	19	19	20	20	20	TSW	TSW	11	**329**	**545.8**
11	11	20	20	20	20	20	20	19	20	19	20	19	20	20	20	20	TSW	TSW	11	**330**	**547.4**
11	11	20	20	20	20	20	20	20	20	19	20	19	20	20	20	20	TSW	TSW	11	**331**	**549**
11	11	20	20	20	20	20	20	20	20	20	20	19	20	20	20	20	TSW	TSW	11	**332**	**550.6**
11	11	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	TSW	TSW	11	**333**	**552.2**
11	11	21	20	20	20	20	20	20	20	20	20	20	20	20	20	20	TSW	TSW	11	**334**	**553.8**
11	11	21	20	20	20	20	20	20	20	20	20	20	20	20	20	21	TSW	TSW	11	**335**	**555.4**
11	11	21	21	20	20	20	20	20	20	20	20	20	20	20	20	21	TSW	TSW	11	**336**	**557**
11	11	21	21	20	20	20	20	20	20	20	20	20	20	21	20	21	TSW	TSW	11	**337**	**558.6**
11	11	21	21	21	20	20	20	20	20	20	20	20	20	21	20	21	TSW	TSW	11	**338**	**560.2**
11	11	21	21	21	20	20	21	20	20	20	20	20	20	21	20	21	TSW	TSW	11	**339**	**561.8**
11	11	21	21	21	20	20	21	20	21	20	20	20	20	21	20	21	TSW	TSW	11	**340**	**563.4**
11	11	21	21	21	20	20	21	20	21	20	21	20	20	21	20	21	TSW	TSW	11	**341**	**565**
11	11	21	21	21	21	20	21	20	21	20	21	20	20	21	20	21	TSW	TSW	11	**342**	**566.6**
11	11	21	21	21	21	20	21	20	21	20	21	20	20	21	21	21	TSW	TSW	11	**343**	**568.2**
11	11	21	21	21	21	21	21	20	21	20	21	20	20	21	21	21	TSW	TSW	11	**344**	**569.8**
11	11	21	21	21	21	21	21	20	21	20	21	20	21	21	21	21	TSW	TSW	11	**345**	**571.4**
11	11	21	21	21	21	21	21	21	21	20	21	20	21	21	21	21	TSW	TSW	11	**346**	**573**
11	11	21	21	21	21	21	21	21	21	21	21	20	21	21	21	21	TSW	TSW	11	**347**	**574.6**
11	11	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	TSW	TSW	11	**348**	**576.2**
11	11	22	21	21	21	21	21	21	21	21	21	21	21	21	21	21	TSW	TSW	11	**349**	**577.8**
11	11	22	21	21	21	21	21	21	21	21	21	21	21	21	21	22	TSW	TSW	11	**350**	**579.4**
11	11	22	22	21	21	21	21	21	21	21	21	21	21	21	21	22	TSW	TSW	11	**351**	**581**
11	11	22	22	21	21	21	21	21	21	21	21	21	21	22	21	22	TSW	TSW	11	**352**	**582.6**
11	11	22	22	22	21	21	21	21	21	21	21	21	21	22	21	22	TSW	TSW	11	**353**	**584.2**
11	11	22	22	22	21	21	22	21	21	21	21	21	21	22	21	22	TSW	TSW	11	**354**	**585.8**
11	11	22	22	22	21	21	22	21	22	21	21	21	21	22	21	22	TSW	TSW	11	**355**	**587.4**
11	11	22	22	22	21	21	22	21	22	21	22	21	21	22	21	22	TSW	TSW	11	**356**	**589**
11	11	22	22	22	22	21	22	21	22	21	22	21	21	22	21	22	TSW	TSW	11	**357**	**590.6**
11	11	22	22	22	22	21	22	21	22	21	22	21	21	22	22	22	TSW	TSW	11	**358**	**592.2**
11	11	22	22	22	22	22	22	21	22	21	22	21	21	22	22	22	TSW	TSW	11	**359**	**593.8**
11	11	22	22	22	22	22	22	21	22	21	22	21	22	22	22	22	TSW	TSW	11	**360**	**595.4**
11	11	22	22	22	22	22	22	22	22	21	22	21	22	22	22	22	TSW	TSW	11	**361**	**597**
11	11	22	22	22	22	22	22	22	22	22	22	21	22	22	22	22	TSW	TSW	11	**362**	**598.6**
11	11	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	TSW	TSW	11	**363**	**600.2**

Table JDA-9. [*pg 1 of 8*] John Day Dam Spill Pattern with No TSWs (Bays 18-19 Closed).

JDA Spill Patterns with No TSWs - # Gate Stops per Spillbay																				Total	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Stops (#)	(kcfs)
	3	2	1														CLOSE	CLOSE		**6**	**9.6**
	3	2	2														CLOSE	CLOSE		**7**	**11.2**
	3	3	2														CLOSE	CLOSE		**8**	**12.8**
	3	3	2	1													CLOSE	CLOSE		**9**	**14.4**
	3	3	2	2													CLOSE	CLOSE			**16.0**
	3	3	2	2	1												CLOSE	CLOSE		**11**	**17.6**
	3	3	2	2	2												CLOSE	CLOSE		**12**	**19.2**
	3	3	2	2	2	1											CLOSE	CLOSE		**13**	**20.8**
	3	3	2	2	2	2											CLOSE	CLOSE		**14**	**22.4**
	3	3	2	2	2	2	1										CLOSE	CLOSE		**15**	**24.0**
	3	3	3	2	2	2	1										CLOSE	CLOSE		**16**	**25.6**
	3	3	3	2	2	2	2										CLOSE	CLOSE		**17**	**27.2**
	3	3	3	2	2	2	2	1									CLOSE	CLOSE		**18**	**28.8**
	3	3	3	3	2	2	2	1									CLOSE	CLOSE		**19**	**30.4**
	3	3	3	3	3	2	2	1									CLOSE	CLOSE			**32.0**
	3	3	3	3	3	2	2	2									CLOSE	CLOSE		**21**	**33.6**
	3	3	3	3	3	2	2	2	1								CLOSE	CLOSE		**22**	**35.2**
	3	3	3	3	3	2	2	2	2								CLOSE	CLOSE		**23**	**36.8**
	3	3	3	3	3	2	2	2	2	1							CLOSE	CLOSE		**24**	**38.4**
	3	3	3	3	3	2	2	2	2	2							CLOSE	CLOSE		**25**	**40.0**
	3	3	3	3	3	2	2	2	2	2	1						CLOSE	CLOSE		**26**	**41.6**
	3	3	3	3	3	2	2	2	2	2	2						CLOSE	CLOSE		**27**	**43.2**
	3	3	3	3	3	3	2	2	2	2	2						CLOSE	CLOSE		**28**	**44.8**
	3	3	3	3	3	3	2	2	2	2	2	1					CLOSE	CLOSE		**29**	**46.4**
	3	3	3	3	3	3	2	2	2	2	2	2					CLOSE	CLOSE			**48.0**
	3	3	3	3	3	3	2	2	2	2	2	2	1				CLOSE	CLOSE		**31**	**49.6**
	3	3	3	3	3	3	3	2	2	2	2	2	1				CLOSE	CLOSE		**32**	**51.2**
	3	3	3	3	3	3	3	2	2	2	2	2	2				CLOSE	CLOSE		**33**	**52.8**
	3	3	3	3	3	3	3	2	2	2	2	2	2	1			CLOSE	CLOSE		**34**	**54.4**
	3	3	3	3	3	3	3	2	2	2	2	2	2	2			CLOSE	CLOSE		**35**	**56.0**
	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1		CLOSE	CLOSE		**36**	**57.6**
	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2		CLOSE	CLOSE		**37**	**59.2**
	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	1	CLOSE	CLOSE		**38**	**60.8**
	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	1	CLOSE	CLOSE		**39**	**62.4**
	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2	1	CLOSE	CLOSE			**64.0**
	4	4	4	3	3	3	3	2	2	2	2	2	2	2	2	1	CLOSE	CLOSE		**41**	**65.6**
	4	4	4	4	3	3	3	2	2	2	2	2	2	2	2	1	CLOSE	CLOSE		**42**	**67.2**
	4	4	4	4	3	3	3	3	2	2	2	2	2	2	2	1	CLOSE	CLOSE		**43**	**68.8**
	4	4	4	4	3	3	3	3	3	2	2	2	2	2	2	1	CLOSE	CLOSE		**44**	**70.4**
	4	4	4	4	4	3	3	3	3	2	2	2	2	2	2	1	CLOSE	CLOSE		**45**	**72.0**
	4	5	4	4	4	3	3	3	3	2	2	2	2	2	2	1	CLOSE	CLOSE		**46**	**73.6**
	4	5	4	4	4	3	3	3	3	2	2	2	2	2	2	2	CLOSE	CLOSE		**47**	**75.2**
	4	5	4	4	4	3	3	3	3	3	2	2	2	2	2	2	CLOSE	CLOSE		**48**	**76.8**
	4	5	4	4	4	3	3	3	3	3	3	2	2	2	2	2	CLOSE	CLOSE		**49**	**78.4**
	4	5	5	4	4	3	3	3	3	3	3	2	2	2	2	2	CLOSE	CLOSE			**80.0**

[a] Spill (kcfs) is calculated as a function of total stops + TSW spill. At Spill >305 kcfs, transition from pattern for juvenile fish to flood.
[b] Gates 1 & 20 blocked at 11 stops (10.3 ft opening).

JDA Spill Patterns with No TSWs - # Gate Stops per Spillbay																				Total	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Stops (#)	(kcfs)
	4	5	5	4	4	4	3	3	3	3	3	2	2	2	2	2	CLOSE	CLOSE		**51**	**81.6**
	4	5	5	4	4	4	3	3	3	3	3	3	2	2	2	2	CLOSE	CLOSE		**52**	**83.2**
	4	5	5	4	4	4	3	3	3	3	3	3	3	2	2	2	CLOSE	CLOSE		**53**	**84.8**
	4	5	5	4	4	4	3	3	3	3	3	3	3	3	2	2	CLOSE	CLOSE		**54**	**86.4**
	4	5	5	4	4	4	3	3	3	3	3	3	3	3	3	2	CLOSE	CLOSE		**55**	**88.0**
	4	5	5	4	4	4	4	3	3	3	3	3	3	3	3	2	CLOSE	CLOSE		**56**	**89.6**
	4	5	5	4	4	4	4	4	3	3	3	3	3	3	3	2	CLOSE	CLOSE		**57**	**91.2**
	4	5	5	5	4	4	4	4	3	3	3	3	3	3	3	2	CLOSE	CLOSE		**58**	**92.8**
	4	5	5	5	4	4	4	4	4	3	3	3	3	3	3	2	CLOSE	CLOSE		**59**	**94.4**
	4	5	5	5	4	4	4	4	4	4	3	3	3	3	3	2	CLOSE	CLOSE		**60**	**96.0**
	4	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	CLOSE	CLOSE		**61**	**97.6**
	4	5	5	5	4	4	4	4	4	4	4	3	3	3	3	3	CLOSE	CLOSE		**62**	**99.2**
	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	CLOSE	CLOSE		**63**	**100.8**
	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	CLOSE	CLOSE		**64**	**102.4**
	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	CLOSE	CLOSE		**65**	**104.0**
	4	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	CLOSE	CLOSE		**66**	**105.6**
	4	5	5	4	4	4	4	4	4	4	4	4	4	4	4	5	CLOSE	CLOSE		**67**	**107.2**
	4	5	5	4	4	4	4	4	4	4	4	4	4	5	4	5	CLOSE	CLOSE		**68**	**108.8**
	4	5	5	5	4	4	4	4	4	4	4	4	4	5	4	5	CLOSE	CLOSE		**69**	**110.4**
	4	5	5	5	4	4	5	4	4	4	4	4	4	5	4	5	CLOSE	CLOSE		**70**	**112.0**
	4	5	5	5	4	4	5	4	5	4	4	4	4	5	4	5	CLOSE	CLOSE		**71**	**113.6**
	4	5	5	5	4	4	5	4	5	4	5	4	4	5	4	5	CLOSE	CLOSE		**72**	**115.2**
	4	5	5	5	5	4	5	4	5	4	5	4	4	5	4	5	CLOSE	CLOSE		**73**	**116.8**
	4	5	5	5	5	4	5	4	5	4	5	4	4	5	5	5	CLOSE	CLOSE		**74**	**118.4**
	4	5	5	5	5	5	5	4	5	4	5	4	4	5	5	5	CLOSE	CLOSE		**75**	**120.0**
	4	5	5	5	5	5	5	4	5	4	5	4	5	5	5	5	CLOSE	CLOSE		**76**	**121.6**
	4	5	5	5	5	5	5	5	5	4	5	4	5	5	5	5	CLOSE	CLOSE		**77**	**123.2**
	4	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	CLOSE	CLOSE		**78**	**124.8**
	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	CLOSE	CLOSE		**79**	**126.4**
	4	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	CLOSE	CLOSE		**80**	**128.0**
	4	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	CLOSE	CLOSE		**81**	**129.6**
	4	6	6	5	5	5	5	5	5	5	5	5	5	5	5	6	CLOSE	CLOSE		**82**	**131.2**
	4	6	6	5	5	5	5	5	5	5	5	5	5	6	5	6	CLOSE	CLOSE		**83**	**132.8**
	4	6	6	6	5	5	5	5	5	5	5	5	5	6	5	6	CLOSE	CLOSE		**84**	**134.4**
	4	6	6	6	5	5	6	5	5	5	5	5	5	6	5	6	CLOSE	CLOSE		**85**	**136.0**
	4	6	6	6	5	5	6	5	6	5	5	5	5	6	5	6	CLOSE	CLOSE		**86**	**137.6**
	4	6	6	6	5	5	6	5	6	5	6	5	5	6	5	6	CLOSE	CLOSE		**87**	**139.2**
	4	6	6	6	6	5	6	5	6	5	6	5	5	6	5	6	CLOSE	CLOSE		**88**	**140.8**
	4	6	6	6	6	5	6	5	6	5	6	5	5	6	6	6	CLOSE	CLOSE		**89**	**142.4**
	4	6	6	6	6	6	6	5	6	5	6	5	5	6	6	6	CLOSE	CLOSE		**90**	**144.0**
	4	6	6	6	6	6	6	5	6	5	6	5	6	6	6	6	CLOSE	CLOSE		**91**	**145.6**
	4	6	6	6	6	6	6	6	6	5	6	5	6	6	6	6	CLOSE	CLOSE		**92**	**147.2**
	4	6	6	6	6	6	6	6	6	6	6	5	6	6	6	6	CLOSE	CLOSE		**93**	**148.8**
	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	CLOSE	CLOSE		**94**	**150.4**
	4	6	7	6	6	6	6	6	6	6	6	6	6	6	6	6	CLOSE	CLOSE		**95**	**152.0**
	4	6	7	6	6	6	6	6	6	6	6	6	6	6	6	7	CLOSE	CLOSE		**96**	**153.6**
	4	6	7	6	6	6	6	6	6	6	6	6	6	7	6	7	CLOSE	CLOSE		**97**	**155.2**
	4	6	7	7	6	6	6	6	6	6	6	6	6	7	6	7	CLOSE	CLOSE		**98**	**156.8**
	4	6	7	7	6	6	7	6	6	6	6	6	6	7	6	7	CLOSE	CLOSE		**99**	**158.4**
	4	6	7	7	6	6	7	6	7	6	6	6	6	7	6	7	CLOSE	CLOSE		**100**	**160.0**

JDA Spill Patterns with No TSWs - # Gate Stops per Spillbay																				Total	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Stops (#)	(kcfs)
	4	6	7	7	6	6	7	6	7	6	7	6	6	7	6	7	CLOSE	CLOSE		**101**	**161.6**
	4	6	7	7	7	6	7	6	7	6	7	6	6	7	6	7	CLOSE	CLOSE		**102**	**163.2**
	4	6	7	7	7	6	7	6	7	6	7	6	6	7	7	7	CLOSE	CLOSE		**103**	**164.8**
	4	6	7	7	7	7	7	6	7	6	7	6	6	7	7	7	CLOSE	CLOSE		**104**	**166.4**
	4	6	7	7	7	7	7	6	7	6	7	6	7	7	7	7	CLOSE	CLOSE		**105**	**168.0**
	4	6	7	7	7	7	7	7	7	6	7	6	7	7	7	7	CLOSE	CLOSE		**106**	**169.6**
	4	6	7	7	7	7	7	7	7	7	7	6	7	7	7	7	CLOSE	CLOSE		**107**	**171.2**
	4	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	CLOSE	CLOSE		**108**	**172.8**
	4	6	8	7	7	7	7	7	7	7	7	7	7	7	7	7	CLOSE	CLOSE		**109**	**174.4**
	4	6	8	7	7	7	7	7	7	7	7	7	7	7	7	8	CLOSE	CLOSE		**110**	**176.0**
	4	6	8	7	7	7	7	7	7	7	7	7	7	8	7	8	CLOSE	CLOSE		**111**	**177.6**
	4	6	8	8	7	7	7	7	7	7	7	7	7	8	7	8	CLOSE	CLOSE		**112**	**179.2**
	4	6	8	8	7	7	8	7	7	7	7	7	7	8	7	8	CLOSE	CLOSE		**113**	**180.8**
	4	6	8	8	7	7	8	7	8	7	7	7	7	8	7	8	CLOSE	CLOSE		**114**	**182.4**
	4	6	8	8	7	7	8	7	8	7	8	7	7	8	7	8	CLOSE	CLOSE		**115**	**184.0**
	4	6	8	8	8	7	8	7	8	7	8	7	7	8	7	8	CLOSE	CLOSE		**116**	**185.6**
	4	6	8	8	8	7	8	7	8	7	8	7	7	8	8	8	CLOSE	CLOSE		**117**	**187.2**
	4	6	8	8	8	8	8	7	8	7	8	7	7	8	8	8	CLOSE	CLOSE		**118**	**188.8**
	4	6	8	8	8	8	8	7	8	7	8	7	8	8	8	8	CLOSE	CLOSE		**119**	**190.4**
	4	6	8	8	8	8	8	8	8	7	8	7	8	8	8	8	CLOSE	CLOSE		**120**	**192.0**
	4	6	8	8	8	8	8	8	8	8	8	7	8	8	8	8	CLOSE	CLOSE		**121**	**193.6**
	4	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	CLOSE	CLOSE		**122**	**195.2**
	4	6	8	8	8	8	8	8	8	8	8	8	8	8	8	9	CLOSE	CLOSE		**123**	**196.8**
	4	6	8	8	8	8	8	8	8	8	8	8	8	9	8	9	CLOSE	CLOSE		**124**	**198.4**
	4	6	8	9	8	8	8	8	8	8	8	8	8	9	8	9	CLOSE	CLOSE		**125**	**200.0**
	4	6	8	9	8	8	9	8	8	8	8	8	8	9	8	9	CLOSE	CLOSE		**126**	**201.6**
	4	6	8	9	8	8	9	8	9	8	8	8	8	9	8	9	CLOSE	CLOSE		**127**	**203.2**
	4	6	8	9	8	8	9	8	9	8	9	8	8	9	8	9	CLOSE	CLOSE		**128**	**204.8**
	4	6	8	9	9	8	9	8	9	8	9	8	8	9	8	9	CLOSE	CLOSE		**129**	**206.4**
	4	6	8	9	9	8	9	8	9	8	9	8	8	9	9	9	CLOSE	CLOSE		**130**	**208.0**
	4	6	8	9	9	9	9	8	9	8	9	8	8	9	9	9	CLOSE	CLOSE		**131**	**209.6**
	4	6	8	9	9	9	9	8	9	8	9	8	9	9	9	9	CLOSE	CLOSE		**132**	**211.2**
	4	6	8	9	9	9	9	9	9	8	9	8	9	9	9	9	CLOSE	CLOSE		**133**	**212.8**
	4	6	8	9	9	9	9	9	9	9	9	8	9	9	9	9	CLOSE	CLOSE		**134**	**214.4**
	4	6	8	9	9	9	9	9	9	9	9	9	9	9	9	9	CLOSE	CLOSE		**135**	**216.0**
	4	6	8	9	9	9	9	9	9	9	9	9	9	9	9	10	CLOSE	CLOSE		**136**	**217.6**
	4	6	8	9	9	9	9	9	9	9	9	9	9	10	9	10	CLOSE	CLOSE		**137**	**219.2**
	4	6	8	10	9	9	9	9	9	9	9	9	9	10	9	10	CLOSE	CLOSE		**138**	**220.8**
	4	6	8	10	9	9	10	9	9	9	9	9	9	10	9	10	CLOSE	CLOSE		**139**	**222.4**
	4	6	8	10	9	9	10	9	10	9	9	9	9	10	9	10	CLOSE	CLOSE		**140**	**224.0**
	4	6	8	10	9	9	10	9	10	9	10	9	9	10	9	10	CLOSE	CLOSE		**141**	**225.6**
	4	6	8	10	10	9	10	9	10	9	10	9	9	10	9	10	CLOSE	CLOSE		**142**	**227.2**
	4	6	8	10	10	9	10	9	10	9	10	9	9	10	10	10	CLOSE	CLOSE		**143**	**228.8**
	4	6	8	10	10	10	10	9	10	9	10	9	9	10	10	10	CLOSE	CLOSE		**144**	**230.4**
	4	6	8	10	10	10	10	9	10	9	10	9	10	10	10	10	CLOSE	CLOSE		**145**	**232.0**
	4	6	8	10	10	10	10	10	10	9	10	9	10	10	10	10	CLOSE	CLOSE		**146**	**233.6**
	4	6	8	10	10	10	10	10	10	10	10	9	10	10	10	10	CLOSE	CLOSE		**147**	**235.2**
	4	6	8	10	10	10	10	10	10	10	10	10	10	10	10	10	CLOSE	CLOSE		**148**	**236.8**
	4	6	8	10	10	10	10	10	10	10	10	10	10	10	10	11	CLOSE	CLOSE		**149**	**238.4**
	4	6	8	10	10	10	10	10	10	10	10	10	10	11	10	11	CLOSE	CLOSE		**150**	**240.0**

JDA Spill Patterns with No TSWs - # Gate Stops per Spillbay																				Total	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Stops (#)	(kcfs)
	4	6	8	10	10	10	11	10	10	10	10	10	10	11	10	11	CLOSE	CLOSE		**151**	**241.6**
	4	6	8	10	10	10	11	10	11	10	10	10	10	11	10	11	CLOSE	CLOSE		**152**	**243.2**
	4	6	8	10	10	10	11	10	11	10	11	10	10	11	10	11	CLOSE	CLOSE		**153**	**244.8**
	4	6	8	10	11	10	11	10	11	10	11	10	10	11	10	11	CLOSE	CLOSE		**154**	**246.4**
	4	6	8	10	11	10	11	10	11	10	11	10	10	11	11	11	CLOSE	CLOSE		**155**	**248.0**
	4	6	8	10	11	11	11	10	11	10	11	10	10	11	11	11	CLOSE	CLOSE		**156**	**249.6**
	4	6	8	10	11	11	11	10	11	10	11	10	11	11	11	11	CLOSE	CLOSE		**157**	**251.2**
	4	6	8	10	11	11	11	11	11	10	11	10	11	11	11	11	CLOSE	CLOSE		**158**	**252.8**
	4	6	8	10	11	11	11	11	11	11	11	10	11	11	11	11	CLOSE	CLOSE		**159**	**254.4**
	4	6	8	10	11	11	11	11	11	11	11	11	11	11	11	11	CLOSE	CLOSE		**160**	**256.0**
	4	6	8	10	11	11	11	11	11	11	11	11	11	12	11	11	CLOSE	CLOSE		**161**	**257.6**
	4	6	8	10	11	11	12	11	11	11	11	11	11	12	11	11	CLOSE	CLOSE		**162**	**259.2**
	4	6	8	10	11	11	12	11	12	11	11	11	11	12	11	11	CLOSE	CLOSE		**163**	**260.8**
	4	6	8	10	11	11	12	11	12	11	12	11	11	12	11	11	CLOSE	CLOSE		**164**	**262.4**
	4	6	8	10	12	11	12	11	12	11	12	11	11	12	11	11	CLOSE	CLOSE		**165**	**264.0**
	4	6	8	10	12	11	12	11	12	11	12	11	11	12	12	11	CLOSE	CLOSE		**166**	**265.6**
	4	6	8	10	12	12	12	11	12	11	12	11	11	12	12	11	CLOSE	CLOSE		**167**	**267.2**
	4	6	8	10	12	12	12	11	12	11	12	11	12	12	12	11	CLOSE	CLOSE		**168**	**268.8**
	4	6	8	10	12	12	12	12	12	11	12	11	12	12	12	11	CLOSE	CLOSE		**169**	**270.4**
	4	6	8	10	12	12	12	12	12	12	12	11	12	12	12	11	CLOSE	CLOSE		**170**	**272.0**
	4	6	8	10	12	12	12	12	12	12	12	12	12	12	12	11	CLOSE	CLOSE		**171**	**273.6**
	4	6	8	10	12	12	12	12	12	12	12	12	12	13	12	11	CLOSE	CLOSE		**172**	**275.2**
	4	6	8	10	12	12	13	12	12	12	12	12	12	13	12	11	CLOSE	CLOSE		**173**	**276.8**
	4	6	8	10	12	12	13	12	13	12	12	12	12	13	12	11	CLOSE	CLOSE		**174**	**278.4**
	4	6	8	10	12	12	13	12	13	12	13	12	12	13	12	11	CLOSE	CLOSE		**175**	**280.0**
	4	6	8	10	12	12	13	12	13	12	13	12	12	13	13	11	CLOSE	CLOSE		**176**	**281.6**
	4	6	8	10	12	13	13	12	13	12	13	12	12	13	13	11	CLOSE	CLOSE		**177**	**283.2**
	4	6	8	10	12	13	13	12	13	12	13	12	13	13	13	11	CLOSE	CLOSE		**178**	**284.8**
	4	6	8	10	12	13	13	13	13	12	13	12	13	13	13	11	CLOSE	CLOSE		**179**	**286.4**
	4	6	8	10	12	13	13	13	13	13	13	12	13	13	13	11	CLOSE	CLOSE		**180**	**288.0**
	4	6	8	10	12	13	13	13	13	13	13	13	13	13	13	11	CLOSE	CLOSE		**181**	**289.6**
	4	6	8	10	12	13	13	13	13	13	13	13	13	14	13	11	CLOSE	CLOSE		**182**	**291.2**
	4	6	8	10	12	13	14	13	13	13	13	13	13	14	13	11	CLOSE	CLOSE		**183**	**292.8**
	4	6	8	10	12	13	14	13	14	13	13	13	13	14	13	11	CLOSE	CLOSE		**184**	**294.4**
	4	6	8	10	12	13	14	13	14	13	14	13	13	14	13	11	CLOSE	CLOSE		**185**	**296.0**
	4	6	8	10	12	13	14	13	14	13	14	13	13	14	14	11	CLOSE	CLOSE		**186**	**297.6**
	4	6	8	10	12	14	14	13	14	13	14	13	13	14	14	11	CLOSE	CLOSE		**187**	**299.2**
	4	6	8	10	12	14	14	13	14	13	14	13	14	14	14	11	CLOSE	CLOSE		**188**	**300.8**
	4	6	8	10	12	14	14	14	14	13	14	13	14	14	14	11	CLOSE	CLOSE		**189**	**302.4**
	4	6	8	10	12	14	14	14	14	14	14	13	14	14	14	11	CLOSE	CLOSE		**190**	**304.0**
	4	6	8	10	12	14	14	14	14	14	14	14	14	14	14	11	CLOSE	CLOSE		**191**	**305.6**
	4	6	8	10	12	14	14	14	14	14	14	14	14	15	14	11	CLOSE	CLOSE		**192**	**307.2**
	4	6	8	10	12	14	15	14	14	14	14	14	14	15	14	11	CLOSE	CLOSE		**193**	**308.8**
	4	6	8	10	12	14	15	14	15	14	14	14	14	15	14	11	CLOSE	CLOSE		**194**	**310.4**
	4	6	8	10	12	14	15	14	15	14	15	14	14	15	14	11	CLOSE	CLOSE		**195**	**312.0**
	4	6	8	10	12	14	15	14	15	14	15	14	14	15	15	11	CLOSE	CLOSE		**196**	**313.6**
	4	6	8	10	12	14	15	14	15	14	15	14	15	15	15	11	CLOSE	CLOSE		**197**	**315.2**
	4	6	8	10	12	14	15	15	15	14	15	14	15	15	15	11	CLOSE	CLOSE		**198**	**316.8**
	4	6	8	10	12	14	15	15	15	15	15	14	15	15	15	11	CLOSE	CLOSE		**199**	**318.4**
	4	6	8	10	12	14	15	15	15	15	15	15	15	15	15	11	CLOSE	CLOSE		**200**	**320.0**

JDA Spill Patterns with No TSWs - # Gate Stops per Spillbay																				Total	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Stops (#)	(kcfs)
	4	6	8	10	12	14	15	15	15	15	15	15	15	16	15	11	CLOSE	CLOSE		**201**	**321.6**
	4	6	8	10	12	14	16	15	15	15	15	15	15	16	15	11	CLOSE	CLOSE		**202**	**323.2**
	4	6	8	10	12	14	16	15	16	15	15	15	15	16	15	11	CLOSE	CLOSE		**203**	**324.8**
	4	6	8	10	12	14	16	15	16	15	16	15	15	16	15	11	CLOSE	CLOSE		**204**	**326.4**
	4	6	8	10	12	14	16	15	16	15	16	15	15	16	16	11	CLOSE	CLOSE		**205**	**328.0**
	4	6	8	10	12	14	16	15	16	15	16	15	16	16	16	11	CLOSE	CLOSE		**206**	**329.6**
	4	6	8	10	12	14	16	16	16	15	16	15	16	16	16	11	CLOSE	CLOSE		**207**	**331.2**
	4	6	8	10	12	14	16	16	16	16	16	15	16	16	16	11	CLOSE	CLOSE		**208**	**332.8**
	4	6	8	10	12	14	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**209**	**334.4**
	4	6	8	10	12	15	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**210**	**336.0**
	4	6	8	10	13	15	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**211**	**337.6**
	4	6	8	11	13	15	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**212**	**339.2**
	4	6	9	11	13	15	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**213**	**340.8**
	4	7	9	11	13	15	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**214**	**342.4**
	5	7	9	11	13	15	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**215**	**344.0**
1	5	7	9	11	13	15	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**216**	**345.6**
1	5	7	9	11	13	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**217**	**347.2**
1	5	7	9	11	14	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**218**	**348.8**
1	5	7	9	12	14	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**219**	**350.4**
1	5	7	10	12	14	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**220**	**352.0**
1	5	8	10	12	14	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**221**	**353.6**
1	6	8	10	12	14	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**222**	**355.2**
2	6	8	10	12	14	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**223**	**356.8**
2	6	8	10	12	15	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**224**	**358.4**
2	6	8	10	13	15	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**225**	**360.0**
2	6	8	11	13	15	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**226**	**361.6**
2	6	9	11	13	15	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**227**	**363.2**
2	7	9	11	13	15	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**228**	**364.8**
3	7	9	11	13	15	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**229**	**366.4**
3	7	9	11	13	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**230**	**368.0**
3	7	9	11	14	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**231**	**369.6**
3	7	9	12	14	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**232**	**371.2**
3	7	10	12	14	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**233**	**372.8**
3	8	10	12	14	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**234**	**374.4**
4	8	10	12	14	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**235**	**376.0**
4	8	10	12	15	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**236**	**377.6**
4	8	10	13	15	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**237**	**379.2**
4	8	11	13	15	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**238**	**380.8**
4	9	11	13	15	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**239**	**382.4**
5	9	11	13	15	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**240**	**384.0**
5	9	11	13	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**241**	**385.6**
5	9	11	14	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**242**	**387.2**
5	9	12	14	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**243**	**388.8**
5	10	12	14	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**244**	**390.4**
6	10	12	14	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**245**	**392.0**
6	10	12	15	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**246**	**393.6**
6	10	13	15	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**247**	**395.2**
6	11	13	15	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**248**	**396.8**
7	11	13	15	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**249**	**398.4**
7	11	13	16	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**250**	**400.0**

JDA Spill Patterns with No TSWs - # Gate Stops per Spillbay																				Total	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Stops (#)	(kcfs)
7	11	14	16	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**251**	**401.6**
8	11	14	16	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**252**	**403.2**
8	11	15	16	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**253**	**404.8**
9	11	15	16	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**254**	**406.4**
9	11	16	16	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**255**	**408.0**
10	11	16	16	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**256**	**409.6**
11	11	16	16	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**257**	**411.2**
11	11	17	16	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**258**	**412.8**
11	11	17	17	16	16	16	16	16	16	16	16	16	16	16	16	11	CLOSE	CLOSE		**259**	**414.4**
11	11	17	17	16	16	16	16	16	16	16	16	16	16	17	16	11	CLOSE	CLOSE		**260**	**416.0**
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11	11	17	17	17	16	16	17	16	16	16	16	16	16	17	16	11	CLOSE	CLOSE		**262**	**419.2**
11	11	17	17	17	16	16	17	16	17	16	16	16	16	17	16	11	CLOSE	CLOSE		**263**	**420.8**
11	11	17	17	17	16	16	17	16	17	16	17	16	16	17	16	11	CLOSE	CLOSE		**264**	**422.4**
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11	11	17	17	17	17	17	17	16	17	16	17	16	16	17	17	11	CLOSE	CLOSE		**267**	**427.2**
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11	11	17	17	17	17	17	17	17	17	16	17	16	17	17	17	11	CLOSE	CLOSE		**269**	**430.4**
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11	11	18	18	18	17	17	18	17	18	17	17	17	17	18	17	11	CLOSE	CLOSE		**277**	**443.2**
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11	11	18	18	18	18	18	18	18	18	17	18	17	18	18	18	11	CLOSE	CLOSE		**283**	**452.8**
11	11	18	18	18	18	18	18	18	18	18	18	17	18	18	18	11	CLOSE	CLOSE		**284**	**454.4**
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11	11	19	19	19	19	19	19	19	19	19	19	19	19	19	19	11	CLOSE	CLOSE		**299**	**478.4**
11	11	20	19	19	19	19	19	19	19	19	19	19	19	19	19	11	CLOSE	CLOSE		**300**	**480.0**

JDA Spill Patterns with No TSWs - # Gate Stops per Spillbay																				Total	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Stops (#)	(kcfs)
11	11	20	20	19	19	19	19	19	19	19	19	19	19	19	19	11	CLOSE	CLOSE		**301**	**481.6**
11	11	20	20	19	19	19	19	19	19	19	19	19	19	20	19	11	CLOSE	CLOSE		**302**	**483.2**
11	11	20	20	20	19	19	19	19	19	19	19	19	19	20	19	11	CLOSE	CLOSE		**303**	**484.8**
11	11	20	20	20	19	19	20	19	19	19	19	19	19	20	19	11	CLOSE	CLOSE		**304**	**486.4**
11	11	20	20	20	19	19	20	19	20	19	19	19	19	20	19	11	CLOSE	CLOSE		**305**	**488.0**
11	11	20	20	20	19	19	20	19	20	19	20	19	19	20	19	11	CLOSE	CLOSE		**306**	**489.6**
11	11	20	20	20	20	19	20	19	20	19	20	19	19	20	19	11	CLOSE	CLOSE		**307**	**491.2**
11	11	20	20	20	20	19	20	19	20	19	20	19	19	20	20	11	CLOSE	CLOSE		**308**	**492.8**
11	11	20	20	20	20	20	20	19	20	19	20	19	19	20	20	11	CLOSE	CLOSE		**309**	**494.4**
11	11	20	20	20	20	20	20	19	20	19	20	19	20	20	20	11	CLOSE	CLOSE		**310**	**496.0**
11	11	20	20	20	20	20	20	20	20	19	20	19	20	20	20	11	CLOSE	CLOSE		**311**	**497.6**
11	11	20	20	20	20	20	20	20	20	20	20	19	20	20	20	11	CLOSE	CLOSE		**312**	**499.2**
11	11	20	20	20	20	20	20	20	20	20	20	20	20	20	20	11	CLOSE	CLOSE		**313**	**500.8**
11	11	21	20	20	20	20	20	20	20	20	20	20	20	20	20	11	CLOSE	CLOSE		**314**	**502.4**
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11	11	22	22	22	22	22	22	22	22	22	22	22	22	22	22	11	CLOSE	CLOSE		**341**	**545.6**
11	11	23	22	22	22	22	22	22	22	22	22	22	22	22	22	11	CLOSE	CLOSE		**342**	**547.2**
11	11	23	23	22	22	22	22	22	22	22	22	22	22	22	22	11	CLOSE	CLOSE		**343**	**548.8**
11	11	23	23	22	22	22	22	22	22	22	22	22	22	23	22	11	CLOSE	CLOSE		**344**	**550.4**
11	11	23	23	23	22	22	22	22	22	22	22	22	22	23	22	11	CLOSE	CLOSE		**345**	**552.0**
11	11	23	23	23	22	22	23	22	22	22	22	22	22	23	22	11	CLOSE	CLOSE		**346**	**553.6**
11	11	23	23	23	22	22	23	22	23	22	22	22	22	23	22	11	CLOSE	CLOSE		**347**	**555.2**
11	11	23	23	23	22	22	23	22	23	22	23	22	22	23	22	11	CLOSE	CLOSE		**348**	**556.8**
11	11	23	23	23	23	22	23	22	23	22	23	22	22	23	22	11	CLOSE	CLOSE		**349**	**558.4**
11	11	23	23	23	23	22	23	22	23	22	23	22	22	23	23	11	CLOSE	CLOSE		**350**	**560.0**

JDA Spill Patterns with No TSWs - # Gate Stops per Spillbay																				Total	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Stops (#)	(kcfs)
11	11	23	23	23	23	23	23	22	23	22	23	22	22	23	23	11	CLOSE	CLOSE		**351**	**561.6**
11	11	23	23	23	23	23	23	22	23	22	23	22	23	23	23	11	CLOSE	CLOSE		**352**	**563.2**
11	11	23	23	23	23	23	23	23	23	22	23	22	23	23	23	11	CLOSE	CLOSE		**353**	**564.8**
11	11	23	23	23	23	23	23	23	23	23	23	22	23	23	23	11	CLOSE	CLOSE		**354**	**566.4**
11	11	23	23	23	23	23	23	23	23	23	23	23	23	23	23	11	CLOSE	CLOSE		**355**	**568.0**
11	11	24	23	23	23	23	23	23	23	23	23	23	23	23	23	11	CLOSE	CLOSE		**356**	**569.6**
11	11	24	24	23	23	23	23	23	23	23	23	23	23	23	23	11	CLOSE	CLOSE		**357**	**571.2**
11	11	24	24	23	23	23	23	23	23	23	23	23	23	24	23	11	CLOSE	CLOSE		**358**	**572.8**
11	11	24	24	24	23	23	23	23	23	23	23	23	23	24	23	11	CLOSE	CLOSE		**359**	**574.4**
11	11	24	24	24	23	23	24	23	23	23	23	23	23	24	23	11	CLOSE	CLOSE		**360**	**576.0**
11	11	24	24	24	23	23	24	23	24	23	23	23	23	24	23	11	CLOSE	CLOSE		**361**	**577.6**
11	11	24	24	24	23	23	24	23	24	23	24	23	23	24	23	11	CLOSE	CLOSE		**362**	**579.2**
11	11	24	24	24	24	23	24	23	24	23	24	23	23	24	23	11	CLOSE	CLOSE		**363**	**580.8**
11	11	24	24	24	24	23	24	23	24	23	24	23	23	24	24	11	CLOSE	CLOSE		**364**	**582.4**
11	11	24	24	24	24	24	24	23	24	23	24	23	23	24	24	11	CLOSE	CLOSE		**365**	**584.0**
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11	11	24	24	24	24	24	24	24	24	23	24	23	24	24	24	11	CLOSE	CLOSE		**367**	**587.2**
11	11	24	24	24	24	24	24	24	24	24	24	23	24	24	24	11	CLOSE	CLOSE		**368**	**588.8**
11	11	24	24	24	24	24	24	24	24	24	24	24	24	24	24	11	CLOSE	CLOSE		**369**	**590.4**
11	11	25	24	24	24	24	24	24	24	24	24	24	24	24	24	11	CLOSE	CLOSE		**370**	**592.0**
11	11	25	25	24	24	24	24	24	24	24	24	24	24	24	24	11	CLOSE	CLOSE		**371**	**593.6**
11	11	25	25	24	24	24	24	24	24	24	24	24	24	25	24	11	CLOSE	CLOSE		**372**	**595.2**
11	11	25	25	25	24	24	24	24	24	24	24	24	24	25	24	11	CLOSE	CLOSE		**373**	**596.8**
11	11	25	25	25	24	24	25	24	24	24	24	24	24	25	24	11	CLOSE	CLOSE		**374**	**598.4**
11	11	25	25	25	24	24	25	24	25	24	24	24	24	25	24	11	CLOSE	CLOSE		**375**	**600.0**

2018 Fish Passage Plan

Chapter 5 – McNary Dam

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McNary Dam *

Project Acronym	MCN
River Mile (RM)	Columbia River – RM 292
Reservoir	Lake Wallula
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 12.5 kcfs \ Mar–Nov: 50 kcfs
Forebay Normal Operating Range (ft)	337’ – 340’
Tailrace Rate of Change Limit (ft)	1.5’/hr
Powerhouse Length (ft)	1,422’
Powerhouse Hydraulic Capacity (kcfs)	232 kcfs
Turbine Units (#)	14 Main Units (S. Morgan Smith Kaplan)
Turbine Unit Generating Capacity (MW)	Rated: 980 MW (70 MW/unit) \ Maximum: 1,127 MW (80.5 MW/unit)
Gatewell Orifice Diameter (in)	Two 12” orifices per gatewell (6 per unit)
Spillway Length (ft)	1,310’
Spillway Hydraulic Capacity (kcfs)	2,200 kcfs
Spillbays (#)	22
Spillway Weirs (#)	2 (Bays 19-20)
Navigation Lock Length x Width (ft)	650’ x 84’ (Usable Space)
Navigation Lock Maximum Lift (ft)	75’
FISH STRUCTURE/OPERATION START DATE	
Fish Lock	1953 (1st Generation)
Adult Fish Counts – WA Shore & OR Shore	1954
Juvenile Bypass System (JBS)	1980 (1st Generation); 1994 (current); Bypass Outfall Flume relocated 2012
Submersible Traveling Screens (STS)	1980 (Prototype Mesh)
Extended-Length Submersible Bar Screens (ESBS)	1997
Juvenile Fish Transportation Program - Corps	1981-2012
Temporary Spillway Weirs (TSW)	2007

* More information is available on the Corps Walla Walla District website for McNary Dam at: www.nww.usace.army.mil/Locations/District-Locks-and-Dams/McNary-Lock-and-Dam/

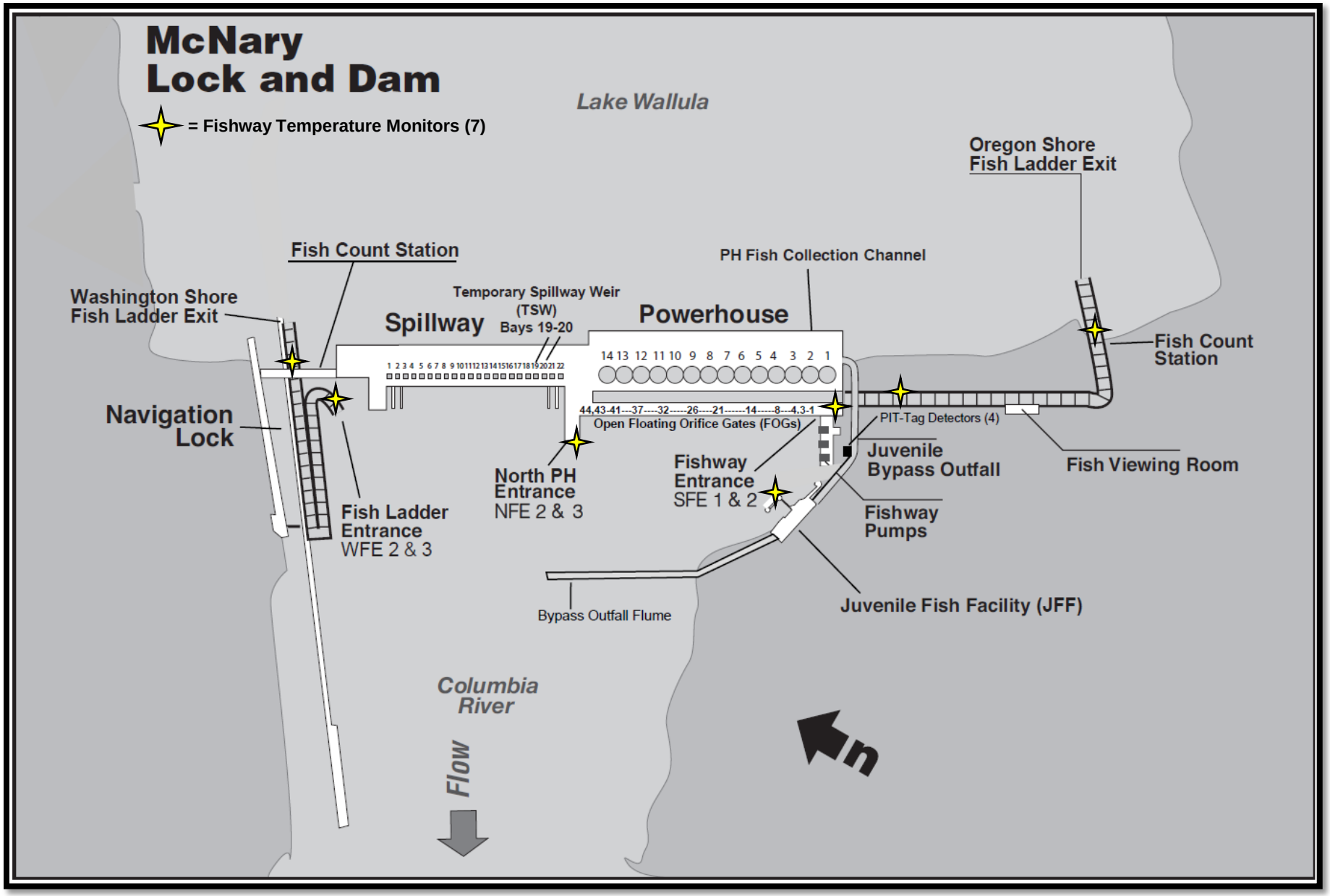
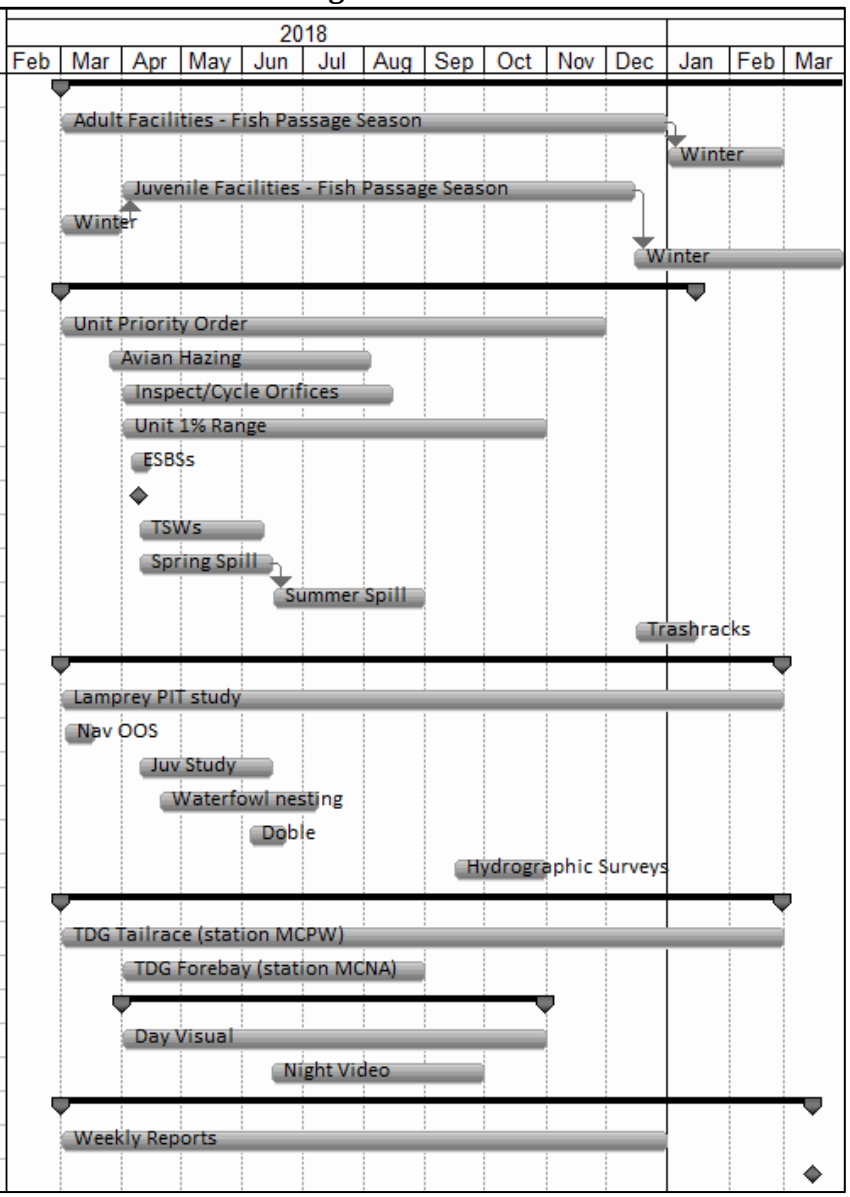


Figure MCN-1. McNary Lock & Dam General Site Plan.

Table MCN-1. McNary Dam Schedule of Operations and Actions Defined in the 2018 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**3/1/18**	**3/30/19**	
Adult Facilities - Fish Passage Season	3/1/18	12/31/18	2.4.2
Adult Facilities - Winter Maintenance	1/1/19	2/28/19	2.4.1
Juvenile Facilities - Fish Passage Season	4/1/18	12/15/18	2.3.2
Juvenile Facilities - Winter Maintenance	3/1/18	3/31/18	2.3.1
	12/15/18	3/30/19	
PROJECT OPERATIONS FOR FISH PASSAGE	**3/1/18**	**1/15/19**	
Turbine unit priority order	3/1/18	11/30/18	Table MCN-5
Avian hazing	3/25/18	8/4/18	App L 5.3
Inspect/cycle orifices ≥ twice per day	4/1/18	8/15/18	2.3.2.3.vi.
Turbine unit 1% operating range	4/1/18	10/31/18	4.3
ESBS install	4/5/18	4/15/18	2.3.2.2.i.
Avian Wires installed NLT April 10	4/10/18	4/10/18	App L 1.4
TSW operation	4/10/18	6/11/18	2.3.2.7
Spring Spill	4/10/18	6/15/18	App E (FOP)
Summer Spill	6/16/18	8/31/18	App E (FOP)
Inspect/rake trashracks	12/16/18	1/15/19	2.3.1.1.
SPECIAL OPS & STUDIES (Appendix A)	**3/1/18**	**2/28/19**	
Adult Lamprey PIT study	3/1/18	2/28/19	App A 5.2
Navigation Lock annual outage	3/3/18	3/18/18	App A 1.4
Juvenile System Survival Study	4/10/18	6/15/18	App A 5.2
Forebay for waterfowl nesting (dates approx)	4/20/18	7/8/18	App A 5.1
Doble testing	6/4/18	6/22/18	App A 5.1
Stilling Basin Surveys	9/15/18	10/31/18	App A 5.2
TDG MONITORING	**3/1/18**	**2/28/19**	
TDG Monitoring - Tailrace (year-round)	3/1/18	2/28/19	2.2
TDG Monitoring - Forebay	4/1/18	8/31/18	2.2
ADULT FISH COUNTING	**4/1/18**	**10/31/18**	
Day Visual 0500-2100 PDT	4/1/18	10/31/18	Table MCN-3
Night Video 2100-0500 PDT	6/15/18	9/30/18	Table MCN-3
REPORTS	**3/1/18**	**3/15/19**	
Weekly Reports	3/1/18	12/31/18	2.5.2
Annual Report due NLT Jan 31	3/15/19	3/15/19	2.5.3



1. FISH PASSAGE INFORMATION

Fish passage facilities at McNary Lock & Dam are shown in **Figure MCN-1**. The schedule for project operations described in the Fish Passage Plan (FPP) and Appendices is in **Table MCN-1**.

1.1. Juvenile Fish Passage.

1.1.1. Juvenile Fish Facilities. Juvenile fish sampling facilities at McNary Dam consist of extended-length submersible bar screens (ESBSs) with flow vanes, vertical barrier screens (VBSs), gatewell orifices, a concrete collection channel with emergency bypass outlets, primary and secondary dewatering structures, a pipeline/corrugated metal flume for routing juvenile fish to the sampling facilities or bypassing them back to the river, and a full-flow PIT tag detection system. Juvenile sampling facilities at McNary include: a separator to separate adult from juvenile fish and juvenile fish by size; a flume system routing juvenile fish either through the secondary bypass system or to the sample system; covered raceways and tanks for holding sampled fish; sampling facilities; an office and sampling building with fish marking facilities; and PIT tag detection and deflection systems. Maintenance of juvenile fish passage facilities that may impact juvenile fish or facility operations should be conducted during the winter maintenance period.

1.1.2. Juvenile Migration Timing. Juvenile fish passage timing at McNary Dam is shown in **Table MCN-2**, based on juvenile fish collection data over the most recent 10-year period (does not reflect bypass (FGE) or spillway passage). Salmon, steelhead, bull trout, lamprey, and other species are routinely counted.

Table MCN-2. Juvenile Salmonid Passage Timing at McNary Dam for Most Recent 10 Years (based on daily & yearly collection data).

Year	10%	50%	90%	#	10%	50%	90%	#
	Yearling Chinook				Subyearling Chinook			
2008	9-Apr	15-May	27-May	48	22-Jun	8-Jul	9-Aug	48
2009	2-May	15-May	25-May	23	18-Jun	4-Jul	22-Jul	34
2010	3-May	17-May	27-May	24	18-Jun	4-Jul	4-Aug	47
2011	29-Apr	8-May	23-May	24	24-Jun	24-Jul	19-Aug	56
2012	29-Apr	11-May	25-May	26	22-Jun	18-Jul	22-Aug	61
2013	1-May	9-May	29-May	28	16-Jun	4-Jul	22-Jul	36
2014	27-Apr	11-May	19-May	22	22-Jun	4-Jul	26-Jul	34
2015	27-Apr	7-May	19-May	22	14-Jun	2-Jul	10-Jul	26
2016	23-Apr	3-May	13-May	20	8-Jun	26-Jun	2-Jul	24
2017	23-Apr	5-May	19-May	26	6-Jun	2-Jul	22-Jul	36
10-Yr	**28-Apr**	**10-May**	**24-May**	**24**	**18-Jun**	**4-Jul**	**24-Jul**	**36**
10-Yr MIN	**9-Apr**	**3-May**	**13-May**	**20**	**6-Jun**	**26-Jun**	**2-Jul**	**24**
10-Yr MAX	**3-May**	**17-May**	**29-May**	**48**	**24-Jun**	**24-Jul**	**22-Aug**	**61**
	Unclipped Steelhead				Clipped Steelhead			
2008	1-May	15-May	29-May	28	3-May	11-May	23-May	20
2009	25-Apr	7-May	23-May	28	27-Apr	7-May	23-May	26
2010	1-May	13-May	2-Jun	32	1-May	9-May	29-May	28
2011	19-Apr	7-May	27-May	38	19-Apr	1-May	17-May	28
2012	24-Apr	5-May	25-May	31	23-Apr	1-May	17-May	24
2013	23-Apr	11-May	2-Jun	40	25-Apr	3-May	19-May	24
2014	23-Apr	7-May	19-May	26	25-Apr	5-May	15-May	20
2015	1-May	15-May	27-May	26	27-Apr	9-May	27-May	30
2016	19-Apr	3-May	23-May	34	21-Apr	1-May	15-May	24
2017	21-Apr	5-May	29-May	38	19-Apr	29-Apr	13-May	24
10-Yr	**23-Apr**	**7-May**	**27-May**	**32**	**25-Apr**	**4-May**	**18-May**	**24**
10-Yr MIN	**19-Apr**	**3-May**	**19-May**	**26**	**19-Apr**	**29-Apr**	**13-May**	**20**
10-Yr MAX	**1-May**	**15-May**	**2-Jun**	**40**	**3-May**	**11-May**	**29-May**	**30**
	Coho				Sockeye (Wild & Hatchery)			
2008	13-May	25-May	6-Jun	24	15-May	25-May	6-Jun	22
2009	13-May	23-May	12-Jun	30	5-May	21-May	2-Jun	28
2010	9-May	31-May	12-Jun	34	11-May	29-May	2-Jun	22
2011	24-Apr	19-May	8-Jun	45	4-May	13-May	31-May	27
2012	7-May	23-May	4-Jun	28	1-May	11-May	21-May	20
2013	3-May	21-May	8-Jun	36	29-Apr	15-May	27-May	28
2014	1-May	17-May	2-Jun	32	3-May	17-May	23-May	20
2015	5-May	21-May	4-Jun	30	27-Apr	17-May	25-May	28
2016	29-Apr	13-May	25-May	26	29-Apr	11-May	19-May	20
2017	1-May	19-May	29-May	28	27-Apr	13-May	25-May	28
10-Yr	**4-May**	**21-May**	**5-Jun**	**30**	**2-May**	**16-May**	**26-May**	**25**
10-Yr MIN	**24-Apr**	**13-May**	**25-May**	**24**	**27-Apr**	**11-May**	**19-May**	**20**
10-Yr MAX	**13-May**	**31-May**	**12-Jun**	**45**	**15-May**	**29-May**	**6-Jun**	**28**

1.2. Adult Fish Passage.

1.2.1. Adult Fish Facilities. McNary Dam adult fish passage facilities consist of separate north and south shore facilities, described below. Maintenance of adult facilities is scheduled for January–February, typically one shore at a time, to minimize impacts on upstream migrants.

1.2.1.1. North Shore Adult Fish Facility. The north shore facilities are comprised of a fish ladder with counting station, submerged orifice PIT-tag antennas in the ladder, a small collection system, and a gravity-flow auxiliary water supply system that has a turbine unit on it operated by North Wasco County PUD. The gravity-flow auxiliary water supply system takes water from the forebay through two conduits, passes the water through a turbine unit (or through a bypass/energy dissipater when the turbine is not in operation) and distributes the water through a diffuser system at the bottom of the ladder and in the transportation channel. The north shore collection system has three downstream entrances (two of which are used during normal operation) and a side entrance into the spillway basin.

1.2.1.2. South Shore Adult Fish Facility. The south shore facilities are comprised of a fish ladder with counting station, submerged orifice PIT-tag antennas in the ladder and antennas at the counting station, two south shore entrances, a powerhouse collection system, and gravity and pumped auxiliary water supply systems.

1.2.1.3. Powerhouse Collection System. The powerhouse collection system contains three downstream entrances and one side entrance into the spillway basin at the north end of the powerhouse, twelve operating floating orifices, and a common transportation channel. At the north end of the powerhouse, two of the downstream entrances are used during normal operation with the other downstream and side entrances closed. The gravity-flow auxiliary water is provided by one conduit from the forebay and supplies the diffusers at the bottom of the ladder at tailwater level. The pumped auxiliary water is supplied by three electric pumps with variable-pitched blades. Two pumps can provide the required flow when the third pump is bulkheaded to prevent water from flowing back through the pump to the river. The electric pumps supply the auxiliary water for the diffusers at the entrances and in the transportation channel. Excess water from the primary dewatering structure in the juvenile fish collection channel is routed to the adult collection system at the north end of the powerhouse.

1.2.2. Adult Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult fish facilities are operated year-round. Adult salmon, steelhead, shad, and lamprey are counted per the schedule in **Table MCN-3** and data are posted daily at: www.fpc.org/adultsalmon_home.html. Sturgeon and bull trout are relatively infrequent and are reported in *Miscellaneous Fish Counts* and in the *Annual Fish Passage Report*.

1.2.2.2. Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage defined in **Table MCN-4**. Time-of-day (diel) distributions of adult salmonid activity at McNary Dam fishway entrances and exits are shown in **Figure MCN-2**.

Table MCN-3. McNary Dam Adult Fish Counting Schedule, 3/1/2018 – 2/28/2019.

Count Period	Counting Method and Hours *
April 1 – October 31	Day Visual 0500–2100 hours (PDT)
June 15 – September 30	Night Video 2100–0500 hours (PDT)

*PST=Pacific Standard Time. PDT=Pacific Daylight Time (in effect during Daylight Saving Time 3/11/18-11/4/18).

Table MCN-4. McNary Dam Adult Fish Count Period and Peak Passage Timing (based on yearly counts from 1954 through most recent count year).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Apr 1 – Jun 8	Apr 20	May 26
Summer Chinook	Jun 9 – Aug 8	Jun 13	Jul 26
Fall Chinook	Aug 9 – Oct 31	Sep 10	Sep 28
Steelhead	Apr 1 – Oct 31	Jul 9	Oct 13
Sockeye	Apr 1 – Oct 31	Jun 24	Oct 11
Coho	Apr 1 – Oct 31	Jun 27	Oct 5
Lamprey	Apr 1 – Oct 31	Jun 21	Aug 12

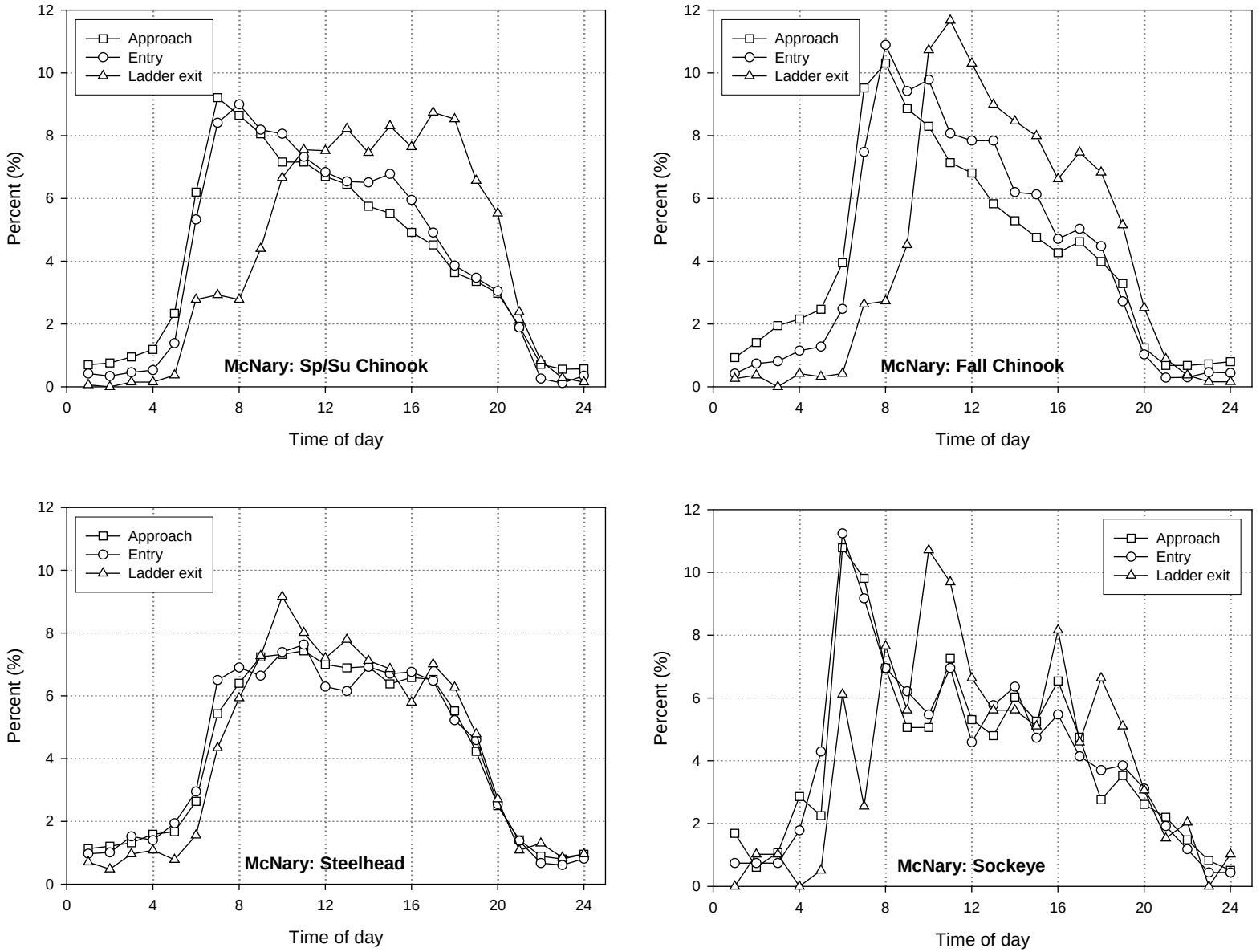


Figure MCN-2. Diel Distribution of Adult Salmonids at McNary Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*).
pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATIONS

2.1. General.

2.1.1. Yearly special operations related to research are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

2.1.2. Research, non-routine maintenance activities and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above or adjacent to any fishway, unless coordinated by the Project, Walla Walla District (NWW) Operations and/or Planning or Construction office through FPOM or FFDRWG. Currently coordinated special operations related to research are described in *Special Project Operations & Studies* (**Appendix A**). These distances are approximate and will be updated after data are collected and analyzed to understand where the threshold for adversely impacting adult fish behavior occurs. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

2.1.3. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed of steps taken to correct the situation immediately following the incident. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least 2 weeks in advance, unless it is deemed an emergency (see also **FPP Chapter 1 - Overview** for coordination guidance). On a monthly basis, as appropriate, the project biologist will provide a summary of any emergency actions undertaken for review by FPOM.

2.2. Spill Management.

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the Fish Passage Plan as **Appendix E**. Spill at McNary Dam will be distributed in spill patterns defined in **Tables MCN-7, -8, -9, -10**.

2.2.2. Involuntary spill is the result of river flow above powerhouse capacity, insufficient load (lack of load), turbine unit outages (forced or scheduled), or failure of a key component of the juvenile fish passage facility which forces spill to provide juvenile fish passage.

2.2.3. Total dissolved gas (TDG) is monitored at McNary Dam during the periods defined in **Table MCN-1**, pursuant to the Corps' annual *TDG Monitoring Plan* and *Dissolved Gas Monitoring Plan of Action 2015-2018*.[1]

[1] TDG Monitoring Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/. TDG Monitoring Plan 2015-2018: pweb.crohms.org/tmt/wqnew/tdg_monitoring/2015-18.pdf

2.3. Operating Criteria – Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance (December 16 – March 31).

2.3.1.1. Prior to January 16, inspect or rake up to four trashracks to assess debris levels. Prioritize raking trashracks at units with known debris issues and longer run times, and ensure that raked units are distributed evenly across the powerhouse to the extent practicable.

2.3.1.2. Forebay Area and Intakes.

i. Remove debris from forebay and trashracks.

ii. Rake trashracks.

iii. Remove debris from gatewell slots.

iv. Measure and log drawdown in gatewell slots.

v. Inspect and repair gatewell dip net as needed.

2.3.1.3. ESBSs, Flow Vanes, and VBSs.

i. Removal of ESBSs will begin on the Monday of the third week of December. After ESBSs are removed ~~at the end of the season~~, inspect for juvenile salmonid mortalities and all other incidental fish mortalities. Inspect ESBSs within a week after removal, or as soon as practical. All mortalities are to be counted, or otherwise estimated, for each ESBS and reported to CENWW-OD-T.

ii. Maintenance completed on all ESBSs.

iii. Inspect ESBSs for good running order and operate debris cleaner one trial run (dogged off at deck level).

iv. Inspect flow vanes to make sure they are in good condition and all surfaces are smooth. Repair as needed.

v. Inspect all VBSs at least once per year by either raising the VBS and visually inspecting or inspecting with an underwater video camera.

2.3.1.4. Collection Channel.

i. Orifice lights operational.

ii. Orifices clean and valves operating correctly.

iii. Orifice air backflush system works correctly.

iv. Netting over handrails and orifice chutes maintained and in good condition.

v. Plastic covers over orifice chutes maintained and in good condition and clean so orifice flow is visible.

2.3.1.5. Dewatering Structure and Flume.

i. Inclined and side dewatering screens are clean and in good condition with no gaps between screen panels, no damaged panels, and no missing silicone.

ii. Cleaning brush systems are maintained and operating correctly.

iii. All valves in good condition and operating correctly.

iv. Stilling well water level sensing device inspected and operable.

v. Flume and pipe interiors smooth with no rough edges.

vi. Maintain full-flow PIT-tag system as required. Coordinate with PSMFC.

2.3.1.6. Sampling Facilities.

i. Flume switch gate is maintained and operational.

ii. Flume is smooth with no rough edges.

iii. Perforated plate and bar screen edges are smooth with no rough edges.

iv. Wet separator and fish distribution system maintained and operating as designed.

v. Brushes on all crowders in good condition or new.

vi. Crowders maintained and operating properly.

vii. All valves, slide gates, and switch gates maintained and operating correctly.

viii. Raceway and tank retainer screens set in place with no holes or sharp wires protruding.

ix. All sampling equipment should be maintained and operating correctly.

x. Maintain juvenile PIT-tag system as required (see "*Columbia Basin PIT-tag Information System, General Gate Maintenance and Inspection, Walla Walla District*", February 2003). Coordinate with PSMFC.

2.3.1.7. Maintenance Records. Record all maintenance and inspections.

2.3.1.8. Avian Predation Areas (Forebay and Tailrace). Inspect bird wires, water cannon, and other deterrent devices and repair or replace as needed. Where possible, install additional

bird wires or other deterrent devices to cover areas of known avian predation activity. Prepare avian abatement contract as needed.

2.3.2. Juvenile Fish Passage Season (April 1 – December 15).

Operate April 1–December 15 for juvenile fish bypass and sampling, and for adult fallback bypass. Operate according to criteria below and in the *Smolt Facility Operating Protocols* (**Appendix J)** for juvenile salmonid bypass and collection (for research purposes).

2.3.2.1. Forebay Area and Intakes.

i. Remove debris from forebay.

ii. Inspect gatewell slots daily for debris, fish buildup, and contaminating substances (particularly oil). Clean gatewells before they become 50% covered with debris. If the volume of debris precludes the ability to keep the gatewell at least 50% clear, they should be cleaned at least once daily. If flows through an orifice or fish conditions give indications that an orifice may be partially obstructed with debris, the orifice will be closed and backflushed to remove the obstruction. If the obstruction cannot be removed, the orifice shall be closed and the alternate orifice for that gatewell slot shall be operated. If both orifices become obstructed or plugged with debris, the turbine unit will not be operated until the gatewell and orifices are cleared of debris.

iii. If a visible accumulation of contaminating substances (e.g., oil) is detected in a gatewell and cannot be removed within 24 hours, the gatewell orifices shall be closed immediately and the turbine unit shut down within one hour until the material has been removed and any problems corrected. A preferred method for removing oil from the water surface is to install absorbent socks, booms, or pads capable of encapsulating the material, tied off with a rope for later disposal. Action should be taken as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow the fish to exit the gatewell. Orifices shall not be closed for longer than 48 hours.

iv. Remove debris from forebay and trashracks as required to minimize fish impacts. Generally this will result in removing debris from trashracks at least four times per year: just prior to fish passage season and monthly for the first three months. Raking may be required when heavy debris loads are present in the river. Fish quality and trashrack differential may also be an indicator of debris buildup on the trashracks. Project biologist shall determine when trash raking is required.

v. Coordinate cleaning efforts with personnel operating juvenile collection facilities.

vi. Dip bulkhead gatewell slots to remove fish prior to installing bulkhead for dewatering bulkhead slot.

2.3.2.2. ESBSs and VBSs.

i. Operate ESBSs with flow vanes attached. Installation of ESBSs ~~will not start prior to April 5~~ may begin as early as April 2 starting at the lowest priority units (least likely to operate) and will be completed by no later than April 15.

ii. Operate ESBSs with debris cleaners in automatic mode. Set cleaning frequency to 60 minutes. Increase or decrease frequency if needed to maintain clean screens.

iii. Inspect ESBSs weekly by underwater video in at least 3 operating turbine units. Spot-check VBSs at the same time.

iv. Conduct additional ESBS inspections if fish condition warrants it.

v. If an ESBS is damaged or fails during juvenile fish passage season, follow procedures in **section 3.2.2.2**. In no case should a turbine unit be operated with a missing or known non-operating or damaged ESBS or VBS. Units shall not operate for more than 10 hours, *and preferably less than 3 hours*, with ESBSs in place and orifices closed. Orifice closure should be minimized by efficient planning and completion of work to be done (e.g., having equipment, materials and personnel ready before closing orifices).

vi. Make formal determination at end of season as to adequacy of bar screen panels and debris cleaner brushes and replace components as necessary.

vii. Measure head differentials across VBSs daily during times of debris. Clean and inspect VBS when head differentials reach 1.5'. When a head differential of 1.5' is reached, the respective turbine unit should be operated at a reduced generation loading if the VBSs cannot be cleaned within 8 hours, to minimize loading on the VBS and potential fish impingement.

viii. Between the spring and summer periods, inspect at least four VBSs in two different turbine units that were operated frequently during the spring. If debris accumulation is noted, inspect other VBSs and clean debris as necessary.

ix. Inspect all VBSs at least once per year and when pulled for cleaning. Repair as needed.

2.3.2.3. Collection Channel.

i. Orifices clean and operating. Operate at least one orifice per gatewell slot (preferably the south orifice). If orifices must be closed to repair any part of the facility, do not close orifices in operating turbine units with ESBSs in place for longer than 10 hours, and preferably less than 3 hours. During periods of high fish numbers or high debris, this time period may be less. Reduce turbine unit loading to the lower end of the 1% efficiency range if deemed necessary by the project biologist. Monitor fish conditions in gatewells hourly or more frequently during orifice closure periods.

ii. Orifice lights operational and lighted on open orifices. Orifice lights and area lights may be turned off the evening before the channel is dewatered at the end of the season (on December 16 or later) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

iii. Replace all burned out orifice lights within 24 hours of notification. Orifice lights shall remain lighted 24 hours/day.

iv. Orifice jets hitting no closer than 3' from back wall, collection channel full.

v. Orifice valves are either fully open or closed.

vi. Cycle orifices at least once per day and more frequently if required. During periods of high fish and debris passage, April 1 through August 15, orifices should be inspected and cycled twice daily or more frequently as determined by the project biologist, to keep orifices clean. If debris is causing continual orifice plugging problems in a particular turbine unit gatewell, the respective turbine unit generation may be restricted to the lower end of the 1% turbine efficiency range to minimize orifice plugging problems.

vii. Netting along handrails maintained in good condition (no holes or gaps).

viii. Plastic covers over orifice chutes in good condition.

2.3.2.4. Dewatering Structure.

i. No gaps between panels or missing silicone in side and inclined screens.

ii. Trash sweeps operating correctly.

iii. The project biologist shall determine the frequency of operation of the trash sweeps. The sweeps should operate at a frequency to maintain a clean screen given present debris loads. Frequency of operation may vary from as low as once every 15 minutes to once every 2 or more hours. This frequency should coincide with the ESBS cycle time.

iv. If problems occur with the automated cleaning system, project personnel shall operate cleaners at least once per shift unless otherwise determined by the project biologist.

v. The dewatering structure may be dewatered twice during the season, during low fish passage periods in June and September, for inspection and cleaning of the dewatering screens. Before dewatering occurs, the project biologist must notify CENWW-OD-T who in turn will coordinate the proposed action with NOAA Fisheries and other FPOM participants.

vi. Lights at the dewatering structure should be turned off at night, unless needed for personnel access, to encourage fish to move downstream volitionally.

2.3.2.5. Sampling Facilities. [Note: normal operations when not sampling fish is to operate the juvenile bypass facilities in full flow bypass to the river. During this operation, fish may be periodically routed through the sampling facilities to sample fish for the Smolt Monitoring Program or for routine sampling to monitor facility descaling and fish condition. Sampling during full flow bypass operations will be coordinated on an as-needed basis. Sampling during the juvenile fish bypass season is normally done every other day, per **Appendix J**.]

i. There should be no holes or gaps between screen panels. All silicone sealer should be in good condition.

ii. Crowder screen brushes should be in good operating condition.

iii. Assure that retainer screens in raceways and tanks are clean with no holes or protruding wires.

iv. Operate wet separator and fish distribution system as designed.

v. Project personnel shall release ice blocks through each 10" bypass line, 1-3 times per day as warranted by woody debris loads, during the spring as a preventative measure for debris plugging. Additional ice blocks shall be passed down the pipelines during high debris periods as needed to keep the pipes debris free. Releasing ice blocks through the pipes should continue during the summer when transporting fish, as determined by the project biologist to keep the pipelines debris free.

vi. Inform PSMFC, in advance if possible, of situations that cause the PIT-tag system to become inoperable (e.g., power outages) or that could result in confounding the interpretation of PIT-tag data (e.g., bypassing fish from raceways to the river, operating in primary bypass mode without an operational full-flow detector, emergency dewatering).

2.3.2.6. Avian Predation Areas (Forebay, Tailrace, and Collection Channel).

i. Bird wires and other avian deterrent devices should be monitored to assure good condition. Any broken wires or devices should be replaced as soon as possible.

ii. Harassment program in place to deter avian predation in areas actively used by birds and not covered by bird wires or other devices.

iii. Project biologists shall routinely monitor project areas to determine areas of active avian predation and, if possible, adjust harassment program to cover these areas or install bird wires or other deterrent devices to discourage avian predation activities. Grebes should be routinely captured in the juvenile fish channel and released below the dam, in coordination with USDA/Wildlife Services.

2.3.2.7. Temporary Spillway Weirs (TSW).[2]

2.3.2.7.a. Spring spill for fish passage will begin with TSWs operating in bays 19, 20 and spill distributed in the patterns in **Table MCN-7**. Both TSWs will be in service through June 7, and removed on June 8 or the next available work day. During TSW removal, spill will be distributed in patterns in **Table MCN-10** to ensure worker safety. Upon completion of TSW removal when both TSWs are not in service, spill will be distributed in patterns in **Table MCN-9** for the remainder of fish passage spill season.

2.3.2.8. Emergency Bypass.

i. Freezing Conditions. When cold weather is forecasted for Umatilla, Oregon, between November 1 and December 15, the McNary Fisheries staff may place the Juvenile Fish Facility (JFF) channel in emergency bypass mode until the beginning of winter maintenance period when the channel is fully dewatered.

- "*Cold weather*" is defined as: daily high temperature <32°F or daily low temperature < 20°F, as forecasted for Umatilla, OR, by NOAA's National Weather Service at www.weather.gov.

- If the projects installs a proposed "X" or "Y" valve in the south trash sluiceway that eliminates the need for emergency bypass, then the fisheries staff may shut down the water supply to the JFF after November 1 until the JFF is re-watered the following March, unless earlier re-watering is required for testing or maintenance.

ii. Late Season Mechanical Failure. After November 30, if a mechanical failure forces the McNary JFF juvenile channel into emergency bypass mode, the McNary Fisheries staff may leave the juvenile channel in emergency bypass mode until the beginning of winter maintenance when the channel is fully dewatered.

2.3.2.9. Inspection and Record Keeping. Inspect all facilities according to fish facilities monitoring plan. Record all inspections.

2.4. Operating Criteria - Adult Fish Facilities.

2.4.1. Adult Facilities - Winter Maintenance (January 1 – end of February).

2.4.1.1. Inspect all staff gauges and water level indicators. Repair and/or clean where necessary.

2.4.1.2. Dewater all ladders and inspect all dewatered sections of fish facilities for projections, debris, or plugged orifices which could injure fish or impede fish passage up the

[2] Spillway weirs provide surface passage routes via spillbay(s). Temporary, or Top, Spillway Weirs (*TSW*s) at Little Goose, McNary and John Day dams can be installed, uninstalled and moved between bays using the gantry crane. Removable Spillway Weirs (*RSW*s) at Lower Granite, Lower Monumental and Ice Harbor dams are "removed" by controlled descent to the bottom of the forebay.

ladder. Fish ladder exit trashracks must have smooth surfaces where fish pass and must have downstream edges that are adequately rounded or padded. Inspect all diffuser gratings and chambers annually by dewatering or by using divers or video inspection techniques. All diffuser gratings and chambers are to be dewatered and physically inspected at least every 3 years. Repair deficiencies.

2.4.1.3. Inspect for and clean debris from fish ladder exits. All trashracks and picketed leads must be clean and installed correctly.

2.4.1.4. Calibrate all water level measuring devices, as necessary, for proper facility operations.

2.4.1.5. Inspect all spill gates and ensure that they are operable.

2.4.1.6. Fish pumps maintained and ready for operation.

2.4.1.7. Maintain adult PIT-tag system as required. Coordinate with PSMFC.

2.4.1.8. Outage periods will be minimized to the extent practicable. Only one ladder may be out of service or operating out of standard operating criteria at any one time, unless specifically coordinated with CENWW-OD-T and FPOM.

2.4.2. Adult Fish Passage Season (March 1 – December 31).

2.4.2.1. Fishway Ladders. Water depth over weirs: 1.0’–1.3'.

2.4.2.2. Counting Windows. The crowder shall be opened to full count slot width and the picketed leads shall be removed when not counting. The crowder shall be open as far as possible to allow accurate counting and shall not be closed to less than 18 inches while counting, to the extent possible. This will usually occur during high turbidity conditions to allow count accuracy criteria to be achieved. All equipment should be maintained and in good condition. The counting window and backboard should be cleaned as needed to maintain good visibility. Crowder ranges at MCN are:

i. Washington Shore = 19 $^{3}/_{16}$” (not adjustable)

ii. Oregon Shore downstream = 13 $^{1}/_{8}$” – 17 $^{5}/_{8}$”

iii. Oregon Shore upstream = 13 $^{1}/_{2}$” – 17 $^{1}/_{8}$”

2.4.2.3. Head on all Fishway Entrances. Head range: 1'–2'.

2.4.2.4. Channel Velocity. Adult collection channel water velocities must flow between 1.5’ and 4’ per second, which is the optimum velocity for returning adult salmon and steelhead to migrate upstream though the fishway. Velocity readings are completed three times per week and included in required fishway inspections and reported in weekly and annual reports.

i. Surface water velocities will be measured in the open access area near the south shore fish entrance by using a large piece of woody debris (stick, bark) timed over a marked fixed distance. A Doppler meter location near the same location measures sub-surface flow. The measurement of the water velocity at this location represents the slowest velocity conditions throughout the length of the channel.

2.4.2.5. North Shore Entrances (WFE 2 & 3).

i. Operate 2 downstream gates.

ii. Weir depth: 8' or greater below tailwater.

2.4.2.6. North Powerhouse Entrances (NFE 2 & 3).

i. Operate 2 downstream gates.

ii. Weir depth: 8' or greater below tailwater.

2.4.2.7. Floating Orifice Gates (FOGs). Operate twelve FOGs (1, 3, 4, 8, 14, 21, 26, 32, 37, 41, 43, 44).

2.4.2.8. South Shore Entrances (SFE 1 & 2).

i. Operate two downstream gates.

ii. Weir depth: 8' or greater below tailwater.

2.4.2.9. Head on Trashracks.

i. Maximum head of 0.5' on ladder exits.

ii. Maximum head on picketed leads shall be 0.5'. Normal head differential on clean leads is 0.3'.

iii. Trashracks and picketed leads installed correctly.

2.4.2.10. Staff Gauges and Water Level Indicators. All staff gauges should be readable at all water levels encountered during the fish passage period. Repair or clean as necessary.

2.4.2.11. Inform PSMFC, in advance if possible, of situations that cause the PIT-tag system to become inoperable (e.g., power outages) or that could result in confounding the interpretation of PIT-tag data (e.g., emergency dewatering).

2.4.2.12. Facility Inspections.

i. Powerhouse operators shall inspect facilities once per day shift and check computer monitor information at least once during each back shift.

ii. Project biologists shall inspect facilities three times per week. Inspect all facilities according to fish facilities monitoring program.

iii. Picketed leads shall be inspected during all inspections to ensure they are clean and in the correct position (all the way down).

iv. Project personnel shall check calibration of fishway control system twice per month. This may be done as part of routine fishway inspections.

v. Inspect fishways daily for foreign substances (particularly oil). If substances are found, corrective actions should be undertaken immediately.

vi. Record all inspections.

2.4.2.13. Fishway Temperature Monitoring. From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits.

i. Temperature monitors shall be placed within 10 meters of all shore-oriented entrances and exits.

ii. If possible, the entrance monitor shall be within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers to allow for sufficient mixing with surface water.

iii. The exit monitor shall be within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

iv. If an existing temperature monitoring location is proposed to be used for either the exit or entrance, it shall be verified that the site accurately reflects water temperature within 10 meters of the entrance or exit.

v. Project Fisheries will submit temperature data to the Fish Passage Center (FPC) on a weekly basis for posting online at:
www.fpc.org/river/Q_ladderwatertempgraph.php

2.5. Fish Facilities Monitoring & Reporting.

2.5.1. Project biologists shall inspect fish passage facilities at the frequencies described in the juvenile and adult fish facilities operating criteria sections.

2.5.2. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31, summarizing operations for Friday through Thursday, and email to CENWW-OD-T by noon the following Monday. Reports shall provide an overview of how the project and the fish passage facilities operated during the week and evaluate resulting fish passage conditions, and include:

i. Any out-of-criteria situations observed and subsequent corrective actions taken;
ii. Any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities;
iii. Adult fishway control calibrations;

iv. ESBS and VBS inspections;
v. Any unusual activities that occurred at the project that may affect fish passage.

2.5.3. Annual Reports. Project biologists shall prepare a draft annual report by February 10 and a final report by March 15 summarizing the operation of the project fish passage facilities for the previous year. The annual report shall also include a description of all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities in discouraging avian predation.

2.5.4. Monthly Inspections. Project biologists inspect project facilities once per month and during dewaterings for the presence of zebra and Quagga mussels. Biologists shall provide a report to CENWW-OD-T on a monthly basis summarizing mussel inspections.

3. FISH FACILITIES MAINTENANCE

3.1. Dewatering & Fish Handling.

3.1.1. Project biologists should be present to provide technical guidance at all project activities that may involve fish handling. All dewaterings shall be accomplished in accordance with approved *Dewatering Guidelines and Fish Salvage Plans* (**Appendix F**). When river temperatures exceed 68°F at the Juvenile Fish Facility (JFF) sample tank, all adult fish handling will be coordinated through CENWW-OD-T. Project *Dewatering Plans*[3] were reviewed and revised in 2011 to ensure they comply with **Appendix F**.

3.2. Maintenance - Juvenile Fish Facilities.

3.2.1. Scheduled Maintenance. Scheduled maintenance of the juvenile facilities is conducted during the entire year. Long-term maintenance or modifications of facilities that require them to be out of service for extended periods of time are conducted during the winter maintenance period from December 16 – March 31. During the fish passage season parts of the facilities are maintained on a daily, weekly, or longer interval to keep them in proper operating condition.

3.2.2. Unscheduled Maintenance. Unscheduled maintenance is the correction of any situation that prevents facilities from operating according to criteria or that will impact fish passage or survival.

3.2.2.1. Notification/Reporting. Maintenance of facilities such as ESBSs, which sometimes break down during the fish passage season, will be carried out as described below. In these cases, repairs will be made as prescribed and CENWW-OD-T will be notified as soon as possible after it becomes apparent that repairs are required. The Operations Manager may determine that work must be initiated prior to notifying CENWW-OD-T if a delay will result in an unsafe situation for people, property, or fish. Unscheduled maintenance that will have a significant impact on fish passage shall be coordinated with NOAA Fisheries and FPOM on a

[3] Project Dewatering Plans are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/

case-by-case basis by CENWW-OD-T. Information required by CENWW-OD-T includes (see also **FPP Chapter 1 - Overview**):

i. Description of outage;
ii. Type of outage required;
iii. Impact on facility operation;
iv. Length of time for repairs; and
v. Potential fish impacts and proposed mitigation measures.

3.2.2.2. ESBSs. The ESBSs deflect fish and water up the gatewell slots as part of the fish bypass system and are inspected periodically throughout the juvenile passage season with a video monitoring system. If an ESBS is found to be damaged, it will be removed and either replaced with a spare, or repaired and returned to service. A turbine unit shall not be operated with a known damaged or nonfunctioning screen or without a full complement of ESBSs, flow vanes and VBSs. If a screen fails on a weekend or at night when maintenance crews are not available, the respective turbine unit will be shut down and generation switched to a fully screened unit. If all screened turbine units are in service, water may be spilled until the affected screen can be removed and repaired or replaced.

3.2.2.3. VBSs. Each gatewell has a VBS located vertically between the bulkhead slot and the operating gate slot to guide fish away from the turbine intake. The VBSs are designed to distribute flow evenly through the screens to minimize fish impingement and/or descaling. The gatewell water surface elevations are routinely measured to determine head differential across the VBSs caused by debris. VBSs are to be pulled and cleaned when head differentials reach 1.5'. Prior to pulling a VBS for cleaning, the turbine unit loading will be lowered to the lower end of the 1% efficiency range and the gatewell dipped with a gatewell basket to remove all fish present in the gatewell unless doing so results in increased mortality (e.g., high numbers of adult or juvenile shad in gatewells). Immediately after dipping, the VBS shall be raised and debris hosed off. The turbine unit shall remain operating at the lower end of 1% while the VBS is being cleaned so gatewell flow will carry the debris into the operating gatewell where it will pass through the turbine unit. Immediately after cleaning the VBS, the VBS shall be lowered to the normal operating position to prevent fish passing from the bulkhead slot into the operating gate slot. The VBSs shall not be raised longer than 30 minutes with the turbine unit running. If VBSs cannot be cleaned within 1 workday of the head differential reaching 1.5', the turbine unit loading will be lowered to the lower end of the 1% range until the VBS can be cleaned. If the cleaning frequency of VBSs exceeds project personnel's cleaning capability of approximately 10 VBSs per day, 7 days per week, project personnel will notify CENWW-OD-T. Then CENWW-OD-T will coordinate with NOAA Fisheries and other FPOM participants regarding an exemption to dipping gatewells prior to cleaning VBSs. An exemption to dipping gatewells prior to cleaning VBSs will be based on fish numbers and TDG levels. If a VBS is found to be damaged during an inspection or cleaning, the VBS panel will be repaired or replaced with a spare panel. The turbine unit will not be operated with a known damaged VBS.

3.2.2.4. Gatewell Orifices. Each gatewell has two orifices with valves to allow fish to exit the gatewell. Under normal operation, one orifice per gatewell (normally the south orifice) is operated. If an orifice becomes blocked with debris or is damaged, it will be closed and the alternate orifice for that gatewell operated until repairs can be made. If both orifices are

blocked with debris, damaged, or must be kept closed, the turbine unit will be taken out of service until repairs can be made. If there is a major failure with the bypass system that prevents the gatewell orifices from operating, traveling screens and bar screens will remain in operation. Turbine units shall not be operated with blocked or closed orifices for longer than 10 hours. During any orifice closure, project personnel shall monitor gatewells for signs of fish problems or mortality. If repairs are expected to take longer than two days, a salvage program will be initiated to dip the juveniles from the gatewells with a gatewell basket until repairs are made and the system watered up again or orifices opened. Juvenile fish shall not remain in gatewells longer than 48 hours. During periods of high fish passage, it may be necessary to cease operation of turbine units with ESBSs in place and with closed orifices in less than 10 hours, depending on fish numbers and condition. Spill may occur to provide an alternate avenue for fish passage during facility outages.

3.2.2.5. Dewatering Structure. The dewatering structure acts as a transition from the collection channel to the bypass pipe/flume. An inclined screen and a side dewatering screen allow excess water to be bled off, with all fish and remaining water transitioning into the bypass pipe. Some of the excess water is discharged into the adult fish facility auxiliary water supply system and some is used as the water supply for the sampling facilities. The dewatering structure contains trash sweeps and an air-burst system for cleaning the dewatering screens of impinged debris. If a trash sweep breaks and interferes with juvenile fish passage through the structure or if a screen is damaged, an emergency bypass system in the collection channel may be used to bypass juveniles while repairs are made. Operation of the emergency bypass system requires the juvenile bypass system to be dewatered and stoplogs inserted at the upstream end of the dewatering structure. The emergency bypass is then opened and the bypass system operated with one orifice per gatewell open. Spill may also be required to bypass juvenile fish while in emergency bypass operations. Prior to any emergency dewatering of the collection channel, the project will notify CENWW-OD-T. Then CENWW-OD-T will be responsible for notifying NOAA Fisheries and other FPOM participants of the action and coordinating changes in spill or other project operations. The emergency bypass system is not equipped with PIT-tag detectors.

3.2.2.6. Bypass Outfall Flume. The corrugated metal bypass flume routes juveniles to either the sampling facilities or to the river below the project through the primary bypass pipe. If a problem interferes with the flume's operation, the project can open the emergency bypass system in the collection system and all of the fish in the bypass system will be diverted into the ice and trash sluiceway and passed to the river through the north powerhouse ice and trash sluiceway exit.

3.2.2.7. Sampling Facilities. The sampling facilities can be operated to collect and hold juveniles for research and sampling purposes, enumerate fish through the sampling system, or bypass part or all of the fish back to the river (secondary bypass). If part of the facility malfunctions or is damaged, the switch gate in the bypass flume will be used to bypass fish directly to the river (primary bypass) until repairs can be made. .

3.3. Maintenance - Adult Fish Facilities.

3.3.1. Scheduled Maintenance. Scheduled maintenance of a facility that must be dewatered to work on or whose maintenance will have a significant effect on fish passage will be done during the January and February winter maintenance period. Maintenance of facilities that will have no effect on fish passage may be conducted at any time. Maintenance is normally conducted on one fish ladder at a time during the winter to provide some fish passage at the project at all times. When facilities are not being maintained during the winter maintenance period, they will be operated according to normal criteria unless otherwise coordinated with NOAA Fisheries and other FPOM participants.

3.3.2. Unscheduled Maintenance.

3.3.2.1. Notification/Reporting. Unscheduled maintenance that will significantly affect facility operation will be coordinated with NOAA Fisheries and other FPOM participants. Coordination procedures for unscheduled maintenance of adult facilities are the same as for juvenile facilities (**section 3.2.2**). If part of a facility malfunctions or is damaged during fish passage season and the facility can still be operated within criteria without any detrimental effects on fish passage, repairs may not be conducted until winter maintenance period or until fewer numbers of fish are passing the project. If part of a facility is damaged or malfunctions that may significantly impact fish passage, it will be repaired as soon as possible.

3.3.2.2. Fish Ladders & Counting Stations. Fish ladders contain tilting weirs, fixed weirs, counting stations with picket leads, and fish exits with trashracks. If any part of the fish ladder fails or is blocked with debris during fish passage season, efforts will first be made to correct the problem without dewatering the ladder. Trashracks, picket leads, tilting weir mechanisms, and counting stations can sometimes be repaired or maintained without dewatering the ladder. The decision to dewater the ladder and make repairs during the fish passage season or wait until the winter maintenance period will be made after coordination with the fish agencies and tribes.

3.3.2.2.a. Hazardous Materials Spill. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.

3.3.2.3. North Shore Auxiliary Water Supply System. The auxiliary water for the north shore fish ladder is provided by gravity-flow from the forebay. The water passes either through a turbine unit or through a bypass system. The turbine/bypass system is operated by North Wasco County PUD. During normal operations, when the turbine unit is operating, water passes through conduits 3 and 4 to the turbine unit. From the turbine unit, the water discharges into an open pool where it feeds into ladder diffusers. If there are problems with the turbine unit, automatic valves close and the auxiliary water is diverted through conduits 1 and 3A to the baffled bypass system within the old fish lock, where the hydraulic head is dissipated and the water discharged into the diffuser pool.

3.3.2.4. South Shore Auxiliary Water Supply System. The south shore auxiliary water is made up of a combination of gravity flow from the forebay, pumped water from the tailrace and 450 cfs of water from the juvenile collection channel. The gravity flow supplies the diffusers above weir 253 (diffusers 7 through 14) and the pumps supply diffusers below weir 253 (diffusers 1 through 7 and main unit diffusers). Diffuser 7 is where both systems meet and is supplied by either gravity flow or pumped flow. Gravity flow diffusers are regulated by rotovalves and pumped flow diffusers by sluice gates. Water from the juvenile collection channel enters the south fishway near the north powerhouse entrances.

i. If a rotovalve fails, the nearest closed rotovalve will be opened to supply flow. If more rotovalves fail than there are closed valves, the sluice gates in diffusers 3 through 7 will be opened more to provide required flows.

ii. If any sluice gates fail, the nearest sluice gates will be opened further to make up the flow.

iii. If one pump fails, the other two pumps will be operated to maintain facilities within criteria.

iv. If two pumps are expected to be out of service short-term (up to five days), then NFE3 will be closed and SFE1, SFE2, NFE2 will be operated as deep as possible while maintaining head differential at 1–2’ at both north and south PH entrances.

v. If two pumps are expected to be out of service long-term (six days or longer), then the middle eight of twelve open floating orifices (4,8,14,21,26,32,37,41) should be closed and monitored before closing main entrances. If extra water is still needed, NFE3 will be closed and SFE1, SFE2, NFE2 will be operated as deep as possible to maintain head differential at 1–2' at both north and south PH entrances.

vi. If all three pumps fail and the outage is expected to last five days or less, CENWW-OD-T will be notified and in turn will coordinate with NOAA Fisheries and other FPOM participants.

vii. If all three pumps fail and the outage is expected to last six days or longer close NFE3 and the middle eight of twelve open floating orifices (4,8,14,21,26,32,37,41) and operate SFE1 and SFE2 as deep as possible while maintaining head differential at 1–2' at the south PH entrances. If a depth of 6' on both gates cannot be maintained, SFE1 will be closed as long as the lamprey passage structure is in place at SFE2, if the lamprey structure is not in place then close SFE2.

viii. If both pumped auxiliary water supply systems and juvenile collection channel are closed or in emergency bypass (eliminating the 450 cfs contribution from the juvenile system), close north powerhouse entrances and eight of twelve open floating orifices starting at the north end of collection channel, and operate SFE1, SFE2 as deep as possible while maintaining head differential at 1–2' at the

south PH entrances. If both gates cannot be maintained at a depth of 6', SFE1 will be closed as long as the lamprey passage structure is in place at SFE2. If the lamprey structure is not in place, close SFE2.

3.3.2.5. Fishway Entrances. Fishway entrances consist of main entrance weirs with hoists and automatic controls, and floating orifices that self-regulate with tailwater fluctuations. If any automatic controls malfunction, the weirs can be operated manually by project personnel and kept within criteria. If there is a further failure that prevents the entrance from being operated manually, the entrance may be lowered down and left in an operating position or an alternate entrance opened until repairs can be made. If a floating orifice fails, it will be pulled out of the water and replaced with a spare floating orifice.

3.3.2.6. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during winter maintenance to ensure they are in place. These inspections are done by both dewatering and physically inspecting the diffuser gratings, or by using underwater video cameras, divers, or other methods. Diffuser gratings may come loose during the fish passage season due to a variety of reasons. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings. If a diffuser grating is known or suspected to have moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway. Coordination of the problems should begin immediately through the established coordination procedure in **section 3.2.2**. If possible, a video inspection should be made as soon as possible to determine extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and tribes through the established coordination procedure. Repairs shall be made as quickly as possible unless otherwise coordinated.

4. TURBINE UNITS OPERATION & MAINTENANCE

4.1. Turbine Unit Priority Order.

4.1.1. Turbine units will be operated in the order of priority defined in **Table MCN-5** to optimize adult and juvenile fish passage. If a unit is out of service, the next unit in the priority order will be operated. Unit priority order may be coordinated differently for fish research, construction, or project maintenance. Unit operation during warm water events are described in **section 4.2.**

Table MCN-5. McNary Dam Turbine Unit Priority Order.

Dates/Operation	Unit Priority Order
March 1 – November 30 Fish Passage/Bypass Season	1, then 14–2 in descending order [a]
Warm Water Operations [b] (see **section 4.2**)	U1 available: STOP every other unit starting w/ 2 and move north. = 2, 4, 6, 8, 10, 12, 14, 3, 5, 7, 9, 11, 13, 1 Unit 1 OOS: STOP every other unit starting w/ 3 and move north. = 3, 5, 7, 9, 11, 13, 2, 4, 6, 8, 10, 12, 14
December 1 – End February Winter Maintenance Period	Any Order (if OR ladder is in service, request to operate Unit 1 or 2 if possible)

a. Provides positive downstream flows at the outfall, based on unit availability.

b. Warm Water Operations priority order may be adjusted if necessary as coordinated by the Project Biologist.

4.2. Warm Water Turbine Operations.

4.2.1. In order to minimize thermal stress on juvenile salmonids during warm water conditions, the turbine operations described below will be implemented at the request of the Project Biologist when *any* of the following conditions occur:

i. Water temperatures in the McNary JFF sample tank >68°F;

ii. Water temperatures elsewhere at the Project (e.g., gatewells) that are likely to induce thermal stress in juvenile salmonids;

iii. Temperature gradients >5°F;

iv. Sample mortality >3%;

v. System mortality >6%.

4.2.2. Operation in Secondary Bypass or Sample Mode. When any of the conditions listed above occur, the Project will begin to shut down units in a staggered order (**Table MCN-5**, stopping every other unit starting at Unit 2, then ascending as necessary to avoid temperature shocks in the juvenile channel (i.e., shutting down units 2, 4, 6, 8, 10, 12 and 14). If possible, Unit 1 shall be left in operation to provide attraction flow to the two entrances of the Oregon shore fish ladder. Project Fisheries will coordinate with CENWW to modify the sequence as necessary to provide equal or better levels of fish protection. Starting and stopping of two or more units at a time should be avoided if possible during warm water periods, especially during the hours of 1000–2400. The Project and CENWW will coordinate these protocols with fish agencies and tribes through FPOM and other entities as necessary. The purpose of these protocols is to provide precautionary measures to avoid or minimize any direct or delayed mortality resulting from additional thermal stress when handling juvenile salmonid fishes.

4.2.3. Continued Mortality. If juvenile salmonid populations continue to experience high mortality after implementing the above turbine operations, collection for fish condition sampling by smolt monitoring staff should continue for up to 8 hours a day. Except for daily monitoring, the Project shall switch to primary bypass, routing fish past the JFF and through the bypass outfall for the duration of the event.

4.3. Turbine Unit Operating Range.

4.3.1. In-Season (April 1–October 31). As defined in the *BPA Load Shaping Guidelines* (**Appendix C**), all units will be operated within ±1% of peak turbine efficiency (1% range) to maximize survival of juvenile fish that pass through the turbines. Turbine unit flow and power output at the lower and upper limits of the 1% range are defined in **Table MCN-6**.

4.3.1.1. If operation outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

i. Meet BPA load requests made pursuant to BPA's policy, statutory requirements, and *Load Shaping Guidelines* (**Appendix C**);

ii. If the draft tube is to be dewatered (**section 4.4.4**), the unit will be operated at full load >1% (or at speed-no-load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs in order to flush fish from the unit;

iii. Operate a turbine unit solely to provide station service; or

iv. Comply with other coordinated fish measures.

4.3.2. Off-Season (November 1–March 31). While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

Table MCN-6. McNary Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Turbine Efficiency (Lower and Upper Limits of 1% Range) and Operating Limits. [a]

Project	With ESBS						No ESBS					
Head	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
(feet)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
62	34.5	7,951	49.7	11,454	68.0	16,311	34.7	7754	50.8	11,346	68.0	15,710
63	35.2	7,963	51.0	11,552	69.6	16,399	35.4	7765	52.1	11,444	69.6	15,793
64	35.8	7,974	52.3	11,646	71.2	16,486	36.0	7776	53.5	11,537	71.2	15,875
65	36.5	7,984	53.7	11,736	72.8	16,571	36.7	7,786	54.8	11,627	72.8	15,955
66	37.0	7,959	55.2	11,869	74.1	16,574	37.2	7,762	56.3	11,759	74.1	15,945
67	37.5	7,934	56.7	11,997	75.3	16,574	37.7	7,739	57.9	11,887	75.3	15,933
68	38.0	7,911	58.2	12,121	76.6	16,572	38.2	7,716	59.4	12,009	76.6	15,919
69	38.5	7,887	59.7	12,240	77.8	16,567	38.7	7,694	60.9	12,128	77.8	15,903
70	39.0	7,864	61.2	12,355	79.0	16,560	39.2	7,671	62.5	12,243	79.0	15,884
71	39.6	7,874	62.1	12,355	79.7	16,433	39.8	7,681	63.4	12,243	79.7	15,782
72	40.2	7,883	63.1	12,354	80.4	16,303	40.4	7,691	64.4	12,242	80.4	15,676
73	40.9	7,892	64.0	12,353	81.0	16,169	41.1	7,699	65.3	12,241	81.0	15,567
74	41.5	7,901	64.9	12,351	81.6	16,033	41.7	7,708	66.3	12,240	81.3	15,455
75	42.2	7,909	65.8	12,350	82.2	15,893	42.4	7,716	67.2	12,239	81.3	15,340
76	42.8	7,907	66.4	12,282	82.5	15,705	43.0	7,714	67.9	12,172	81.3	15,161
77	43.4	7,905	67.1	12,216	82.8	15,513	43.6	7,713	68.5	12,107	81.3	14,979
78	44.0	7,903	67.7	12,151	83.1	15,319	44.2	7,711	69.1	12,044	81.3	14,795
79	44.6	7,900	68.3	12,088	83.3	15,122	44.8	7,709	69.7	11,981	81.3	14,608
80	45.2	7,897	68.9	12,026	83.4	14,922	45.5	7,706	70.3	11,920	81.3	14,418
81	45.9	7,911	70.0	12,067	83.7	14,747	46.1	7,720	71.5	11,961	81.3	14,256
82	46.5	7,925	71.1	12,106	83.8	14,569	46.8	7,734	72.6	12,000	81.3	14,091
83	47.2	7,939	72.2	12,145	84.0	14,389	47.4	7,747	73.7	12,038	81.3	13,924
84	47.9	7,952	73.3	12,182	84.1	14,206	48.1	7,759	74.9	12,076	81.3	13,754
85	48.5	7,964	74.4	12,219	84.2	14,020	48.8	7,772	76.0	12,112	81.3	13,582
86	49.2	7,987	75.1	12,179	84.0	13,806	49.5	7,794	76.7	12,073	81.3	13,373
87	50.0	8,008	75.7	12,140	83.8	13,588	50.2	7,815	77.3	12,034	81.3	13,161

a. Table values derived from HDC report (Mar 1999; updated Jan 2005). Flow (cfs) is calculated based on turbine efficiency, head, and power output (MW). "Operating Limit" is the maximum safe operating point, based on cavitation or generator limit (added Feb 2018).

4.4. Turbine Unit Maintenance.

4.4.1. Maintenance Schedules.

4.4.1.1. Turbine unit maintenance schedules will be reviewed annually by Project and District Operations biologists for fish impacts.

4.4.1.2. Each turbine unit requires annual maintenance that may take from several days to two weeks, and is normally scheduled from mid-July through late December. Annual maintenance of priority units for adult passage is normally conducted in November-December, but can be completed in mid-August.

4.4.1.3. Priority unit maintenance will be scheduled for winter maintenance period or when there are few fish passing the project, to the extent possible. Impacts to migrating adults should be minimized.

4.4.1.4. When possible, units used for temperature operations should remain available.

4.4.1.5. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take over one year to accomplish.

4.4.1.6. Turbine units, governors, exciters, and control systems require periodic maintenance, calibration, and testing which may take them outside of the 1% peak efficiency range. This work will be scheduled in compliance with the *BPA Load Shaping Guidelines* (**Appendix C**) to minimize impacts on juvenile fish.

4.4.2. Operational Testing.

4.4.2.1. Pre-Maintenance: Units may be operationally tested for up to 30 minutes prior to going into maintenance status by running at speed-no-load and various loads within the 1% range for pre-maintenance measurements and testing, and to allow all fish to move through the unit.

4.4.2.2. Post-Maintenance: Units may be operationally tested while remaining in maintenance or forced outage status by running the unit for up to a cumulative time of 30 minutes (within 1% range) before returning to operational status.

4.4.2.3. Operational testing of a unit under maintenance is in addition to a unit in run status required for power plant reliability. Operational testing may deviate from FPP priority order and may require water that would otherwise be used for spill if the unit running for reliability is at its 1% lower limit (i.e., minimum generation). Water for operational testing will be used from powerhouse allocation when possible, and diverted from spill only to the extent necessary to maintain generation system reliability.

4.4.3. Head Gates. [4] Head gates will normally remain in standard operating position except as required for maintenance.

4.4.4. Dewatering. Dewatering turbine units should be accomplished in accordance with project dewatering plans. If the turbine unit draft tube is to be dewatered, operate unit with full load for a minimum of 15 minutes prior to installing tail logs. If not possible to load, run unit at speed-no-load for minimum of 15 minutes. This is to reduce the number of fish in the scrollcase prior to installing stop logs. If a turbine unit is out of service for maintenance for an extended period of time without tailrace stoplogs in place, efforts should be made to not open the wicket gates if the scroll case must be dewatered at a later date without the unit being spun beforehand.

5. FOREBAY DEBRIS REMOVAL

5.1.1. Debris at projects can adversely impact fish passage conditions by plugging or blocking trashracks, VBSs, gatewell orifices, dewatering screens, separators, and facility piping resulting in impingement, injuries, and descaling of fish. Removing debris at its source in the forebay is sometimes necessary to maintain safe and efficient fish passage conditions, navigation, and other project activities. The preferred option is to remove debris at each project when possible to avoid passing debris on to the next project downstream. Debris can be removed from the forebay by:

i. Using a boat to physically encircle debris with a log boom to pull it to the spillway where operators can spill it or to the shore to be removed by crane;

ii. removing the debris from the top of the dam using a crane and scoop;

iii. passing debris via the spillway with special turbine and/or spill operations;

iv. Using a boom, spreader bar or other device, suspended from a crane, to move the debris to the spillway, in coordination with special powerhouse and spill operations (if needed).

5.1.2. Debris Spill. If the Project does not have forebay debris removal capability, the only viable alternative is to pass the debris via spill. Except in an emergency, the Project shall contact CENWW-OD-T and the John Day Dam Control Room and Fishery Biologist at least one workday in advance of debris spill operations. CENWW-OD-T will notify FPOM and the special operation will be detailed in a teletype issued by RCC. In an emergency operation, notification may be provided as described below**.**

5.1.3. Special Spills. All special spills (other than normal spill patterns for ongoing spill operations) and project operations for passing debris will be coordinated prior to the operations taking place. Each project shall contact CENWW-OD-T at least two workdays prior to the day they want the special project operation for spilling to pass debris. Then CENWW-OD-T shall coordinate the special operation with RCC, NOAA Fisheries, and other FPOM participants. Project personnel shall provide CENWW-OD-T the reason for the debris spill request, including

[4] Head gates may also be referred to as “operating” gates. The terms are interchangeable.

an explanation of Project facilities being impacted by debris, the date and time of the requested spill, and any special powerhouse or other operations required to move debris to the spillway. When a debris spill is coordinated and approved, RCC shall issue a teletype detailing the specifics of the special operations.

5.1.4. Emergency Spills. Implement as necessary to pass woody debris that is accumulating in the forebay and compromising the safe, unobstructed passage of fish**.** The operating project will immediately spill the woody debris to remove obstructions to fish passage. The operating project will notify CENWW-OD-T of the emergency spill as soon as possible to notify RCC, NOAA Fisheries, and other FPOM participants.

Table MCN-7. [*pg 1 of 5*] McNary Dam Spill Patterns for Fish Passage with TSWs in Bays 19-20.

MCN Spill Patterns with TSWs (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22 [b]	(#)	(kcfs)
																		TSW	TSW	1		**1**	**21.2**
																	1	TSW	TSW	1		**2**	**23.2**
																	1	TSW	TSW	1	1	**3**	**25.2**
																	1	TSW	TSW	2	1	**4**	**27.1**
																	2	TSW	TSW	2	1		**29.0**
																1	2	TSW	TSW	2	1	**6**	**31.0**
																2	2	TSW	TSW	2	1	**7**	**32.9**
														1		2	2	TSW	TSW	2	1	**8**	**34.9**
														1		2	2	TSW	TSW	2	2	**9**	**36.8**
														2		2	2	TSW	TSW	2	2	**10**	**38.7**
														2	1	2	2	TSW	TSW	2	2	**11**	**40.7**
														2	2	2	2	TSW	TSW	2	2	**12**	**42.6**
													1	2	2	2	2	TSW	TSW	2	2	**13**	**44.6**
													2	2	2	2	2	TSW	TSW	2	2	**14**	**46.5**
										1		2		2	2	2	2	TSW	TSW	2	2		**48.5**
										2		2		2	2	2	2	TSW	TSW	2	2	**16**	**50.4**
								1		2		2		2	2	2	2	TSW	TSW	2	2	**17**	**52.4**
								2		2		2		2	2	2	2	TSW	TSW	2	2	**18**	**54.3**
								2	1	2		2		2	2	2	2	TSW	TSW	2	2	**19**	**56.3**
								2	2	2		2		2	2	2	2	TSW	TSW	2	2	**20**	**58.2**
								2	2	2		2	1	2	2	2	2	TSW	TSW	2	2	**21**	**60.2**
								2	2	2		2	2	2	2	2	2	TSW	TSW	2	2	**22**	**62.1**
								2	2	2	1	2	2	2	2	2	2	TSW	TSW	2	2	**23**	**64.1**
								2	2	2	2	2	2	2	2	2	2	TSW	TSW	2	2	**24**	**66.0**
						1		2	2	2	2	2	2	2	2	2	2	TSW	TSW	2	2		**68.0**
						2		2	2	2	2	2	2	2	2	2	2	TSW	TSW	2	2	**26**	**69.9**
				1		2		2	2	2	2	2	2	2	2	2	2	TSW	TSW	2	2	**27**	**71.9**
				2		2		2	2	2	2	2	2	2	2	2	2	TSW	TSW	2	2	**28**	**73.8**
2.5	2	3.5		2		2		2		2		2	1	2		2	2	TSW	TSW	2	2	**29**	**75.3**
2.5	2	3.5		2		2		2		2		2	1	2	1	2	2	TSW	TSW	2	2	**30**	**77.3**
2.5	2	3.5		2	1	2		2		2		2	1	2	1	2	2	TSW	TSW	2	2	**31**	**79.3**

[a] Spill (kcfs) is calculated as a function of total stops + TSW spill at forebay elevation 339 ft.
[b] Bays 1 & 22 *MAY* require special open/close sequence (pending field test verification). Open Bays 2–21 for ≥ 10 minutes, then open Bays 1, 22. Close Bays 1, 22 first.
[c] Bays 19-20 with TSWs = fixed spill of ~19.2 kcfs (~9.6 kcfs per bay) at fb el 339'. Raise tainter gates ~3-5 ft above water surface to ensure free flow through TSWs.

MCN Spill Patterns with TSWs (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22 [b]	(#)	(kcfs)
2.5	2	3.5		2	1	2		2	1	2		2	1	2	1	2	2	TSW	TSW	2	2	**32**	**81.3**
2.5	2	3.5		2	1	2		2	1	2	1	2	1	2	1	2	2	TSW	TSW	2	2	**33**	**83.3**
2.5	2	3.5		2	1	2	1	2	1	2	1	2	1	2	1	2	2	TSW	TSW	2	2	**34**	**85.3**
2.5	2	3.5	1	2	1	2	1	2	1	2	1	2	1	2	1	2	2	TSW	TSW	2	2	**35**	**87.3**
2.5	2	3.5	1	2	1	2	1	2	1	2	1	2	1	2	1	2	2	TSW	TSW	2.5	2.5	**36**	**89.0**
2.5	2	3.5	1	2	1	2	1	2	1	2	1	2	2	2	1	2	2	TSW	TSW	2.5	2.5	**37**	**90.9**
2.5	2	3.5	1	2	1	2	1	2	1	2	1	2	2	2	2	2	2	TSW	TSW	2.5	2.5	**38**	**92.8**
2.5	2	3.5	1	2	2	2	1	2	1	2	1	2	2	2	2	2	2	TSW	TSW	2.5	2.5	**39**	**94.7**
2.5	2	3.5	1	2	2	2	1	2	2	2	1	2	2	2	2	2	2	TSW	TSW	2.5	2.5	**40**	**96.6**
2.5	2	3.5	1	2	2	2	1	2	2	2	2	2	2	2	2	2	2	TSW	TSW	2.5	2.5	**41**	**98.5**
2.5	2	3.5	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	TSW	TSW	2.5	2.5	**42**	**100.4**
2.5	2	3.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	TSW	TSW	2.5	2.5	**43**	**102.3**
2.5	2.5	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	TSW	TSW	2.5	2.5	**44**	**103.9**
2.5	2.5	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	TSW	TSW	3.5	2.5	**45**	**105.6**
2.5	2.5	4	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	3	TSW	TSW	2.5	2.5	**46**	**107.3**
2.5	2.5	4	2	2	2	2.5	2	2	2	2.5	2	2	2	2	2.5	2.5	3	TSW	TSW	2.5	2.5	**47**	**109.0**
2.5	2.5	4	2	2.5	2	2.5	2	2	2	2.5	2	2	2	2.5	2.5	2.5	3	TSW	TSW	2.5	2.5	**48**	**110.7**
2.5	2.5	4	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2.5	2.5	3	TSW	TSW	2.5	2.5	**49**	**112.4**
2.5	2.5	4	2	2.5	2.5	2.5	2	2.5	2.5	2.5	2	2.5	2	2.5	2.5	2.5	3	TSW	TSW	2.5	2.5	**50**	**114.1**
2.5	2.5	4	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2	2.5	2.5	2.5	3	TSW	TSW	2.5	2.5	**51**	**115.8**
2.5	2.5	4	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2	2.5	2.5	2.5	3	TSW	TSW	2.5	2.5	**52**	**117.5**
2.5	2.5	4	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	TSW	TSW	3	2.5	**53**	**119.2**
2.5	2.5	4	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	TSW	TSW	3	2.5	**54**	**120.9**
2.5	2.5	4.5	3	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	2.5	2.5	2.5	3	3	3	TSW	TSW	3	2.5	**55**	**122.6**
2.5	2.5	4.5	3	2.5	2.5	3	2.5	2.5	2.5	3	2.5	3	2.5	2.5	3	3	3	TSW	TSW	3	2.5	**56**	**124.3**
2.5	2.5	4.5	3	3	2.5	3	2.5	3	2.5	3	2.5	3	2.5	2.5	3	3	3	TSW	TSW	3	2.5	**57**	**126.0**
2.5	2.5	4.5	3	3	3	3	2.5	3	2.5	3	2.5	3	2.5	3	3	3	3	TSW	TSW	3	2.5	**58**	**127.7**
2.5	2.5	5	3	3	3	3	2.5	3	3	3	2.5	3	2.5	3	3	3	3	TSW	TSW	3	2.5	**59**	**129.3**
2.5	2.5	5	3	3	3	3	3	3	3	3	3	3	2.5	3	3	3	3	TSW	TSW	3	2.5	**60**	**131.0**
3	3	5	3	3	3	3	3	3	3	3	3	3	2.5	3	3	3	3	TSW	TSW	3	2.5	**61**	**132.7**
3	3	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	TSW	TSW	3	3	**62**	**134.4**
3	3	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	TSW	TSW	3	3	**63**	**136.0**
3	3	5	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	TSW	TSW	3	3	**64**	**137.6**
3	4	5	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	TSW	TSW	3	3	**65**	**139.2**
4	4	5	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	TSW	TSW	3	3	**66**	**140.8**
4	4	5	3	3	3	4	3	3	3	3	3	3	3	3	3	4	4	TSW	TSW	3	3	**67**	**142.4**
4	4	5	3	3	3	4	3	3	3	4	3	3	3	3	3	4	4	TSW	TSW	3	3	**68**	**144.0**

MCN Spill Patterns with TSWs (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22 [b]	(#)	(kcfs)
4	4	5	3	4	3	4	3	3	3	4	3	3	3	3	3	4	4	TSW	TSW	3	3	**69**	**145.6**
4	4	5	3	4	3	4	3	3	3	4	3	3	3	4	3	4	4	TSW	TSW	3	3	**70**	**147.2**
4	4	5	3	4	3	4	3	4	3	4	3	3	3	4	3	4	4	TSW	TSW	3	3	**71**	**148.8**
4	4	5	3	4	3	4	3	4	3	4	3	4	3	4	3	4	4	TSW	TSW	3	3	**72**	**150.4**
4	4	5	3	4	4	4	3	4	3	4	3	4	3	4	3	4	4	TSW	TSW	3	3	**73**	**152.0**
4	4	5	3	4	4	4	3	4	4	4	3	4	3	4	3	4	4	TSW	TSW	3	3	**74**	**153.6**
4	4	5	3	4	4	4	3	4	4	4	4	4	3	4	3	4	4	TSW	TSW	3	3	**75**	**155.2**
4	4	5	3	4	4	4	4	4	4	4	4	4	3	4	3	4	4	TSW	TSW	3	3	**76**	**156.8**
4	4	5	3	4	4	4	4	4	4	4	4	4	3	4	4	4	4	TSW	TSW	3	3	**77**	**158.4**
4	4	5	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	TSW	TSW	3	3	**78**	**160.0**
4	4	5	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	TSW	TSW	4	3	**79**	**161.6**
4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	TSW	TSW	4	3	**80**	**163.2**
4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	TSW	TSW	4	3	**81**	**164.8**
4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	TSW	TSW	4	3	**82**	**166.4**
4	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	TSW	TSW	4	3	**83**	**168.0**
5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	TSW	TSW	4	3	**84**	**169.6**
5	5	5	4	4	4	5	4	4	4	4	4	4	4	4	4	5	5	TSW	TSW	4	3	**85**	**171.2**
5	5	5	4	4	4	5	4	4	4	5	4	4	4	4	4	5	5	TSW	TSW	4	3	**86**	**172.8**
5	5	5	4	5	4	5	4	4	4	5	4	4	4	4	4	5	5	TSW	TSW	4	3	**87**	**174.4**
5	5	5	4	5	4	5	4	4	4	5	4	4	4	5	4	5	5	TSW	TSW	4	3	**88**	**176.0**
5	5	5	4	5	4	5	4	5	4	5	4	4	4	5	4	5	5	TSW	TSW	4	3	**89**	**177.6**
5	5	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	5	TSW	TSW	4	3	**90**	**179.2**
5	5	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	5	TSW	TSW	5	3	**91**	**180.8**
5	5	5	4	5	5	5	4	5	4	5	4	5	4	5	4	5	5	TSW	TSW	5	3	**92**	**182.4**
5	5	5	4	5	5	5	4	5	5	5	4	5	4	5	4	5	5	TSW	TSW	5	3	**93**	**184.0**
5	5	5	4	5	5	5	4	5	5	5	5	5	4	5	4	5	5	TSW	TSW	5	3	**94**	**185.6**
5	5	5	4	5	5	5	5	5	5	5	5	5	4	5	4	5	5	TSW	TSW	5	3	**95**	**187.2**
5	5	5	4	5	5	5	5	5	5	5	5	5	4	5	5	5	5	TSW	TSW	5	3	**96**	**188.8**
5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	TSW	TSW	5	3	**97**	**190.4**
5	5	6	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	TSW	TSW	5	3	**98**	**192.0**
5	5	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	TSW	TSW	5	3	**99**	**193.6**
5	5	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	TSW	TSW	5	3	**100**	**195.2**
5	5	6	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	TSW	TSW	5	3	**101**	**196.8**
5	5	6	5	5	5	5	5	5	5	5	5	5	5	6	5	6	6	TSW	TSW	5	3	**102**	**198.4**
5	5	6	5	5	5	5	5	5	5	5	5	6	5	6	5	6	6	TSW	TSW	5	3	**103**	**200.0**
5	5	6	5	5	5	5	5	5	5	5	5	6	5	6	6	6	6	TSW	TSW	5	3	**104**	**201.6**
5	5	6	6	5	5	5	5	5	5	5	5	6	5	6	6	6	6	TSW	TSW	5	3	**105**	**203.2**

MCN Spill Patterns with TSWs (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22 [b]	(#)	(kcfs)
5	5	6	6	5	5	5	5	5	5	5	5	6	5	6	6	6	6	TSW	TSW	6	3	**106**	**204.8**
5	5	6	6	5	5	5	5	5	5	5	6	6	5	6	6	6	6	TSW	TSW	6	3	**107**	**206.4**
5	5	6	6	5	5	5	5	5	5	5	5	6	6	6	6	6	6	TSW	TSW	6	4	**108**	**208.0**
5	5	6	6	6	5	5	5	5	5	5	6	6	6	6	6	6	6	TSW	TSW	6	4	**110**	**211.2**
5	5	6	6	6	5	6	5	5	5	6	6	6	6	6	6	6	6	TSW	TSW	6	4	**112**	**214.4**
5	5	6	6	6	6	6	5	6	5	6	6	6	6	6	6	6	6	TSW	TSW	6	4	**114**	**217.6**
5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	TSW	TSW	6	4	**116**	**220.8**
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	TSW	TSW	6	4	**118**	**224.0**
6	6	6	6	6	6	6	6	6	6	7	6	7	6	7	6	7	6	TSW	TSW	6	4	**122**	**230.4**
6	6	6	6	6	6	7	6	7	6	7	6	7	6	7	6	7	6	TSW	TSW	6	4	**124**	**233.6**
6	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	TSW	TSW	6	4	**126**	**236.8**
7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	7	TSW	TSW	6	4	**128**	**240.0**
7	6	7	6	7	6	7	6	7	6	7	6	7	7	7	7	7	7	TSW	TSW	6	4	**130**	**243.2**
7	6	7	6	7	6	7	6	7	7	7	7	7	7	7	7	7	7	TSW	TSW	6	4	**132**	**246.4**
7	6	7	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	TSW	TSW	6	4	**134**	**249.6**
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	TSW	TSW	6	4	**136**	**252.8**
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	TSW	TSW	6	6	**138**	**256.0**
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	TSW	TSW	7	7	**140**	**259.2**
8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	TSW	TSW	7	8	142	**262.6**
8	8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	TSW	TSW	8	8	144	**266.0**
8	8	8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	TSW	TSW	8	8	145	**267.7**
8	8	8	8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	TSW	TSW	8	8	146	**269.4**
8	8	8	8	8	7	7	7	7	7	7	7	7	7	7	7	7	8	TSW	TSW	8	8	148	**272.8**
8	8	8	8	8	8	7	7	7	7	7	7	7	7	7	7	8	8	TSW	TSW	8	8	150	**276.2**
8	8	8	8	8	8	8	7	7	7	7	7	7	7	7	8	8	8	TSW	TSW	8	8	152	**279.6**
8	8	8	8	8	8	8	8	7	7	7	7	7	7	8	8	8	8	TSW	TSW	8	8	154	**283.0**
8	8	8	8	8	8	8	8	8	7	7	7	7	8	8	8	8	8	TSW	TSW	8	8	156	**286.4**
8	8	8	8	8	8	8	8	8	8	7	7	8	8	8	8	8	8	TSW	TSW	8	8	158	**289.8**
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	TSW	TSW	8	8	160	**293.2**
9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	TSW	TSW	8	9	162	**296.4**
9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	TSW	TSW	9	9	164	**299.6**
9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	TSW	TSW	9	9	165	**301.2**
9	9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	TSW	TSW	9	9	166	**302.8**
9	9	9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	9	TSW	TSW	9	9	168	**306.0**
9	9	9	9	9	9	8	8	8	8	8	8	8	8	8	8	9	9	TSW	TSW	9	9	170	**309.2**
9	9	9	9	9	9	9	8	8	8	8	8	8	8	8	9	9	9	TSW	TSW	9	9	172	**312.4**
9	9	9	9	9	9	9	9	8	8	8	8	8	8	9	9	9	9	TSW	TSW	9	9	174	**315.6**

MCN Spill Patterns with TSWs (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22 [b]	(#)	(kcfs)
9	9	9	9	9	9	9	9	9	8	8	8	8	9	9	9	9	9	TSW	TSW	9	9	176	**318.8**
9	9	9	9	9	9	9	9	9	9	8	8	9	9	9	9	9	9	TSW	TSW	9	9	178	**322.0**
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	TSW	TSW	9	9	180	**325.2**
10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	TSW	TSW	9	10	182	**328.4**
10	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	TSW	TSW	10	10	184	**331.6**

Table MCN-8. McNary Dam Spill Patterns with TSWs for Navigation.

MCN Spill Patterns with TSWs for Navigation (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22 [b]	(#)	(kcfs)
																		TSW	TSW	1		**1**	**21.2**
																	1	TSW	TSW	1		**2**	**23.2**
	1																1	TSW	TSW	1		**3**	**25.2**
	2																1	TSW	TSW	1		**4**	**27.1**
	3																1	TSW	TSW	1		**5**	**28.8**
	3																1	TSW	TSW	1	1	**6**	**30.8**
	4																1	TSW	TSW	1	1	**7**	**32.4**
	3	2															1	TSW	TSW	1	1	**8**	**34.7**
	4	2															1	TSW	TSW	1	1	**9**	**36.3**
	4	3															1	TSW	TSW	1	1	**10**	**38.0**
	4	3													1		1	TSW	TSW	1	1	**11**	**40.0**
	4	4													1		1	TSW	TSW	1	1	**12**	**41.6**
	4	4												1	1		1	TSW	TSW	1	1	**13**	**43.6**
	4	4										1		1	1		1	TSW	TSW	1	1	**14**	**45.6**
	4	4										2		1	1		1	TSW	TSW	1	1	**15**	**47.5**
	4	4								1		2		1	1		1	TSW	TSW	1	1	**16**	**49.5**
	4	4						1		1		2		1	1		1	TSW	TSW	1	1	**17**	**51.5**
	4	4						1		2		2		1	1		1	TSW	TSW	1	1	**18**	**53.4**
	4	4						1		2		2		1	1		1	TSW	TSW	2	1	**19**	**55.3**
	4	4						1		2		2		1	1		2	TSW	TSW	2	1	**20**	**57.2**
	4	4						2		2		2		1	1		2	TSW	TSW	2	1	**21**	**59.1**
	4	4						2		2		2		1	2		2	TSW	TSW	2	1	**22**	**61.0**
	4	4						2		2		2		2	2		2	TSW	TSW	2	1	**23**	**62.9**
	5	4						2		2		2		2	2		2	TSW	TSW	2	1	**24**	**64.5**
	5	4						2		2		2		2	2		2	TSW	TSW	2	2	**25**	**66.4**

Table MCN-9. [*pg 1 of 4*]. McNary Dam Spill Patterns with No TSWs.

MCN Spill Patterns with No TSWs (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22 [b]	(#)	(kcfs)
																		3				3	5.6
																		4				4	7.2
																	2	3				5	9.5
																	2	4				6	11.1
																	2	3	2			7	13.4
																	2	4	2			8	15.0
														1			2	4	2			9	17.0
														2			2	4	2			10	18.9
													1	2			2	4	2			11	20.9
													2	2			2	4	2			12	22.8
											1		2	2			2	4	2			13	24.8
											2		2	2			2	4	2			14	26.7
									1		2		2	2			2	4	2			15	28.7
									2		2		2	2			2	4	2			16	30.6
							1		2		2		2	2			2	4	2			17	32.6
							2		2		2		2	2			2	4	2			18	34.5
					1		2		2		2		2	2			2	4	2			19	36.5
					2		2		2		2		2	2			2	4	2			20	38.4
					2		2		2		2		2	2			2	5	2			21	40.0
	2				2		2		2		2		2	2			2	4	2			22	42.3
	2	1			2		2		2		2		2	2			2	4	2			23	44.3
	2	2			2		2		2		2		2	2			2	4	2			24	46.2
	3	2			2		2		2		2		2	2			2	4	2			25	47.9
	3	3			2		2		2		2		2	2			2	4	2			26	49.6
	3	3			2		2		2		2		2	2			3	4	2			27	51.3
	3	3			2		2		2		2		2	2			4	4	2			28	52.9
	3	3			2		2		2		2		2	2		2	3	4	2			29	55.2
	3	3			2		2		2		2		2	2		2	4	4	2			30	56.8
	3	3			2		2		2		2		2	2		2	4	5	2			31	58.4
	3	3			2		2		2		2		2	2		2	5	5	2			32	60.0
2	3	3			2		2		2		2		2	2		2	5	4	2			33	62.3
2	3	3	2		2		2		2		2		2	2		2	4	4	2			34	64.6
2	3	3	2	2	2		2		2		2		2	2		2	4	3	2			35	66.9
2	3	3	2	2	2	2	2		2		2		2	2		2	3	3	2			36	69.2
2	3	3	2	2	2	2	2		2		2	1	2	2		2	3	3	2			37	71.2
2	3	4	2	2	2	2	2		2		2	2	2	2		2	2	3	2			38	73.0

MCN Spill Patterns with No TSWs (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22 [b]	(#)	(kcfs)
2	4	4	2	2	2	2	2	2	2		2	2	2	2		2	2	3				39	74.6
2	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2					40	76.8
3	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2					41	78.5
3	4	4	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2					42	80.2
3	5	5	3	2	3	2	2	2	2	2	2	2	2	2	2	2						43	81.2
3	5	5	3	2	3	2	3	2	2	2	2	2	2	2	2	2						44	82.9
3	5	5	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2					45	85.1
3	5	5	3	2	3	2	3	2	2	2	2	2	2	2	2	2	2					46	86.8
3	5	5	3	2	3	2	3	2	3	2	2	2	2	2	2	2	2					47	88.5
3	5	5	3	2	3	2	3	2	3	2	3	2	2	2	2	2	2					48	90.2
3	5	5	3	2	3	2	3	2	3	2	2	2	2	2	2	2	2	2				49	92.4
3	5	5	3	2	3	2	3	2	3	2	3	2	2	2	2	2	2	2				50	94.1
3	5	5	3	2	3	2	3	2	3	2	3	2	2	3	2	2	2	2				51	95.8
3	5	5	3	2	3	2	3	2	3	2	3	2	2	3	2	2	2	2	2			52	98.0
3	5	5	3	2	3	2	3	2	3	2	3	2	2	3	2	2	2	2	2			53	99.7
3	5	5	3	2	3	2	3	2	3	2	3	2	2	3	2	3	2	2	2			54	101.4
3	5	5	3	2	3	2	3	2	3	2	3	2	2	3	2	3	2	3	2			55	103.1
3	5	5	3	2	3	2	3	2	3	2	3	2	2	3	2	3	2	2	2	2		56	105.3
3	5	5	3	2	3	2	3	2	3	2	3	2	2	3	2	3	2	3	2	2		57	107.0
3	5	5	3	3	3	2	3	2	3	2	3	2	2	3	2	3	2	3	2	2		58	108.7
3	5	5	3	3	3	3	3	2	3	2	3	2	2	3	2	3	2	3	2	2		59	110.4
3	5	5	3	3	3	3	3	2	3	2	3	2	2	3	2	3	2	3	2	3		60	112.1
3	5	5	3	3	3	3	3	2	3	2	3	2	2	3	2	3	2	3	2	2	2	61	114.3
3	5	5	3	3	3	3	3	2	3	2	3	2	2	3	2	3	2	3	2	3	2	62	116.0
4	5	5	3	3	3	3	3	2	3	2	3	2	2	3	2	3	2	3	2	3	2	63	117.6
4	5	5	3	3	3	3	3	3	3	2	3	2	2	3	2	3	2	3	2	3	2	64	119.3
4	5	5	3	3	3	3	3	3	3	3	3	2	2	3	2	3	2	3	2	3	2	65	121.0
4	5	5	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	3	2	3	2	66	122.7
4	5	5	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	3	2	67	124.4
4	5	6	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	3	2	68	126.0
4	6	6	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	3	2	69	127.6
4	6	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	70	129.3
4	6	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	71	131.0
4	6	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	72	132.7
4	6	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	73	134.4
4	6	6	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	74	136.0
4	6	6	4	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	75	137.6

MCN Spill Patterns with No TSWs (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22 [b]	(#)	(kcfs)
4	6	6	4	3	4	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	**76**	**139.2**
4	6	7	4	3	4	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	**77**	**140.8**
4	7	7	4	3	4	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	**78**	**142.4**
4	7	7	4	3	4	3	4	3	3	3	3	3	3	3	4	3	3	3	3	3	3	**79**	**144.0**
4	7	7	4	3	4	3	4	3	3	3	3	3	3	3	4	3	4	3	3	3	3	**80**	**145.6**
4	7	7	4	3	4	3	4	3	3	3	3	3	4	3	4	3	4	3	3	3	3	**81**	**147.2**
4	7	7	4	3	4	3	4	3	3	3	4	3	4	3	4	3	4	3	3	3	3	**82**	**148.8**
4	7	7	4	3	4	3	4	3	3	3	4	3	4	3	4	3	4	3	4	3	3	**83**	**150.4**
4	7	7	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	3	**84**	**152.0**
4	7	7	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	**85**	**153.6**
5	7	7	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	**86**	**155.2**
5	7	8	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	**87**	**156.9**
5	8	8	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	**88**	**158.6**
5	8	8	4	3	4	3	4	3	4	3	4	3	4	3	4	4	4	3	4	3	4	**89**	**160.2**
5	8	8	4	3	4	3	4	3	4	3	4	3	4	3	4	4	4	4	4	3	4	**90**	**161.8**
5	8	8	4	3	4	3	4	3	4	3	4	3	4	4	4	4	4	4	4	3	4	**91**	**163.4**
5	8	8	4	3	4	3	4	3	4	3	4	3	4	4	4	4	4	4	4	4	4	**92**	**165.0**
5	8	8	4	3	4	3	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	**93**	**166.6**
5	8	8	4	3	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	**94**	**168.2**
5	8	8	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	**95**	**169.8**
5	8	8	4	3	4	3	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	**96**	**171.4**
5	8	8	4	3	4	3	4	4	4	4	4	4	4	4	4	5	4	5	4	4	4	**97**	**173.0**
5	8	8	4	3	4	3	4	4	4	4	4	4	5	4	4	5	4	5	4	4	4	**98**	**174.6**
5	8	8	4	3	4	3	4	4	4	4	5	4	5	4	4	5	4	5	4	4	4	**99**	**176.2**
5	8	8	4	3	4	3	4	4	4	4	5	4	5	4	5	5	4	5	4	4	4	**100**	**177.8**
5	8	8	4	3	4	3	4	4	4	4	5	4	5	4	5	5	4	5	4	5	4	**101**	**179.4**
5	8	8	4	3	4	4	4	4	4	4	5	4	5	4	5	5	4	5	4	5	4	**102**	**181.0**
5	8	8	4	3	4	4	4	4	5	4	5	4	5	4	5	5	4	5	4	5	4	**103**	**182.6**
5	8	8	4	3	4	4	4	4	5	4	5	4	5	4	5	5	5	5	4	5	4	**104**	**184.2**
5	8	8	4	3	4	4	5	4	5	4	5	4	5	4	5	5	5	5	4	5	4	**105**	**185.8**
5	8	8	4	3	4	4	5	4	5	4	5	4	5	5	5	5	5	5	4	5	4	**106**	**187.4**
5	8	8	4	4	4	4	5	4	5	4	5	4	5	5	5	5	5	5	4	5	4	**107**	**189.0**
5	8	8	4	4	5	4	5	4	5	4	5	4	5	5	5	5	5	5	4	5	4	**108**	**190.6**
6	8	8	4	4	5	4	5	4	5	4	5	4	5	5	5	5	5	5	4	5	4	**109**	**192.2**
6	8	8	4	4	5	4	5	4	5	4	5	4	5	5	5	5	5	5	5	5	4	**110**	**193.8**
6	8	8	5	4	5	4	5	4	5	4	5	4	5	5	5	5	5	5	5	5	4	**111**	**195.4**
6	8	8	5	4	5	4	5	4	5	4	5	5	5	5	5	5	5	5	5	5	4	**112**	**197.0**

MCN Spill Patterns with No TSWs (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22 [b]	(#)	(kcfs)
6	8	8	5	4	5	4	5	4	5	5	5	5	5	5	5	5	5	5	5	5	4	**113**	**198.6**
6	8	8	5	4	5	4	5	4	5	5	5	5	5	5	5	6	5	5	5	5	4	**114**	**200.2**
6	8	8	5	4	5	4	5	4	5	5	5	5	5	5	5	6	5	5	5	5	5	**115**	**201.8**
6	8	8	5	4	5	4	5	4	5	5	5	5	5	6	5	6	5	5	5	5	5	**116**	**203.4**
6	8	8	5	4	5	4	5	4	5	5	5	5	5	6	5	6	5	6	5	5	5	**117**	**205.0**
6	8	8	5	4	5	5	5	4	5	5	5	5	5	6	5	6	5	6	5	5	5	**118**	**206.6**
6	8	8	5	4	5	5	5	4	5	5	5	6	5	6	5	6	5	6	5	6	5	**120**	**209.8**
6	8	8	5	4	5	5	5	4	5	5	5	6	5	6	6	6	6	6	5	6	5	**122**	**213.0**
6	8	8	5	5	5	5	5	5	5	5	5	6	5	6	6	6	6	6	5	6	5	**124**	**216.2**
7	9	8	5	5	5	5	5	5	5	5	5	6	5	6	6	6	6	6	5	6	5	**126**	**219.4**
7	9	8	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	5	**128**	**222.6**
7	9	8	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	**130**	**225.8**
7	9	8	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	**132**	**229.0**
7	9	8	5	5	5	5	5	5	6	6	6	6	6	7	6	6	7	6	6	6	6	**134**	**232.2**
7	9	8	5	5	5	5	5	5	6	6	6	6	6	7	7	6	7	7	6	6	6	**136**	**235.4**
7	9	8	5	5	5	5	5	5	6	6	6	6	7	7	7	7	7	7	6	6	6	**138**	**238.6**
7	9	8	5	5	5	5	6	6	6	6	6	6	7	7	7	7	7	7	6	6	6	**140**	**241.8**
7	9	8	5	5	5	5	6	6	6	6	6	6	7	7	7	8	7	7	7	6	6	**142**	**245.1**
7	9	8	5	5	5	5	6	6	6	6	6	6	7	8	7	8	7	8	7	6	6	**144**	**248.5**
7	9	8	5	5	5	5	6	6	7	6	7	6	7	8	7	8	7	8	7	6	6	**146**	**251.7**
7	9	8	6	5	6	5	6	6	7	6	7	6	7	8	7	8	7	8	7	6	6	**148**	**254.9**
7	9	8	6	5	6	5	6	6	7	6	7	7	7	8	7	8	7	8	7	7	6	**150**	**258.1**
7	9	8	6	5	6	5	6	6	7	6	7	8	7	8	7	8	7	8	7	7	7	**152**	**261.4**
7	9	8	6	6	6	6	6	6	7	6	7	8	7	8	7	8	7	8	7	7	7	**154**	**264.6**
7	9	8	6	6	6	6	6	6	7	7	7	8	7	8	8	8	7	8	7	7	7	**156**	**267.9**
7	9	8	6	6	6	6	6	6	7	7	7	8	8	8	8	8	8	8	7	7	7	**158**	**271.3**
7	9	8	6	6	6	6	6	6	7	7	8	8	8	8	8	8	8	8	8	7	7	**160**	**274.7**
7	9	8	6	6	7	6	6	7	7	7	8	8	8	8	8	8	8	8	8	7	7	**162**	**277.9**
7	9	8	6	6	7	6	6	7	7	8	8	8	8	8	8	8	8	8	8	8	7	**164**	**281.3**
7	9	8	7	6	7	6	7	7	7	8	8	8	8	8	8	8	8	8	8	8	7	**166**	**284.5**
7	9	8	7	6	7	6	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	**168**	**287.9**
7	9	8	7	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	**170**	**291.1**
8	9	8	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	**172**	**294.5**
8	9	8	7	8	7	8	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	**174**	**297.9**
8	9	8	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	**176**	**301.3**

Table MCN-10. [*pg 1 of 5*]. McNary Dam Spill Patterns during TSW Removal in Bays 19-20.

MCN Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22 [b]	(#)	(kcfs)
								2		2		2		2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		12	23.4
								2	1	2		2		2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		13	25.4
								2	2	2		2		2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		14	27.3
								2	2	2		2	1	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		15	29.3
								2	2	2		2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		16	31.2
								2	2	2	1	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		17	33.2
								2	2	2	2	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		18	35.1
						1		2	2	2	2	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		19	37.1
						2		2	2	2	2	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		20	39.0
				1		2		2	2	2	2	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		21	41.0
				2		2		2	2	2	2	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		22	42.9
2.5	2	3.5		2		2		2		2		2	1	2		2	CLOSE	CLOSE	CLOSE	CLOSE		23	44.4
2.5	2	3.5		2		2		2		2		2	1	2	1	2	CLOSE	CLOSE	CLOSE	CLOSE		24	46.4
2.5	2	3.5		2	1	2		2		2		2	1	2	1	2	CLOSE	CLOSE	CLOSE	CLOSE		25	48.4
2.5	2	3.5		2	1	2		2	1	2		2	1	2	1	2	CLOSE	CLOSE	CLOSE	CLOSE		26	50.4
2.5	2	3.5		2	1	2		2	1	2	1	2	1	2	1	2	CLOSE	CLOSE	CLOSE	CLOSE		27	52.4
2.5	2	3.5		2	1	2	1	2	1	2	1	2	1	2	1	2	CLOSE	CLOSE	CLOSE	CLOSE		28	54.4
2.5	2	3.5	1	2	1	2	1	2	1	2	1	2	1	2	1	2	CLOSE	CLOSE	CLOSE	CLOSE		29	56.4
2.5	2	3.5	1	2	1	2	1	2	1	2	1	2	2	2	1	2	CLOSE	CLOSE	CLOSE	CLOSE		30	58.3
2.5	2	3.5	1	2	1	2	1	2	1	2	1	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		31	60.2
2.5	2	3.5	1	2	2	2	1	2	1	2	1	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		32	62.1
2.5	2	3.5	1	2	2	2	1	2	2	2	1	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		33	64.0
2.5	2	3.5	1	2	2	2	1	2	2	2	2	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		34	65.9
2.5	2	3.5	1	2	2	2	2	2	2	2	2	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		35	67.8
2.5	2	3.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		36	69.7
2.5	2.5	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	CLOSE	CLOSE	CLOSE	CLOSE		37	71.3
2.5	2.5	4	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	CLOSE	CLOSE	CLOSE	CLOSE		38	73.0
2.5	2.5	4	2	2	2	2.5	2	2	2	2.5	2	2	2	2	2.5	2.5	CLOSE	CLOSE	CLOSE	CLOSE		39	74.7
2.5	2.5	4	2	2.5	2	2.5	2	2	2	2.5	2	2	2	2.5	2.5	2.5	CLOSE	CLOSE	CLOSE	CLOSE		40	76.4
2.5	2.5	4	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2.5	2.5	CLOSE	CLOSE	CLOSE	CLOSE		41	78.1
2.5	2.5	4	2	2.5	2.5	2.5	2	2.5	2.5	2.5	2	2.5	2	2.5	2.5	2.5	CLOSE	CLOSE	CLOSE	CLOSE		42	79.8
2.5	2.5	4	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2	2.5	2.5	2.5	CLOSE	CLOSE	CLOSE	CLOSE		43	81.5
2.5	2.5	4	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2	2.5	2.5	2.5	CLOSE	CLOSE	CLOSE	CLOSE		44	83.2
2.5	2.5	4	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	CLOSE	CLOSE	CLOSE	CLOSE		45	84.1
2.5	2.5	4	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	CLOSE	CLOSE	CLOSE	CLOSE		46	85.8
2.5	2.5	4.5	3	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	2.5	2.5	2.5	3	3	CLOSE	CLOSE	CLOSE	CLOSE		47	87.4

MCN Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22 [b]	(#)	(kcfs)
2.5	2.5	4.5	3	2.5	2.5	3	2.5	2.5	2.5	3	2.5	3	2.5	2.5	3	3	CLOSE	CLOSE	CLOSE	CLOSE		48	89.1
2.5	2.5	4.5	3	3	2.5	3	2.5	3	2.5	3	2.5	3	2.5	2.5	3	3	CLOSE	CLOSE	CLOSE	CLOSE		49	90.8
2.5	2.5	4.5	3	3	3	3	2.5	3	2.5	3	2.5	3	2.5	3	3	3	CLOSE	CLOSE	CLOSE	CLOSE		50	92.5
2.5	2.5	5	3	3	3	3	2.5	3	3	3	2.5	3	2.5	3	3	3	CLOSE	CLOSE	CLOSE	CLOSE		51	94.2
2.5	2.5	5	3	3	3	3	3	3	3	3	3	3	2.5	3	3	3	CLOSE	CLOSE	CLOSE	CLOSE		52	95.9
3	3	5	3	3	3	3	3	3	3	3	3	3	2.5	3	3	3	CLOSE	CLOSE	CLOSE	CLOSE		53	97.6
3	3	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	CLOSE	CLOSE	CLOSE	CLOSE		53	98.4
3	3	5	3	3	3	3	3	3	3	3	3	3	3	3	3	4	CLOSE	CLOSE	CLOSE	CLOSE		54	100.0
3	4	5	3	3	3	3	3	3	3	3	3	3	3	3	3	4	CLOSE	CLOSE	CLOSE	CLOSE		55	101.6
4	4	5	3	3	3	3	3	3	3	3	3	3	3	3	3	4	CLOSE	CLOSE	CLOSE	CLOSE		56	103.2
4	4	5	3	3	3	4	3	3	3	3	3	3	3	3	3	4	CLOSE	CLOSE	CLOSE	CLOSE		57	104.8
4	4	5	3	3	3	4	3	3	3	4	3	3	3	3	3	4	CLOSE	CLOSE	CLOSE	CLOSE		58	106.4
4	4	5	3	4	3	4	3	3	3	4	3	3	3	3	3	4	CLOSE	CLOSE	CLOSE	CLOSE		59	108.0
4	4	5	3	4	3	4	3	3	3	4	3	3	3	4	3	4	CLOSE	CLOSE	CLOSE	CLOSE		60	109.6
4	4	5	3	4	3	4	3	4	3	4	3	3	3	4	3	4	CLOSE	CLOSE	CLOSE	CLOSE		61	111.2
4	4	5	3	4	3	4	3	4	3	4	3	4	3	4	3	4	CLOSE	CLOSE	CLOSE	CLOSE		62	112.8
4	4	5	3	4	4	4	3	4	3	4	3	4	3	4	3	4	CLOSE	CLOSE	CLOSE	CLOSE		63	114.4
4	4	5	3	4	4	4	3	4	4	4	3	4	3	4	3	4	CLOSE	CLOSE	CLOSE	CLOSE		64	116.0
4	4	5	3	4	4	4	3	4	4	4	4	4	3	4	3	4	CLOSE	CLOSE	CLOSE	CLOSE		65	117.6
4	4	5	3	4	4	4	4	4	4	4	4	4	3	4	3	4	CLOSE	CLOSE	CLOSE	CLOSE		66	119.2
4	4	5	3	4	4	4	4	4	4	4	4	4	3	4	4	4	CLOSE	CLOSE	CLOSE	CLOSE		67	120.8
4	4	5	4	4	4	4	4	4	4	4	4	4	3	4	4	4	CLOSE	CLOSE	CLOSE	CLOSE		68	122.4
4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	CLOSE	CLOSE	CLOSE	CLOSE		69	124.0
4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	5	CLOSE	CLOSE	CLOSE	CLOSE		70	125.6
4	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	5	CLOSE	CLOSE	CLOSE	CLOSE		71	127.2
5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	5	CLOSE	CLOSE	CLOSE	CLOSE		72	128.8
5	5	5	4	4	4	5	4	4	4	4	4	4	4	4	4	5	CLOSE	CLOSE	CLOSE	CLOSE		73	130.4
5	5	5	4	4	4	5	4	4	4	5	4	4	4	4	4	5	CLOSE	CLOSE	CLOSE	CLOSE		74	132.0
5	5	5	4	5	4	5	4	4	4	5	4	4	4	4	4	5	CLOSE	CLOSE	CLOSE	CLOSE		75	133.6
5	5	5	4	5	4	5	4	4	4	5	4	4	4	5	4	5	CLOSE	CLOSE	CLOSE	CLOSE		76	135.2
5	5	5	4	5	4	5	4	5	4	5	4	4	4	5	4	5	CLOSE	CLOSE	CLOSE	CLOSE		77	136.8
5	5	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	CLOSE	CLOSE	CLOSE	CLOSE		78	138.4
5	5	5	4	5	5	5	4	5	4	5	4	5	4	5	4	5	CLOSE	CLOSE	CLOSE	CLOSE		79	140.0
5	5	5	4	5	5	5	4	5	5	5	4	5	4	5	4	5	CLOSE	CLOSE	CLOSE	CLOSE		80	141.6
5	5	5	4	5	5	5	4	5	5	5	5	5	4	5	4	5	CLOSE	CLOSE	CLOSE	CLOSE		81	143.2
5	5	5	4	5	5	5	5	5	5	5	5	5	4	5	4	5	CLOSE	CLOSE	CLOSE	CLOSE		82	144.8
5	5	5	4	5	5	5	5	5	5	5	5	5	4	5	5	5	CLOSE	CLOSE	CLOSE	CLOSE		83	146.4

MCN Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22 [b]	(#)	(kcfs)
5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	CLOSE	CLOSE	CLOSE	CLOSE		**84**	**148.0**
5	5	6	5	5	5	5	5	5	5	5	5	5	4	5	5	5	CLOSE	CLOSE	CLOSE	CLOSE		**85**	**149.6**
5	5	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	CLOSE	CLOSE	CLOSE	CLOSE		**86**	**151.2**
5	5	6	5	5	5	5	5	5	5	5	5	5	5	5	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**87**	**152.8**
5	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**88**	**154.4**
6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**89**	**156.0**
6	6	6	5	5	5	6	5	5	5	5	5	5	5	5	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**90**	**157.6**
6	6	6	5	5	5	6	5	5	5	6	5	5	5	5	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**91**	**159.2**
6	6	6	5	6	5	6	5	5	5	6	5	5	5	5	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**92**	**160.8**
6	6	6	5	6	5	6	5	5	5	6	5	5	5	6	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**93**	**162.4**
6	6	6	5	6	5	6	5	6	5	6	5	5	5	6	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**94**	**164.0**
6	6	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**95**	**165.6**
6	6	6	5	6	6	6	5	6	5	6	5	6	5	6	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**96**	**167.2**
6	6	6	5	6	6	6	5	6	6	6	5	6	5	6	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**97**	**168.8**
6	6	6	5	6	6	6	5	6	6	6	6	6	5	6	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**98**	**170.4**
6	6	6	5	6	6	6	6	6	6	6	6	6	5	6	5	6	CLOSE	CLOSE	CLOSE	CLOSE		**99**	**172.0**
6	6	6	5	6	6	6	6	6	6	6	6	6	5	6	6	6	CLOSE	CLOSE	CLOSE	CLOSE		**100**	**173.6**
6	6	6	6	6	6	6	6	6	6	6	6	6	5	6	6	6	CLOSE	CLOSE	CLOSE	CLOSE		**101**	**175.2**
6	6	7	6	6	6	6	6	6	6	6	6	6	5	6	6	6	CLOSE	CLOSE	CLOSE	CLOSE		**102**	**176.8**
6	6	7	6	6	6	6	6	6	6	6	6	6	6	6	6	6	CLOSE	CLOSE	CLOSE	CLOSE		**103**	**178.4**
6	6	7	6	6	6	6	6	6	6	6	6	6	6	6	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**104**	**180.0**
6	7	7	6	6	6	6	6	6	6	6	6	6	6	6	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**105**	**181.6**
7	7	7	6	6	6	6	6	6	6	6	6	6	6	6	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**106**	**183.2**
7	7	7	6	6	6	7	6	6	6	6	6	6	6	6	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**107**	**184.8**
7	7	7	6	6	6	7	6	6	6	7	6	6	6	6	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**108**	**186.4**
7	7	7	6	7	6	7	6	6	6	7	6	6	6	6	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**109**	**188.0**
7	7	7	6	7	6	7	6	6	6	7	6	6	6	7	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**110**	**189.6**
7	7	7	6	7	6	7	6	7	6	7	6	6	6	7	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**111**	**191.2**
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7	7	7	6	7	7	7	6	7	6	7	6	7	6	7	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**113**	**194.4**
7	7	7	6	7	7	7	6	7	7	7	6	7	6	7	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**114**	**196.0**
7	7	7	6	7	7	7	6	7	7	7	7	7	6	7	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**115**	**197.6**
7	7	7	6	7	7	7	7	7	7	7	7	7	6	7	6	7	CLOSE	CLOSE	CLOSE	CLOSE		**116**	**199.2**
7	7	7	6	7	7	7	7	7	7	7	7	7	6	7	7	7	CLOSE	CLOSE	CLOSE	CLOSE		**117**	**200.8**
7	7	7	7	7	7	7	7	7	7	7	7	7	6	7	7	7	CLOSE	CLOSE	CLOSE	CLOSE		**118**	**202.4**
7	7	8	7	7	7	7	7	7	7	7	7	7	6	7	7	7	CLOSE	CLOSE	CLOSE	CLOSE		**119**	**204.1**
7	7	8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	CLOSE	CLOSE	CLOSE	CLOSE		**120**	**205.7**

MCN Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22 [b]	(#)	(kcfs)
7	7	8	7	7	7	7	7	7	7	7	7	7	7	7	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**121**	**207.4**
7	8	8	7	7	7	7	7	7	7	7	7	7	7	7	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**122**	**209.1**
8	8	8	7	7	7	7	7	7	7	7	7	7	7	7	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**123**	**210.8**
8	8	8	7	7	7	8	7	7	7	7	7	7	7	7	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**124**	**212.5**
8	8	8	7	7	7	8	7	7	7	8	7	7	7	7	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**125**	**214.2**
8	8	8	7	8	7	8	7	7	7	8	7	7	7	7	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**126**	**215.9**
8	8	8	7	8	7	8	7	7	7	8	7	7	7	8	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**127**	**217.6**
8	8	8	7	8	7	8	7	8	7	8	7	7	7	8	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**128**	**219.3**
8	8	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**129**	**221.0**
8	8	8	7	8	8	8	7	8	7	8	7	8	7	8	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**130**	**222.7**
8	8	8	7	8	8	8	7	8	8	8	7	8	7	8	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**131**	**224.4**
8	8	8	7	8	8	8	7	8	8	8	8	8	7	8	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**132**	**226.1**
8	8	8	7	8	8	8	8	8	8	8	8	8	7	8	7	8	CLOSE	CLOSE	CLOSE	CLOSE		**133**	**227.8**
8	8	8	7	8	8	8	8	8	8	8	8	8	7	8	8	8	CLOSE	CLOSE	CLOSE	CLOSE		**134**	**229.5**
8	8	8	8	8	8	8	8	8	8	8	8	8	7	8	8	8	CLOSE	CLOSE	CLOSE	CLOSE		**135**	**231.2**
8	8	9	8	8	8	8	8	8	8	8	8	8	7	8	8	8	CLOSE	CLOSE	CLOSE	CLOSE		**136**	**232.8**
8	8	9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	CLOSE	CLOSE	CLOSE	CLOSE		**137**	**234.5**
8	8	9	8	8	8	8	8	8	8	8	8	8	8	8	8	9	CLOSE	CLOSE	CLOSE	CLOSE		**138**	**236.1**
8	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	9	CLOSE	CLOSE	CLOSE	CLOSE		**139**	**237.7**
9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	8	9	CLOSE	CLOSE	CLOSE	CLOSE		**140**	**239.3**
9	9	9	8	8	8	8	8	8	8	8	8	8	8	8	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**141**	**240.9**
9	9	9	8	8	8	8	8	8	8	8	8	8	8	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**142**	**242.5**
9	9	9	8	8	8	8	8	8	8	8	8	8	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**143**	**244.1**
9	9	9	9	8	8	8	8	8	8	8	8	8	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**144**	**245.7**
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9	9	9	9	9	8	8	8	8	8	8	9	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**147**	**250.5**
9	9	9	9	9	9	8	8	8	8	8	9	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**148**	**252.1**
9	9	9	9	9	9	9	8	8	8	8	9	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**149**	**253.7**
9	9	9	9	9	9	9	8	8	8	9	9	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**150**	**255.3**
9	9	9	9	9	9	9	9	8	8	9	9	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**151**	**256.9**
9	9	9	9	9	9	9	9	8	9	9	9	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**152**	**258.5**
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**153**	**260.1**
10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		**154**	**261.7**
10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	10	CLOSE	CLOSE	CLOSE	CLOSE		**155**	**263.3**
10	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	10	CLOSE	CLOSE	CLOSE	CLOSE		**156**	**264.9**
10	10	9	9	9	9	9	9	9	9	9	9	9	9	9	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**157**	**266.5**

MCN Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22 [b]	(#)	(kcfs)
10	10	10	9	9	9	9	9	9	9	9	9	9	9	9	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**158**	**268.1**
10	10	10	9	9	9	9	9	9	9	9	9	9	9	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**159**	**269.7**
10	10	10	10	9	9	9	9	9	9	9	9	9	9	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**160**	**271.3**
10	10	10	10	9	9	9	9	9	9	9	9	9	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**161**	**272.9**
10	10	10	10	10	9	9	9	9	9	9	9	9	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**162**	**274.5**
10	10	10	10	10	9	9	9	9	9	9	9	10	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**163**	**276.1**
10	10	10	10	10	10	9	9	9	9	9	9	10	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**164**	**277.7**
10	10	10	10	10	10	9	9	9	9	9	10	10	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**165**	**279.3**
10	10	10	10	10	10	10	9	9	9	9	10	10	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**166**	**280.9**
10	10	10	10	10	10	10	9	9	9	10	10	10	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**167**	**282.5**
10	10	10	10	10	10	10	10	9	9	10	10	10	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**168**	**284.1**
10	10	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**169**	**285.7**
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**170**	**287.3**
11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	CLOSE	CLOSE	CLOSE	CLOSE		**171**	**288.8**
11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11	CLOSE	CLOSE	CLOSE	CLOSE		**172**	**290.3**
11	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11	CLOSE	CLOSE	CLOSE	CLOSE		**173**	**291.8**
11	11	10	10	10	10	10	10	10	10	10	10	10	10	10	11	11	CLOSE	CLOSE	CLOSE	CLOSE		**174**	**293.3**
11	11	11	10	10	10	10	10	10	10	10	10	10	10	10	11	11	CLOSE	CLOSE	CLOSE	CLOSE		**175**	**294.8**
11	11	11	10	10	10	10	10	10	10	10	10	10	10	11	11	11	CLOSE	CLOSE	CLOSE	CLOSE		**176**	**296.3**
11	11	11	11	10	10	10	10	10	10	10	10	10	10	11	11	11	CLOSE	CLOSE	CLOSE	CLOSE		**177**	**297.8**
11	11	11	11	10	10	10	10	10	10	10	10	10	11	11	11	11	CLOSE	CLOSE	CLOSE	CLOSE		**178**	**299.3**
11	11	11	11	11	10	10	10	10	10	10	10	10	11	11	11	11	CLOSE	CLOSE	CLOSE	CLOSE		**179**	**300.8**

2018 Fish Passage Plan

Chapter 6 – Ice Harbor Dam

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Ice Harbor Dam

Project Acronym *	IHR
River Mile (RM)	Snake River – RM 9.7
Reservoir	Lake Sacajawea
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 0 kcfs \ Mar–Jul: 9.5 kcfs \ Aug–Nov: 7.5 kcfs
Forebay Normal Operating Range (ft)	437’ – 440’
Tailrace Rate of Change Limit (ft)	1.5’/hr
Powerhouse Length (ft)	671’
Powerhouse Hydraulic Capacity (kcfs)	106 kcfs
Turbine Units (#)	6 (Units 1-3 Smith Kaplan; Units 4-6 Allis Chalmers Kaplan)
Turbine Unit Generating Capacity (MW)	Rated: 603 MW (Units 1-3 @ 90 MW + Units 4-6 @ 111 MW) Maximum: 693 MW (Units 1-3 @ 103 MW + Units 4-6 @ 128 MW)
Spillway Length (ft)	590’
Spillway Hydraulic Capacity (kcfs)	850 kcfs
Spillbays (#)	10
Spillway Weirs (#)	1 Removable Spillway Weir (RSW) in Bay 2
Navigation Lock Length x Width (ft)	650’ x 84’ (Usable Space)
Navigation Lock Max. Lift (ft)	100’
FISH STRUCTURE/OPERATION START DATE	
Juvenile Bypass System (JBS)	1961 (1st Generation)
Orifices (12” diameter)	1965 (2nd Generation)
Transportation Research Program - NMFS	1965
Submersible Traveling Screens (STS)	1994
Juvenile Fish Transportation Program - Corps	1981
Removable Spillway Weir (RSW)	2005
Adult Fish Counts	1969 (South Shore & North Shore)

*Project acronym designated by US Army Corps of Engineers, Northwestern Division, Columbia Basin Water Management Division. Due to the large number of projects managed by NWD, the acronym may differ from other commonly used acronyms. For example, Ice Harbor is often abbreviated as **ICE**. However, that acronym is assigned to another NWD project, so the official Corps NWD acronym for Ice Harbor is **IHR**.

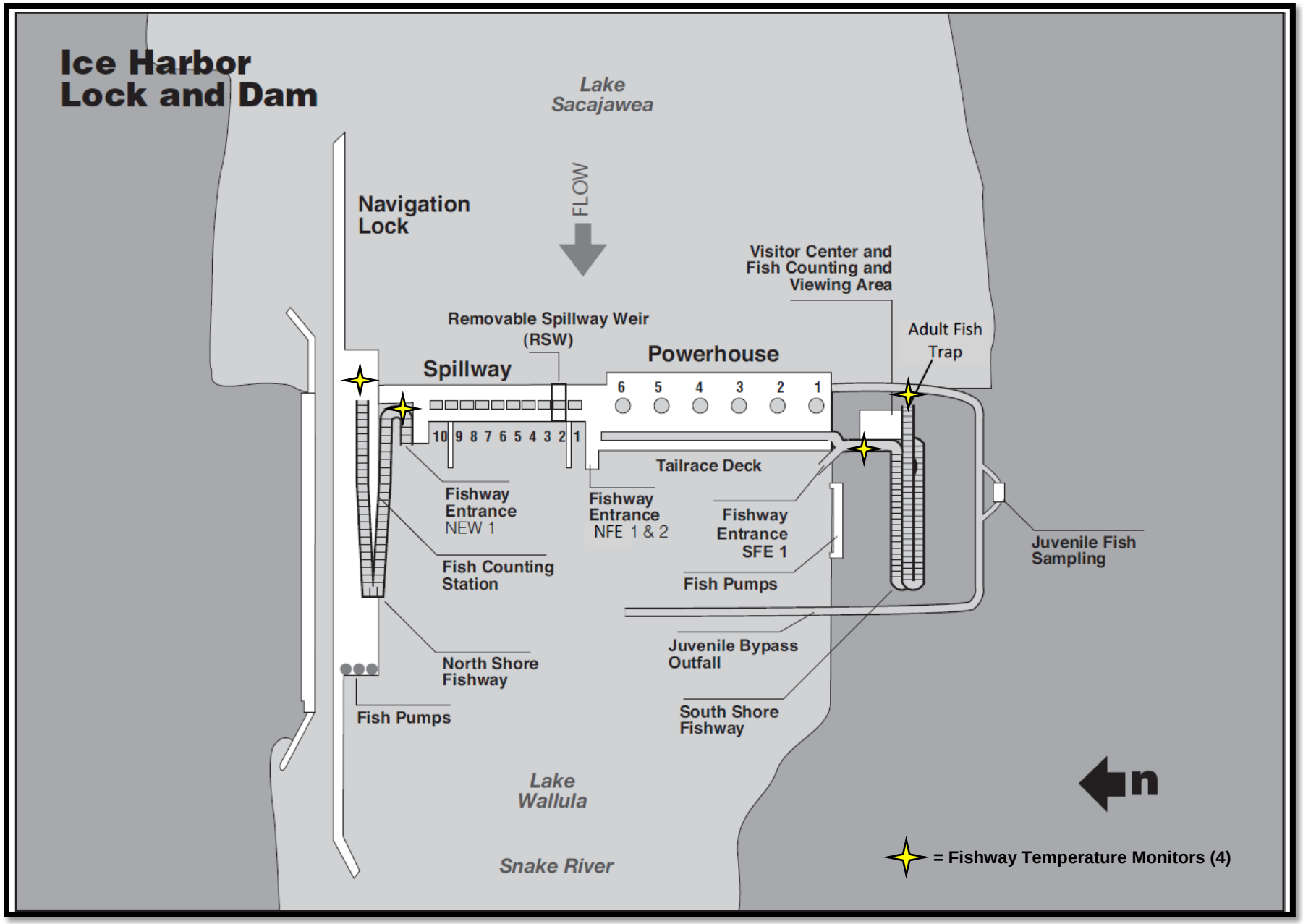
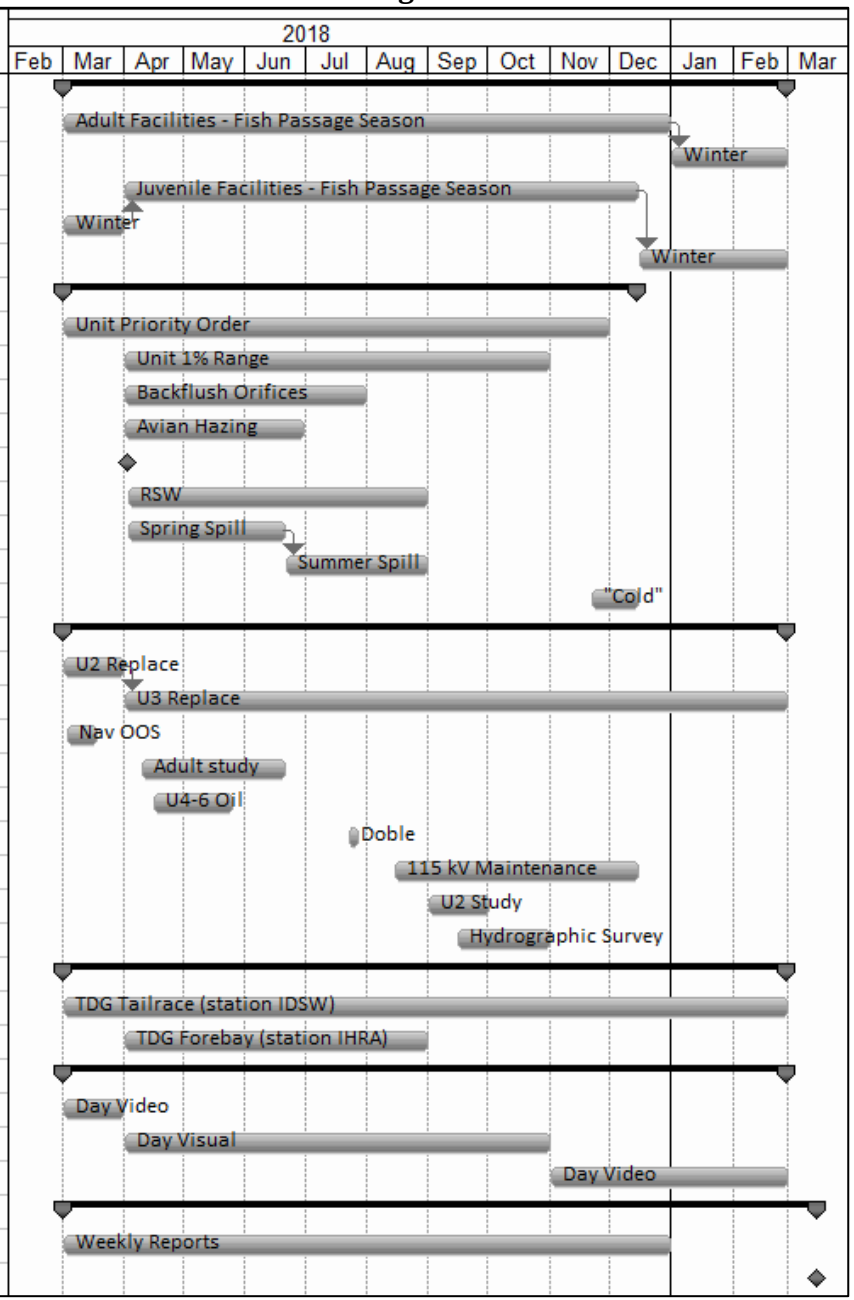


Figure IHR-1. Ice Harbor Lock and Dam General Site Plan.

Table IHR-1. Ice Harbor Dam Schedule of Operations and Actions Defined in the 2018 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**3/1/18**	**2/28/19**	
Adult Facilities - Fish Passage Season	3/1/18	12/31/18	2.4.2
Adult Facilities - Winter Maintenance	1/1/19	2/28/19	2.4.1
Juvenile Facilities - Fish Passage Season	4/1/18	12/15/18	2.3.2
Juvenile Facilities - Winter Maintenance	3/1/18	3/31/18	2.3.1
	12/16/18	2/28/19	
PROJECT OPERATIONS FOR FISH PASSAGE	**3/1/18**	**12/15/18**	
Turbine unit priority order	3/1/18	11/30/18	Table IHR-4
Turbine unit 1% operating range	4/1/18	10/31/18	4.2
Backflush orifices ≥ once per 8 hrs	4/1/18	7/31/18	2.3.2.3.vi.
Avian hazing	4/1/18	6/30/18	App L 6.2
Avian Wires installed NLT April 3	4/3/18	4/3/18	App L 1.4
Spillway weir in service (end date approx)	4/3/18	8/31/18	2.3.2.7
Spring Spill	4/3/18	6/20/18	App E (FOP)
Summer Spill	6/21/18	8/31/18	App E (FOP)
STS removal during cold weather	11/22/18	12/15/18	2.3.2.2.ix
SPECIAL OPS & STUDIES (Appendix A)	**3/1/18**	**2/28/19**	
Unit 2 Replacement	3/1/18	3/31/18	App A 6.1
Unit 3 Replacement	4/1/18	2/28/19	App A 6.1
Navigation Lock annual outage	3/3/18	3/18/18	App A 1.4
Adult Passage & Behavior	4/10/18	6/20/18	App A 6.2
Units 4, 5, 6 Oil Replace	4/16/18	5/25/18	App A 6.1
Doble testing	7/23/18	7/27/18	App A 1.5
115 kV Maintenance	8/15/18	12/15/18	App A 6.1
Unit 2 Study	9/1/18	10/1/18	App A 6.2
Stilling Basin Survey	9/15/18	10/31/18	App A 6.2
TDG MONITORING	**3/1/18**	**2/28/19**	
TDG Monitoring - Tailrace (year-round)	3/1/18	2/28/19	2.2
TDG Monitoring - Forebay	4/1/18	8/31/18	2.2
ADULT FISH COUNTING	**3/1/18**	**2/28/19**	
Day Video 0400-2000 PST	3/1/18	3/31/18	Table IHR-2
Day Visual 0500-2100 PDT	4/1/18	10/31/18	Table IHR-2
Day Video 0400-2000 PST	11/1/18	2/28/19	Table IHR-2
REPORTS	**3/1/18**	**3/15/19**	
Weekly Reports	3/1/18	12/31/18	2.5.2
Annual Report due	3/15/19	3/15/19	2.5.3



1. FISH PASSAGE INFORMATION

Ice Harbor Lock & Dam fish passage facilities and other structures are shown in **Figure IHR-1**. The schedule of Ice Harbor Dam operations that are described in the Fish Passage Plan (FPP) and Appendices is in **Table IHR-1**.

1.1. Juvenile Fish Passage.

1.1.1. Juvenile Fish Facilities. The juvenile fish facilities at Ice Harbor Dam consist of standard length submersible traveling screens (STS), vertical barrier screens (VBS), 12" orifices, collection channel and dewatering structure, sampling facilities, transportation flume/pipe to the tailrace, and a full-flow PIT-tag detection system. Maintenance of juvenile fish facilities that may impact fish or facility operations should be conducted during the winter maintenance period.

1.1.2. Juvenile Fish Migration Timing. Juvenile fish passage timing at Ice Harbor Dam corresponds closely with juvenile passage at Lower Monumental Dam (**FPP Chapter 7 - Lower Monumental Dam, Table LMN-2**). Salmon, steelhead, bull trout, lamprey, and other species are routinely counted when sampling occurs at Ice Harbor Dam.

1.2. Adult Fish Passage.

1.2.1. Adult Fish Facilities. Ice Harbor Dam adult fish facilities are made up of separate north and south shore facilities, described below. Maintenance of adult facilities is scheduled for January–February, typically one shore at a time, to minimize impacts on upstream migrants.

1.2.1.1. North Shore facilities include a fish ladder with counting station, a small collection system, and a pumped auxiliary water supply system. The collection system includes two downstream entrances and one side entrance into the spillway basin. In normal operation, one downstream entrance is used and the other two entrances are closed. The auxiliary water is supplied by two electric pumps, with a third pump as a backup.

1.2.1.2. South Shore facilities are comprised of a fish ladder with counting station, two south shore entrances, a powerhouse collection system, and a pumped auxiliary water supply system. The powerhouse collection system includes two downstream entrances and one side entrance into the spillway basin at the north end of the powerhouse, four operating floating orifices, and a common transportation channel. One of the downstream north powerhouse entrances and four of the floating orifices are used during normal operation. At the south shore entrances, one entrance is normally used. The auxiliary water is supplied by eight electric pumps, of which between six and eight are normally used to provide the required flow. Excess water from the juvenile fish passage facilities is routed into the fish pump discharge chamber to provide additional attraction flow. The upper ends of both ladders have PIT-tag detectors.

1.2.2. Adult Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult fish facilities are operated year-round. Adult salmon, steelhead, shad, and lamprey are counted per the schedule in **Table IHR-2** and data are posted daily at: www.fpc.org/adultsalmon_home.html.

Sturgeon and bull trout are relatively infrequent and are reported in *Miscellaneous Fish Counts* and in the *Annual Fish Passage Report*. Relatively few fish pass through the north ladder so one fish counter can effectively count both ladders simultaneously from the south shore counting room by direct observation of the south viewing window/slot and by video monitor connected to the north shore counting room.

1.2.2.2. Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage defined in **Table IHR-3**. Time-of-day (diel) distributions of adult salmonids at fishway entrances and exits are shown in **Figure IHR-2**.

Table IHR-2. Ice Harbor Dam Adult Fish Counting Schedule, 3/1/2018 – 2/28/2019.

Count Period	Counting Method and Hours *
March 1 – 31	Day Video 0400-2000 (PST)
April 1 – October 31	Day Visual 0500–2100 hours (PDT)
November 1 – end of February	Day Video 0400-2000 (PST)

*PST=Pacific Standard Time. PDT=Pacific Daylight Time (in effect during Daylight Saving Time 3/11/18-11/4/18).

Table IHR-3. Ice Harbor Dam Adult Fish Count Period and Peak Passage Timing (based on yearly counts from 1962 through most recent count year).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Apr 1 – Jun 11	Apr 22	Jun 11
Summer Chinook	Jun 12 – Aug 11	Jun 12	Jul 23
Fall Chinook	Aug 12 – Dec 31	Sep 2	Sep 30
Steelhead	Apr 1 – Oct 31	Sep 15	Oct 12
Sockeye	Apr 1 – Oct 31	Jul 1	Sep 22
Lamprey	Apr 1 – Oct 31	Jul 21	Sep 3

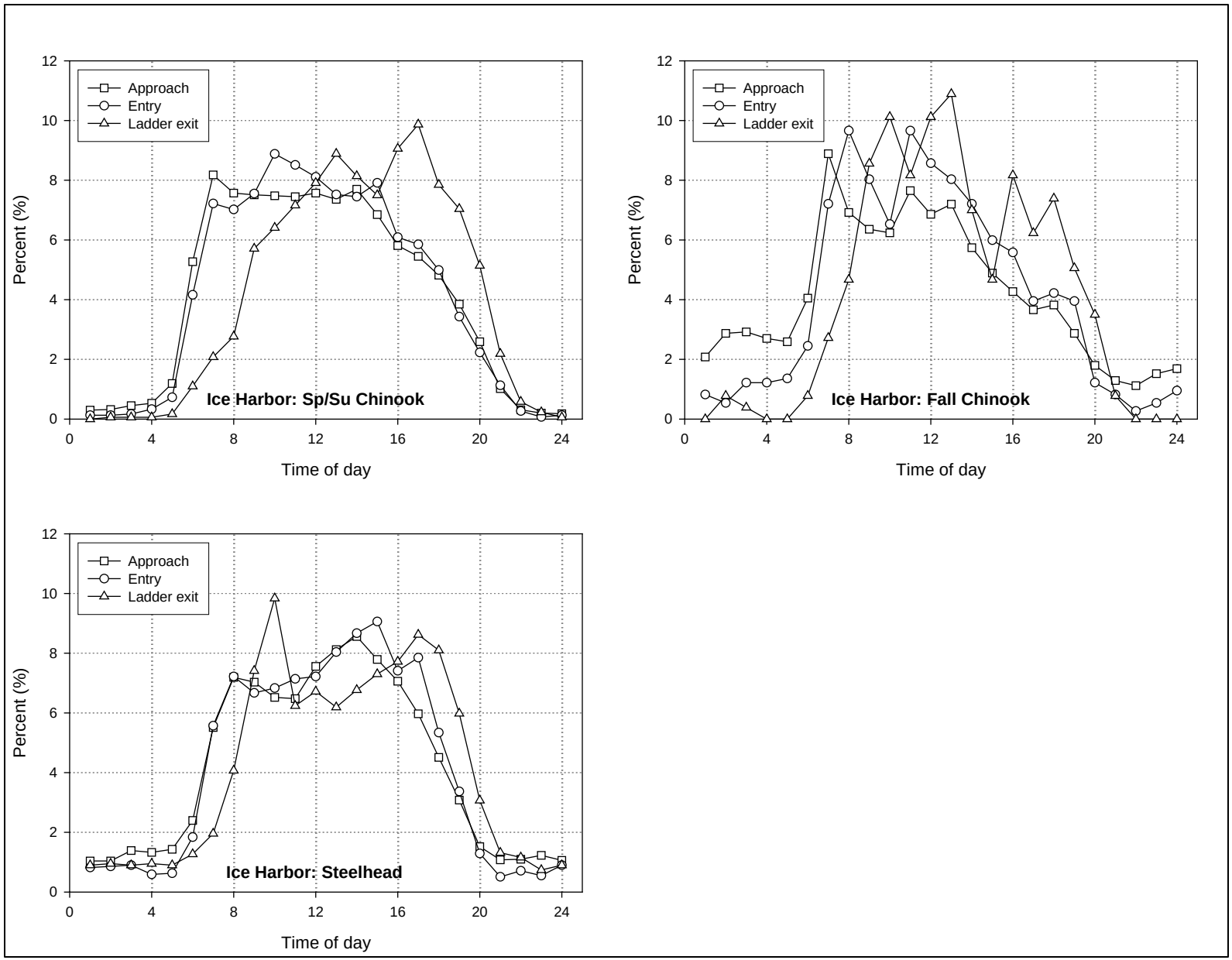


Figure IHR-2. Diel Distribution of Adult Salmonids at Ice Harbor Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*).
pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATIONS

2.1. General.

2.1.1. Yearly special operations related to research are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

2.1.2. Research, non-routine maintenance activities, and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. These distances are approximate and will be updated after data are collected and analyzed to determine the threshold for adverse impacts to adult fish behavior. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

2.1.3. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed immediately following the incident of steps taken to correct the situation. On a monthly basis, as necessary, the project biologist will provide FPOM a summary of any emergency actions undertaken.

2.1.4. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least two weeks in advance, unless it is deemed an emergency (see also **FPP Chapter 1 - Overview** for coordination guidance).

2.2. Spill Management.

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the Fish Passage Plan as **Appendix E**. Spill at Ice Harbor will be distributed in patterns defined in **Table IHR-6 through IHR-9**.

2.2.2. Involuntary spill is the result of river flow above powerhouse capacity, insufficient load (lack of load), turbine unit outages (forced or scheduled), or failure of a key component of the juvenile fish passage facility which forces spill to provide juvenile fish passage.

2.2.3. Total dissolved gas (TDG) is monitored at Ice Harbor Dam during the periods defined in **Table IHR-1**, pursuant to the Corps' annual *TDG Monitoring Plan* and *Dissolved Gas Monitoring Plan of Action 2015-2018*.[1]

[1] TDG Monitoring Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/. TDG Monitoring Plan 2015-2018: pweb.crohms.org/tmt/wqnew/tdg_monitoring/2015-18.pdf

2.3. Operating Criteria – Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance Period (December 16–March 31).

2.3.1.1. Forebay Area and Intakes.

i. Remove debris from forebay and gatewell slots.

ii. Rake trashracks just prior to the operating season.

iii. Measure gatewell drawdown in slots after cleaning trashracks with STSs installed.

iv. Inspect and repair gatewell dip net as needed.

2.3.1.2. Submersible Traveling Screens (STSs) and Vertical Barrier Screens (VBSs).

i. Maintenance completed on all screens.

ii. Inspect STSs prior to installation and operate one trial run (dogged off on deck) to ensure proper operation.

iii. Log trial run.

iv. Inspect all VBSs at least once per year with underwater video camera. Repair as needed.

2.3.1.3. Collection Channel.

i. Water-up valve capable of operating when needed.

ii. Orifice lights are operational.

iii. Orifices clean and valves operating correctly.

iv. Orifice air backflush system works correctly.

v. Netting along handrails maintained and in good condition.

vi. Netting or covers over orifice chutes maintained and in good condition.

2.3.1.4. Dewatering Structure and Flume.

i. Inclined screen should be clean and in good condition with no gaps between screen panels, damaged panels, or missing silicone.

ii. Screen cleaning system (brush and air flush) maintained and operating correctly.

iii. Overflow weirs should be maintained, tested, and operating correctly.

iv. All valves should be operating correctly.

v. Flume interior should be smooth with no rough edges.

vi. Maintain full-flow PIT-tag system as required. Coordinate with PSMFC.

2.3.1.5. Sampling Facilities.

i. Flume dewatering structure maintained in good operating condition with no holes or gaps between dewatering screen panels. Silicone sealer in good condition.

ii. Flume drop gate should be maintained and in good operating condition.

iii. The wet separator and fish distribution system should be maintained and ready for operation as designed.

iv. All dewatering screens and seals in separator and flume must be in good condition with no holes or gaps between panels, or sharp edges.

v. All valves and switch gates maintained and in good operating condition.

vi. All sampling equipment maintained and in good operating condition.

vii. Maintain juvenile PIT-tag system as required. Coordinate with PSMFC.

2.3.1.6. Avian Predation Areas (Forebay and Tailrace). Inspect bird wires, water cannon, and other deterrent devices and repair or replace as needed. Where possible, install additional bird wires or other deterrent devices to cover areas of known avian predation activity. Prepare avian abatement contract as needed.

2.3.1.7. Maintenance Records. Record all maintenance and inspections.

2.3.2. Juvenile Fish Passage Season (April 1–December 15). Operate in accordance with criteria below April 1–October 31 for juvenile fish passage and November 1–December 15 for adult fallbacks.

2.3.2.1. Forebay Area and Intakes.

i. Remove debris from forebay.

ii. Inspect gatewell slots daily (preferably early in day shift) for debris, fish buildup, and contaminating substances (particularly oil). Clean gatewells before they become 50% covered with debris. If the volume of debris precludes the ability to keep the gatewell at least 50% clear, they should be cleaned at least once daily. If flows through an orifice or fish conditions give indications that an orifice may be partially obstructed with debris, the orifice will be closed and backflushed

to remove the obstruction. If the obstruction cannot be removed, the orifice shall be closed and the alternate orifice for that gatewell slot shall be operated. If both orifices become obstructed or plugged with debris, the turbine unit will not be operated until the gatewell and orifices are cleared of debris.

iii. If a visible accumulation of contaminating substances (e.g., oil) is detected in a gatewell and cannot be removed within 24 hours, the gatewell orifices shall be closed immediately and the turbine unit shut down within one hour until the material has been removed and any problems corrected. A preferred method for removing oil from the water surface is to install lipophilic socks, booms, or pads capable of encapsulating the material, tied off with a rope for later disposal. Action should be taken as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow fish to exit the gatewell. Orifices shall not be closed for longer than 48 hours.

iv. Remove debris from trashracks as necessary to maintain less than 1' of additional drawdown in gate slots (relative to drawdown with a clean screen). Additional raking may be required when heavy debris loads are present in the river. Coordinate turbine unit outages with other project work activities, if possible, to minimize turbine unit outages during the spring.

v. Dip bulkhead gatewell slots to remove fish prior to installing bulkhead for dewatering bulkhead slot.

2.3.2.2. STSs and VBSs.

i. Operate STSs in cycling mode when average fork length of sub-yearling Chinook salmon or sockeye is greater than 120 mm at Lower Monumental Juvenile Fish Facility.

ii. Operate STSs in continuous-run mode when average fork length of sub-yearling Chinook salmon or sockeye is less than 120 mm at Lower Monumental Juvenile Fish Facility, or if there is evidence that smaller juvenile fish are present at Ice Harbor.

iii. Inspect each STS by underwater video once per month. Spot check VBSs at the same time.

iv. Record STS amp readings daily.

v. If an STS or VBS is damaged or fails during the juvenile fish passage season, follow procedures detailed under unscheduled maintenance of STSs. In no case should a turbine unit be operated with a missing or a known non-operating or damaged STS or VBS.

vi. Up to half of the STSs may be removed after October 1 for annual maintenance provided there is no operation of units without screens.

vii. Make a formal determination at the end of the season as to the adequacy of STS screen mesh and replacement if necessary.

viii. Inspect at least two VBSs in two different turbine units between spring and summer. Both turbine units should have been operated frequently in the spring. If debris accumulation is noted, inspect other VBSs and clean as necessary.

ix. If extreme cold weather is forecasted (< 20°F for ≥ 24 hours) between Thanksgiving and December 15, STSs may be removed. The project will first request special permission from CENWW-OD-T. CENWW-OD-T will inform NOAA Fisheries and FPOM of the action. NOAA's National Weather Service forecast for Ice Harbor Dam is available at: forecast.weather.gov/MapClick.php?lat=46.2469&lon=-118.8807

2.3.2.3. Collection Channel.

i. Orifices clean and operating. Operate at least one orifice per gatewell slot (preferably the north orifice). If the project is operating within the Minimum Operating Pool (MOP), additional orifices may be operated to maintain a full collection channel. If orifices must be closed to repair any part of the facility, monitor the gatewells hourly (unit is operating) or at least every two hours (unit is not operating) for fish condition and behavior. See **section 3.2.2.3** to determine if the unit must be shut down and if fish must be dipped from the gatewell(s).

ii. Orifice lights operational and operating on open orifices. Orifice lights and area lights may be turned off the evening before the channel is dewatered at the end of the season (dewatering occurs on December 16 or later) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

iii. Replace all burned out orifice lights within 24 hours of notification. Orifice lights shall remain lighted 24 hours/day.

iv. Orifice jets hitting no closer than 3' from back wall, collection channel full.

v. Orifice valves are either fully open or closed.

vi. Backflush orifices at least once per day. During periods of high fish and debris passage, April 1 through July 31, orifices should be inspected and backflushed once per 8-hour shift or more frequently as determined by the project biologist, to keep orifices clean.

vii. Water-up valve capable of operating when needed.

viii. The netting along handrails should be maintained in good condition with no holes or gaps in the netting.

ix. Netting or covers over orifice chutes in good condition.

2.3.2.4. Dewatering Structure.

i. Trash sweep operating correctly. Project Fisheries shall determine the sweep frequency of at least once every four hours, or shorter as necessary to maintain a clean screen. If automated cleaning system problems occur, operate manually at least once per work shift, or more as necessary to maintain a clean screen.

ii. Clean trapezoidal section at least once per day, and more frequently if required to maintain a clean condition.

iii. Check overflow weirs to make sure they are operating correctly, perform maintenance as required.

iv. There should be no gaps between screen panels in the inclined screen or holes in the screen panels.

v. Lights at the dewatering structure should be turned off at night, unless needed for personnel access, to encourage fish to move downstream volitionally.

2.3.2.5. Sampling Facilities.

i. All screens should be inspected to make sure there are no holes or sharp edges.

ii. Operate wet separator and fish distribution system as designed. Sample fish no less than twice per week with no more than three days between sample days during the main juvenile bypass season to monitor juvenile fish descaling and other fish condition parameters. The sample goal should be 100 fish of each of the predominant species of salmonids on each sample day, with no more than four hours of sampling. All fish collected during the sample will be examined and recorded. Increased frequency may be necessary during periods when injuries are noted or suspected (e.g., high debris periods). Sampling is not recommended when water temperatures exceed 70^0 F unless authorized by an ESA permit. Fish condition reporting should follow the standardized SMP protocol and be sent to FPC within twelve hours after sampling.

iii. Crowder screen brushes should be maintained in good operating condition with no holes or sharp edges in the crowder screen.

iv. Operate pre-anesthetic system as designed.

v. Inform PSMFC, in advance if possible, of situations that cause the PIT-tag system to become inoperable (e.g. power outages) or that could result in confounding the interpretation of PIT-tag data (e.g. operating in primary bypass mode without an operational full-flow detector, emergency dewaterings).

2.3.2.6. Avian Predation Areas (Forebay and Tailrace).

i. Bird wires and other avian deterrent devices shall be monitored to ensure good condition. Any broken wires or devices shall be replaced as soon as possible.

ii. Harassment program in place to deter avian predation in areas actively used by birds and not covered by bird wires or other devices.

iii. Project biologists shall routinely monitor project areas to determine areas of active avian predation and, if possible, adjust harassment program to cover these areas or install bird wires or other deterrent devices to discourage avian predation.

2.3.2.7. Removable Spillway Weir (RSW).[2]

i. The RSW in spillbay 2 will be in the raised position and operational on the first day of spill for juvenile fish passage.

ii. When the RSW is in operation, spill through Bay 2 is fixed at approximately 8.4 kcfs. The spillgate shall be raised to where it does not touch flow passing down the RSW.

iii. When the National Weather Service forecasts Ice Harbor inflow to exceed 200 kcfs, initiate aggressive forebay debris removal so that RSW operation will not be impeded and coordinate with RCC and CENWW-OD-T.

iv. Complete RSW stow (complete rotation to the landing pad) when inflows exceed 260 kcfs, upstream river gauge flows are increasing, and the NWS forecasts Ice Harbor inflow to exceed 300 kcfs.

v. On or after June 21 (start of summer spill), when average daily total project outflow is less than 30 kcfs and forecasted to remain below 30 kcfs for three days or more on a declining hydrograph, the RSW will be closed and spill will be distributed in patterns for spill with no RSW in **Table IHR-6**. The RSW will be re-opened if average daily total project outflow increases above 30 kcfs and is forecasted to remain above 30 kcfs for three or more days. NWRFC inflow forecast for Ice Harbor Dam at:
www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?IHDW1

2.3.2.8. Inspection and Record Keeping. Inspect all facilities according to fish facilities monitoring plans. Record all maintenance and inspections.

[2] Spillway weirs provide surface passage routes via spillbay(s). Temporary, or Top, Spillway Weirs (*TSW*s) at Little Goose, McNary and John Day dams can be installed, uninstalled and moved between bays using the gantry crane. Removable Spillway Weirs (*RSW*s) at Lower Granite, Lower Monumental and Ice Harbor dams are "removed" by controlled descent to the bottom of the forebay.

2.4. Operating Criteria - Adult Fish Facilities.

2.4.1. Adult Facilities - Winter Maintenance (January 1–end of February).

2.4.1.1. Inspect all staff gauges and water level indicators. Repair and/or clean where necessary.

2.4.1.2. Dewater all ladders and inspect all dewatered sections of fish facilities for projections, debris, or plugged orifices which could injure fish or impede fish passage up the ladder. Fish ladder exit trashracks must have smooth surfaces where fish pass, and must have downstream edges that are adequately rounded or padded. Spare trashracks should be on hand for use as necessary. Inspect all diffuser gratings and chambers annually by dewatering or by using divers or video inspection techniques. All diffuser gratings and chambers are to be dewatered and physically inspected at least every 3 years. Repair deficiencies.

2.4.1.3. Inspect for and clean debris from the fish ladder exits. All trashracks and picketed leads must be clean and installed correctly.

2.4.1.4. Calibrate all water level measuring devices, as necessary, for proper facility operations.

2.4.1.5. Inspect all spill gates and ensure that they are operable.

2.4.1.6. Fish pumps maintained and ready for operation.

2.4.1.7. Maintain adult PIT-tag system as required. Coordinate with PSMFC.

2.4.1.8. Maintain the adult fish trap as required. This can also be done outside of the January-February period because the trap is removable.

2.4.2. Adult Fish Passage Season (March 1–December 31).

Note: During extremely high flows when tailwater level exceeds elevation 353' msl, project personnel will monitor for water seepage from the auxiliary water supply conduit into the powerhouse warehouse. If personnel determine that water seeping into the powerhouse could affect safety and equipment, the transverse bulkhead to the auxiliary water supply conduit will be installed and the number of AWS pumps in operation will be accordingly reduced until flooding is reduced to a manageable level.

2.4.2.1. Fishway Ladders. Water depth over weirs: 1' to 1.3'.

2.4.2.2. Counting Windows. The crowder shall be opened to full count slot width and the picketed leads shall be removed when not counting. The crowder shall be open as far as possible to allow accurate counting and shall not be closed to less than 18” while counting. This will usually occur during high turbidity conditions to allow count accuracy criteria to be achieved. All equipment should be maintained and in good condition. The counting window

and backboard should be cleaned as needed to maintain good visibility. Crowder ranges at IHR are as follows:

- North = 19.5” (fixed width)
- South = 19.5” (fixed width)

2.4.2.3. Head on all Fishway Entrances. Head range: 1' to 2'.

2.4.2.4. North Shore Entrance (NEW 1). Elevation at top of gate on sill = 332.25'.

i. Operate downstream gate closest to shore.

ii. Weir depth: 8' or greater below tailwater. At tailwaters less than 340.25', weirs should be on sill. Note that at low river flow and tailwater, some of the diffusers are above tailwater and project may only be able to maintain a 6' weir depth.

iii. North Shore Lower Diffuser Gates: If tailwater is below 344', diffuser gates should be fully open. If tailwater is above 344', diffuser gates should be ½ open.

2.4.2.5. North Powerhouse Entrances (NFE 1&2). Elevation at top of gate on sill=332.25'.

i. Operate one downstream gate.

ii. Weir depth: 8' or greater below tailwater. At tailwaters less than elevation 340.25', weirs should be on sill. [*Note: At low tailwater, weirs will bottom out and will be less than 8' below tailwater*.]

2.4.2.6. Floating Orifice Gates. Operate 4 floating orifices, OG1, 4, 10, and 12.

2.4.2.7. South Shore Entrance (SFE-1). Elevation of top of gate when on sill = 332.25'.

i. Operate entrance closest to powerhouse.

ii. Weir depth: 8' or greater below tailwater. At tailwaters less than elevation 340.25', weirs should be on sill. *[Note: At low tailwater, weirs will bottom out and will be less than 8' below tailwater.]*

2.4.2.8. Channel Velocity. 1.5 to 4.0 feet per second (fps). Ice Harbor Dam monitors water velocity at the junction pool in the lower south fish ladder. The current device utilizes Doppler Technology. Decision for placement was not only what was considered to be the single most representative position, but also the placement for maintenance and ease of installation. In addition, head is measured at the north, north powerhouse, and south fishway entrances.

2.4.2.9. Head on Trashracks.

i. Maximum head of 0.3’ on ladder exits.

ii. Maximum head on picketed leads shall be 0.3'.

iii. Trashracks and picketed leads installed correctly.

2.4.2.10. Staff Gauges and Water Level Indicators. All staff gauges should be readable at all water levels encountered during the fish passage period. Repair or clean as necessary.

2.4.2.11. Inform PSMFC, in advance if possible, of situations that cause the PIT-tag system to become inoperable (e.g. power outages) or that could result in confounding the interpretation of PIT-tag data (e.g. emergency dewaterings).

2.4.2.12. Facility Inspections.

i. Powerhouse operators shall inspect facilities once per day shift and check computer monitor information at least once during each back shift.

ii. Project biologists shall inspect facilities three times per week. Inspect all facilities according to fish facilities monitoring program.

iii. Picketed leads shall be inspected during all inspections to ensure they are clean and in the correct position (all the way down).

iv. Project personnel shall check calibration of fishway control system twice per month to ensure that it is kept within calibration. This may be done as part of routine fishway inspections.

v. Inspect fishways daily for foreign substances (particularly oil). If substances are found, corrective actions should be undertaken immediately.

vi. Record all inspections.

2.4.2.13. Fishway Temperature Monitoring. From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits.

i. Temperature monitors shall be placed within 10 meters of all shore-oriented entrances and exits.

ii. If possible, the entrance monitor shall be within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers to allow for sufficient mixing with surface water.

iii. The exit monitor shall be within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

iv. If an existing temperature monitoring location is proposed to be used for either the exit or entrance, it shall be verified that the site accurately reflects water temperature within 10 meters of the entrance or exit.

v. Project Fisheries will submit temperature data to the Fish Passage Center (FPC) on a weekly basis for posting online at: www.fpc.org/river/Q_ladderwatertempgraph.php.

2.5. Fish Facility Monitoring & Reporting.

2.5.1. Project biologists shall inspect fish passage facilities at the frequencies listed in the juvenile and adult fish facilities operating criteria sections.

2.5.2. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31, summarizing operations for Friday through Thursday, and email to CENWW-OD-T by noon the following Monday. Reports shall provide an overview of how the project and the fish passage facilities operated during the week and evaluate resulting fish passage conditions, and include:

i. Any out-of-criteria situations observed and subsequent corrective actions taken;
ii. Any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities;
iii. Adult fishway control calibrations;
iv. STS and VBS inspections;
v. Any unusual activities at the project that may have affected fish passage.

2.5.3. Annual Reports. Project biologists shall prepare a draft annual report by February 10 and a final report by March 15 summarizing the operation of the project fish passage facilities for the previous year. The annual report shall also include a description of actions taken to discourage avian predation at the project, and an overview of the effectiveness of those activities in discouraging predation.

2.5.4. Project Inspections. Project biologists inspect project facilities once per month and during dewaterings for the presence of zebra and Quagga mussels. Biologists shall provide a report to CENWW-OD-T on a monthly basis summarizing mussel inspections.

3. FISH FACILITIES MAINTENANCE

3.1. Dewatering & Fish Handling.

3.1.1. Project biologists should be present to provide technical guidance at all project activities that may involve fish handling. All dewatering (also referred to as "unwatering") shall be accomplished in accordance with approved *Dewatering Guidelines and Fish Salvage Plans* (**Appendix F**). When river temperatures reach 70°F or greater, all adult fish handling will be coordinated through CENWW-OD-T. Project *Dewatering Plans*[3] were reviewed and revised in 2011 to ensure that they comply with **Appendix F**.

3.2. Maintenance - Juvenile Fish Facilities.

3.2.1. Scheduled Maintenance. Scheduled maintenance of juvenile facilities is conducted year-round. Long-term maintenance or modifications that require facilities to be out of service for

[3] Project Dewatering Plans are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/

extended periods of time are conducted during the winter maintenance period December 16–March 31. During the fish passage season, parts of the facilities are maintained on a daily, weekly, or longer interval to keep them in proper operating condition.

3.2.2. Unscheduled Maintenance. Unscheduled maintenance is the correction of any situation that prevents facilities from operating within criteria or that will impact fish passage or survival.

3.2.2.1. Notification/Reporting. Maintenance of facilities such as STSs, which sometimes break down during fish passage season, will be carried out as described below. In these cases, repairs will be made as prescribed and CENWW-OD-T will be notified as soon as possible after it becomes apparent that repairs are required. The Operations Manager has the authority to initiate work prior to notifying CENWW-OD-T if a delay of the work will result in an unsafe situation for people, property, or fish. Unscheduled maintenance that will have a significant impact on fish passage shall be coordinated with NOAA Fisheries and FPOM on a case-by-case basis by CENWW-OD-T. Information required by CENWW-OD-T includes:

i. Description of the problem.
ii. Type of outage required.
iii. Impact on facility operation.
iv. Length of time for repairs.
v. Expected impacts on fish passage and proposed measures to mitigate them.

3.2.2.2. STS. The STSs are inspected periodically throughout the juvenile migration season with a video monitoring system. If a screen is found to be damaged it will be removed and either replaced with the spare STS or repaired and returned to service. A turbine unit shall not be operated with a known damaged or nonfunctioning STS or without a full complement of STSs. If an STS fails on a weekend or at night when maintenance crews are not available, the respective turbine unit will be shut down and generation switched to another fully screened unit. If all screened turbine units are in service, additional water may be spilled until the effected STS can be removed and repaired or replaced.

3.2.2.3. Gatewell Orifices. Each gatewell has two 12" orifices with air operated valves to allow fish to exit the gatewell. Under normal operation, one orifice per gatewell is operated. To minimize blockage from debris, orifices are cycled and back flushed at least once per day, and more frequently if required by heavy debris loads. If an air valve fails or is blocked with debris, the valve should be closed and the alternate orifice for that gatewell operated until repairs can be made. If both orifices are blocked with debris, damaged, or must be kept closed, the turbine unit will be taken out of service until repairs can be made. If repairs are to take longer than 48 hours, juvenile fish will be dipped from the gatewell with a gatewell dip basket in accordance with the project dewatering and fish-handling plan.

3.2.2.4. Dewatering Structure. The dewatering structure acts as a transition from the collection channel to the corrugated metal flume. An inclined screen allows excess water to be bled off, with all fish and remaining water transitioning into the corrugated metal flume. The excess water is discharged into the adult fish facility auxiliary water supply system and is also used as the water supply for the sampling facilities. The dewatering structure contains a trash sweep for cleaning the rectangular portion of the inclined screen, and an air blow back system for cleaning the transition (trapezoidal) section of the screen. The dewatering screen

has a set of differential pressure sensors for determining head differential across the screen. If the sensors detect a 0.15' differential it initiates continuous screen cleaning. If the sensors detect a differential of 0.30' it closes all but 3 orifices (Unit 1 orifices remain open) in the juvenile collection channel. Both conditions trigger an alarm at the control panel and in the control room. If the trash sweep breaks and interferes with juvenile fish passage through the structure or if the inclined screen or other component of the structure is damaged, the orifices may need be closed and the collection channel dewatered to allow repairs to be made. If the orifices are closed and the collection channel dewatered, the traveling screens will remain in operation. Fish will be allowed to accumulate in the gatewells for up to 2 days. If repairs are expected to take longer than 2 days, a salvage program will be initiated to remove fish from gatewells, with a gatewell dip basket, until repairs can be made and the system watered up again. While the collection channel is out of service, project personnel shall monitor gatewells for signs of fish problems or mortality. Spill may be provided as an alternative avenue for fish passage during the collection channel outage.

3.2.2.5. Bypass Flume. The bypass flume transports fish to the sampling facilities and to the tailrace below the project. If there is a problem with the flume that requires it to be dewatered, procedures will be taken similar to **section 3.1**.

3.2.2.6. Sampling Facilities. Under normal operation, juvenile fish are routed around the sampling facilities, except when sampling is being conducted. If there is a problem with the sampling facilities when it is in operation, the drop gate will be lowered to keep all juvenile fish in the bypass flume/pipe to bypass them directly to the river below the project. All fish in the sampling facility will then be released back to the river prior to sampling if there are any problems with holding them in the sample tank until they can be sampled.

3.3. Maintenance - Adult Fish Facilities.

3.3.1. Scheduled Maintenance. Scheduled maintenance of a facility that must be dewatered to work on or where maintenance will have a significant effect on fish passage will be done during the January–February winter maintenance period. Maintenance of facilities that will have no effect on fish passage may be conducted at any time. Maintenance is normally conducted on one fish ladder at a time during the winter to provide some fish passage at all times. When facilities are not being maintained during the winter maintenance period, they will be operated according to normal criteria unless otherwise coordinated with NOAA Fisheries and FPOM.

3.3.2. Unscheduled Maintenance.

3.3.2.1. Notification/Reporting. Unscheduled maintenance that will significantly affect facility operation will be coordinated with NOAA Fisheries and other FPOM participants. Coordination procedures for unscheduled maintenance of adult facilities are the same as for juvenile facilities (**section 3.2.2.**). If part of a facility malfunctions or is damaged during the fish passage season, and the facility can still be operated within criteria without any detrimental effects on fish passage, repairs may not be conducted until the winter maintenance period or until fewer numbers of fish are passing the project. If part of a facility is damaged or malfunctions that may significantly impact fish passage, it will be repaired as soon as possible.

3.3.2.2. Fish Ladders and Counting Stations. The fish ladders contain fixed weirs, counting stations with picket leads, and fish exits with trashracks. If any part of the ladder fails or is blocked with debris during fish passage season, efforts will first be made to correct the problem without dewatering the ladder. Trashracks, picket leads, and counting stations can sometimes be repaired or maintained without dewatering the ladder. The decision to dewater the ladder and make repairs during the fish passage season or wait until the winter maintenance period will be made after coordination with the fish agencies and tribes.

3.3.2.2.a. Hazardous Materials Spill. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.

3.3.2.3. North Shore Auxiliary Water Supply System. The north shore facilities contain three electric pumps that provide auxiliary water to the diffusers at the bottom of the ladder and at the entrances. During normal operation two pumps are required to provide the necessary auxiliary water.

3.3.2.3.a. If a pump fails during 2-pump operation, the pump on standby will be operated to provide the necessary flows.

3.3.2.3.b. If two or all three pumps fail, the NEW1 weir will be maintained at a level of 6' below tailwater until repairs are made.

3.3.2.4. South Shore Auxiliary Water Supply System. The south shore auxiliary water is supplied by 8 electric pumps and 150-180 cfs of excess water from the juvenile fish facilities. Fluctuating water levels can require up to 8 pumps to be operated to provide the auxiliary water and meet criteria.

3.3.2.4.a. If one pump fails, a standby pump will be started to keep the fishway within criteria. If more pumps fail, this procedure will continue until all the standby pumps are in operation.

3.3.2.4.b. If criteria cannot be met within 24 hours, the floating orifices should be closed in the following order: OG-12 and OG-10.

3.3.2.4.c. If the required head differential of 1' to 2' cannot be reached when the floating orifices are closed, SSE 1 and NFE 2 will be closed equally at 1' intervals until it is reached or until the weirs are 5' below tailwater. Then the remaining floating orifices should be closed in the following order: OG-4 and OG-1.

3.3.2.4.d. If there is still not enough auxiliary water to maintain the head differential on the two main entrances, NFE 2 will be closed, the transportation channel bulkheaded off at the junction pool, and SSE 1 operated as deep as possible to maintain the head differential. If it cannot be maintained at a depth of 6' or greater, the weir will remain at 6' regardless of the head.

3.3.2.5. Fishway Entrances. The fishway entrances consist of main entrance weirs with hoists and automatic controls, and floating orifices which auto-regulate with tailwater fluctuations.

3.3.2.5.a. If any of the automatic controls malfunction, Project personnel will operate the weirs manually to maintain within criteria.

3.3.2.5.b. If there is a further failure that prevents the entrance from being operated manually, an alternate entrance will be opened until repairs can be made.

3.3.2.5.c. If a floating orifice fails, it will be pulled out of the water and the entrance bulkheaded off until the floating orifice is repaired.

3.3.2.6. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during winter maintenance to ensure they are in place. Inspections are done either by dewatering and physically inspecting the gratings, or by using underwater video cameras, divers, or other methods. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings.

3.3.2.6.a. Diffuser gratings may come loose during fish passage season due to a variety of reasons. If a grating is known or suspected to have moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish. Coordination of issues should begin immediately through the established coordination procedure for Unscheduled Maintenance (**section 3.2.2.1.**). If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If gratings are found to be missing or displaced, creating openings into the diffuser chambers, a repair plan shall be developed and coordinated with the fish agencies and tribes through the established coordination procedure. Repairs shall be made as quickly as possible unless otherwise coordinated.

4. TURBINE UNIT OPERATION & MAINTENANCE

4.1. Turbine Unit Priority Order.

4.1.1. From March 1 through November 30, turbine units will be operated in the order of priority defined in **Table IHR-4** to enhance adult and juvenile fish passage. Model studies of Ice Harbor Dam show that spill at low flows can cause eddying in front of the powerhouse. The unit priority order is defined to minimize eddying during spill and provide the best fish passage conditions. If a turbine unit is out of service for maintenance or repair, the next unit in the priority order shall be operated.

4.1.2. Unit priority order may be coordinated differently to allow for fish research, construction, or project maintenance activities. Hours of operations may be coordinated and adjusted in-season by CENWW-OD-T (through coordination with TMT) if necessary for fish passage or other conditions at the project.

4.1.3. Single Unit Operation. Ice Harbor should not operate a single unit on the *Ice Harbor-Franklin No.2 115kV* line. This line is connected to the *Sacajawea 500/115kV* transformer and the operation of a single unit on the line jeopardizes BPA system reliability. Therefore, IHR should not be run as a single or two-unit project with Unit(s) 3 and/or 4 without switching those units to the *Ice Harbor-Franklin No.3 115kV* line, disconnecting the *No.2 115kV* line from Ice Harbor, and disabling the transfer trip for the *No.2 115kV* line at Ice Harbor. This switching is necessary to prevent the loss of all Ice Harbor generation and the *Sacajawea* transformer if there is an outage of the *No.2 115kV* line. If single-unit operation is necessary and switching has not occurred in the yard, the project will operate Unit 1, 2, 6, or 5. Running Unit 3 or 4 alone on the *No. 2 115kV* line can only occur if the project operator can accomplish the needed switching.

Table IHR-4. Ice Harbor Dam Turbine Unit Priority Order.

Season	Operation	Unit Priority Order
March 1 – November 30 Fish Passage Season	Single-Unit Operation w/ NO Line Switching	1, 2, 6, 5
	Single-Unit Operation AFTER Line Switching Or Multiple-Unit Operation	1, 2, 3, 6, 4, 5
December 1 – end of February Winter Maintenance	Single-Unit Operation w/ NO Line Switching	Any order for Units 1, 2, 5, 6
	Single-Unit Operation AFTER Line Switching Or Multiple-Unit Operation	Any Order

4.2. Turbine Unit Operating Range.

4.2.1. In-Season (April 1–October 31). As defined in the *BPA Load Shaping Guidelines* (**Appendix C**), all units will be operated within ±1% of peak turbine efficiency (1% range) to maximize survival of juvenile fish that pass through the turbines. Turbine unit flow and power output at the lower and upper limits of the 1% range are defined in **Table IHR-5**.

4.2.1.1. If operation outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

i. Meet BPA load requests made pursuant to BPA's policy, statutory requirements, and *Load Shaping Guidelines* (**Appendix C**);

ii. If the draft tube is to be dewatered (**section 4.3.3**), the unit will be operated at full load >1% (or at speed-no-load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs in order to flush fish from the unit;

iii. Operate a turbine unit solely to provide station service; or

iv. Comply with other coordinated fish measures.

4.2.1.2. Minimum Generation. All of the lower Snake River projects may be required to keep one generating unit online at all times to maintain power system reliability. The minimum generation flow range for each unit is defined in the FOP Table 1 (**Appendix E**), as derived from the lower limits of the 1% range and actual unit operations. During low flow, there may not be enough river flow to meet this generation requirement and the FOP spill target. Under these circumstances, the project will operate the first available priority unit at minimum generation and spill the remainder of outflow. Actual attainable minimum generation may vary depending on real-time conditions.

4.2.2. Off-Season (November 1–March 31). While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

Table IHR-5. Ice Harbor Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Turbine Efficiency (Lower and Upper Limits of 1% Range) and Operating Limits.[a]

Project Head (feet)	IHR Unit 1 - With STS						IHR Unit 1 - No STS					
	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	51.7	8,417	83.6	13,590	92.8	16,053	51.9	8,340	89.9	14,452	102.6	16,859
86	52.6	8,443	84.6	13,585	94.3	16,077	52.7	8,367	91.0	14,447	103.1	16,715
87	53.4	8,469	85.6	13,580	95.7	16,099	53.5	8,392	92.0	14,441	103.5	16,568
88	54.2	8,494	86.6	13,574	97.3	16,144	54.3	8,417	93.1	14,436	103.5	16,420
89	55.0	8,518	87.6	13,569	99.0	16,187	55.1	8,441	94.2	14,430	103.5	16,252
90	55.8	8,542	88.6	13,563	100.1	16,158	55.9	8,465	95.3	14,424	103.5	16,034
91	56.5	8,548	89.8	13,585	101.0	16,058	56.6	8,471	96.5	14,448	103.5	15,822
92	57.1	8,554	90.9	13,607	101.9	15,960	57.3	8,477	97.8	14,471	103.5	15,614
93	57.8	8,559	92.1	13,628	102.8	15,864	58.0	8,482	99.0	14,494	103.5	15,411
94	58.5	8,565	93.2	13,649	103.5	15,769	58.6	8,488	100.3	14,516	103.5	15,213
95	59.2	8,570	94.4	13,669	103.5	15,675	59.3	8,493	101.5	14,537	103.5	15,019
96	59.9	8,589	95.3	13,662	103.5	15,425	60.1	8,511	102.5	14,530	103.5	14,845
97	60.7	8,607	96.3	13,655	103.5	15,180	60.8	8,529	103.5 [b]	14,676	103.5	14,676
98	61.5	8,624	97.3	13,648	103.5	14,941	61.6	8,546	103.5 [b]	14,509	103.5	14,509
99	62.2	8,641	98.2	13,641	103.5	14,708	62.4	8,563	103.5 [b]	14,347	103.5	14,347
100	63.0	8,658	99.2	13,634	103.5	14,481	63.1	8,580	103.5 [b]	14,187	103.5	14,187
101	64.0	8,707	99.9	13,590	103.5	14,318	64.1	8,629	103.5 [b]	14,037	103.5	14,037
102	65.0	8,756	100.6	13,547	103.5	14,158	65.2	8,677	103.5 [b]	13,890	103.5	13,890
103	66.0	8,804	101.3	13,505	103.5	14,001	66.2	8,725	103.5 [b]	13,746	103.5	13,746
104	67.0	8,850	102.0	13,463	103.5	13,847	67.2	8,771	103.5 [b]	13,605	103.5	13,605
105	68.0	8,896	102.6	13,422	103.5	13,697	68.2	8,816	103.5 [b]	13,466	103.5	13,466
	IHR Unit 2 [c] - With STS						IHR Unit 2 [c] - No STS					
85	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
86	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
87	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
88	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
89	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
90	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
91	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
92	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
93	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
94	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
95	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
96	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
97	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
98	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
99	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
100	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
101	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
102	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
103	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
104	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
105	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

a. Table values derived from HDC report (March 2007). Flow (cfs) calculated from turbine efficiency, head, and power output (MW). "Operating Limit" is the maximum safe operating point, based on cavitation or generator limit (added Feb 2018).

b. At project head ≥ 97 ft, Units 1, 4, 5, and 6 with No STS are restricted by the Operating Limit and cannot achieve the modeled upper limit of the 1% range. Power (MW) and flow (cfs) values shown are at Operating Limit.

c. Unit 2 is out of service through spring 2018 for turbine replacement. Table will be revised pending index tests.

Project Head (feet)	IHR Unit 3 [d] - With STS						IHR Unit 3 [d] - No STS					
	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	69.8	11,404	74.1	12,100	n/a	n/a	70.9	11,452	75.2	12,141	n/a	n/a
86	70.8	11,423	75.0	12,098	n/a	n/a	71.9	11,471	76.1	12,140	n/a	n/a
87	71.8	11,442	75.9	12,097	n/a	n/a	72.9	11,490	77.0	12,139	n/a	n/a
88	72.8	11,460	76.8	12,096	n/a	n/a	73.9	11,508	77.9	12,137	n/a	n/a
89	73.8	11,477	77.7	12,094	n/a	n/a	74.9	11,526	78.9	12,136	n/a	n/a
90	74.7	11,494	78.6	12,092	n/a	n/a	75.9	11,542	79.8	12,134	n/a	n/a
91	75.9	11,544	80.1	12,184	n/a	n/a	77.1	11,593	81.3	12,226	n/a	n/a
92	77.1	11,593	81.6	12,274	n/a	n/a	78.3	11,642	82.8	12,316	n/a	n/a
93	78.3	11,641	83.1	12,362	n/a	n/a	79.5	11,690	84.4	12,404	n/a	n/a
94	79.5	11,688	84.6	12,447	n/a	n/a	80.7	11,737	85.9	12,490	n/a	n/a
95	80.6	11,734	86.1	12,531	n/a	n/a	81.9	11,783	87.4	12,575	n/a	n/a
96	81.1	11,683	86.5	12,452	n/a	n/a	82.4	11,732	87.8	12,495	n/a	n/a
97	81.7	11,633	86.9	12,374	n/a	n/a	82.9	11,682	88.2	12,417	n/a	n/a
98	82.2	11,584	87.2	12,297	n/a	n/a	83.5	11,633	88.5	12,340	n/a	n/a
99	82.7	11,536	87.6	12,223	n/a	n/a	84.0	11,585	88.9	12,265	n/a	n/a
100	83.2	11,489	88.0	12,149	n/a	n/a	84.5	11,537	89.3	12,192	n/a	n/a
101	84.1	11,500	89.0	12,168	n/a	n/a	85.4	11,549	90.3	12,210	n/a	n/a
102	85.0	11,511	90.0	12,186	n/a	n/a	86.4	11,560	91.4	12,229	n/a	n/a
103	85.9	11,522	91.0	12,204	n/a	n/a	87.3	11,571	92.4	12,247	n/a	n/a
104	86.9	11,533	92.0	12,222	n/a	n/a	88.2	11,582	93.4	12,265	n/a	n/a
105	87.8	11,544	93.1	12,239	n/a	n/a	89.2	11,593	94.5	12,282	n/a	n/a
	IHR Units 4, 5[e], 6 - With STS						IHR Units 4, 5[e], 6 - No STS					
85	58.9	9,369	93.1	14,810	121.8	20,745	62.0	9,745	110.7	17,413	121.8	19,401
86	59.7	9,380	94.4	14,824	122.7	20,569	62.8	9,756	112.3	17,430	122.7	19,283
87	60.6	9,390	95.7	14,838	123.4	20,392	63.7	9,767	113.8	17,447	123.4	19,162
88	61.4	9,400	97.0	14,851	124.2	20,212	64.5	9,777	115.3	17,462	124.2	19,039
89	62.2	9,410	98.2	14,864	124.9	20,034	65.4	9,787	116.8	17,477	124.9	18,905
90	63.0	9,419	99.5	14,876	125.6	19,747	66.3	9,797	118.3	17,492	125.6	18,752
91	63.7	9,416	100.7	14,885	126.2	19,569	67.0	9,794	119.8	17,503	126.2	18,599
92	64.5	9,414	102.0	14,895	126.9	19,389	67.8	9,792	121.3	17,515	126.9	18,445
93	65.2	9,411	103.2	14,904	127.2	19,159	68.6	9,789	122.7	17,525	127.2	18,242
94	65.9	9,409	104.5	14,912	127.2	18,893	69.3	9,787	124.2	17,535	127.2	18,004
95	66.6	9,406	105.7	14,921	127.2	18,633	70.1	9,784	125.7	17,545	127.2	17,771
96	67.5	9,416	106.7	14,892	127.2	18,396	70.9	9,794	126.8	17,512	127.2	17,560
97	68.3	9,425	107.7	14,864	127.2	18,165	71.8	9,804	127.2 [b]	17,353	127.2	17,353
98	69.1	9,434	108.6	14,836	127.2	17,938	72.7	9,813	127.2 [b]	17,150	127.2	17,150
99	69.9	9,442	109.6	14,809	127.2	17,717	73.5	9,822	127.2 [b]	16,952	127.2	16,952
100	70.7	9,451	110.6	14,782	127.2	17,499	74.4	9,831	127.2 [b]	16,757	127.2	16,757
101	71.4	9,446	112.9	14,939	127.2	17,251	75.1	9,825	127.2 [b]	16,573	127.2	16,573
102	72.0	9,441	115.1	15,093	127.2	17,009	75.7	9,820	127.2 [b]	16,393	127.2	16,393
103	72.7	9,436	117.4	15,244	127.2	16,771	76.4	9,815	127.2 [b]	16,216	127.2	16,216
104	73.3	9,431	119.7	15,392	127.2	16,539	77.1	9,810	127.2 [b]	16,042	127.2	16,042
105	74.0	9,426	121.9	15,538	127.2	16,312	77.8	9,805	127.2 [b]	15,872	127.2	15,872

d. Unit 3 has fixed blades and restricted operating range of approximately 11.4-12.5 kcfs (HDC report March 2015), but is scheduled to go out of service for turbine replacement starting in spring 2018 after Unit 2 returns to service. Table will be revised after completion of U3 turbine replacement and index testing.

e. Unit 5 has fixed blades and restricted operating range of approximately 13-14 kcfs (from 2017 U5 abbreviated index test).

4.3. Turbine Unit Maintenance.

4.3.1. Maintenance Schedule.

4.3.1.1. Turbine unit maintenance schedules will be reviewed annually by Project and Operations Division biologists for fish impacts.

4.3.1.2. Each turbine unit requires annual maintenance that may take from several days to two weeks, and is normally scheduled between mid-July and late November. Maintenance of priority units for adult passage is normally conducted in November or December, but can be completed in mid-August.

4.3.1.3. Priority unit maintenance will be scheduled for the winter maintenance period, or when there are few fish passing the project, to the extent possible. Impacts to migrating adults should be minimized.

4.3.1.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take more than one year to accomplish.

4.3.1.5. Turbine units, governors, exciters, and control systems require periodic maintenance, calibration, and testing which may take them outside of the 1% range. This work will be scheduled in compliance with the *BPA Load Shaping Guidelines* (**Appendix C**) to minimize impacts on juvenile fish.

4.3.2. Operational Testing. Operational testing of a unit under maintenance is in addition to a unit in run status required for power plant reliability. Operational testing may deviate from FPP priority order and may require water that would otherwise be used for spill if the unit running for reliability is at its 1% lower limit (i.e., minimum generation). Water for operational testing will be used from the powerhouse allocation if possible, and will only be diverted from spill to the extent necessary to maintain power system reliability.

4.3.2.1. Pre-Maintenance: Before going into maintenance status, the unit may be operationally tested for up to 30 minutes (or up to 1 hour for 6-year overhaul) by running at full load, speed-no-load, and various loads within the 1% range for pre-maintenance measurements and testing, and to allow all fish to move through the unit. The unit will be run continuously during testing. Prior to installing stop logs for unwatering, the unit will be operated to flush fish, as described in **section 4.3.3. Unwatering Units**.

4.3.2.2. Post-Maintenance: After maintenance or repair while the unit remains in maintenance or forced outage status, the unit may be operationally tested for up to 30 minutes (or up to 2 hours for 6-year overhaul) by running the unit continuously within the 1% range in order to get the unit up to operational temperature.

4.3.3. Unwatering Units. Unwatering turbine units (also referred to as “dewatering”) should be accomplished in accordance with project *Dewatering Plans*[3]. If the turbine unit scroll case and/or draft tube is to be dewatered, operate unit with full load for a minimum of 15 minutes prior to

installing tail logs or lowering head gates.[4] If not possible to load, run unit at speed-no-load for minimum of 15 minutes. This is to reduce the number of fish in the scroll case prior to installing stop logs. If a turbine unit is out of service for maintenance for an extended period of time without tailrace stoplogs in place, efforts should be made to not open the wicket gates if the scroll case must be dewatered at a later date without the unit being spun beforehand.

4.3.4. Doble Testing. See **Appendix A** for yearly test schedule. Transformer Doble testing is required every three years, so one of the three lines is taken out of service every year to test two transformers. Doble testing is normally scheduled in the July/August timeframe in conjunction with scheduled unit maintenance. At Ice Harbor, the configuration of transmission lines requires two units along with the associated line to be out of service during testing (Line 1=Units 1-2, Line 2=Units 3-4, Line 3=Units 5-6). Since Ice Harbor has multiple transformer banks, transmission lines, and redundant switching capability, the remaining units will be available for operation during testing and will be operated in accordance with FPP priority order within the 1% range.

4.3.5. Turbine Unit Outages during High Flows. During high spring flows, turbine unit outages for NERC regulatory requirements, inspecting fish screens, repairing research equipment (e.g., hydroacoustic or radio telemetry equipment), and/or other fish items may cause increased spill in order to maintain reservoir levels within operating ranges. This may result in TDG exceeding standards. It is important that this work be conducted when scheduled to ensure facilities are working correctly and not injuring migrating fish, and that important fish research data are collected. To facilitate this work, reservoir storage may be utilized to minimize impacts from taking units out of service and increasing spill.

4.3.5.1. At Ice Harbor, this special operation may take place when flows are above 100 kcfs or when increased spill will result in TDG exceeding standards. The activities covered under these operations will be coordinated with TMT whenever possible.

4.3.5.2. For scheduled inspection or repair of research equipment, reservoirs shall be drafted to MOP and allowed to fill 1' above the MOP range as work is accomplished. After the work, reservoirs will slowly be drafted back to MOP. When inspection or repair work can be scheduled ahead of time, the following process will be followed:

i. Project personnel shall schedule unit outages through the approved outage scheduling procedure by noon Tuesday of the week prior to the outage.

ii. Project personnel shall also contact CENWW-OD-T and RCC by the same time period and inform them of the intended work.

iii. RCC will coordinate the work activities through TMT.

iv. After coordination with TMT, RCC shall issue a teletype issuing instructions to project and BPA personnel for the scheduled work.

[4] Head gates may also be referred to as “operating” gates at some projects. The terms are interchangeable.

v. Spill will be increased by one gate stop setting (about 1.7 kcfs) above passing inflow to slowly lower the level of Ice Harbor pool to MOP prior to the scheduled work taking place.

vi. When the work takes place, additional spill will not be provided and the reservoir will be allowed to refill until the reservoir is 1' above MOP (a 2' pondage from where the pool was when the work started). At this point, screen inspections shall stop. (At Snake River projects, this should allow about one normal workday for the scheduled work.)

vii. At the conclusion of the work, the reservoir shall be drafted back down to MOP utilizing a one spillbay stop increase in spill above passing inflow.

viii. If work, such as screen inspections, is incomplete, project personnel shall schedule another turbine unit outage for a date where it can be implemented.

4.3.5.3. If the required work is of an emergency nature that does not normally require the unit to be taken out of service (e.g., failed hydroacoustic transducer versus failed fish screen), and cannot wait for the above process to be implemented, project personnel shall notify CENWW-OD-T and RCC to get approval to do the work. If approved, the unit shall be taken out of service and the reservoir level may be operated up to 1' above MOP. At this point, the unit must be returned to service and the reservoir will be drafted back to MOP using one spillbay stop setting above passing inflows.

5. FOREBAY DEBRIS REMOVAL

5.1.1. Debris can impact fish passage conditions by plugging or blocking trashracks, VBSs, gatewell orifices, dewatering screens, separators, and/or facility piping, resulting in fish impingement, injuries, and descaling. Removing debris at its source in the forebay is sometimes necessary to maintain safe and efficient fish passage conditions, navigation, and other project activities. Debris can be removed from the forebay by: physically encircling the debris with log booms and pulling it to shore with boats where it can be removed with a crane; removing the debris from the top of the dam using a crane and scoop; or passing the debris through the spillway with special powerhouse operations and spill. The preferred option is to remove debris at each project when possible to avoid passing debris on to the next project downstream. However, some projects do not have forebay debris removal capability and the only viable alternative is to spill the debris.

5.1.2. Normally, the project shall contact CENWW-OD-T at least two workdays prior to the day the special operation is required. Using information provided by the project, CENWW-OD-T will notify FPOM and RCC will issue a teletype detailing the special operations.

5.1.3. All special spills (other than normal spill patterns for ongoing spill operations) and project operations for passing debris will be coordinated prior to the operations taking place. Each project shall contact CENWW-OD-T at least two workdays prior to the day they want the special project operations for spilling to pass debris. Project personnel shall provide CENWW-OD-T the reason for the debris spill request including an explanation of project facilities impacted by

debris, the date and time of the requested spill, and any special powerhouse or other operations required to move the debris to the spillway. Using information provided by the project, CENWW-OD-T shall coordinate the special operations with RCC, NOAA Fisheries and FPOM. When a debris spill is coordinated and approved, RCC shall issue a teletype detailing the specifics of the special operations.

5.1.4. Emergency Spill. Emergency spills may be implemented if necessary to pass woody debris that are accumulating in front of the spillbay weir(s), compromising the safe, unobstructed passage of fish. The operating project will immediately spill the woody debris to remove the obstructions to fish passage. The operating project will notify CENWW-OD-T of the emergency spill as soon as possible to provide notification to RCC, NOAA Fisheries, and other FPOM participants.

Table IHR-6. Ice Harbor Dam Spill Patterns with No RSW (Bay 2 Closed). [a, b]

IHR Spill Patterns with No RSW - # Gate Stops per Spillbay										Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	Bay 9	Bay 10	(#)	(kcfs)
	CLOSE								1	**1**	**1.7**
	CLOSE	1							1	**2**	**3.5**
	CLOSE	1						1	1	**3**	**5.2**
	CLOSE	1	1					1	1	**4**	**6.9**
	CLOSE	1	1		1			1	1	**5**	**8.7**
	CLOSE	1	1		1	1		1	1	**6**	**10.4**
	CLOSE	1	1		1	1	1	1	1	**7**	**12.1**
	CLOSE	1	1	1	1	1	1	1	1	**8**	**13.8**
	CLOSE	1	1	1	1	1	1	1	2	**9**	**15.6**
	CLOSE	2	1	1	1	1	1	1	2	**10**	**17.3**
	CLOSE	2	1	1	1	1	1	2	2	**11**	**19**
	CLOSE	2	2	1	1	1	1	2	2	**12**	**20.7**
	CLOSE	2	2	1	2	1	1	2	2	**13**	**22.4**
	CLOSE	5.5		5.5				1.5	1.5	**14**	**23.8**
	CLOSE	5		5		5				**15**	**25.5**
	CLOSE	5		5		5			1	**16**	**27.2**
	CLOSE	5.5		5.5		5			1	**17**	**28.9**
	CLOSE	5.5		5.5		5.5			1.5	**18**	**30.5**
	CLOSE	6		6		6			1	**19**	**32.0**
	CLOSE	5		5		5		5		**20**	**34.0**
	CLOSE	5		5		5		5	1	**21**	**35.7**
	CLOSE	5.5		5		5		5.5	1	**22**	**37.3**
	CLOSE	5.5		5.5		5.5		5.5	1	**23**	**39.0**
	CLOSE	6		5.5		5.5		6	1	**24**	**40.6**
	CLOSE	6		6		6		6	1	**25**	**42.1**
	CLOSE	5	5	5		5		5	1	**26**	**44.2**
	CLOSE	5.5	5	5		5		5.5	1	**27**	**45.8**
	CLOSE	5.5	5	5.5		5.5		5.5	1	**28**	**47.5**
	CLOSE	5.5	5.5	5.5		5.5		6	1	**29**	**49.1**
	CLOSE	5.5	5.5	6		6		6	1	**30**	**50.7**
	CLOSE	6	6	6		6		6	1	**31**	**52.2**
	CLOSE	6	6	6.5		6.5		6	1	**32**	**54.0**
	CLOSE	6.5	6.5	6.5		6.5		6	1	**33**	**55.8**
	CLOSE	6	6	5	5	5		6	1	**34**	**57.5**
	CLOSE	6	6	5	5	6		6	1	**35**	**59.1**
	CLOSE	6	6	6	5	6		6	1	**36**	**60.7**
	CLOSE	6	6	6	6	6		6	1	**37**	**62.3**
	CLOSE	6	6	6	6	7		6	1	**38**	**64.1**
	CLOSE	6	6	6	6	7		7	1	**39**	**65.7**
	CLOSE	6	6	6	7	7		7	1	**40**	**67.4**
	CLOSE	6	6	7	7	7		7	1	**41**	**69.1**
	CLOSE	6	7	7	7	7		7	1	**42**	**70.8**
	CLOSE	7	7	7	7	7		7	1	**43**	**72.5**
6	CLOSE	6	6	6	6	7		6	1	**44**	**74.1**

IHR Spill Patterns with No RSW - # Gate Stops per Spillbay										Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	Bay 9	Bay 10	(#)	(kcfs)
6	CLOSE	6	6	6	7	7		6	1	**45**	**75.8**
6	CLOSE	6	6	7	7	7		6	1	**46**	**77.5**
6	CLOSE	6	7	7	7	7		6	1	**47**	**79.2**
6	CLOSE	7	7	7	7	7		6	1	**48**	**80.9**
6	CLOSE	6	6	6	6	6	6	6	1	**49**	**82.5**
6	CLOSE	6	6	6	6	7	6	6	1	**50**	**84.2**
6	CLOSE	6	6	6	7	7	6	6	1	**51**	**85.9**
6	CLOSE	6	6	6	7	7	6	7	1	**52**	**87.6**
6	CLOSE	6	6	7	7	7	6	7	1	**53**	**89.3**
6	CLOSE	6	7	7	7	7	6	7	1	**54**	**91.0**
6	CLOSE	7	7	7	7	7	6	7	1	**55**	**92.7**

a. Spill (kcfs) is calculated as a function of the total number of gate stops at forebay elevation 438.0 ft.

b. When total project outflow is < 30 kcfs, the RSW will be closed and spill distributed in patterns defined in this table (see **section 2.3.2.7**).

Table IHR-7. [*pg 1 of 2*] Ice Harbor Dam Spill Patterns with RSW for 30% Spill. [a, b, c]

Total Outflow	Spill [a]		IHR Spill Patterns for 30% Spill - # Gate Stops per Spillbay										Total Stops
(kcfs)	(kcfs)	(%) [b]	1	2 [c]	3	4	5	6	7	8	9	10	(#)
28.0	**8.4**	**30.0%**		RSW									**0**
33.7	**10.1**	**30.0%**		RSW								1	**1**
39.3	**11.8**	**30.0%**		RSW							1	1	**2**
45.0	**13.5**	**30.0%**		RSW						1	1	1	**3**
50.7	**15.2**	**30.0%**		RSW					1	1	1	1	**4**
56.3	**16.9**	**30.0%**		RSW				1	1	1	1	1	**5**
62.0	**18.6**	**30.0%**		RSW	5							1	**6**
67.7	**20.3**	**30.0%**		RSW	5						1	1	**7**
73.3	**22.0**	**30.0%**		RSW	5					1	1	1	**8**
79.0	**23.7**	**30.0%**		RSW	5				1	1	1	1	**9**
84.7	**25.4**	**30.0%**		RSW	5			1	1	1	1	1	**10**
90.3	**27.1**	**30.0%**		RSW	5		5					1	**11**
96.0	**28.8**	**30.0%**		RSW	5		5				1	1	**12**
101.7	**30.5**	**30.0%**		RSW	5		5			1	1	1	**13**
107.3	**32.2**	**30.0%**		RSW	5		5			1	1	2	**14**
113.0	**33.9**	**30.0%**		RSW	5		5			1	2	2	**15**
118.7	**35.6**	**30.0%**		RSW	5		5			2	2	2	**16**
120.4 [b]	**37.3**	**31.0%**		RSW	6		5			2	2	2	**17**
122.1	**39.0**	**31.9%**		RSW	6		6			2	2	2	**18**
123.8	**40.7**	**32.9%**		RSW	6		6		1	2	2	2	**19**
125.5	**42.4**	**33.8%**		RSW	6		6		2	2	2	2	**20**
127.2	**44.1**	**34.7%**		RSW	5		5		5	2	2	2	**21**
128.9	**45.8**	**35.5%**		RSW	5		5		6	2	2	2	**22**
130.6	**47.5**	**36.4%**		RSW	5		6		6	2	2	2	**23**
132.3	**49.2**	**37.2%**		RSW	6		6		6	2	2	2	**24**
134.0	**50.9**	**38.0%**		RSW	6		6		6	2	3	2	**25**
135.7	**52.6**	**38.8%**		RSW	6		6		6	2	4	2	**26**
137.4	**54.3**	**39.5%**		RSW	6		6		6	2	5	2	**27**
139.1	**56.0**	**40.3%**		RSW	6		6		6	2	6	2	**28**
140.8	**57.7**	**41.0%**		RSW	6		6	1	6	2	6	2	**29**
142.5	**59.4**	**41.7%**		RSW	6		6	2	6	2	6	2	**30**
144.2	**61.1**	**42.4%**		RSW	6		6	3	6	2	6	2	**31**
145.9	**62.8**	**43.0%**		RSW	6		6	4	6	2	6	2	**32**
147.6	**64.5**	**43.7%**		RSW	6		6	5	6	2	6	2	**33**
149.3	**66.2**	**44.3%**		RSW	6		6	6	6	2	6	2	**34**
151.0	**67.9**	**45.0%**		RSW	6		6	6	6	3	6	2	**35**
152.7	**69.6**	**45.6%**		RSW	6		6	6	6	4	6	2	**36**
154.4	**71.3**	**46.2%**		RSW	6		6	6	6	5	6	2	**37**
156.1	**73.0**	**46.8%**		RSW	6		6	6	6	6	6	2	**38**
157.8	**74.7**	**47.3%**		RSW	6	1	6	6	6	6	6	2	**39**
159.5	**76.4**	**47.9%**		RSW	6	2	6	6	6	6	6	2	**40**
161.2	**78.1**	**48.4%**		RSW	6	3	6	6	6	6	6	2	**41**
162.9	**79.8**	**49.0%**		RSW	6	4	6	6	6	6	6	2	**42**
164.6	**81.5**	**49.5%**		RSW	6	5	6	6	6	6	6	2	**43**

Total Outflow	Spill [a]		IHR Spill Patterns for 30% Spill - # Gate Stops per Spillbay										Total Stops
(kcfs)	(kcfs)	(%) [b]	1	2 [c]	3	4	5	6	7	8	9	10	(#)
166.3	**83.2**	**50.0%**		RSW	6	6	6	6	6	6	6	2	**44**
168.0	**84.9**	**50.5%**		RSW	7	6	6	6	6	6	6	2	**45**
169.7	**86.6**	**51.0%**		RSW	7	7	6	6	6	6	6	2	**46**
171.4	**88.3**	**51.5%**		RSW	7	7	7	6	6	6	6	2	**47**
173.1	**90.0**	**52.0%**		RSW	7	7	7	7	6	6	6	2	**48**
174.8	**91.7**	**52.5%**		RSW	7	7	7	7	7	6	6	2	**49**
176.5	**93.4**	**52.9%**		RSW	7	7	7	7	7	7	6	2	**50**
178.2	**95.1**	**53.4%**		RSW	7	7	7	7	7	7	7	2	**51**
179.9	**96.8**	**53.8%**		RSW	8	7	7	7	7	7	7	2	**52**
181.6	**98.5**	**54.2%**		RSW	8	8	7	7	7	7	7	2	**53**
183.3	**100.2**	**54.7%**		RSW	8	8	8	7	7	7	7	2	**54**
185.0	**101.9**	**55.1%**		RSW	8	8	8	8	7	7	7	2	**55**
186.7	**103.6**	**55.5%**		RSW	8	8	8	8	8	7	7	2	**56**
188.4	**105.3**	**55.9%**		RSW	8	8	8	8	8	8	7	2	**57**
190.1	**107.0**	**56.3%**		RSW	8	8	8	8	8	8	8	2	**58**
191.8	**108.7**	**56.7%**		RSW	9	8	8	8	8	8	8	2	**59**
193.5	**110.4**	**57.1%**		RSW	9	9	8	8	8	8	8	2	**60**
195.2	**112.1**	**57.4%**		RSW	9	9	9	8	8	8	8	2	**61**
196.9	**113.8**	**57.8%**		RSW	9	9	9	9	8	8	8	2	**62**
198.6	**115.5**	**58.2%**		RSW	9	9	9	9	9	8	8	2	**63**
200.3	**117.2**	**58.5%**		RSW	9	9	9	9	9	9	8	2	**64**
202.0	**118.9**	**58.9%**		RSW	9	9	9	9	9	9	9	2	**65**
203.7	**120.6**	**59.2%**		RSW	10	9	9	9	9	9	9	2	**66**
205.4	**122.3**	**59.5%**		RSW	10	10	9	9	9	9	9	2	**67**
207.1	**124.0**	**59.9%**		RSW	10	10	10	9	9	9	9	2	**68**
208.8	**125.7**	**60.2%**		RSW	10	10	10	10	9	9	9	2	**69**
210.5	**127.4**	**60.5%**		RSW	10	10	10	10	10	9	9	2	**70**
212.2	**129.1**	**60.8%**		RSW	10	10	10	10	10	10	9	2	**71**
213.9	**130.8**	**61.2%**		RSW	10	10	10	10	10	10	10	2	**72**
215.6	**132.5**	**61.5%**		RSW	11	10	10	10	10	10	10	2	**73**
217.3	**134.2**	**61.8%**		RSW	11	11	10	10	10	10	10	2	**74**
219.0	**135.9**	**62.1%**		RSW	11	11	11	10	10	10	10	2	**75**
220.7	**137.6**	**62.3%**		RSW	11	11	11	11	10	10	10	2	**76**
222.4	**139.3**	**62.6%**		RSW	11	11	11	11	11	10	10	2	**77**
224.1	**141.0**	**62.9%**		RSW	11	11	11	11	11	11	10	2	**78**
225.8	**142.7**	**63.2%**		RSW	11	11	11	11	11	11	11	2	**79**
227.5	**144.4**	**63.5%**		RSW	12	11	11	11	11	11	11	2	**80**
229.2	**146.1**	**63.7%**		RSW	12	12	11	11	11	11	11	2	**81**
230.9	**147.8**	**64.0%**		RSW	12	12	12	11	11	11	11	2	**82**
232.6	**149.5**	**64.3%**		RSW	12	12	12	12	11	11	11	2	**83**

a. Spill (kcfs) is calculated as a function of the total number of gate stops plus RSW spill at forebay elevation 438.0 ft.

b. Spill will be > 30% when total outflow is > ~118.7 kcfs (project at max turbine capacity).

c. RSW in Bay 2 = fixed spill of ~8.4 kcfs at forebay 438.0 ft. When total project outflow is < 30 kcfs, the RSW will be closed and spill distributed in patterns defined in **Table IHR-6** (see **section 2.3.2.7**).

Table IHR-8. [*pg 1 of 2*] Ice Harbor Dam Spill Patterns with RSW.[a, b]

IHR Spill Patterns w/ RSW - # Gate Stops per Spillbay										Total Stops	Spill [a]
Bay 1	Bay 2 [b]	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay	Bay 9	Bay 10	(#)	(kcfs)
	RSW									**0**	**8.4**
	RSW								1	**1**	**10.1**
	RSW							1	1	**2**	**11.8**
	RSW						1	1	1	**3**	**13.5**
	RSW					1	1	1	1	**4**	**15.2**
	RSW				1	1	1	1	1	**5**	**17.0**
	RSW		5						1	**6**	**18.6**
	RSW		5					1	1	**7**	**20.3**
	RSW		5				1	1	1	**8**	**22.0**
	RSW		5			1	1	1	1	**9**	**23.7**
	RSW		5		5					**10**	**25.3**
	RSW		5		5				1	**11**	**27.0**
	RSW		5		5			1	1	**12**	**28.7**
	RSW		5		5		1	1	1	**13**	**30.4**
	RSW		5		5	1	1	1	1	**14**	**32.1**
	RSW		5		5	1	1	1	2	**15**	**33.8**
	RSW		5		5	1	1	2	2	**16**	**35.5**
	RSW		5		5	1	2	2	2	**17**	**37.2**
	RSW		5		5	2	2	2	2	**18**	**38.9**
	RSW		5		5	2	2	2	3	**19**	**40.6**
	RSW		5		5	2	2	3	3	**20**	**42.3**
	RSW		5		5	5	2	2	2	**21**	**44.0**
	RSW		6		5	5	2	2	2	**22**	**45.6**
	RSW		6		6	5	2	2	2	**23**	**47.3**
	RSW		6		6	6	2	2	2	**24**	**48.9**
	RSW		6	5	5	5	1	1	2	**25**	**50.7**
	RSW		6	5	5	5	1	2	2	**26**	**52.4**
	RSW		6	5	5	5	2	2	2	**27**	**54.1**
	RSW		6	6	5	5	2	2	2	**28**	**55.7**
	RSW		6	6	5	5	2	3	2	**29**	**57.4**
	RSW		6	6	5	5	2	4	2	**30**	**59.1**
	RSW		6	6	5	5	2	5	2	**31**	**60.7**
	RSW		6	6	5	5	3	5	2	**32**	**62.4**
	RSW		6	6	5	5	4	5	2	**33**	**64.1**
	RSW		6	6	5	5	5	5	2	**34**	**65.8**
	RSW	1	6	6	5	5	5	5	2	**35**	**67.5**
	RSW	2	6	6	5	5	5	5	2	**36**	**69.2**
	RSW	3	6	6	5	5	5	5	2	**37**	**70.9**
	RSW	4	6	6	5	5	5	5	2	**38**	**72.6**
	RSW	5	6	6	5	5	5	5	2	**39**	**74.2**
	RSW	6	6	6	5	5	5	5	2	**40**	**75.9**
	RSW	6	6	6	6	5	5	5	2	**41**	**77.5**
	RSW	6	6	6	6	6	5	5	2	**42**	**79.2**
	RSW	6	6	6	6	6	6	5	2	**43**	**80.9**
	RSW	6	6	6	6	6	6	6	2	**44**	**82.5**
	RSW	7	6	6	6	6	6	6	2	**45**	**84.1**
	RSW	7	7	6	6	6	6	6	2	**46**	**85.7**
	RSW	7	7	7	6	6	6	6	2	**47**	**87.3**
	RSW	7	7	7	7	6	6	6	2	**48**	**88.9**
	RSW	7	7	7	7	7	6	6	2	**49**	**90.5**
	RSW	7	7	7	7	7	7	6	2	**50**	**92.1**
	RSW	7	7	7	7	7	7	7	2	**51**	**93.7**
	RSW	8	7	7	7	7	7	7	2	**52**	**95.3**
	RSW	8	8	7	7	7	7	7	2	**53**	**96.9**
	RSW	8	8	8	7	7	7	7	2	**54**	**98.5**

IHR Spill Patterns w/ RSW - # Gate Stops per Spillbay										Total Stops	Spill [a]
Bay 1	Bay 2 [b]	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay	Bay 9	Bay 10	(#)	(kcfs)
	RSW	8	8	8	8	7	7	7	2	**55**	**100.1**
	RSW	8	8	8	8	8	7	7	2	**56**	**101.7**
	RSW	8	8	8	8	8	8	7	2	**57**	**103.3**
	RSW	8	8	8	8	8	8	8	2	**58**	**104.9**
	RSW	9	8	8	8	8	8	8	2	**59**	**106.6**
	RSW	9	9	8	8	8	8	8	2	**60**	**108.3**
	RSW	9	9	9	8	8	8	8	2	**61**	**110.0**
	RSW	9	9	9	9	8	8	8	2	**62**	**111.7**
	RSW	9	9	9	9	9	8	8	2	**63**	**113.4**
	RSW	9	9	9	9	9	9	8	2	**64**	**115.2**
	RSW	9	9	9	9	9	9	9	2	**65**	**116.9**
	RSW	10	9	9	9	9	9	9	2	**66**	**118.4**
	RSW	10	10	9	9	9	9	9	2	**67**	**119.9**
	RSW	10	10	10	9	9	9	9	2	**68**	**121.4**
	RSW	10	10	10	10	9	9	9	2	**69**	**122.9**
	RSW	10	10	10	10	10	9	9	2	**70**	**124.4**
	RSW	10	10	10	10	10	10	9	2	**71**	**125.9**
	RSW	10	10	10	10	10	10	10	2	**72**	**127.4**
	RSW	11	10	10	10	10	10	10	2	**73**	**129.1**
	RSW	11	11	10	10	10	10	10	2	**74**	**130.8**
	RSW	11	11	11	10	10	10	10	2	**75**	**132.5**
	RSW	11	11	11	11	10	10	10	2	**76**	**134.2**
	RSW	11	11	11	11	11	10	10	2	**77**	**135.9**
	RSW	11	11	11	11	11	11	10	2	**78**	**137.6**
	RSW	11	11	11	11	11	11	11	2	**79**	**139.3**
	RSW	12	11	11	11	11	11	11	2	**80**	**140.8**
	RSW	12	12	11	11	11	11	11	2	**81**	**142.3**
	RSW	12	12	12	11	11	11	11	2	**82**	**143.8**
	RSW	12	12	12	12	11	11	11	2	**83**	**145.3**
	RSW	12	12	12	12	12	11	11	2	**84**	**146.8**
	RSW	12	12	12	12	12	12	11	2	**85**	**148.3**
	RSW	12	12	12	12	12	12	12	2	**86**	**149.8**
	RSW	13	12	12	12	12	12	12	2	**87**	**151.4**
	RSW	13	13	12	12	12	12	12	2	**88**	**153.0**
	RSW	13	13	13	12	12	12	12	2	**89**	**154.6**
	RSW	13	13	13	13	12	12	12	2	**90**	**156.2**
	RSW	13	13	13	13	13	12	12	2	**91**	**157.8**
	RSW	13	13	13	13	13	13	12	2	**92**	**159.4**
	RSW	13	13	13	13	13	13	13	2	**93**	**161.0**
	RSW	14	13	13	13	13	13	13	2	**94**	**162.6**
	RSW	14	14	13	13	13	13	13	2	**95**	**164.2**
	RSW	14	14	14	13	13	13	13	2	**96**	**165.8**
	RSW	14	14	14	14	13	13	13	2	**97**	**167.4**
	RSW	14	14	14	14	14	13	13	2	**98**	**169.0**
	RSW	14	14	14	14	14	14	13	2	**99**	**170.6**
	RSW	14	14	14	14	14	14	14	2	**100**	**172.2**

a. Spill (kcfs) is calculated as a function of the total number of gate stops plus RSW spill at forebay elevation 438.0 ft.

b. RSW in Bay 2 = fixed spill of ~8.4 kcfs at forebay 438.0 ft. When total project outflow is < 30 kcfs, the RSW will be closed and spill distributed in patterns defined in **Table IHR-6** (see **section 2.3.2.7**).

2018 Fish Passage Plan

Chapter 7 – Lower Monumental Dam

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Chapter 7 - Lower Monumental Dam

Project Acronym*	LMN
River Mile (RM)	Snake River RM 41.6
Reservoir	Lake Herbert G. West
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 0 kcfs \ Mar–Nov: 11.5 kcfs
Forebay Normal Operating Range (ft)	537’ – 540’
Tailrace Rate of Change Limit (ft/hr)	1.5’/hr
Powerhouse Length (ft)	656’
Powerhouse Hydraulic Capacity (kcfs)	130 kcfs
Turbine Units (#)	6 (Units 1-3 BLH Kaplan; Units 4-6 Allis Chalmers Kaplan)
Turbine Unit Generating Capacity (MW)	Rated: 810 MW (Units 1-6 @135 MW). Maximum: 930 MW (Units 1-6 @155 MW)
Gatewell Orifice Diameter	12”
Spillway Length (ft)	498’
Spillway Hydraulic Capacity (kcfs)	850 kcfs
Spillbays (#)	8
Spillway Weirs (#)	1 Removable Spillway Weir (RSW) in Bay 8
Navigation Lock Length x Width (ft)	650’ x 84’ (Usable Space)
Navigation Lock Max. Lift (ft)	100’
FISH STRUCTURE/OPERATION START DATE	
Juvenile Bypass System (JBS)	1969 (1st Generation) / 1991 (current)
Submersible Traveling Screens (STS)	1992
Juvenile Fish Transportation Program - Corps	1993
Removable Spillway Weir (RSW)	2008
Bypass Outfall Flume Relocation	2012
Adult Fish Counts	1969 (South Shore & North Shore)

*****Project acronym designated by US Army Corps of Engineers, Northwestern Division, Columbia Basin Water Management Division. Due to the large number of projects managed by NWD, this acronym may differ from other acronyms used in the region. For example, a common acronym for Lower Monumental is **LMO**. However, that acronym is assigned to another NWD project, so the official Corps NWD acronym is **LMN**.

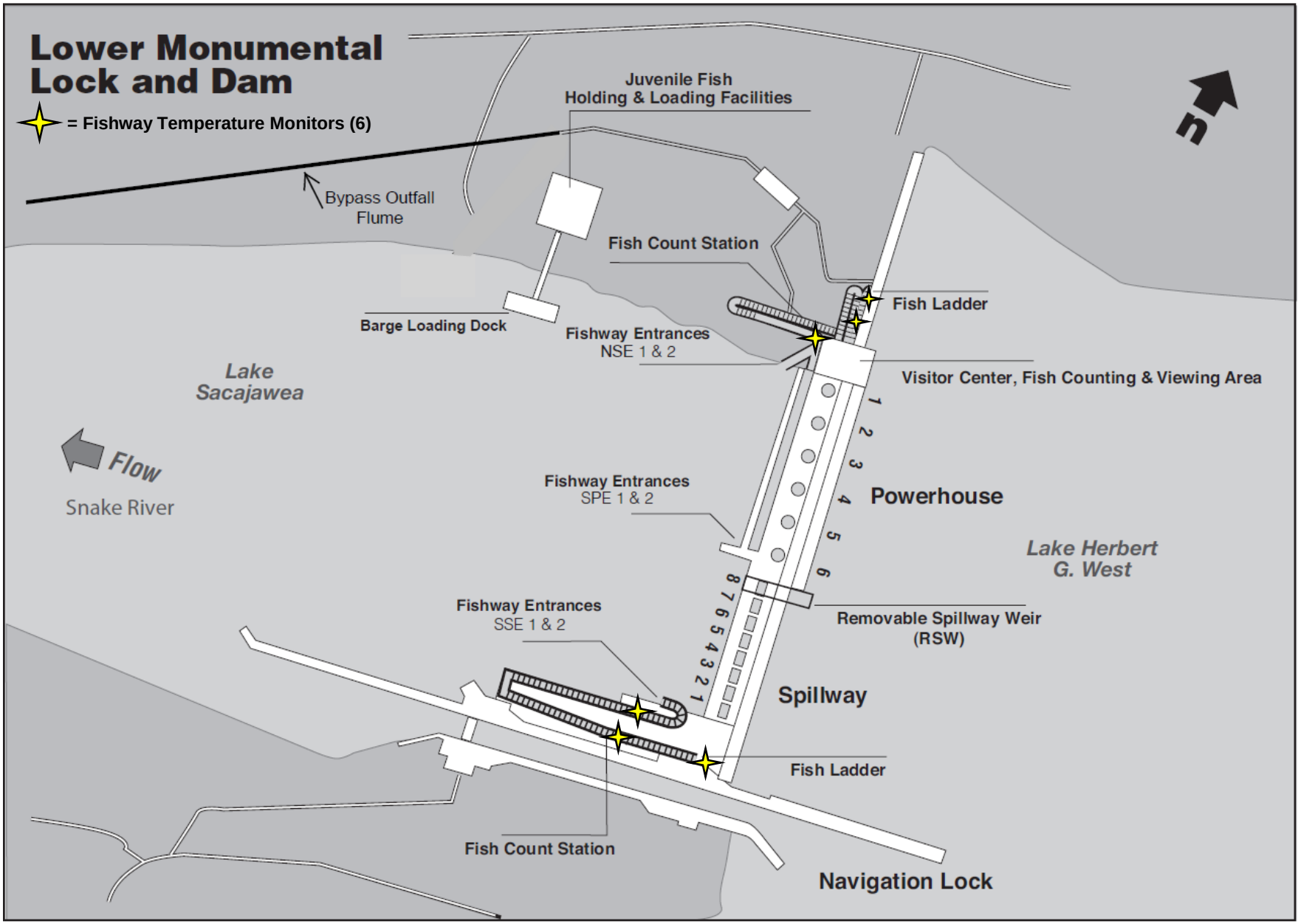
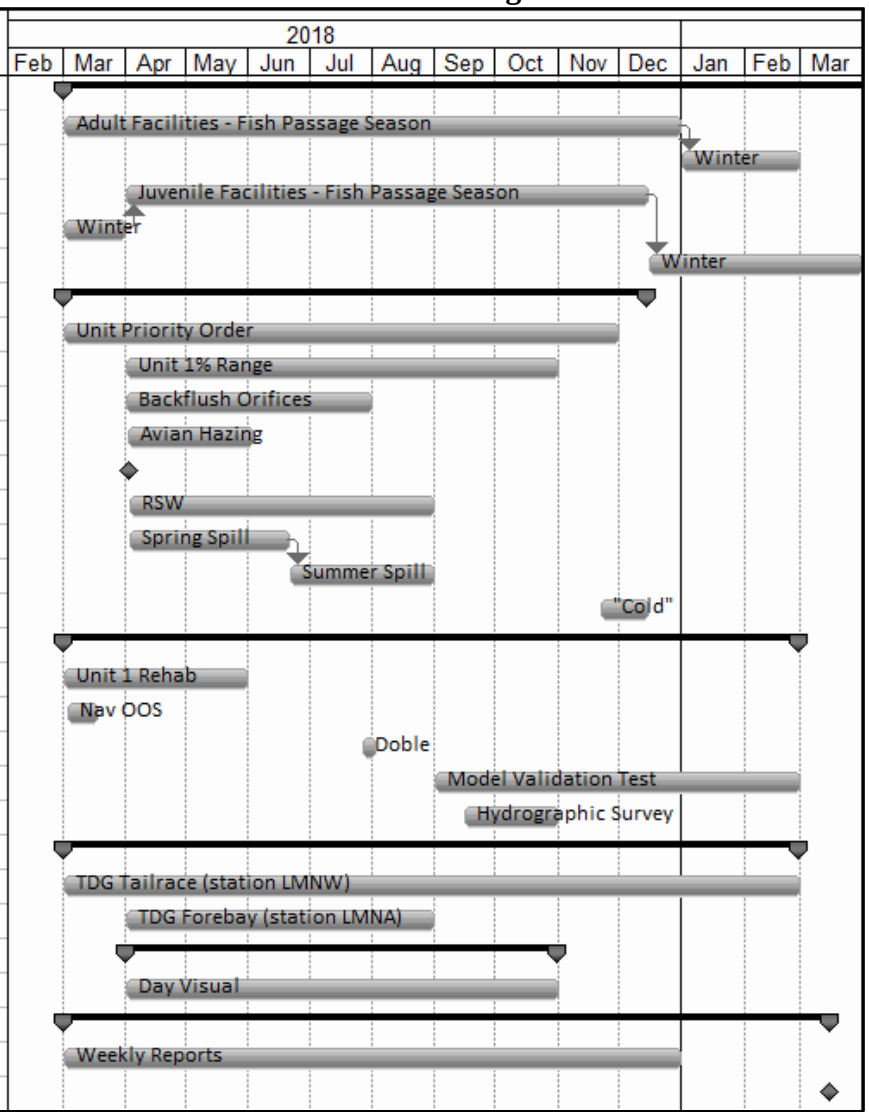


Figure LMN-1. Lower Monumental Lock & Dam General Site Plan.

Table LMN-1. Lower Monumental Dam Schedule of Operations and Actions Defined in the 2018 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**3/1/18**	**3/31/19**	
Adult Facilities - Fish Passage Season	3/1/18	12/31/18	2.4.2
Adult Facilities - Winter Maintenance	1/1/19	2/28/19	2.4.1
Juvenile Facilities - Fish Passage Season	4/1/18	12/15/18	2.3.2
Juvenile Facilities - Winter Maintenance	3/1/18	3/31/18	2.3.1
	12/16/18	3/31/19	
PROJECT OPERATIONS FOR FISH PASSAGE	**3/1/18**	**12/15/18**	
Turbine unit priority order	3/1/18	11/30/18	Table LMN-5
Turbine unit 1% operating range	4/1/18	10/31/18	4.2
Backflush orifices ≥ once per 8 hrs	4/1/18	7/31/18	2.3.2.3.vi
Avian hazing	4/2/18	6/2/18	App L 7.2
Avian Wires installed NLT April 3	4/3/18	4/3/18	App L 1.4
Spillway weir in service (end date approx)	4/3/18	8/31/18	2.3.2.7
Spring Spill	4/3/18	6/20/18	App E (FOP)
Summer Spill	6/21/18	8/31/18	App E (FOP)
STS removal during cold weather	11/22/18	12/15/18	2.3.2.2
SPECIAL OPS & STUDIES (Appendix A)	**3/1/18**	**2/28/19**	
Unit 1 Rehab (started Jan 2016)	3/1/18	5/31/18	App A 7.1
Navigation Lock annual outage	3/3/18	3/18/18	App A 1.4
Doble testing	7/27/18	8/2/18	App A 1.5
Model Validation Testing	9/1/18	2/28/19	App A 7.1
Stilling Basin Surveys (all Snake R. projects)	9/15/18	10/31/18	App A 7.2
TDG MONITORING	**3/1/18**	**2/28/19**	
TDG Monitoring - Tailrace (year-round)	3/1/18	2/28/19	2.2
TDG Monitoring - Forebay	4/1/18	8/31/18	2.2
ADULT FISH COUNTING	**4/1/18**	**10/31/18**	
Day Visual 0500-2100 PDT	4/1/18	10/31/18	Table LMN-3
REPORTS	**3/1/18**	**3/15/19**	
Weekly Reports	3/1/18	12/31/18	2.5.2
Annual Report due	3/15/19	3/15/19	2.5.3



1. FISH PASSAGE INFORMATION

Lower Monumental Lock & Dam fish passage facilities and other structures are shown in **Figure LMN-1**. The schedule of Lower Monumental operations that are described in the Fish Passage Plan (FPP) and Appendices is in **Table LMN-1**.

1.1. Juvenile Fish Passage.

1.1.1. Juvenile Fish Facilities. The Lower Monumental juvenile fish facilities consist of standard-length submersible traveling screens (STS), vertical barrier screens (VBS), 12" orifices, collection gallery, dewatering structure, and a bypass flume to the tailrace. Transportation facilities consist of a separator to sort by size and separate from adult fish, sampling facilities, raceways, office and sampling building, truck and barge loading facilities, and PIT-tag detection and deflector systems. Maintenance of juvenile fish facilities that may impact fish or facility operations should be conducted during the winter maintenance period.

1.1.2. Juvenile Fish Migration Timing. Juvenile fish passage timing at Lower Monumental Dam is shown in **Table LMN-2**, based on collection data from the most recent 10-year period (does not reflect fish guidance efficiency or passage via the RSW or spillway). Salmon, steelhead, bull trout, lamprey, and other species are routinely counted.

Table LMN-2. Juvenile Salmonid Passage Timing at Lower Monumental Dam for Most Recent 10 Years Based on Daily & Yearly Collection Data.

Year	10%	50%	90%	# Days	10%	50%	90%	# Days
	Yearling Chinook				Subyearling Chinook			
2008	18-May	21-May	28-May	10	5-Jun	14-Jun	5-Jul	30
2009	10-May	20-May	27-May	17	2-Jun	9-Jun	3-Jul	31
2010	18-May	21-May	8-Jun	21	8-Jun	12-Jun	7-Jul	29
2011	10-May	15-May	21-May	11	31-May	23-Jun	24-Jul	54
2012	6-May	12-May	24-May	18	6-Jun	19-Jun	6-Jul	30
2013	9-May	13-May	16-May	7	5-Jun	12-Jun	13-Jul	38
2014	3-May	8-May	21-May	18	3-Jun	11-Jun	11-Jul	38
2015	2-May	8-May	14-May	12	30-May	8-Jun	30-Jun	31
2016	22-Apr	5-May	11-May	19	5-Jun	11-Jun	5-Jul	30
2017	18-Apr	6-May	14-May	26	18-Apr	6-May	17-Jun	60
10-Yr MEDIAN	**7-May**	**12-May**	**21-May**	**18**	**4-Jun**	**11-Jun**	**5-Jul**	**31**
10-Yr MIN	**18-Apr**	**5-May**	**11-May**	**7**	**18-Apr**	**6-May**	**17-Jun**	**29**
10-Yr MAX	**18-May**	**21-May**	**8-Jun**	**26**	**8-Jun**	**23-Jun**	**24-Jul**	**60**
	Unclipped Steelhead				Clipped Steelhead			
2008	20-May	21-May	31-May	11	18-May	21-May	28-May	10
2009	10-May	22-May	6-Jun	27	10-May	20-May	1-Jun	22
2010	18-May	26-May	11-Jun	24	8-May	23-May	9-Jun	32
2011	14-May	20-May	1-Jun	18	11-May	16-May	29-May	18
2012	8-May	19-May	2-Jun	25	7-May	15-May	27-May	20
2013	9-May	14-May	21-May	12	8-May	14-May	19-May	11
2014	3-May	15-May	28-May	25	2-May	8-May	25-May	23
2015	3-May	12-May	22-May	19	1-May	8-May	20-May	19
2016	20-Apr	6-May	16-May	26	22-Apr	30-Apr	11-May	19
2017	22-Apr	9-May	23-May	31	20-Apr	2-May	13-May	23
10-Yr MEDIAN	**8-May**	**17-May**	**29-May**	**25**	**7-May**	**14-May**	**26-May**	**20**
10-Yr MIN	**20-Apr**	**6-May**	**16-May**	**11**	**20-Apr**	**30-Apr**	**11-May**	**10**
10-Yr MAX	**20-May**	**26-May**	**11-Jun**	**31**	**18-May**	**23-May**	**9-Jun**	**32**
	Coho				Sockeye (Wild & Hatchery)			
2008	20-May	20-May	24-May	4	21-May	22-May	3-Jun	13
2009	18-May	26-May	30-Jun	43	20-May	23-May	2-Jun	13
2010	19-May	5-Jun	14-Jun	26	23-May	3-Jun	16-Jun	24
2011	13-May	21-May	3-Jun	21	13-May	30-May	12-Jun	30
2012	9-May	22-May	5-Jun	27	9-May	22-May	3-Jun	25
2013	10-May	14-May	22-May	12	18-May	20-May	23-May	5
2014	7-May	21-May	29-May	22	3-May	14-May	25-May	22
2015	10-May	18-May	29-May	19	16-May	19-May	21-May	5
2016	2-May	9-May	19-May	17	21-May	22-May	26-May	5
2017	9-May	15-May	29-May	20	20-Apr	14-May	26-May	36
10-Yr MEDIAN	**10-May**	**20-May**	**29-May**	**21**	**17-May**	**22-May**	**29-May**	**18**
10-Yr MIN	**2-May**	**9-May**	**19-May**	**4**	**20-Apr**	**14-May**	**21-May**	**5**
10-Yr MAX	**20-May**	**5-Jun**	**30-Jun**	**43**	**23-May**	**3-Jun**	**16-Jun**	**36**

1.2. Adult Fish Passage.

1.2.1. Adult Fish Facilities. Lower Monumental adult fish facilities are comprised of north and south shore ladders and collection systems with a common auxiliary water supply. Maintenance occurs in Jan–Feb, typically one shore at a time to minimize impacts on upstream migrants.

1.2.1.1. The north shore ladder connects to two north shore entrances and the powerhouse collection system. The powerhouse collection system has two entrances at the downstream south end of the powerhouse (a former side entrance is permanently closed) and a common transportation channel. Two north shore entrances, two downstream south powerhouse entrances, and none of the floating orifices will be used during fish passage season.

1.2.1.2. The south shore ladder has two downstream entrances (a former side entrance is permanently closed). Three turbine-driven pumps provide auxiliary water from the north side of the powerhouse to the powerhouse diffusers via a supply conduit under the powerhouse collection channel, and to the south shore collection system diffuser via a supply conduit under the spillway. Excess water from the juvenile bypass system (approximately 200-240 cfs) is added to the auxiliary water supply for the powerhouse collection system.

1.2.2. Adult Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult facilities are operated year-round. Adult salmon, steelhead, shad, and lamprey are counted per the schedule in **Table LMN-3**, and data are posted daily at: www.fpc.org/adultsalmon_home.html. Sturgeon and bull trout are relatively infrequent and are reported in *Miscellaneous Fish Counts* and in the *Annual Fish Passage Report*. Relatively few fish pass through the south ladder so one person can count both ladders simultaneously from the north shore counting room by direct observation of the north viewing window and by video monitor connected to the south shore counting room.

1.2.2.2. Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage defined in **Table LMN-4**. Time-of-day (diel) distributions of adult salmonids at fishway entrances and exits are shown in **Figure LMN-2**.

Table LMN-3. Lower Monumental Dam Adult Fish Counting Schedule, 3/1/18-2/28/19.

Count Period	Counting Method and Hours *
April 1 – October 31	Visual 0500–2100 hours (PDT)

*PST=Pacific Standard Time. PDT=Pacific Daylight Time (in effect during Daylight Saving Time 3/11/18-11/4/18).

Table LMN-4. Lower Monumental Dam Adult Fish Count Period and Peak Passage Timing (based on yearly counts from 1969 through most recent count year).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Apr 1 – Jun 13	Apr 20	May 28
Summer Chinook	Jun 14 – Aug 13	Jun 14	Jul 12
Fall Chinook	Aug 14 – Oct 31	Sep 4	Sep 30
Steelhead	Apr 1 – Oct 31	Sep 13	Oct 13
Sockeye	Apr 1 – Oct 31	Jun 24	Jul 25
Lamprey	Apr 1 – Oct 31	Jul 14	Aug 8

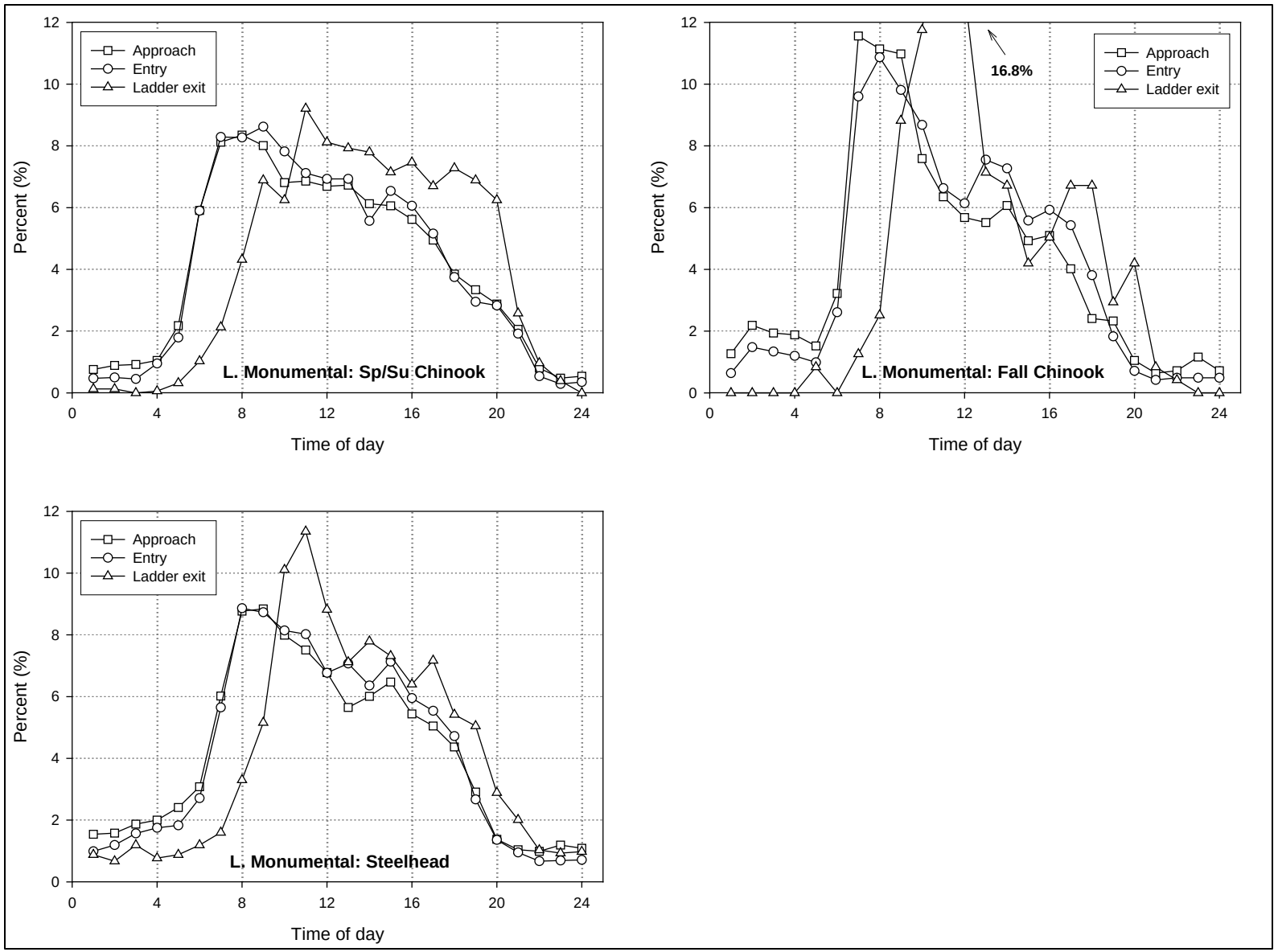


Figure LMN-2. Diel Distribution of Adult Salmonids at Lower Monumental Fishway Entrances and Exits (*Keefer & Caudill 2008*).
pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATIONS

2.1. General.

2.1.1. Yearly special operations related to research are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

2.1.2. Research, non-routine maintenance activities, and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. These distances are approximate and will be updated after data are collected and analyzed to determine the threshold for adverse impacts to adult fish behavior. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

2.1.3. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed immediately following the incident of steps taken to correct the situation. On a monthly basis, as necessary, the project biologist will provide FPOM a summary of any emergency actions undertaken.

2.1.4. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least two weeks in advance, unless it is deemed an emergency (see also **FPP Chapter 1 - Overview** for coordination guidance).

2.2. Spill Management.

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the Fish Passage Plan as **Appendix E**. Spill at Lower Monumental will be distributed in patterns defined in **Table LMN-7 through LMN-9.**

2.2.2. Involuntary spill is the result of river flow above powerhouse capacity, insufficient load (lack of load), turbine unit outages (forced or scheduled), or failure of a key component of the juvenile fish passage facility which forces spill to provide juvenile fish passage.

2.2.3. Total dissolved gas (TDG) is monitored at Lower Monumental Dam during the periods defined in **Table LMN-1**, pursuant to the Corps' annual *TDG Monitoring Plan* and *Dissolved Gas Monitoring Plan of Action 2015-2018*.[1]

2.2.4. To ensure navigation safety, short-term spill adjustments may be required, including spill reduction, spill pattern adjustments, and/or spill stoppages that result in forebay exceedances of the Minimum Operating Pool (MOP) range. The Corps will make short-term spill adjustments in real-time as appropriate to provide safe navigation conditions. Actual operations will vary depending on spill patterns, turbine operations, experience of boat captains, etc. See the FOP (**Appendix E**) for more information.

[1] TDG Monitoring Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/. TDG Monitoring Plan 2015-2018: pweb.crohms.org/tmt/wqnew/tdg_monitoring/2015-18.pdf

2.3. Operating Criteria – Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance (December 16–March 31).

2.3.1.1. Forebay Area and Intakes.

i. Remove debris from forebay and gatewell slots.

ii. Rake trashracks just prior to the operating season.

iii. Measure drawdown in gatewell slots after cleaning trashracks with STSs installed.

iv. Inspect and repair gatewell dip net as needed.

2.3.1.2. Submersible Traveling Screens (STS) and Vertical Barrier Screens (VBS).

i. Maintenance completed on all screens.

ii. Inspect STSs prior to installation and operate one trial run (dogged off on deck) to ensure proper operation.

iii. Log results of trial run.

iv. Inspect all VBSs with underwater video camera at least once per year. Repair as needed.

2.3.1.3. Collection Channel.

i. Water-up valve capable of operating when needed.

ii. Orifice lights are operational.

iii. Orifices clean and valves operating correctly.

iv. Orifice air backflush system works correctly.

2.3.1.4. Transportation Facilities.

i. Primary bypass flume switch gate maintained and in good operating condition.

ii. Flume interior smooth with no rough edges.

iii. Perforated plate edges smooth with no rough edges.

iv. Wet separator and fish distribution system should be maintained and ready for operation as designed.

v. Brushes and screens on crowders in good condition with no holes in screens or rough edges.

vi. Crowders maintained, tested, and operating correctly.

vii. All valves, slide gates, and switch gates maintained and in good operating condition.

viii. Retainer screens in place with no holes in screens or sharp wires protruding.

ix. Barge and truck loading pipes should be free of debris, cracks, or blockages. Truck and barge loading hose couplings should have no rough edges and barge loading boom should be maintained and tested.

x. All sampling equipment should be maintained and in good operating condition prior to watering up the facilities.

xi. Maintain juvenile PIT-tag system as required (see "*Columbia Basin PIT-tag Information System, General Gate Maintenance and Inspection, Walla Walla District*", February 2003). Coordinate with PSMFC.

xii. Mini- and midi-tanks maintained and in good operating condition.

2.3.1.5. Dewatering Structure and Flume.

i. Inclined screen clean and in good condition with no gaps between screen panels, damaged panels, or missing silicone.

ii. Screen cleaning system (brush and air flush) maintained and operating correctly.

iii. Overflow weirs should be maintained, tested and operating correctly.

iv. All valves should be operating correctly.

v. Flume interior should be smooth with no rough edges.

2.3.1.6. Avian Predation Areas (Forebay and Tailrace). Inspect bird wires, avian deterrent devices, and other deterrent devices and repair or replace as needed. Where possible, install additional bird wires or other deterrent devices to cover areas of known avian predation activity. Prepare avian abatement contract as needed.

2.3.1.7. Maintenance Records. Record all maintenance and inspections.

2.3.1.8. RSW Maintenance. See **section 2.3.2.8** below.

2.3.2. Juvenile Fish Passage Season (April 1–December 15).

Operate April 1–September 30 for juvenile fish bypass, collection, and transport, and October 1–December 15 for adult fallbacks. Operate according to criteria below and in the *Corps of Engineers Juvenile Fish Transportation Plan* (**Appendix B**). The transportation program may be revised in accordance with ESA Section 10 permit and the NOAA Fisheries Biological Opinion.

2.3.2.1. Forebay Area and Intakes.

i. Remove debris from forebay.

ii. Inspect gatewell slots daily (preferably early in day shift) for debris, fish buildup, and contaminating substances (particularly oil). Clean gatewells before they become 50% covered with debris. If the volume of debris precludes the ability to keep the gatewell at least 50% clear, they should be cleaned at least once daily. If flows through an orifice or fish conditions give indications that an orifice may be partially obstructed with debris, the orifice will be closed and backflushed to remove the obstruction. If the obstruction cannot be removed, the orifice shall be closed and the alternate orifice for that gatewell slot shall be operated. If both orifices become obstructed or plugged with debris, the turbine unit will not be operated until the gatewell and orifices are cleared of debris.

iii. If a visible accumulation of contaminating substances (e.g., oil) is detected in a gatewell and cannot be removed within 24 hours, the gatewell orifices shall be closed immediately and the turbine unit shut down within one hour until the material has been removed and any problems corrected. A preferred method for removing oil from the water surface is to install lipophilic socks, booms, or pads capable of encapsulating the material, and tie off with a rope for later disposal. Action should be taken as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow fish to exit the gatewell. Orifices shall not be closed for longer than 48 hours.

iv. Log gatewell drawdown differentials in bulkhead slots at least once a week.

v. Remove debris from forebay and trashracks as necessary to maintain less than 1' of additional drawdown in gate slots (relative to drawdown with a clean screen). Additional raking may be required when heavy debris loads are present in the river. Coordinate turbine unit outages with other project work activities, if possible, to minimize turbine unit outages during the spring.

vi. Coordinate cleaning efforts with personnel operating juvenile collection facilities.

vii. Dip bulkhead gatewell slots to remove fish prior to installing bulkhead for dewatering bulkhead slot.

2.3.2.2. STS, VBS, and Head Gates.

i. Operate STSs in cycle mode when average fork length of sub-yearling Chinook or sockeye is greater than 120 mm.

ii. Operate STSs in continuous-run mode when average fork length of sub-yearling Chinook salmon or sockeye is less than 120 mm or if fish condition deteriorates.

iii. Inspect each installed STS by underwater video camera once per month. Spot check VBSs at the same time.

iv. Record STS amp readings daily.

v. If an STS is damaged or fails during the juvenile fish passage season, follow procedures defined in **section 3.2.2**. In no case should a turbine unit be operated with a missing or a known non-operating or damaged STS.

vi. Up to half of the STSs may be pulled after October 1 for maintenance as long as unscreened turbine units are not operated.

vii. Make a formal determination at the end of the season as to the adequacy of STS mesh and any replacement needs.

viii. Inspect at least two VBSs in two different turbine units between spring and summer. Both turbine units should have been operated frequently in the spring. If a debris accumulation is noted, inspect other VBSs and clean debris as necessary.

ix. Turbine units are to be operated with *raised* head gates when STSs are installed (April 1 through December 15) to improve fish guidance efficiency (FGE), except as provided in **section 4.3**.

x. If extreme cold weather is forecasted (< 20°F for ≥ 24 hours) between Thanksgiving and December 15, STSs may be removed. The project will first request special permission from CENWW-OD-T. CENWW-OD-T will inform NOAA Fisheries and FPOM of the action. NOAA's National Weather Service forecast for Lower Monumental Dam is available at: forecast.weather.gov/MapClick.php?lat=46.56353885200048&lon=-118.53924714099969

2.3.2.3. Collection Channel.

i. Ensure orifices are clean and operable. Operate at least one orifice per gatewell slot (preferably the north orifice). If the project is operating within MOP, additional orifices may be operated to maintain a full collection channel. If orifices must be closed to repair any part of the facility, monitor the gatewells for fish condition and behavior hourly (unit is operating) or at least every two hours

(unit is not operating). See **section 3.2.2.3** to determine if the turbine unit must be shut down and if fish must be dipped from the gatewell(s).

ii. Ensure that orifice lights are functional and operating in open orifices. Orifice lights and area lights may be turned off the evening before the channel is dewatered at the end of the season to encourage fish to exit the channel volitionally (dewatering occurs December 16 or later). Area lights can be turned on briefly for personnel access if necessary.

iii. Replace all burned out orifice lights within 24 hours of notification. Orifice lights shall remain lighted 24 hours/day.

iv. Orifice jets must hit no closer than 3' from the back wall with the collection channel full.

v. Orifice valves must be either fully open or fully closed.

vi. Backflush orifices at least once per day and more frequently if required. During periods of high debris volumes and fish numbers, April 1 through July 31, orifices should be inspected and backflushed once per 8-hour shift or more frequently as determined by the project biologist, to keep orifices clean.

vii. Water-up valve capable of operating when needed.

2.3.2.4. Dewatering Structure.

i. Assure the trash sweep is operating correctly. The frequency of the sweep should be set as necessary to maintain a clean screen, with a minimum operation of at least once per hour. Operate the air flush as specified by the project biologist to maintain a clean screen.

ii. Hand clean trapezoidal section once a day or as often as needed to maintain a clean condition.

iii. Check overflow weirs to make sure they are operating correctly, perform maintenance as required.

iv. There should be no gaps between screen panels or damaged panels in the inclined screen.

v. Lights at the dewatering structure should be turned off at night, unless needed for personnel access, to encourage fish to move downstream volitionally.

2.3.2.5. Transportation Facilities.

i. All screens should be inspected to make sure there are no holes or sharp edges.

ii. Crowder screen brushes should be maintained in good operating condition, with no holes or sharp edges on crowder screens.

iii. Inspect raceway and tank retainer screens to make sure they are clean with no holes or protruding wires.

iv. Operate wet separator and fish distribution system as designed.

v. Truck and barge loading facilities in good operating condition.

vi. Inform PSMFC, in advance if possible, of situations that will require the PIT-tag system to become inoperable (e.g. power outages) or that could result in confounding the interpretation of PIT-tag data (e.g. bypassing fish from raceways to the river, operating in primary bypass mode without an operational full-flow detector, emergency dewaterings).

2.3.2.6. Avian Predation Areas (Forebay and Tailrace).

i. Bird wires and other avian deterrent devices should be monitored to ensure good condition. Any broken wires or devices should be replaced as soon as possible.

ii. Harassment program in place to deter avian predation in areas actively used by birds and not covered by bird wires or other devices.

iii. Project biologists shall routinely monitor project areas to determine areas of active avian predation and, if possible, adjust harassment program to cover these areas or install bird wires or other deterrents to discourage avian predation.

2.3.2.7. Removable Spillway Weir[2] (RSW).

i. The RSW in spillbay 8 will be in the raised position and operational on the first day of spring spill for juvenile fish passage.

ii. When the RSW is in operation, spill through Bay 8 is fixed at approximately 6.8 kcfs. The spillgate shall be raised to where it does not touch flow passing down the RSW.

iii. When the Northwest River Forecast Center forecasts Lower Monumental inflows above 200 kcfs, initiate aggressive forebay debris removal so that RSW operation will not be impeded and coordinate with RCC and CENWW-OD-T.

[2] Spillway weirs provide surface passage routes via spillbay(s). Temporary, or Top, Spillway Weirs (*TSW*s) at Little Goose, McNary and John Day dams can be installed, uninstalled and moved between bays using the gantry crane. Removable Spillway Weirs (*RSW*s) at Lower Granite, Lower Monumental and Ice Harbor dams are "removed" by controlled descent to the bottom of the forebay.

iv. Complete RSW stow (complete rotation to the landing pad) when inflows exceed 260 kcfs, upstream river gauge flows are increasing, and the NWS forecasts Lower Monumental inflow to exceed 300 kcfs.

v. On or after June 21 (start of summer spill), when average daily total project outflow is less than 30 kcfs and forecasted to remain below 30 kcfs for three days or more on a declining hydrograph, the RSW will be closed and spill will be distributed in patterns for spill with no RSW in **Table LMN- 9**. The RSW will be re-opened if average daily total project outflow increases above 30 kcfs and is forecasted to remain above 30 kcfs for three or more days. The NWRFC inflow forecast for Lower Monumental Dam is available at: www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?LMNW1

vi. When the project is not spilling, the RSW may be operated for short periods of time upon request by the Project Biologist through CENWW if it appears the juvenile fish transportation facility and barge holding capacities will be exceeded, as described in the *Juvenile Fish Transportation Plan* (**Appendix B**).

2.3.2.8. RSW Maintenance (September 1 – April 1). Prior to inspections listed below, if a debris raft is present in the forebay and will interfere with defined operations, a debris spill will be coordinated in accordance with **section 5**. Debris in the RSW seals or between the transition plate and ogee will adversely affect RSW operation.

i. Transition Plate inspection will be performed annually to validate that transition from the RSW to the ogee is intact. The primary means of inspection will be done with divers or an ROV:

- If divers are used, Units 5&6 and spillbays 7&8 will be removed from service. Units 5&6 outages will require deviation from FPP priority order (**Table LMN-5**). Coordination of unit outages will follow normal outage notification guidelines. Up to a week before the inspection, bay 8 will need to be opened 1 or 2 stops to facilitate clearing of debris and silt from the transition plates. Spilling through bay 8 will be coordinated with RCC following normal guidelines.

- If an ROV is used, bay 8 will be out of service for the inspection. The morning of the inspection, bay 8 will need to be opened 1 or 2 stops to facilitate clearing of debris and silt from the transition plates. Spilling water through bay 8 will be coordinated with RCC following normal guidelines.

ii. Transition Plate bolts, umbilical and seal will be inspected by divers and will require the RSW to be disengaged from the face of the dam and tipped back to the pierce point. Prior to moving the RSW, bay 8 will need to be opened 1 or 2 stops to remove debris or silt that has accumulated on the transition plates or beak region that would slide off onto the ogee and cause problems when the RSW is stowed. Spill through bay 8 will occur up to a week before the inspection and will be coordinated with RCC through normal guidelines. This inspection will also

require units 5&6 and bays 7&8 out of service. Units 5&6 outages will require a deviation from FPP priority order. Coordination of the unit outages will follow normal outage notification guidelines. Upon completion of the dive, prior to stowing the RSW, bay 8 will need to be opened up to 3 stops to clean any debris from the ogee. The anticipated duration of this inspection is 1 to 3 days. Reports of the inspection will be submitted to the CENWW biological staff.

iii. Loss of Transition Plate(s) or seals will render the RSW out of service until repaired. The level of inspection will initialize with a diver or ROV inspection as defined above for Transition Plate Inspection. The repair and replacement effort will be similar to Transition Plate Bolt, Umbilical and seal inspection above. The timeframe will be longer to repair and or install a new plate(s) or seals. Required outages will be coordinated as listed above for the necessary actions.

2.3.2.9. Inspection and Record Keeping.

i. Inspect fish facilities at least once every 8 hours. Inspect all facilities according to fish facilities monitoring program.

ii. Record all maintenance and inspections.

2.4. Operating Criteria - Adult Fish Facilities.

2.4.1. Winter Maintenance Period (January 1 – end of February).

2.4.1.1. Inspect all staff gauges and water level indicators. Repair and/or clean as necessary.

2.4.1.2. Dewater all ladders and inspect all dewatered sections of fish facilities for projections, debris, or plugged orifices which could injure fish or impede fish passage up the ladder. Fish ladder exit trashracks must have smooth surfaces where fish pass, and must have downstream edges that are adequately rounded or padded. Spare trashracks should be on hand for use as necessary. Inspect all diffuser gratings and chambers annually by dewatering or by using divers or video inspection techniques. All diffuser gratings and chambers are to be dewatered and physically inspected at least every 3 years. Repair deficiencies.

2.4.1.3. Inspect for and clean debris from the fish ladder exits. All trashracks and picketed leads must be clean and installed correctly.

2.4.1.4. Calibrate all water level measuring devices, as necessary, for proper facility operations.

2.4.1.5. Inspect all spill gates and ensure that they are operable.

2.4.1.6. Fish pumps maintained and ready for operation.

2.4.1.7. Maintain adult PIT-tag system as required. Coordinate with PSMFC.

2.4.2. Adult Fish Passage Season (March 1 – December 31).

Note: Operating Ice Harbor within MOP (437'–438' msl) for juvenile salmonids may result in some of the Lower Monumental adult fishway entrances bottoming out on their sills prior to reaching criteria depths. Continuous operation within MOP may also result in increased pumping head on the auxiliary water supply pumps, decreasing the amount of water pumped.

2.4.2.1. Fishway Ladders. Water depth over weirs: 1' to 1.3'.

2.4.2.2. Counting Windows. All counting slots at Lower Monumental Dam are fixed at a width of 19". All equipment should be maintained and in good condition. The counting window and backboard should be cleaned as needed to maintain good visibility.

2.4.2.3. Head on all Fishway Entrances. Head range: 1' to 2'.

2.4.2.4. North Shore Entrances (NSE 1&2). Top of gate elevation on sill = 429'.

i. Operate both gates.

ii. Weir depth: 8' or greater below tailwater.

2.4.2.5. Floating Orifice Gates. No floating orifice gates will be operated.

2.4.2.6. South Powerhouse Entrances (SPE 1&2). Top of gate elev. on sill =432'.

i. Operate both downstream gates.

ii. Weir depth: 8' or greater below tailwater. At tailwaters below elevation 440', weirs should be on sill.

2.4.2.7. South Shore Entrances (SSE 1&2). Top of gate elev. on sill = 431'.

i. Operate both downstream gates.

ii. Weir depth: SSE 1 operate 8' or greater below tailwater. SSE 2 raised 6' above sill. At tailwaters below elevation 439', SSE 1 weir should be on sill.

2.4.2.8. Channel Velocity. 1.5' to 4' per second.

i. A permanently installed "*RED LION PLC with DETEC sensor*" type 3020-1002, 4-20 milliamp unit was installed (by Leopold Stevens Inc., Gresham, OR) in the collection channel at the unit 1 / unit 2 transition. The unit is located in the channel's length and width to avoid the non-characteristic high readings that would occur on the slope near an entrance or the non-characteristic low reading that would occur in the turbulent zone on the curve from the pump discharge supply conduit. The location of the sending unit typifies the velocity conditions throughout the length of the channel.

- To read the meter, the toggle switch is positioned in the "ON" position. As the unit warms up the velocity reading output shows the numerical readout increasing. When it stabilizes and repeats a number the reading is recorded.

- The velocity reading is a part of the ladder inspections that are done 3 times per week at Lower Monumental; additionally the reading will be added to the state biologists daily inspection form so that daily readings are documented.

2.4.2.9. Head on Trashracks.

i. Maximum head of 0.5' on ladder exits.

ii. Maximum head on south shore picketed leads shall be 0.3'. Maximum head on north shore picketed leads shall be 0.4'.

iii. Trashracks and picketed leads installed correctly.

2.4.2.10. Staff Gauges and Water Level Indicators. All staff gauges should be readable at all water levels encountered during fish passage period. Repair or clean as necessary.

2.4.2.11. Facility Inspections.

i. Powerhouse operators shall physically inspect facilities once per day shift and check computer monitor information at least once during each back shift.

ii. Project biologists shall inspect facilities three times per week. Inspect all facilities according to fish facilities monitoring program.

iii. Picketed leads shall be inspected during all inspections to ensure they are clean and in the correct position (all the way down).

iv. Project personnel shall check fishway control system twice per month to ensure calibration. This may be done as part of routine fishway inspections.

v. Inspect fishways daily for foreign substances (particularly oil). If substances are found, corrective actions should be undertaken immediately.

vi. Record all inspections.

2.4.2.12. Fishway Temperature Monitoring. From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits.

i. Temperature monitors shall be placed within 10 meters of all shore-oriented entrances and exits.

ii. If possible, the entrance monitor shall be within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers to allow for sufficient mixing with surface water.

iii. The exit monitor shall be within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

iv. If an existing temperature monitoring location is proposed to be used for either the exit or entrance, it shall be verified that the site accurately reflects water temperature within 10 meters of the entrance or exit.

v. Project Fisheries will submit temperature data to the Fish Passage Center (FPC) on a weekly basis for posting online at: www.fpc.org/river/Q_ladderwatertempgraph.php.

2.5. Fish Facility Monitoring and Reporting.

2.5.1. Project biologists shall inspect fish passage facilities at the frequencies listed in the juvenile and adult fish facilities operating criteria sections.

2.5.2. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31, summarizing project operations for Friday–Thursday, and email to CENWW-OD-T by noon the following Monday. Reports shall provide an overview of how the project and fish passage facilities operated during the week and evaluate resulting fish passage conditions, including:

i. Any out-of-criteria situations observed and subsequent corrective actions taken;
ii. Any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities;
iii. Adult fishway control calibrations;
iv. STS and VBS inspections;
v. Any unusual activities at the project that may have affected fish passage.

2.5.3. Annual Reports. Project biologists shall prepare a draft annual report by February 10 and a final report by March 15 summarizing the operation of the project fish passage facilities for the previous year. The annual report shall also include a description of actions taken to discourage avian predation at the project, and an overview of the effectiveness of those activities in discouraging predation.

2.5.4. Project Inspections. Project biologists inspect project facilities once per month and during dewaterings for the presence of zebra and Quagga mussels. Biologists shall provide a report to CENWW-OD-T on a monthly basis summarizing mussel inspections.

3. FISH FACILITIES MAINTENANCE

3.1. Dewatering & Fish Handling.

3.1.1. Project biologists should be present to provide technical guidance at all project activities that may involve fish handling. All dewatering (also referred to as “unwatering”) shall be accomplished in accordance with approved *Dewatering Guidelines and Fish Salvage Plans* (**Appendix F**). When river temperatures reach 70°F or greater, all adult fish handling will be

coordinated through CENWW-OD-T. *Dewatering Plans*[3] were reviewed and revised in 2011 to ensure that they comply with **Appendix F**.

3.2. Maintenance - Juvenile Fish Facilities.

3.2.1. Scheduled Maintenance. Scheduled maintenance of juvenile facilities is conducted throughout the year. Long-term maintenance or modifications that require facilities to be out of service for extended periods of time are conducted during the winter maintenance period (December 16–March 31). During the fish passage season parts of the facilities are maintained on a daily, weekly, or longer interval to keep them in proper operating condition.

3.2.2. Unscheduled Maintenance. Unscheduled maintenance is to correct any situation that prevents facilities from operating according to criteria or that will impact fish passage or survival.

3.2.2.1. Notification/Reporting. Maintenance of facilities such as STSs, which sometimes break down during fish passage season, will be carried out as described below. In these cases, repairs will be made as prescribed and CENWW-OD-T will be notified as soon as possible after it becomes apparent that repairs are required. The Operations Manager has the authority to initiate work prior to notifying CENWW-OD-T if a delay of the work will result in an unsafe situation for people, property, or fish. Unscheduled maintenance that will have a significant impact on fish passage shall be coordinated with NOAA Fisheries and FPOM on a case-by-case basis by CENWW-OD-T. Information required by CENWW-OD-T includes:

i. Description of the problem;
ii. Type of outage required;
iii. Impact on facility operation;
iv. Length of time for repairs;
v. Expected impacts on fish passage and proposed measures to mitigate them.

3.2.2.2. STS. The STSs are inspected periodically throughout the juvenile migration season with a video monitoring system. If a screen is found to be damaged it will be removed and either replaced with the spare STS or repaired and returned to service. A turbine unit shall not be operated with a known damaged or nonfunctioning STS or without a full complement of STSs. If an STS fails on a weekend or at night when maintenance crews are not available, the respective turbine unit will be shut down and generation switched to another, fully screened unit. If all screened turbine units are in service, water may be spilled until the affected STS can be removed and repaired or replaced.

3.2.2.3. Gatewell Orifices. Each gatewell has two 12" orifices with air operated valves to allow fish to exit the gatewell. Under normal operation, one orifice per gatewell is operated. To minimize blockage from debris, orifices are cycled and backflushed at least once per day, and more frequently if required by heavy debris loads. If an air-valve fails, the valve should be closed and the alternate orifice for that gatewell operated until repairs can be made. If both orifices are blocked with debris, damaged, or must be kept closed, the turbine unit will be taken out of service until repairs can be made. If repairs are to take longer than 48 hours,

[3] Project Dewatering Plans are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/

juvenile fish will be dipped from the gatewell with a gatewell dip basket. During any closure event of orifices in an operating turbine unit, gatewells will be checked hourly. During times of high fish passage or if there is evidence of any difficulty in holding fish in gatewells, fish are to be dipped from the gatewells at a more frequent interval.

3.2.2.4. Dewatering Structure. The dewatering structure acts as a transition from the collection channel to the corrugated metal flume. An inclined screen allows excess water to be bled off, with all fish and remaining water transitioning into the corrugated metal flume. The excess water is discharged into the adult fish facility auxiliary water supply system and is also used as the water supply for the transportation facilities. The dewatering structure contains a trash sweep and air burst system for cleaning the inclined screen of impinged debris. If the cleaning systems break and interfere with juvenile fish passage through the structure or if the inclined screen is damaged, an emergency bypass system at the upstream end of the dewatering structure will be used to bypass juveniles while repairs are made. Operation of the emergency bypass system requires the juvenile bypass system to be dewatered and stoplogs inserted at the upstream end of the inclined screen. The emergency bypass is then opened and the bypass system operated with 6 gatewell orifices open. Orifices will then need to be routinely rotated, every three hours, in order to let juveniles emigrate from all of the gatewells. While the facilities are in emergency bypass operation, project personnel shall monitor gatewells for signs of fish problems or mortality. Spill may be provided as an alternative avenue for fish passage during a collection channel outage.

3.2.2.5. Bypass Flume. The corrugated metal flume transports juveniles to either the transportation facilities or to the river below the project (primary bypass). If there is a problem with the flume that interferes with its operation, the emergency bypass system at the upper end of the flume can be opened and all of the fish in the bypass system diverted to the river below the project through the secondary emergency bypass system while repairs are made. Since the piping to the river for secondary emergency bypass is also part of the raw water supply for the load and hold facility, the load and hold must be evacuated of fish and dewatered before going into secondary emergency bypass.

3.2.2.6. Transportation Facilities. The transportation facilities can be operated to collect and hold juveniles for the transportation program or to bypass them back to the river (secondary bypass). If part of the facility malfunctions or is damaged, efforts will first be made to bypass the fish around the damaged area. If this is not possible, the fish will be bypassed to the river via the primary bypass pipe.

3.3. Maintenance - Adult Fish Facilities.

3.3.1. Scheduled Maintenance. Scheduled maintenance of a facility that must be dewatered to work on or where maintenance will have a significant effect on fish passage will be done during the January–February winter maintenance period. Maintenance of facilities that will have no effect on fish passage may be conducted at any time. Maintenance is normally conducted on one fish ladder at a time during the winter to provide some fish passage at all times. When facilities are not being maintained during the winter maintenance period, they will be operated according to normal criteria unless otherwise coordinated with NOAA Fisheries and FPOM.

3.3.1.1. Auxiliary Water Supply System. The auxiliary water for the ladders and collection systems is supplied by three turbine-driven pumps on the north shore, with at least two pumps being required for normal operation. On a monthly basis, each pump, one pump at a time, may be taken out of service for up to two days for maintenance. The maintenance performed during this outage is routine monthly and quarterly maintenance as defined within the COE maintenance program. This maintenance will not be performed when river conditions will not allow the ladder to remain in criteria using only a two-pump operation.

3.3.2. Unscheduled Maintenance.

3.3.2.1. Notification/Reporting. Unscheduled maintenance that will significantly affect the operation of a facility will be coordinated with NOAA Fisheries and other FPOM participants. Coordination procedures for unscheduled maintenance of adult facilities are the same as for juvenile facilities in **section 3.2.2.1**. If part of a facility malfunctions or is damaged during the fish passage season and the facility can still be operated within criteria without any detrimental effects on fish passage, repairs may not be conducted until the winter maintenance period or until fewer numbers of fish are passing the project. If part of a facility is damaged or malfunctions that may significantly impact fish passage, it will be repaired as soon as possible.

3.3.2.2. Fish Ladders and Counting Stations. The fish ladders contain fixed weirs, counting stations with picket leads, and fish exits with trashracks. If any part of the ladder fails or is blocked with debris during the fish passage season, efforts will first be made to correct the problem without dewatering. Trashracks, picket leads, and counting stations can sometimes be repaired or maintained without dewatering the ladder. The decision to dewater the ladder and make repairs during the fish passage season or wait until the winter maintenance period will be made after coordination with the fish agencies and tribes.

3.3.2.2.a. Hazardous Materials Spill. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.

3.3.2.3. Auxiliary Water Supply (AWS). The auxiliary water for fish ladders and collection systems is supplied by three turbine-driven pumps on the north shore, with at least two pumps required for normal operation. If one, two, or all three pumps fail, the fishway will be adjusted in the following manner until repairs can be made:

i. SPE 2 and/or SSE 2 will be closed and SPE 1 raised to provide the required 1-2' head differential in the system. If the desired differential cannot be reached by the time SPE 1 reaches 5' below tailwater, SPE 1 should be closed, the collection channel bulkheaded off at the junction pool, and NSE 1 and 2 and SSE 1 operated as deep as possible to maintain the head. If it cannot be maintained at a depth greater than 6', the weirs should be maintained at 6' regardless of head differential.

3.3.2.4. Fishway Entrances. The fishway entrances consist of main entrance weirs with hoists and automatic controls. If any of the automatic controls malfunction, the weirs can be operated manually by project personnel and kept within criteria. If there is a further failure which prevents an entrance from being operated manually, the weirs can usually be left in a lowered position while repairs are being conducted or the entrance may be closed and the water redistributed to other entrances while repairs are made.

3.3.2.5. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during winter maintenance to ensure they are in place, either by dewatering and physically inspecting the diffuser gratings, or by using underwater video cameras, divers, or other methods. Diffuser gratings may come loose during the fish passage season due to a variety of reasons. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings. If a diffuser grating is known or suspected to have moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway. Coordination should begin immediately through the established unscheduled maintenance coordination procedures in **section 3.2.2.1**. If possible, a video inspection should be done as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and tribes through the established coordination procedure. Repairs shall be made as quickly as possible unless coordinated differently.

4. TURBINE UNIT OPERATION & MAINTENANCE

4.1. Turbine Unit Priority Order.

4.1.1. From March 1 through November 30, turbine units will be operated in the order of priority defined in **Table LMN-5** in order to enhance adult and juvenile fish passage. If a turbine unit is out of service for maintenance or repair, the next unit in the priority order shall be operated.

4.1.2. Unit priority order may be coordinated differently to allow for fish research, construction, or project maintenance activities.

4.1.3. Unit 1 provides the best fish passage conditions by eliminating the eddy at the juvenile fish loading dock and providing attraction flow to the North adult fish ladder. Therefore, the default priority order for fish passage is Units 1-6 (in order from north to south). However, due to blade seal failures on Units 2, 3, and 4, the blades were hydraulically locked at a fixed angle, which restricts these units to a narrow operating range (see 1% range tables in **section 4.2**). To avoid excessive wear and tear from repeated starts/stops, Units 2, 3, and 4 are operated last-on/last-off in the priority order for all flow conditions until repairs are completed (*currently scheduled for Unit 4 by the end of FY18*). When Unit 1 is not available, Unit 2 will be the first priority unit for fish passage.

Table LMN-5. Lower Monumental Dam Turbine Unit Priority Order.

Season	Unit Priority Order
March 1 – November 30 Fish Passage Season	DEFAULT 1, 2, 3, 4, 5, 6 MODIFIED ORDER for Fixed-Blade Units* Start-up (U1 available): 1, 5, 6, 2*, 3*, 4* Start-up (U1 not available): 2*, 5, 6, 3*, 4* Shutdown: 6, 5, 3* or 4* any order, then 2*, 1
December 1 – End of February Winter Maintenance Period	Any Order

*As of Feb 2018, Units 2, 3, and 4 have hydraulically locked blades and will be operated in a modified priority order to minimize starts/stops. When Unit 1 is unavailable, Unit 2 will be first priority for fish passage. When the blade seals are replaced (*currently scheduled for Unit 4 in 2018*), the unit will resume operating in its default order.

4.2. Turbine Unit Operating Range.

4.2.1. In-Season (April 1–October 31). As defined in the *BPA Load Shaping Guidelines* (**Appendix C**), all units will be operated within ±1% of peak turbine efficiency (1% range) to maximize survival of juvenile fish that pass through the turbines. Turbine unit flow and power output at the lower and upper limits of the 1% range are defined in **Table LMN-6**.

4.2.1.1. If operation outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

i. Meet BPA load requests made pursuant to BPA's policy, statutory requirements, and *Load Shaping Guidelines* (**Appendix C**);

ii. If the draft tube is to be dewatered (**section 4.3.4**), the unit will be operated at full load >1% (or at speed-no-load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs in order to flush fish from the unit;

iii. Operate a turbine unit solely to provide station service; or

iv. Comply with other coordinated fish measures.

4.2.1.2. Minimum Generation. All of the lower Snake River projects may be required to keep one generating unit online at all times to maintain power system reliability. The minimum generation flow range for each unit is defined in the FOP Table 1 (**Appendix E**), as derived from the lower limits of the 1% range and actual unit operations. During low flow, there may not be enough river flow to meet this generation requirement and the FOP spill target. Under these circumstances, the project will operate the first available priority unit at minimum generation and spill the remainder of outflow. Actual attainable minimum generation may vary depending on real-time conditions.

4.2.2. Off-Season (November 1–March 31). While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

Table LMN-6. Lower Monumental Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Turbine Efficiency (Lower and Upper Limits of 1% Range) and Operating Limits. [a]

Project	LMN Units 1[b], 2[c], 3[c] - With STS						LMN Units 1[b], 2[c], 3[c] - No STS					
Head	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
(feet)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	68.6	11,169	128.5	20,905	140.9	24,344	69.2	11,123	125.8	20,216	140.9	23,569
86	69.4	11,154	131.0	21,056	142.8	24,273	70.0	11,109	128.3	20,363	142.8	23,542
87	70.2	11,140	133.5	21,204	144.6	24,200	70.8	11,094	130.8	20,506	144.6	23,513
88	70.9	11,125	136.1	21,348	146.5	24,126	71.6	11,080	133.3	20,645	146.5	23,482
89	71.7	11,111	138.6	21,488	148.3	24,050	72.3	11,066	135.8	20,781	148.3	23,450
90	72.4	11,097	141.2	21,625	150.2	23,974	73.1	11,052	138.3	20,913	150.2	23,415
91	73.3	11,088	141.6	21,418	151.5	23,815	74.0	11,043	138.7	20,714	151.5	23,268
92	74.1	11,079	142.0	21,216	152.8	23,654	74.8	11,035	139.1	20,518	152.8	23,119
93	75.0	11,071	142.4	21,018	154.0	23,492	75.7	11,026	139.5	20,327	154.0	22,968
94	75.8	11,061	142.8	20,824	155.2	23,420	76.5	11,017	139.9	20,140	155.2	22,850
95	76.7	11,052	143.2	20,634	155.2	22,904	77.4	11,009	140.3	19,956	155.2	22,409
96	77.7	11,071	143.3	20,416	155.2	22,592	78.4	11,027	140.4	19,746	155.2	22,125
97	78.8	11,088	143.5	20,203	155.2	22,286	79.5	11,044	140.6	19,540	155.2	21,847
98	79.8	11,105	143.6	19,994	155.2	21,988	80.5	11,061	140.7	19,338	155.2	21,576
99	80.8	11,121	143.8	19,789	155.2	21,696	81.5	11,078	140.9	19,141	155.2	21,309
100	81.8	11,137	144.0	19,589	155.2	21,410	82.6	11,093	141.0	18,947	155.2	21,049
101	82.7	11,138	145.9	19,641	155.2	21,130	83.5	11,095	142.9	18,998	155.2	20,798
102	83.6	11,140	147.8	19,692	155.2	20,857	84.3	11,096	144.8	19,047	155.2	20,553
103	84.5	11,141	149.7	19,741	155.2	20,589	85.2	11,098	146.7	19,095	155.2	20,312
104	85.4	11,142	151.6	19,789	155.2	20,326	86.1	11,099	148.5	19,142	155.2	20,077
105	86.2	11,143	153.5	19,837	155.2	20,069	87.0	11,100	150.4	19,188	155.2	19,846
	LMN Units 4[d], 5, 6 - With STS						LMN Units 4[d], 5, 6 - No STS					
85	89.8	14,150	123.8	19,493	141.3	25,052	89.5	13,962	122.5	19,102	141.3	24,441
86	91.0	14,160	125.5	19,519	143.3	24,978	90.7	13,971	124.2	19,128	143.3	24,414
87	92.2	14,169	127.2	19,545	145.4	24,904	91.9	13,981	125.9	19,153	145.4	24,385
88	93.4	14,178	128.9	19,569	147.4	24,829	93.1	13,990	127.6	19,177	147.4	24,356
89	94.6	14,187	130.6	19,593	149.4	24,753	94.2	13,998	129.3	19,201	149.4	24,324
90	95.7	14,195	132.3	19,616	151.4	24,676	95.4	14,006	131.0	19,224	151.4	24,291
91	96.9	14,196	133.9	19,613	153.5	24,623	96.5	14,007	132.5	19,221	153.5	24,230
92	98.0	14,197	135.4	19,610	155.2	24,553	97.7	14,008	134.0	19,218	155.2	24,168
93	99.2	14,197	136.9	19,607	155.2	23,936	98.8	14,009	135.5	19,215	155.2	23,577
94	100.3	14,198	138.5	19,603	155.2	23,343	99.9	14,010	137.1	19,211	155.2	23,008
95	101.4	14,198	140.0	19,600	155.2	22,771	101.1	14,010	138.6	19,208	155.2	22,460
96	102.3	14,170	140.5	19,456	155.2	22,389	102.0	13,982	139.1	19,067	155.2	21,828
97	103.2	14,142	141.0	19,315	155.2	22,017	102.9	13,954	139.6	18,929	155.2	21,478
98	104.1	14,114	141.5	19,177	155.2	21,654	103.8	13,928	140.1	18,794	155.2	21,136
99	105.1	14,087	142.0	19,042	155.2	21,300	104.7	13,901	140.5	18,662	155.2	20,803
100	106.0	14,061	142.5	18,909	155.2	20,955	105.6	13,875	141.0	18,532	155.2	20,723
101	107.3	14,091	143.9	18,909	155.2	20,701	106.9	13,904	142.5	18,532	155.2	20,477
102	108.5	14,120	145.4	18,909	155.2	20,452	108.2	13,933	143.9	18,532	155.2	20,236
103	109.8	14,149	146.8	18,909	155.2	20,208	109.4	13,962	145.3	18,532	155.2	19,999
104	111.1	14,177	148.2	18,909	155.2	19,970	110.7	13,989	146.7	18,532	155.2	19,768
105	112.4	14,204	149.6	18,909	155.2	19,736	112.0	14,017	148.1	18,532	155.2	19,541

a. Table values derived from HDC report (July 2003). Flow (cfs) is calculated based on turbine efficiency, head, and power output (MW). "Operating Limit" is the maximum safe operating point, based on cavitation or generator limit (added Feb 2018).

b. Unit 1 was previously fixed-blade and is being restored to adjustable-blade with full 1% range (est. RTS spring 2018).

c. Units 2 and 3 runner blades are hydraulically locked due to failed blade seals (Sep 2017). Unit 2 is restricted to the lower 1% (~11-13 kcfs) and Unit 3 to the upper 1% (~18-20 kcfs) until the blade seals are replaced.

d. Unit 4 runner blades are hydraulically locked due to failed blade seals (Dec 2017). Unit 4 is restricted to the upper 1% (~17-19 kcfs) until the blade seals are replaced (currently scheduled in FY2018).

4.3. Turbine Unit Maintenance.

4.3.1. Maintenance Schedule.

4.3.1.1. Turbine unit maintenance schedules will be reviewed annually by Project and Operations Division biologists for fish impacts.

4.3.1.2. Each turbine unit requires annual maintenance that may take from several days to two weeks, and is normally scheduled between mid-July and late November. Maintenance of priority units for adult passage is normally conducted in November–December, but can be conducted in mid-August.

4.3.1.3. Priority unit maintenance will be scheduled for winter maintenance period, or when there are few fish passing the project, to the extent possible. Impacts to migrating adults should be minimized.

4.3.1.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take over one year to accomplish.

4.3.1.5. Turbine units, governors, exciters, and control systems require periodic maintenance, calibration, and testing which may take them outside of the 1% range. This work will be scheduled in compliance with *BPA Load Shaping Guidelines* (**Appendix C**) to minimize impacts on juvenile fish.

4.3.2. Operational Testing.

4.3.2.1. Pre-Maintenance: Units may be operationally tested for up to 30 minutes before going into maintenance status by running the unit at speed-no-load and various loads within the 1% range for pre-maintenance measurements and testing, and to allow all fish to move through the unit.

4.3.2.2. Post-Maintenance: Units may be operationally tested after maintenance or repair while remaining in maintenance or forced outage status. Operational testing may consist of running the unit for up to a cumulative time of 30 minutes (within 1% range) before it is returned to operational status.

4.3.2.3. Operational testing of unit under maintenance is in addition to a unit in run status required for power plant reliability. Operational testing may deviate from FPP priority order and may require water that would otherwise be used for spill if the unit running for reliability is at its 1% lower limit (i.e., minimum generation). Water for operational testing will be used from the powerhouse allocation if possible, and water diverted from spill only to the extent necessary to maintain generation system reliability.

4.3.3. Head Gates.[4]

4.3.3.1. Turbine units are to be operated with head gates in the *raised* position to improve fish passage conditions when STSs are installed, except as provided below:

4.3.3.2. Operation of units with head gates in the standard operating position shall be restricted to July 1–December 15, and shall not occur unless at least four other turbine units are available for service. No more than one unit at a time shall be operated with head gates in the standard operating position and the unit will be operated on last-on, first-off priority.

4.3.3.3. Head gates are used to dewater turbine units to facilitate annual maintenance. Unit outage periods will be minimized to the actual time required for maintenance by lowering operating gates in one unit to the standard operating position and connecting to hydraulic cylinders on the afternoon of the last regular workday (typically Thursday) prior to the start of the maintenance. The unit may be operated with head gates in the standard operating position until 0700 hours of the next regular workday (typically Monday).

4.3.3.4. Once maintenance is completed, the turbine unit can be operated with head gates in the standard operating position until 1200 hours of the first regular workday.

4.3.3.5. If unit maintenance or raising of the head gates is delayed beyond the times stated above, the unit shall be immediately taken out of service until work can be completed.

4.3.4. Dewatering Units. Dewatering (also referred to as "unwatering") should be accomplished in accordance with project *Dewatering Plans*.[3] If the turbine unit draft tube is to be dewatered, operate unit with full load for a minimum of 15 minutes prior to installing tail logs. If not possible to load, run unit at speed-no-load for minimum of 15 minutes. This is to reduce the number of fish in the scrollcase prior to installing stop logs. If a turbine unit is out of service for maintenance for an extended period of time without tailrace stoplogs in place, efforts should be made to not open the wicket gates if the scroll case must be dewatered at a later date without the unit being spun beforehand.

4.3.5. Doble Testing. See **Appendix A** for yearly test schedule. Transformer Doble testing is required every three years, or more frequently if there is a known problem with a transformer, and requires the associated turbine units to be out of service for 2–3 workdays. Doble testing is normally scheduled for August or early September in conjunction with other scheduled unit maintenance to minimize impacts on fish passage. To conduct testing, the distribution lines must be disconnected from the transformers and normal generation stopped. One turbine unit will operate at speed-no-load (approximately 5 kcfs) to provide project power and operation of fish passage facilities (station service). Spill may be provided to meet minimum required project discharge during testing. If Doble testing will impact priority units for fish passage, adult passage timing should be considered to minimize impacts to migrating adults. Available units will be operated in accordance with FPP priority order and within the 1% range.

4.3.6. Six-Year Overhaul. One unit per year is scheduled for a 6-year overhaul that requires unwatering the unit to perform more in-depth maintenance other than annual checks. This level

[4] Head gates may also be referred to as "operating" gates at some projects. The terms are interchangeable.

of maintenance requires additional consideration before the outage (pre-outage) and after the work is complete (post-outage). During the work, many systems and sub-systems of the unit may be disassembled, replaced or repaired. The overhaul unit outage will be scheduled during a period which minimizes impacts to fish. The work will start as recommended in **section 4.3.1**.

4.3.6.1. Pre-Outage: prior to going out-of-service for a 6-year overhaul, the unit may need to be run continuously for 48 hours, which may require a deviation from FPP unit priority in **Table LMN-5**. Scheduling the unit first in line for maintenance should allow for ample water to accomplish a 48-hour run time for pre-maintenance checks. More water will be required for Unit 4, 5 or 6, as these units require an additional 2-3 kcfs at lower operating points.

4.3.6.2. Post-Outage: following a 6-year overhaul, the unit must be run continuously for 48 hours to ensure it is ready for service. A second period of 48 hours of intermittent testing may be required to fix minor items detected in the first continuous run. This post-outage run will require a deviation from FPP unit priority in **Table LMN-5** and from **section 4.3.3** to allow the unit to run with the head gate cylinder in place and the head gate in the lower position. More water will be required for Unit 4, 5 or 6, as these units require an additional 2-3 kcfs at lower operating points. The 1% range constraint will remain in place.

4.3.7. Turbine Unit Outages during High Flows. During high spring flows, turbine unit outages for inspecting fish screens, repairing research equipment (e.g., hydroacoustic or radio-telemetry), and/or other fish items may cause increased spill in order to maintain reservoir levels within operating ranges. This may result in TDG exceeding standards. It is important that this work be conducted when scheduled to ensure that facilities are working correctly and not injuring migrating fish, and that important fish research data are collected. To facilitate this work, reservoir storage may be utilized to minimize impacts from taking turbine units out of service and increasing spill. At Lower Monumental, this special operation shall take place when flow is above 120 kcfs or when increased spill will result in TDG exceeding standards. The activities covered under these operations will be coordinated with TMT whenever possible.

5. FOREBAY DEBRIS REMOVAL

5.1.1. Debris at projects can impact fish passage conditions. Debris can plug or block trashracks, VBSs, gatewell orifices, dewatering screens, separators, and facility piping resulting in impingement, injuries, and descaling of fish. Removing debris at its source in the forebay is sometimes necessary to maintain safe and efficient fish passage conditions, navigation, and other project activities. Debris can be removed from the forebay by: physically encircling the debris with log booms and pulling it to shore with boats where it can be removed with a crane, removing the debris from the top of the dam using a crane and scoop, or passing the debris through the spillway with special powerhouse operations and spill. The preferred option is to remove debris at each project when possible to avoid passing debris on to the next project downstream. This is not always possible at each project as some projects do not have forebay debris removal capability. In this case, the only viable alternative is to spill the debris. Normally, the project shall contact CENWW-OD-T at least two workdays prior to the day the special operation is required. Using information provided by the project, CENWW-OD-T will notify FPOM and RCC will issue a teletype detailing the special operations.

5.1.2. Debris Spill Coordination. All special spills (other than normal patterns for ongoing spill operations) and project operations for passing debris will be coordinated prior to operations taking place. Each project shall contact CENWW-OD-T at least two workdays prior to the day of the requested special project debris spill operation. Project personnel shall provide CENWW-OD-T the reason for the debris spill request including an explanation of project facilities impacted by debris, the date and time of the requested spill, and any special powerhouse or other operations required to move the debris to the spillway. Using information provided by the project, CENWW-OD-T shall coordinate the special operations with RCC, NOAA Fisheries and FPOM. When a debris spill is coordinated and approved, RCC shall issue a teletype detailing the specifics of the special operations.

5.1.3. Emergency Spills. Emergency spills may be implemented if necessary to pass woody debris accumulating in front of the spillbay weir and compromising the safe unobstructed fish passage. The project will immediately spill the woody debris obstructing fish passage and will notify CENWW-OD-T of the emergency spill as soon as possible to notify RCC, NOAA Fisheries, and FPOM.

Table LMN-7. [pg *1 of 3*] Lower Monumental Dam Bulk Spill Patterns with RSW. [a]

LMN Bulk Spill Patterns - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
	2				4		RSW	**6**	**16.3**
	3				4		RSW	**7**	**17.8**
	3			1	4		RSW	**8**	**19.6**
	3			1	5		RSW	**9**	**21.3**
1	3			1	5		RSW	**10**	**23.1**
1	1	1	1	1	6		RSW	**11**	**25.4**
1	1	1	1	2	6		RSW	**12**	**26.9**
1	1	1	2	2	6		RSW	**13**	**28.4**
1	1	1	2	4	5		RSW	**14**	**29.6**
1	1	1	2	5	5		RSW	**15**	**31.3**
2	1	1	2	5	5		RSW	**16**	**32.8**
2	1	2	2	5	5		RSW	**17**	**34.3**
2	2	2	2	5	5		RSW	**18**	**35.8**
3	2	2	2	5	5		RSW	**19**	**37.3**
3	3	2	2	5	5		RSW	**20**	**38.8**
3	3	2	2	5	5	1	RSW	**21**	**40.6**
3	3	2	2	5	5	2	RSW	**22**	**42.1**
3	3	2	3	5	5	2	RSW	**23**	**43.6**
3	3	3	3	5	5	2	RSW	**24**	**45.1**
3	3	3	3	5	6	2	RSW	**25**	**46.8**
3	3	3	3	6	6	2	RSW	**26**	**48.5**
3	3	3	3	6	6	3	RSW	**27**	**50.0**
3	3	3	3	6	6	4	RSW	**28**	**51.4**
3	3	3	3	6	6	5	RSW	**29**	**53.1**
3	3	3	3	6	6	6	RSW	**30**	**54.8**
3	3	3	4	6	6	6	RSW	**31**	**56.2**
3	3	4	4	6	6	6	RSW	**32**	**57.6**
3	4	4	4	6	6	6	RSW	**33**	**59.0**
4	4	4	4	6	6	6	RSW	**34**	**60.4**
4	4	4	5	6	6	6	RSW	**35**	**62.1**
4	4	5	5	6	6	6	RSW	**36**	**63.8**
4	5	5	5	6	6	6	RSW	**37**	**65.5**
5	5	5	5	6	6	6	RSW	**38**	**67.2**
5	5	5	6	6	6	6	RSW	**39**	**68.9**
5	5	6	6	6	6	6	RSW	**40**	**70.6**
5	6	6	6	6	6	6	RSW	**41**	**72.3**
6	6	6	6	6	6	6	RSW	**42**	**74.0**
6	6	6	6	6	7	6	RSW	**43**	**75.6**
6	7	6	6	6	7	6	RSW	**44**	**77.2**
6	7	6	6	7	7	6	RSW	**45**	**78.8**
6	7	7	6	7	7	6	RSW	**46**	**80.4**
6	7	7	7	7	7	6	RSW	**47**	**82.0**
7	7	7	7	7	7	6	RSW	**48**	**83.6**
7	7	7	7	7	7	7	RSW	**49**	**85.2**
7	7	7	7	7	8	7	RSW	**50**	**87.0**
7	8	7	7	7	8	7	RSW	**51**	**88.8**

LMN Bulk Spill Patterns - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
7	8	7	7	8	8	7	RSW	**52**	**90.6**
7	8	8	7	8	8	7	RSW	**53**	**92.4**
7	8	8	8	8	8	7	RSW	**54**	**94.2**
8	8	8	8	8	8	7	RSW	**55**	**96.0**
8	8	8	8	8	8	8	RSW	**56**	**97.8**
8	8	8	8	8	9	8	RSW	**57**	**99.4**
8	9	8	8	8	9	8	RSW	**58**	**101.0**
8	9	8	8	9	9	8	RSW	**59**	**102.6**
8	9	9	8	9	9	8	RSW	**60**	**104.2**
8	9	9	9	9	9	8	RSW	**61**	**105.8**
9	9	9	9	9	9	8	RSW	**62**	**107.4**
9	9	9	9	9	9	9	RSW	**63**	**109.0**
9	9	9	9	9	10	9	RSW	**64**	**110.8**
9	10	9	9	9	10	9	RSW	**65**	**112.6**
9	10	9	9	10	10	9	RSW	**66**	**114.4**
9	10	10	9	10	10	9	RSW	**67**	**116.2**
9	10	10	10	10	10	9	RSW	**68**	**118.0**
10	10	10	10	10	10	9	RSW	**69**	**119.8**
10	10	10	10	10	10	10	RSW	**70**	**121.6**
10	10	10	10	10	11	10	RSW	**71**	**123.3**
10	11	10	10	10	11	10	RSW	**72**	**125.0**
10	11	10	10	11	11	10	RSW	**73**	**126.7**
10	11	11	10	11	11	10	RSW	**74**	**128.4**
10	11	11	11	11	11	10	RSW	**75**	**130.1**
11	11	11	11	11	11	10	RSW	**76**	**131.8**
11	11	11	11	11	11	11	RSW	**77**	**133.5**
11	11	11	11	11	12	11	RSW	**78**	**135.2**
11	12	11	11	11	12	11	RSW	**79**	**136.9**
11	12	11	11	12	12	11	RSW	**80**	**138.6**
11	12	12	11	12	12	11	RSW	**81**	**140.3**
11	12	12	12	12	12	11	RSW	**82**	**142.0**
12	12	12	12	12	12	11	RSW	**83**	**143.7**
12	12	12	12	12	12	12	RSW	**84**	**145.4**
12	12	12	12	12	13	12	RSW	**85**	**147.1**
12	13	12	12	12	13	12	RSW	**86**	**148.8**
12	13	12	12	13	13	12	RSW	**87**	**150.5**
12	13	13	12	13	13	12	RSW	**88**	**152.2**
12	13	13	13	13	13	12	RSW	**89**	**153.9**
13	13	13	13	13	13	12	RSW	**90**	**155.6**
13	13	13	13	13	13	13	RSW	**91**	**157.3**
13	13	13	13	13	14	13	RSW	**92**	**159.0**
13	14	13	13	13	14	13	RSW	**93**	**160.7**
13	14	13	13	14	14	13	RSW	**94**	**162.4**
13	14	14	13	14	14	13	RSW	**95**	**164.1**
13	14	14	14	14	14	13	RSW	**96**	**165.8**
14	14	14	14	14	14	13	RSW	**97**	**167.5**
14	14	14	14	14	14	14	RSW	**98**	**169.2**
14	14	14	14	14	15	14	RSW	**99**	**171.0**

LMN Bulk Spill Patterns - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
14	15	14	14	14	15	14	RSW	**100**	**172.8**
14	15	14	14	15	15	14	RSW	**101**	**174.6**
14	15	15	14	15	15	14	RSW	**102**	**176.4**
14	15	15	15	15	15	14	RSW	**103**	**178.2**
15	15	15	15	15	15	14	RSW	**104**	**180.0**
15	15	15	15	15	15	15	RSW	**105**	**181.8**

a. Spill (kcfs) is calculated as a function of total stops + RSW spill at forebay elevation 537.0 ft.

b. Bay 8 w/ RSW = fixed spill of ~6.8 kcfs at forebay 537.0 ft. Raise Bay 8 tainter gate above stop 9 to ensure free surface and debris passage. When total project outflow is < 30 kcfs, RSW will be closed and spill distributed in patterns defined in **Table LMN- 9** (see criteria in **section 2.3.2.7.v**),

Table LMN-8. [*pg 1 of 3*] Lower Monumental Dam Uniform Spill Patterns with RSW. [a, b]

LMN Uniform Spill Patterns - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
	1	1	1	1	1		RSW	**5**	**15.8**
1	1	1	1	1	1		RSW	**6**	**17.6**
1	1	1	1	1	1	1	RSW	**7**	**19.4**
1	1	1	1	1	2	1	RSW	**8**	**20.9**
1	2	1	1	1	2	1	RSW	**9**	**22.4**
1	2	1	1	2	2	1	RSW	**10**	**23.9**
1	2	2	1	2	2	1	RSW	**11**	**25.4**
1	2	2	2	2	2	1	RSW	**12**	**26.9**
2	2	2	2	2	2	1	RSW	**13**	**28.4**
2	2	2	2	2	2	2	RSW	**14**	**29.9**
2	2	2	2	2	3	2	RSW	**15**	**31.4**
2	3	2	2	2	3	2	RSW	**16**	**32.9**
2	3	2	2	3	3	2	RSW	**17**	**34.4**
2	3	3	2	3	3	2	RSW	**18**	**35.9**
2	3	3	3	3	3	2	RSW	**19**	**37.4**
3	3	3	3	3	3	2	RSW	**20**	**38.9**
3	3	3	3	3	3	3	RSW	**21**	**40.4**
3	3	3	3	3	4	3	RSW	**22**	**41.8**
3	4	3	3	3	4	3	RSW	**23**	**43.2**
3	4	3	3	4	4	3	RSW	**24**	**44.6**
3	4	4	3	4	4	3	RSW	**25**	**46**
3	4	4	4	4	4	3	RSW	**26**	**47.4**
4	4	4	4	4	4	3	RSW	**27**	**48.8**
4	4	4	4	4	4	4	RSW	**28**	**50.2**
4	4	4	4	4	5	4	RSW	**29**	**51.9**
4	5	4	4	4	5	4	RSW	**30**	**53.6**
4	5	4	4	5	5	4	RSW	**31**	**55.3**
4	5	5	4	5	5	4	RSW	**32**	**57**
4	5	5	5	5	5	4	RSW	**33**	**58.7**
5	5	5	5	5	5	4	RSW	**34**	**60.4**
5	5	5	5	5	5	5	RSW	**35**	**62.1**
5	5	5	5	5	6	5	RSW	**36**	**63.8**
5	6	5	5	5	6	5	RSW	**37**	**65.5**
5	6	5	5	6	6	5	RSW	**38**	**67.2**
5	6	6	5	6	6	5	RSW	**39**	**68.9**
5	6	6	6	6	6	5	RSW	**40**	**70.6**
6	6	6	6	6	6	5	RSW	**41**	**72.3**
6	6	6	6	6	6	6	RSW	**42**	**74**
6	6	6	6	6	7	6	RSW	**43**	**75.6**
6	7	6	6	6	7	6	RSW	**44**	**77.2**
6	7	6	6	7	7	6	RSW	**45**	**78.8**
6	7	7	6	7	7	6	RSW	**46**	**80.4**
6	7	7	7	7	7	6	RSW	**47**	**82**
7	7	7	7	7	7	6	RSW	**48**	**83.6**
7	7	7	7	7	7	7	RSW	**49**	**85.2**
7	7	7	7	7	8	7	RSW	**50**	**87**
7	8	7	7	7	8	7	RSW	**51**	**88.8**

LMN Uniform Spill Patterns - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
7	8	7	7	8	8	7	RSW	**52**	**90.6**
7	8	8	7	8	8	7	RSW	**53**	**92.4**
7	8	8	8	8	8	7	RSW	**54**	**94.2**
8	8	8	8	8	8	7	RSW	**55**	**96**
8	8	8	8	8	8	8	RSW	**56**	**97.8**
8	8	8	8	8	9	8	RSW	**57**	**99.4**
8	9	8	8	8	9	8	RSW	**58**	**101**
8	9	8	8	9	9	8	RSW	**59**	**102.6**
8	9	9	8	9	9	8	RSW	**60**	**104.2**
8	9	9	9	9	9	8	RSW	**61**	**105.8**
9	9	9	9	9	9	8	RSW	**62**	**107.4**
9	9	9	9	9	9	9	RSW	**63**	**109**
9	9	9	9	9	10	9	RSW	**64**	**110.8**
9	10	9	9	9	10	9	RSW	**65**	**112.6**
9	10	9	9	10	10	9	RSW	**66**	**114.4**
9	10	10	9	10	10	9	RSW	**67**	**116.2**
9	10	10	10	10	10	9	RSW	**68**	**118**
10	10	10	10	10	10	9	RSW	**69**	**119.8**
10	10	10	10	10	10	10	RSW	**70**	**121.6**
10	10	10	10	10	11	10	RSW	**71**	**123.3**
10	11	10	10	10	11	10	RSW	**72**	**125**
10	11	10	10	11	11	10	RSW	**73**	**126.7**
10	11	11	10	11	11	10	RSW	**74**	**128.4**
10	11	11	11	11	11	10	RSW	**75**	**130.1**
11	11	11	11	11	11	10	RSW	**76**	**131.8**
11	11	11	11	11	11	11	RSW	**77**	**133.5**
11	11	11	11	11	12	11	RSW	**78**	**135.2**
11	12	11	11	11	12	11	RSW	**79**	**136.9**
11	12	11	11	12	12	11	RSW	**80**	**138.6**
11	12	12	11	12	12	11	RSW	**81**	**140.3**
11	12	12	12	12	12	11	RSW	**82**	**142**
12	12	12	12	12	12	11	RSW	**83**	**143.7**
12	12	12	12	12	12	12	RSW	**84**	**145.4**
12	12	12	12	12	13	12	RSW	**85**	**147.1**
12	13	12	12	12	13	12	RSW	**86**	**148.8**
12	13	12	12	13	13	12	RSW	**87**	**150.5**
12	13	13	12	13	13	12	RSW	**88**	**152.2**
12	13	13	13	13	13	12	RSW	**89**	**153.9**
13	13	13	13	13	13	12	RSW	**90**	**155.6**
13	13	13	13	13	13	13	RSW	**91**	**157.3**
13	13	13	13	13	14	13	RSW	**92**	**159**
13	14	13	13	13	14	13	RSW	**93**	**160.7**
13	14	13	13	14	14	13	RSW	**94**	**162.4**
13	14	14	13	14	14	13	RSW	**95**	**164.1**
13	14	14	14	14	14	13	RSW	**96**	**165.8**
14	14	14	14	14	14	13	RSW	**97**	**167.5**
14	14	14	14	14	14	14	RSW	**98**	**169.2**
14	14	14	14	14	15	14	RSW	**99**	**171**

LMN Uniform Spill Patterns - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
14	15	14	14	14	15	14	RSW	**100**	**172.8**
14	15	14	14	15	15	14	RSW	**101**	**174.6**
14	15	15	14	15	15	14	RSW	**102**	**176.4**
14	15	15	15	15	15	14	RSW	**103**	**178.2**
15	15	15	15	15	15	14	RSW	**104**	**180**
15	15	15	15	15	15	15	RSW	**105**	**181.8**

a. Spill (kcfs) is calculated as a function of total stops + RSW spill at forebay elevation 537.0 ft (based on interim spillway rating table 2-Apr-2009).

b. Bay 8 w/ RSW = fixed spill of ~6.8 kcfs at forebay 537.0 ft. Raise Bay 8 tainter gate above stop 9 to ensure free surface and debris passage. When total project outflow is < 30 kcfs, RSW will be closed and spill distributed in patterns defined in **Table LMN- 9** (see criteria in **section 2.3.2.7.v**)**.**

Table LMN- 9. Lower Monumental Dam Spill Patterns with No RSW (Bay 8 Closed). [a, b]

LMN Spill Patterns w/ NO RSW - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
	1						CLOSE	**1**	**1.8**
	1					1	CLOSE	**2**	**3.6**
	1			1		1	CLOSE	**3**	**5.4**
	2			1		1	CLOSE	**4**	**6.9**
	2			1		2	CLOSE	**5**	**8.4**
	2			2		2	CLOSE	**6**	**9.9**
	2			2		3	CLOSE	**7**	**11.4**
	2			3		3	CLOSE	**8**	**12.9**
	2			3		4	CLOSE	**9**	**14.3**
	2			3		5	CLOSE	**10**	**16.0**
	2			4		5	CLOSE	**11**	**17.4**

a. Spill (kcfs) is calculated as a function of total stops at forebay elevation 537.0 ft.

b. When total project outflow is < 30 kcfs, RSW will be closed and spill distributed in patterns defined in this table (see criteria in **section 2.3.2.7.v**).

2018 Fish Passage Plan

Chapter 8 – Little Goose Dam

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Chapter 8 - Little Goose Dam

Project Acronym*	LGS
River Mile (RM)	Snake River - RM 70.3
Reservoir	Lake Bryan
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 0 kcfs \ Mar–Nov: 11.5 kcfs
Forebay Normal Operating Range (ft)	633’ – 638’
Tailrace Rate of Change Limit (ft)	1.5’/hr
Powerhouse Length (ft)	656’
Powerhouse Hydraulic Capacity (kcfs)	130 kcfs
Turbine Units (#)	6 (Units 1-3 BLH Kaplan; Units 4-6 Allis Chalmers Kaplan)
Turbine Generating Capacity (MW)	Rated: 810 MW (Units 1-6 @ 135 MW) \ Maximum: 930 MW (Units 1-6 @ 155 MW)
Gatewell Orifice Diameter (in)	35 gatewells w/ 12” orifice; 1 gatewell w/ 14” orifice
Spillway Length (ft)	512’
Spillway Hydraulic Capacity (kcfs)	850 kcfs
Spillbays (#)	8
Spillway Weirs (#)	1 Adjustable Spillway Weir (ASW) in Bay 1 w/ high crest (el. 622 ft) or low crest (el. 618 ft).
Navigation Lock Length x Width (ft)	650’ x 84’ (Usable Space)
Navigation Lock Max. Lift (ft)	101’
FISH STRUCTURE/OPERATION START DATE	
Juvenile Bypass System (JBS)	1970 (1st Generation) \ 1989 (2nd Generation) \ 2010 Outfall Flume Relocation
Submersible Traveling Screens (STS)	1971 (Prototype Mesh) \ 1994 (Complete)
Extended-Length Submersible Bar Screens (ESBS)	1997
Transportation Research Program - NMFS	1971-1975
Juvenile Fish Transportation Program - Corps	1981 \ 1991 (3rd Generation)
Adjustable Spillway Weir (ASW)	2009 \ 2018 (replaced with Adjustable Spillway Weir)
Adult Fish Counts – South Shore	1970-1981; 1991-present

*Project acronym designated by US Army Corps of Engineers, Northwestern Division, Columbia Basin Water Management Division. Due to the large number of projects managed by NWD, this acronym may differ from other acronyms used in the region. For example, a common acronym for Little Goose is **LGO**. However, that acronym is assigned to another NWD project, so the official Corps NWD acronym is **LGS**.

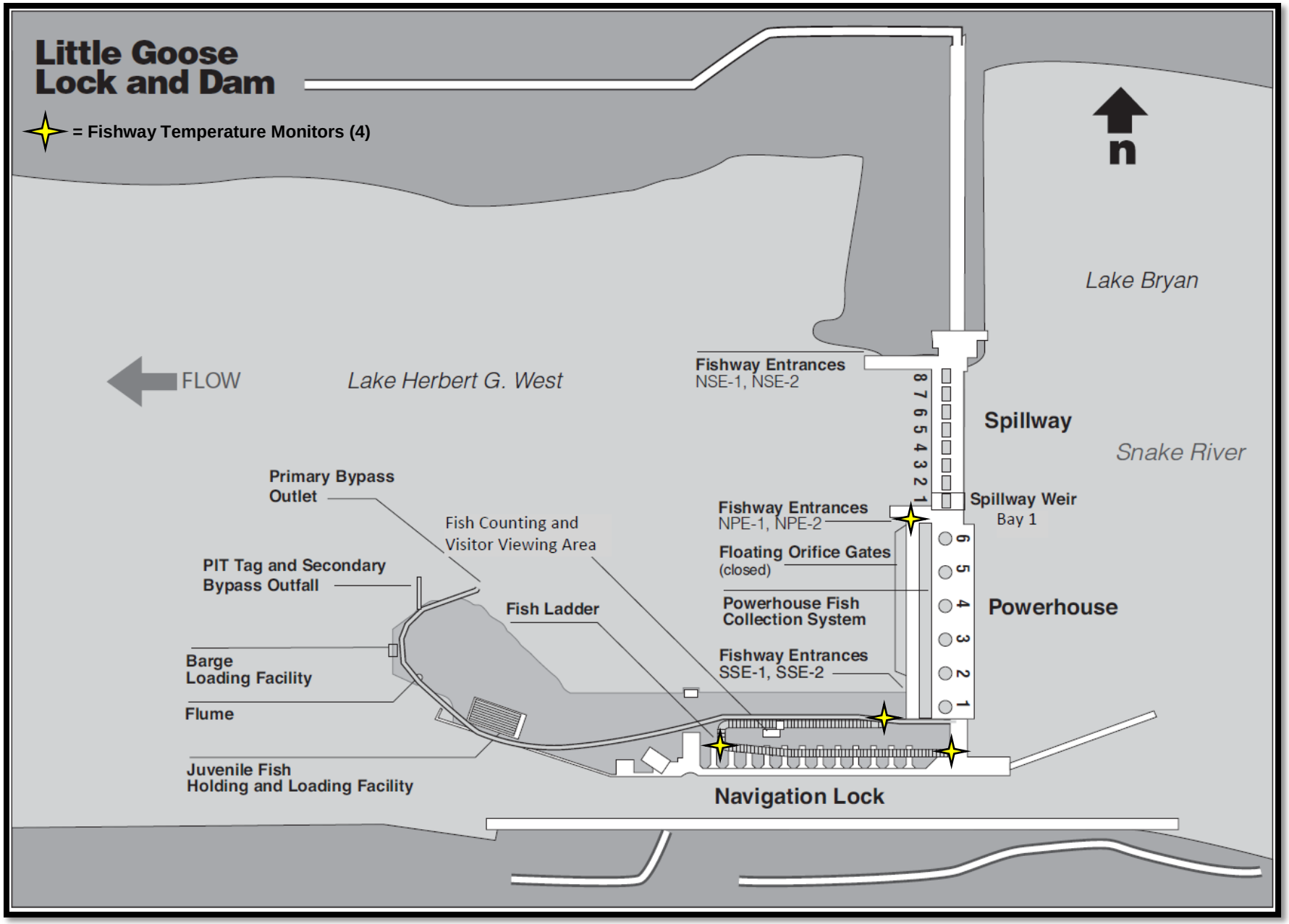
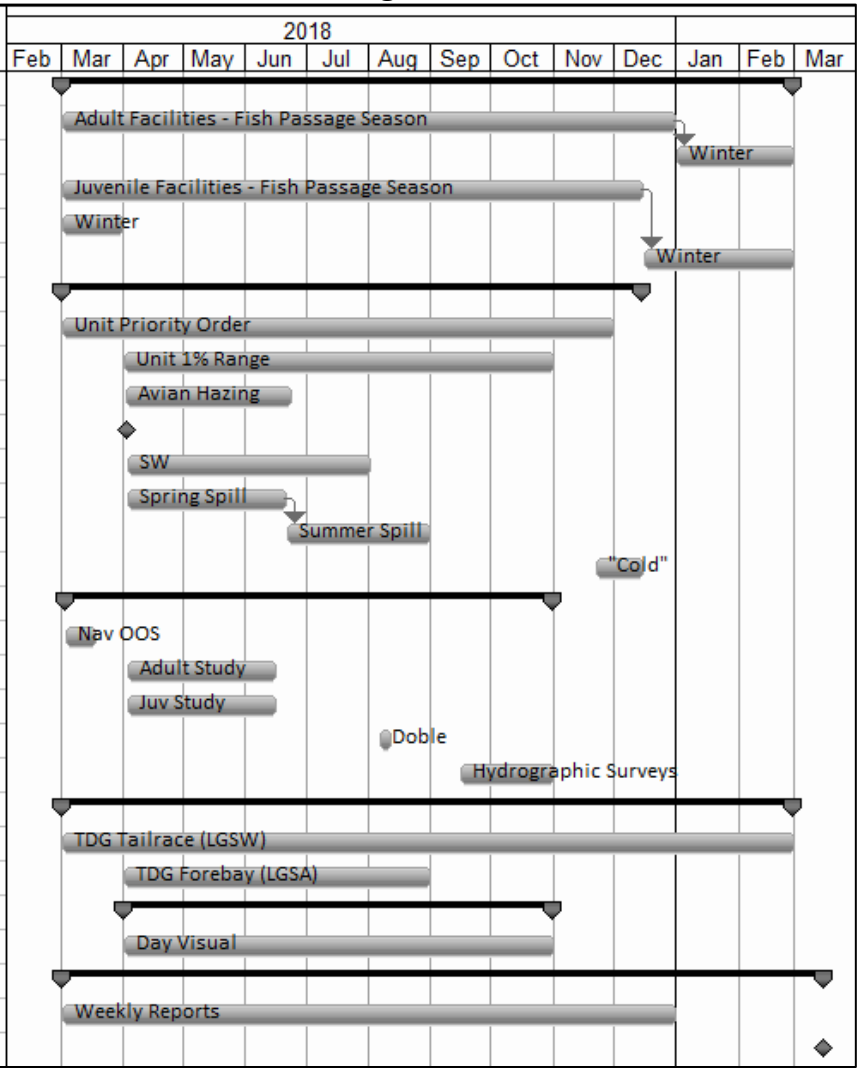


Figure LGS-1. Little Goose Lock & Dam General Site Plan.

Table LGS-1. Little Goose Dam Schedule of Operations and Actions Defined in the 2018 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**3/1/18**	**2/28/19**	
Adult Facilities - Fish Passage Season	3/1/18	12/31/18	2.4.2
Adult Facilities - Winter Maintenance	1/1/19	2/28/19	2.4.1
Juvenile Facilities - Fish Passage Season	3/1/18	12/15/18	2.3.2
Juvenile Facilities - Winter Maintenance	3/1/18	3/31/18	2.3.1
	12/16/18	2/28/19	
PROJECT OPERATIONS FOR FISH PASSAGE	**3/1/18**	**12/15/18**	
Turbine unit priority order	3/1/18	11/30/18	Table LGS-5
Turbine unit 1% operating range	4/1/18	10/31/18	4.2
Avian hazing	4/2/18	6/23/18	App L 8.2
Avian Wires installed NLT April 3	4/3/18	4/3/18	App L 1.4
Spillway weir in service (end date approx)	4/3/18	8/1/18	2.3.2.7
Spring Spill	4/3/18	6/20/18	App E (FOP)
Summer Spill	6/21/18	8/31/18	App E (FOP)
ESBS removal during cold weather	11/22/18	12/15/18	2.3.2.2
SPECIAL OPS & STUDIES (Appendix A)	**3/3/18**	**10/31/18**	
Navigation Lock annual outage	3/3/18	3/18/18	App A 1.4
Adult Passage and Behavior Study	4/3/18	6/15/18	App A 8.2
Juvenile Survival Study	4/3/18	6/15/18	App A 8.2
Doble testing	8/6/18	8/11/18	App A 1.5
Stilling Basin Surveys	9/15/18	10/31/18	App A 8.2
TDG MONITORING	**3/1/18**	**2/28/19**	
TDG Monitoring - Tailrace (LGSW)	3/1/18	2/28/19	2.2.5
TDG Monitoring - Forebay (LGSA)	4/1/18	8/31/18	2.2.5
ADULT FISH COUNTING	**4/1/18**	**10/31/18**	
Day Visual 0500-2100 PDT	4/1/18	10/31/18	Table LGS-3
REPORTS	**3/1/18**	**3/15/19**	
Weekly Reports	3/1/18	12/31/18	2.5.2
Annual Report due	3/15/19	3/15/19	2.5.3



1. FISH PASSAGE INFORMATION

Little Goose Dam fish passage facilities and other structures are shown in **Figure LGS-1**. The schedule of Little Goose Dam operations that are described in the Fish Passage Plan (FPP) and Appendices is in **Table LGS-1.**

1.1. Juvenile Fish Passage.

1.1.1. Juvenile Fish Facilities. The juvenile fish facilities at Little Goose Dam consist of a bypass system and juvenile transportation facilities. Maintenance of fish facilities that may impact fish or facility operation should be conducted during the winter maintenance period.

i. The bypass system consists of extended-length submersible bar screens (ESBS) with flow vanes, vertical barrier screens (VBS), one 14” and thirty-five 12" gatewell orifices, a bypass channel running the length of the powerhouse, a metal flume mounted on the face of the dam and upper end of the fish ladder, a dewatering structure to drain excess water, two emergency bypass systems, and one corrugated metal flume to transport fish to either transportation facilities or the river.

ii. The transportation facilities include a separator structure, raceways for holding fish, a distribution system for distributing fish among raceways, a sampling and marking building, truck and barge loading facilities, and PIT-tag detection and diversion systems.

1.1.2. Juvenile Fish Migration Timing. Juvenile fish passage timing at Little Goose Dam is shown in **Table LGS-2**, based on collection data from the most recent 10-year period (does not reflect fish guidance efficiency or passage via the spillway weir or spillway). From 2006–2009, fish collection at Little Goose Dam began later in the season and may have skewed the passage dates in the table. Salmon, steelhead, bull trout, lamprey, and other species are counted when they are observed in the juvenile monitoring facility.

Table LGS-2. Juvenile Salmonid Passage Timing at Little Goose Dam for Most Recent 10 Years Based on Daily & Yearly Collection Data.

Year	10%	50%	90%	# Days	10%	50%	90%	# Days
	Yearling Chinook				Subyearling Chinook			
2008	5-May	15-May	28-May	23	4-Jun	20-Jun	23-Jul	49
2009	24-Apr	7-May	23-May	29	29-May	7-Jun	30-Jun	32
2010	2-May	15-May	29-May	27	6-Jun	12-Jun	8-Jul	32
2011	5-May	12-May	19-May	14	4-Jun	17-Jun	20-Jul	46
2012	30-Apr	7-May	21-May	21	4-Jun	16-Jun	12-Jul	38
2013	5-May	10-May	16-May	11	2-Jun	13-Jun	29-Jul	57
2014	2-May	9-May	20-May	18	31-May	14-Jun	15-Jul	45
2015	24-Apr	7-May	12-May	18	30-May	19-Jun	13-Jul	44
2016	16-Apr	30-Apr	10-May	24	4-Jun	13-Jun	4-Jul	30
2017	16-Apr	28-Apr	15-May	29	30-May	8-Jun	12-Jul	43
10-Yr MEDIAN	**1-May**	**8-May**	**19-May**	**22**	**3-Jun**	**13-Jun**	**12-Jul**	**44**
10-Yr MIN	**16-Apr**	**28-Apr**	**10-May**	**11**	**29-May**	**7-Jun**	**30-Jun**	**30**
10-Yr MAX	**5-May**	**15-May**	**29-May**	**29**	**6-Jun**	**20-Jun**	**29-Jul**	**57**
	Unclipped Steelhead				Clipped Steelhead			
2008	8-May	18-May	1-Jun	24	1-May	12-May	23-May	22
2009	24-Apr	4-May	29-May	35	23-Apr	30-Apr	25-May	32
2010	3-May	22-May	8-Jun	36	2-May	20-May	7-Jun	36
2011	7-May	16-May	6-Jun	30	4-Apr	12-May	20-May	46
2012	30-Apr	17-May	2-Jun	33	25-Apr	9-May	26-May	31
2013	6-May	13-May	21-May	15	4-May	12-May	18-May	14
2014	2-May	11-May	27-May	25	22-Apr	7-May	26-May	34
2015	26-Apr	13-May	26-May	30	24-Apr	8-May	22-May	28
2016	16-Apr	2-May	19-May	33	18-Apr	28-Apr	13-May	25
2017	16-Apr	28-Apr	25-May	39	14-Apr	26-Apr	15-May	31
10-Yr MEDIAN	**1-May**	**13-May**	**28-May**	**32**	**23-Apr**	**8-May**	**22-May**	**31**
10-Yr MIN	**16-Apr**	**2-May**	**19-May**	**15**	**4-Apr**	**26-Apr**	**13-May**	**14**
10-Yr MAX	**8-May**	**22-May**	**8-Jun**	**39**	**4-May**	**20-May**	**7-Jun**	**46**
	Coho				Sockeye (Wild & Hatchery)			
2008	12-May	22-May	30-May	18	20-May	26-May	6-Jun	17
2009	16-May	24-May	21-Jun	36	28-Apr	22-May	30-May	32
2010	15-May	22-May	7-Jun	23	20-May	28-May	8-Jun	19
2011	7-May	16-May	22-May	15	14-Apr	13-May	15-Jun	62
2012	5-May	20-May	31-May	26	13-May	23-May	3-Jun	21
2013	10-May	15-May	22-May	12	17-May	19-May	22-May	5
2014	7-May	18-May	28-May	21	2-May	9-May	25-May	23
2015	7-May	17-May	26-May	19	14-May	18-May	21-May	7
2016	30-Apr	9-May	21-May	21	17-May	22-May	28-May	11
2017	5-May	19-May	31-May	26	22-Apr	20-May	30-May	38
10-Yr MEDIAN	**7-May**	**18-May**	**29-May**	**21**	**13-May**	**21-May**	**30-May**	**20**
10-Yr MIN	**30-Apr**	**9-May**	**21-May**	**12**	**14-Apr**	**9-May**	**21-May**	**5**
10-Yr MAX	**16-May**	**24-May**	**21-Jun**	**36**	**20-May**	**28-May**	**15-Jun**	**62**

1.2. Adult Fish Passage.

1.2.1. Adult Fish Facilities. Adult fish passage facilities at Little Goose Dam are comprised of one fish ladder on the south shore, two south shore entrances, a powerhouse collection system, north shore entrances with a transportation channel underneath the spillway to the powerhouse collection system, and auxiliary water supply system. The powerhouse collection system is comprised of two downstream facing entrances into the spillway basin on the north end of the powerhouse, and a common transportation channel. The north shore entrances are comprised of two downstream facing entrances into the spillway basin. The auxiliary water is supplied by three turbine-driven pumps that pump water from the tailrace into the distribution system for the diffusers. Additional water is supplied to the auxiliary water supply system from the juvenile fish facilities primary dewatering structure. Maintenance is scheduled for January–February to minimize impacts on upstream migrants.

1.2.2. Adult Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult fish facilities are operated year-round. Adult salmon, steelhead, shad, and lamprey are counted per the schedule in **Table LGS-3**, and data are posted daily at: www.fpc.org/adultsalmon_home.html. Sturgeon and bull trout are relatively infrequent and are reported in *Miscellaneous Fish Counts* and in the *Annual Fish Passage Report*.

1.2.2.2. Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage defined in **Table LGS-4**. Time-of-day (diel) distributions of adult salmonids at Little Goose Dam fishway entrances and exits are shown in **Figure LGS-2**.

Table LGS-3. Little Goose Dam Adult Fish Counting Schedule, 3/1/2018 – 2/28/2019.

Count Period	Counting Method and Hours *
April 1 – October 31	Visual 0500–2100 hours (PDT)

*PST=Pacific Standard Time. PDT=Pacific Daylight Time (in effect during Daylight Saving Time 3/11/18-11/4/18).

Table LGS-4. Little Goose Dam Adult Fish Count Period and Peak Passage Timing (based on yearly counts from 1970 through the most recent count year).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Apr 1 – Jun 15	Apr 20	Jun 1
Summer Chinook	Jun 16 – Aug 15	Jun 16	Jul 12
Fall Chinook	Aug 16 – Oct 31	Sep 3	Sep 30
Steelhead	Apr 1 – Oct 31	Sep 6	Oct 14
Sockeye	Jun 15 – Oct 31	Jun 24	Jul 25
Lamprey	Apr 1 – Oct 31	Jul 6	Aug 20

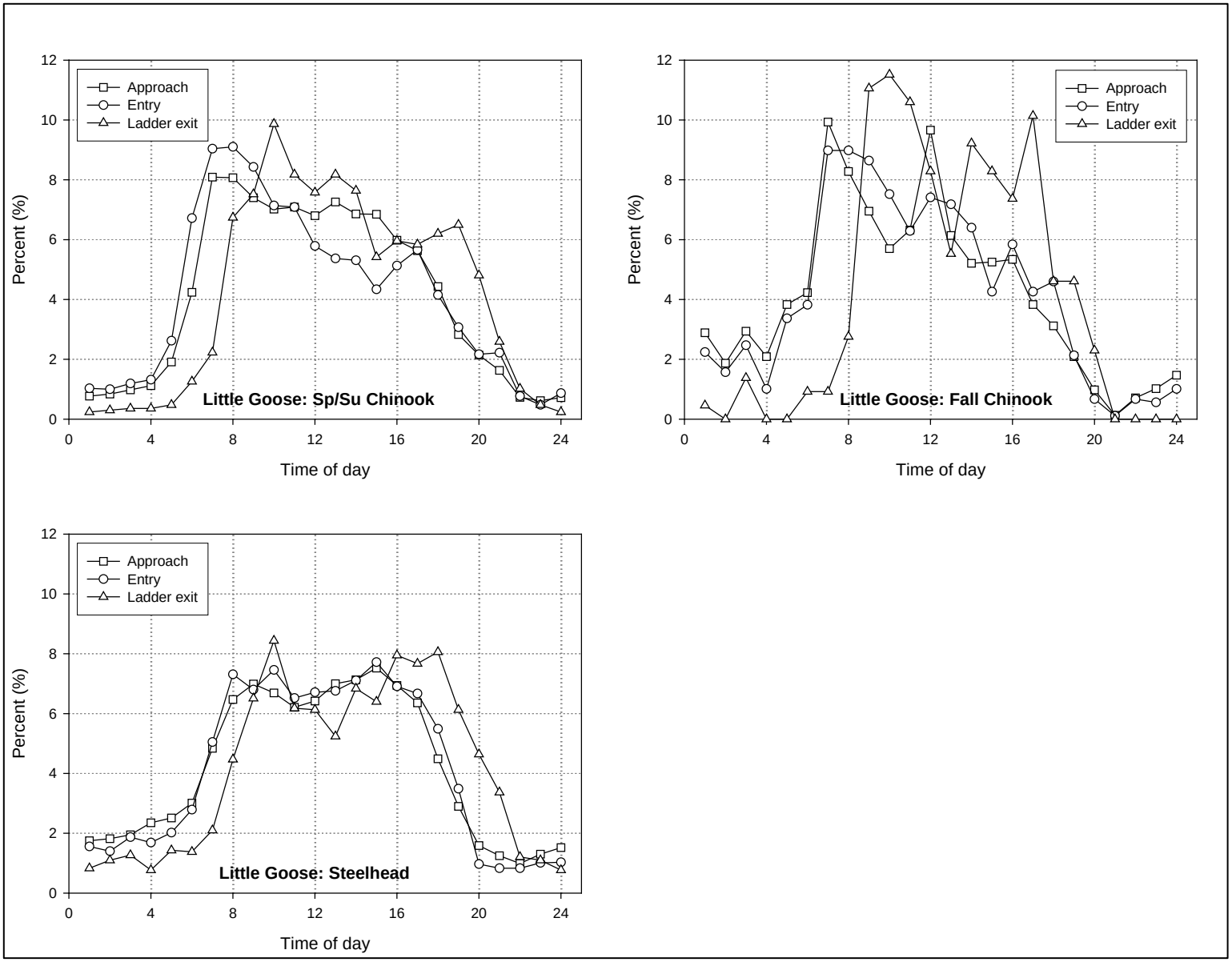


Figure LGS-2. Diel Distribution of Adult Salmonids at Little Goose Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*).
pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATIONS

2.1. General.

2.1.1. Yearly special operations related to research are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

2.1.2. Research, non-routine maintenance activities, and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. These distances are approximate and will be updated after data are collected and analyzed to determine the threshold for adverse impacts to adult fish behavior. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

2.1.3. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed immediately following the incident of steps taken to correct the situation. On a monthly basis, as necessary, the project biologist will provide FPOM a summary of any emergency actions undertaken.

2.1.4. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least two weeks in advance, unless it is deemed an emergency (see also **FPP Chapter 1 - Overview** for coordination guidance).

2.2. Spill Management.

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the Fish Passage Plan as **Appendix E**. Spill at Little Goose will be distributed in spill patterns defined in **Table LGS-7** through **LGS-10**.

2.2.2. Involuntary spill is the result of river flow above powerhouse capacity, insufficient load (lack of load), turbine unit outages (forced or scheduled), or failure of a key component of the juvenile fish passage facility which forces spill to provide juvenile fish passage.

2.2.3. Total dissolved gas (TDG) is monitored at Little Goose Dam during the periods defined in **Table LGS-1**, pursuant to the Corps' annual *TDG Monitoring Plan* and *Dissolved Gas Monitoring Plan of Action 2015-2018*.[1]

2.2.4. During years when fish passage spill is provided at Little Goose and Project Biologists or researchers observe an extraordinary congregation of juvenile fish delaying in the forebay, they will notify NOAA Fisheries and CENWW to request a fish flush spill (FFS) that evening. The FFS request will be for up to three hours from 2000–2300 hours, for up to 50% of river flow during those hours, using a uniform spill pattern to minimize TDG.

[1] TDG Monitoring Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/. TDG Monitoring Plan 2015-2018: pweb.crohms.org/tmt/wqnew/tdg_monitoring/2015-18.pdf

2.3. Operating Criteria – Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance (December 16–March 31*).

**In 2018, the bypass system will begin operations on March 1, as described below.*

2.3.1.1. Forebay Area and Intakes.

i. Remove debris from forebay and gatewell slots.

ii. Rake trashracks just prior to the operating season.

iii. Measure drawdown in gatewell slots after cleaning trashracks with ESBSs installed.

iv. Inspect and repair gatewell dip net as needed.

2.3.1.2. ESBS, Flow Vanes, and VBS. *In 2018, install screens by March 1 in at least the first three operational units in the priority order (**Table LGS-5**). Additional units may be screened prior to April 1 if maintenance schedules allow.*

i. After ESBSs are removed for winter maintenance, inspect for juvenile salmonid mortalities and all other incidental fish mortalities. Inspect ESBSs within a week after removal, or as soon as practical. All mortalities are to be counted, or otherwise estimated, for each ESBS and reported to CENWW-OD-T.

ii. Maintenance completed on all screens.

iii. Inspect ESBSs prior to installation and operate debris cleaner (dogged off on deck) to ensure proper operation.

iv. Log results of trial run.

v. Inspect VBSs with underwater video camera at least 1x/year; repair as needed.

vi. Inspect flow vanes to make sure they are in good condition and all surfaces smooth. Repair as needed.

2.3.1.3. Collection Channel.

i. Water-up valve capable of operating when needed.

ii. Orifice lights operational.

iii. Orifices clean and valves operating correctly.

iv. Orifice cycling and air backflush system operational.

2.3.1.4. Transportation Facilities.

i. Flume switch gate maintained and in good operating condition.

ii. Flume interior smooth with no rough edges.

iii. Perforated plate smooth with no rough edges.

iv. Wet separator and fish distribution system maintained and ready for operation as designed.

v. Brushes and screens on crowders in good condition with no holes in screens or rough edges.

vi. Crowders maintained, tested, and operating correctly.

vii. All valves, slide gates, and switch gates maintained and in good operating condition.

viii. Retainer screens in place with no holes in screens or sharp wires protruding.

ix. Barge and truck loading pipes free of debris, cracks, or blockages and barge loading boom maintained and tested.

x. All sampling equipment should be maintained and in good operating condition prior to watering up the facilities. *In 2018, the bypass system will begin operations on March 1.*

xi. Maintain juvenile PIT-tag system as required (see "*Columbia Basin PIT-tag Information System, General Gate Maintenance and Inspection, Walla Walla District*", February 2003). Coordinate with PSMFC.

xii. Mini- and midi-tanks maintained and in good operating condition.

2.3.1.5. Dewatering Structure and Flume.

i. Inclined screen clean and in good condition with no gaps between screen panels or damaged panels.

ii. Cleaning brush and air burst systems maintained and operating correctly.

iii. Overflow weirs should be maintained, tested and operating correctly.

iv. All valves operating correctly.

v. Baffle boards under inclined screen in good condition.

vi. Flume interior should be smooth with no rough edges.

2.3.1.6. Avian Predation Areas (Forebay and Tailrace). Inspect bird wires, water cannon, and other deterrent devices and repair or replace as needed. Where possible, install additional bird wires or other deterrent devices to cover areas of known avian predation activity. Prepare avian abatement contract as needed.

2.3.1.7. Maintenance Records. Record all maintenance and inspections.

2.3.2. Juvenile Fish Passage Season (April 1*–December 15).

In 2018, the bypass system will begin operations on March 1, as described below.

Operate from April 1 through October 31 for juvenile bypass, collection, and transport *(except in 2018 when bypass operations begin March 1),* and from November 1 through December 15 for adult fallbacks. Operate according to criteria defined below and in the *Corps of Engineers Juvenile Fish Transportation Plan* (**Appendix B**). The transport program may be revised in accordance with the ESA Section 10 permit and NOAA Fisheries Biological Opinion.

2.3.2.1. Forebay Area and Intakes.

i. Remove debris from forebay. All floating debris will be removed whenever two acres of debris accumulates in spring and one acre in summer or fall.

ii. Inspect gatewell slots daily (preferably early in day shift) for debris, fish buildup, and contaminating substances (particularly oil). Clean gatewells before they become 50% covered with debris. If the volume of debris precludes the ability to keep the gatewell at least 50% clear, they should be cleaned at least once daily. If orifice flow or fish conditions are observed that indicate an orifice may be obstructed with debris, the orifice will be closed and backflushed to remove the obstruction. If the obstruction cannot be removed, the orifice will be closed and the alternate orifice for that gatewell slot operated. If both orifices become obstructed or plugged with debris the turbine unit will not be operated until the gatewell and orifices are cleared of debris.

iii. If a visible accumulation of contaminating substances (e.g., oil) is detected in a gatewell and cannot be removed within 24 hours, the gatewell orifices shall be closed immediately and the turbine unit shut down within one hour until the material has been removed and any problems corrected. A preferred method for removing oil from the water surface is to install absorbent (not adsorbent) socks, booms, or pads capable of encapsulating the material, and tie off with a rope for later disposal. Action should be taken as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow fish to exit the gatewell. Orifices shall not be closed for longer than 48 hours.

iv. Log drawdown differentials in bulkhead slots at least once a week April 1–June 30, *except in 2018 starting on March 1,* and biweekly (once every two weeks) for the remainder of the operating season.

v. Remove debris from forebay and trashracks as necessary to maintain less than 1' of additional drawdown in gate slots (relative to drawdown with a clean screen). Additional raking may be required when heavy debris loads are present in the river or when fish condition indicates an issue.

vi. Coordinate cleaning efforts with staff operating juvenile collection facilities.

vii. Dip bulkhead gatewell slots to remove fish prior to installing bulkhead for dewatering a bulkhead slot.

2.3.2.2. ESBS, VBS, and Operating Gates. *In 2018, install screens by March 1 in at least the first three operational units in the priority order (**Table LGS-5**). Additional units may be screened prior to April 1 if maintenance schedules allow.*

i. Operate ESBSs with flow vanes attached to screen.

ii. Operate ESBSs with debris cleaners in automatic mode. Set cleaning frequency as required to maintain clean screens and good fish passage condition. Change cleaning frequency as needed.

iii. Monitor ESBS operating status regularly throughout work shifts via the ESBS operating computer display located in the control room.

iv. Inspect ESBS, cleaning brush control panels located in the orifice gallery for cleaning brush failures (trouble lights) at least once per day throughout the entire fish passage season.

v. Manually operate ESBS cleaning brush monthly during the fish passage season April through December 15 (more frequently if required)*, except in 2018 when bypass operations begin March 1,* to verify proper and complete up-and-down brush travel and to monitor and record amperage draws.

vi. Inspect ESBS by underwater video during turbine unit annual maintenance (more frequently if required). Thoroughly inspect VBSs at the same time.

vii. Inspect at least two VBSs in two different turbine units by means of underwater video between spring and summer. Both turbine units should have been operated frequently during the spring. If a debris accumulation is noted, inspect other VBSs and clean debris as necessary.

viii. If an ESBS is damaged or fails during juvenile fish passage season, follow procedures defined in **section 3.2.2**. In no case should a turbine unit be operated with a missing or a known non-operating or damaged ESBS, except as noted.

ix. Up to half of the ESBSs may be pulled after October 1 for maintenance as long as unscreened turbine units are not operated.

x. At the end of the season, make a formal determination on the adequacy of ESBS bar screen panels and debris cleaner brushes, and replace components as necessary.

xi. Log VBS head differentials at least once per week April 1–June 30 (more frequently if required)*, except in 2018 beginning on March 1,* and biweekly (once every two weeks) for the remainder of the operating season. When a head differential of 1.5' is reached, the respective turbine unit should be operated at a reduced loading (≤ 110 MW) to minimize loading on the VBS and potential fish impingement until the VBS can be cleaned. Clean VBSs as soon as possible after a 1.5' head differential is reached.

xii. Inspect at least two VBSs in two different turbine units between spring and summer. Both units should have been operated frequently in the spring. If debris accumulation is noted, inspect other VBSs and clean debris as necessary.

xiii. If extreme cold weather is forecasted (< 20°F for ≥ 24 hours) between Thanksgiving and December 15, screens may be removed. The project will first request special permission from CENWW-OD-T. CENWW-OD-T will inform NOAA Fisheries and FPOM of the action. NOAA's National Weather Service forecast for Little Goose Dam is available at: forecast.weather.gov/MapClick.php?lat=46.5874&lon=-118.0261

2.3.2.3. Collection Channel.

i. Orifices clean and operating. Operate at least one orifice per gatewell slot (preferably the north orifice). If the project is operating within the Minimum Operating Pool (MOP), additional orifices may be operated to maintain a full collection channel. If orifices must be closed to repair any part of the facility, do not close orifices in operating turbine units with ESBSs in place for longer than 5 hours. If possible, keep to less than 3 hours. Reduce turbine unit loading to the lower end of the 1% efficiency range if deemed necessary by the Project Biologist. Monitor fish conditions in gatewells hourly or more frequently during orifice closure periods.

ii. Orifice lights operational and operating on open orifices. Orifice lights and area lights may be turned off the evening before channel is dewatered at end of season (dewatering occurs on December 16 or later) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

iii. Replace all burned out orifice lights within 24 hours of notification. Orifice lights shall remain lighted 24 hours/day.

iv. Orifice jets hitting no closer than 3' from back wall, collection channel full.

v. Orifice valves are either fully open or closed.

vi. Backflush orifices at least once per day and more frequently if required. During periods of high fish and debris passage, April 1 through July 31 (*except in 2018 when bypass operations begin March 1)*, orifices should be inspected and backflushed three times per 24 hours, or more frequently as determined by the Project Biologist to keep orifices clean. If debris is causing continual orifice plugging problems in a particular turbine unit gatewell, the respective turbine unit generation may be restricted to the lower end of the 1% turbine efficiency range to minimize orifice plugging problems. Little Goose does not currently have an automatic backflush system in operation.

vii. Water-up valve capable of operating when needed.

2.3.2.4. Transportation Facilities.

i. Operate wet separator and fish distribution system as designed.

ii. Crowder screen brushes should be maintained in good operating condition with no holes or sharp edges on crowder screens.

iii. Inspect raceway and tank retainer screens to make sure they are clean with no holes or protruding wires.

iv. Barge and truck loading pipes and related equipment free of debris, cracks, or blockages, and in good condition. Barge loading boom in good operating condition.

v. Inform PSMFC, in advance if possible, of situations that cause the PIT-tag system to become inoperable (e.g. power outages) or that could result in confounding the interpretation of PIT-tag data (e.g. bypassing fish from raceways to the river, operating in primary bypass mode without an operational full-flow detector, emergency dewaterings).

2.3.2.5. Dewatering Structure.

i. Trash sweep and air burst systems operating correctly. The frequency of screen cleaning should be set as necessary to maintain a clean screen.

ii. Hand clean trapezoidal section as often as required to maintain in clean condition, with a minimum of once per day.

iii. Check overflow weirs to make sure they are operating correctly, perform maintenance as required.

iv. There should be no gaps between screen panels or damaged panels in the inclined screen. Screen panels in place and tightly secured.

v. Lights at the dewatering structure should be turned off at night, unless needed for personnel access, to encourage fish to move downstream volitionally.

2.3.2.6. Avian Predation Areas (Forebay and Tailrace).

i. Bird wires and other avian deterrent devices should be monitored to ensure good condition, and any broken wires or devices replaced as soon as possible.

ii. Harassment program in place to deter avian predation in areas actively used by birds and not covered by bird wires or other devices.

iii. Project biologists shall routinely monitor project areas to determine areas of active avian predation and, if possible, adjust the harassment program to cover these areas or install bird wires or other deterrents to discourage avian predation.

2.3.2.7. Adjustable Spillway Weir (ASW).[2]

2.3.2.7.a. High Crest (ASW-Hi): Spring spill for fish passage will start with the ASW in Bay 1 in high crest elevation 622 msl (approximate flow 7 kcfs) and spill distributed in patterns for "Spring Spill" (**Table LGS-7**) or "ASW-Hi 30% Spill" (**Table LGS-8**). High crest will be maintained the entire spill season unless conditions described below are met.

2.3.2.7.b. Low Crest (ASW-Lo): If flow increases above 85 kcfs (i.e., during the spring freshet) and the criteria in **b.1** below are met, the ASW will be changed to low crest elevation 618 msl (approximate flow 11 kcfs) and spill distributed in patterns for "Spring Spill" (**Table LGS- 7)**.

b.1. The crest change from high to low will occur when the current STP forecasts inflow above 85 kcfs for at least 3 consecutive days, or if observed conditions indicate flow will exceed 85 kcfs before the next STP is issued, as determined by NWW Water Management.

b.2. The ASW will be changed back to high crest when observed day average project outflow drops below 85 kcfs and forecasted inflow is below 85 kcfs for at least 3 consecutive days.

2.3.2.7.c. No ASW (Bay 1 Closed): On or after August 1, when observed day average project outflow drops below 35 kcfs and forecasted inflow is below 35 kcfs for at least 3 days, the ASW will be closed for the remainder of the spill season and spill distributed in "Uniform" patterns with No ASW (**Table LGS-10**). The ASW will be closed after RCC issues the teletype and coordinated through CENWW-OD-T. The ASW will be closed no earlier than August 1 to avoid impacts to subyearling migration even if the low flow criteria are achieved prior to August 1, unless an adult passage delay is observed or if necessary due to unit operational constraints at low flow. *Closing the ASW prior to August 1 will be coordinated through FPOM by CENWW-OD-T.*

[2] Spillway weirs provide surface passage routes via spillbay(s). Temporary, or Top, Spillway Weirs (*TSW*s) at Little Goose, McNary and John Day dams can be installed, uninstalled and moved between bays using the gantry crane. Removable Spillway Weirs (*RSW*s) at Lower Granite, Lower Monumental and Ice Harbor dams are "removed" by controlled descent to the bottom of the forebay.

2.3.2.8. Inspection and Record Keeping.

i. Inspect fish facilities at least once every 8 hours. Inspect all facilities according to fish facilities monitoring program.

ii. Record all maintenance and inspections.

2.4. Operating Criteria - Adult Fish Facilities.

2.4.1. Adult Facilities - Winter Maintenance (January 1 – end of February).

2.4.1.1. Inspect all staff gauges and water level indicators; repair and/or clean as necessary.

2.4.1.2. Dewater the ladder and inspect all dewatered sections of fish facilities for projections, debris, or plugged orifices which could injure fish or impede fish passage up the ladder. The fish ladder exit trashrack must have smooth surfaces where fish pass, and must have downstream edges that are adequately rounded or padded. A spare trashrack should be on hand for use as necessary. Inspect all diffuser gratings and chambers, and the fallout fence, annually by dewatering or by using divers or video inspection techniques. All diffuser gratings and chambers are to be dewatered and physically inspected at least every 3 years. Repair deficiencies.

2.4.1.3. Inspect for and clean debris from the fish ladder exit. The trashrack and picketed leads must be clean and installed correctly.

2.4.1.4. Calibrate all water level measuring devices as necessary for proper facility operations.

2.4.1.5. Inspect all spill gates and ensure that they are operable.

2.4.1.6. Fish pumps maintained and ready for operation.

2.4.1.7. Inspect ladder netting and repair prior to fish passage season.

2.4.2. Adult Fish Passage Season (March 1 – December 31).

***Note*:** Lower Monumental pool may be operated within MOP (forebay range 537'–538') as part of the Corps' efforts to improve migration conditions for juvenile salmonids. This may result in some of the Little Goose adult fishway entrances bottoming out on their sills prior to reaching criteria depths. Continuous operation at MOP may also result in increased pumping head on the auxiliary water supply pumps, decreasing the amount of water pumped.

2.4.2.1. Fishway Ladder. Water depth over weirs: 1' to 1.3'.

2.4.2.2. Counting Window. The Little Goose counting window slot is fixed at a width of no less than 18”. All equipment should be maintained and in good condition. The counting window and backboard should be cleaned as needed to maintain good visibility.

2.4.2.3. Fishway Entrance Head. Head range: 1' – 2' at all entrances.

2.4.2.4. North Shore Entrances (NSE-1&2). Top of gate elev. on sill = 529'.

i. Operate both downstream gates.

ii. Weir depth: 6' or greater below tailwater.

2.4.2.5. North Powerhouse Entrances (NPE-1&2). Top of gate elev. on sill = 532'.

i. Operate both downstream gates.

ii. Weir Depth: 7' or greater below tailwater (tailwater permitting). At tailwater below elevation 539', entrance weirs should be on sill.

2.4.2.6. Floating Orifice Gates (FOGs). No FOGs will be operated. Inspect fish fallout fence for debris buildup, holes, etc.

2.4.2.7. South Shore Entrances (SSE-1&2). Top of gate elev. on sill = 529'.

i. Operate both gates.

ii. Weir depth: 8' or greater below tailwater.

2.4.2.8. Channel Velocity. 1.5' – 4' per second.

i. Adult collection channel water velocities must be between 1.5 and 4 feet per second. This is the optimum velocity for returning adult salmon and steelhead to migrate upstream through the fishway. Velocity readings will be included in required fishway inspections and reported in weekly and annual reports.

ii. Surface water velocities will be measured in the open access area near the south shore weir / fish entrance. The surface velocity will be measured using a piece of woody debris (stick, bark) or water bubble timed over a marked fixed distance. The measurement of the water velocity at this location typifies the velocity conditions throughout the length of the channel.

iii. Subsurface water velocity will be measured and reported once per month using an underwater flowmeter. The average velocity will be calculated using several measurements taken at various depths across the width of the channel that best represents the average subsurface flow. The measurements will be taken at a location in the channel that represents the overall flow characteristic.

2.4.2.9. Tunnel Lights. Lights in the tunnel section under the spillway shall be on during fish passage season.

2.4.2.10. Head on Trashracks.

i. Ladder exit maximum head of 0.5'.

ii. Picketed leads maximum head of 0.3'.

iii. Trashrack and picketed leads installed correctly.

2.4.2.11. Staff Gauges and Water Level Indicators. All staff gauges should be readable at all water levels encountered during the fish passage period. Repair or clean as necessary.

2.4.2.12. Facility Inspections.

i. Powerhouse operators shall inspect facilities once per day shift and check computer monitor information at least once during each back shift.

ii. Project biologists shall inspect facilities three times per week. Inspect all facilities according to fish facilities monitoring program.

iii. Picketed leads shall be checked during all inspections to ensure they are clean and in the correct position (all the way down and vanes in line with flow).

iv. Project personnel shall check calibration of fishway control system twice per month to ensure that it is kept within calibration. This may be done as part of routine fishway inspections.

v. Inspect fishways daily for foreign substances (particularly oil). If substances are found, corrective actions should be undertaken immediately.

vi. Record all inspections.

2.4.2.13. Fishway Temperature Monitoring. From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits.

i. Temperature monitors shall be placed within 10 meters of all shore-oriented entrances and exits.

ii. If possible, the entrance monitor shall be within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers to allow for sufficient mixing with surface water.

iii. The exit monitor shall be within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

iv. If an existing temperature monitoring location is proposed to be used for either the exit or entrance, it shall be verified that the site accurately reflects water temperature within 10 meters of the entrance or exit.

v. Project Fisheries will submit temperature data to the Fish Passage Center (FPC) on a weekly basis for posting online at: www.fpc.org/river/Q_ladderwatertempgraph.php.

2.4.2.14. Adult Fish Ladder Exit Pool Cooling Pump. Operate forebay exit pool cooling pump that sprays upstream of the fish ladder exit to enhance conditions for adult fish exiting

the ladder and to supplement cooler water throughout the ladder. The water supply for the manifold at the exit pool originates from an added forebay pump with intake at elevation 543' in the forebay, which is 90' below the MOP range (633-638').

i. Begin operation of exit pool cooling pump after June 1 and when the forebay temperature at 0.5 meters exceeds 64°F (18°C) at any time. Forebay temperature string data are online at: http://pweb.crohms.org/ftppub/water_quality/tempstrings

ii. Continue this operation until September 1 and until water temperature at the 0.5m forebay string is < 68°F (20°C) for 3 consecutive days; at that time, discontinue pump operation until water temperature has declined below 64°F and then use criteria as described above to re-start the pump operation.

iii. The pump may be turned on or off at the Project Biologist's discretion if adult passage delays are observed either in the forebay or within the ladder, and operation of the pump is believed to influence the adult passage issue.

2.5. Fish Facility Monitoring & Reporting.

2.5.1. Project biologists shall inspect fish passage facilities at frequencies listed in the juvenile and adult fish facilities operating criteria sections.

2.5.2. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31 that summarize project operations for Friday through Thursday and email to CENWW-OD-T by noon the following Monday. Reports shall provide an overview of how project and fish passage facilities operated during the week and evaluate resulting fish passage conditions, and include:

i. Any out-of-criteria situations observed and corrective actions taken;

i. Any equipment malfunctions, breakdowns or damage along with a summary of resulting repair activities;

ii. Adult fishway control calibrations;

iii. ESBS and VBS inspections;

iv. Any unusual activities at the project that may have affected fish passage.

2.5.3. Annual Reports. Project biologists shall prepare a draft annual report by February 10 and a final report by March 15 summarizing the operation of the project fish passage facilities for the previous year. The annual report shall also include a description of all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities.

2.5.4. Project Inspections. Project biologists also inspect project facilities once per month and during dewaterings for the presence of zebra and Quagga mussels. Biologists shall provide a report to CENWW-OD-T on a monthly basis summarizing mussel inspections.

3. FISH FACILITIES MAINTENANCE

3.1. Dewatering & Fish Handling.

3.1.1. Project biologists should be present to provide guidance at all project activities that may involve fish handling. Dewatering (also referred to as "unwatering") shall be accomplished pursuant to approved *Dewatering Guidelines and Fish Salvage Plans* (**Appendix F**). *Dewatering Plans*[3] were reviewed and revised in 2011 to ensure they comply with **Appendix F**. When river temperatures are ≥ 70°F, all adult fish handling will be coordinated through CENWW-OD-T.

3.2. Maintenance - Juvenile Fish Facilities.

3.2.1. Scheduled Maintenance. Scheduled maintenance of juvenile facilities is conducted throughout the year. Long-term maintenance or modifications of facilities that require them to be out of service for extended periods of time are conducted during the winter maintenance period (December 16–March 31) *[NOTE: in 2018, bypass operations will begin March 1, as described in **sections 2.3.1 and 2.3.2**]*. During fish passage season, parts of the facilities are maintained on a daily, weekly, or longer interval to keep them in proper operating condition.

3.2.2. Unscheduled Maintenance. Unscheduled maintenance is the correction of any situation that prevents facilities from operating according to criteria or that will impact fish passage or survival.

3.2.2.1. Notification/Reporting. Maintenance of facilities such as ESBSs, which sometimes break down during fish passage season, will be carried out as described below. In these cases, repairs will be made as prescribed and CENWW-OD-T will be notified as soon as possible after it becomes apparent that repairs are required. The Operations Manager has the authority to initiate work prior to notifying CENWW-OD-T if a delay of the work will result in an unsafe situation for people, property, or fish. Unscheduled maintenance that will have a significant impact on fish passage shall be coordinated with NOAA Fisheries and FPOM on a case-by-case basis by CENWW-OD-T. Information required by CENWW-OD-T includes:

i. Description of the problem;

ii. Type of outage required;

iii. Impact on facility operation;

iv. Length of time for repairs;

v. Expected impacts on fish passage and proposed measures to mitigate them.

3.2.2.2. ESBS. The ESBSs are inspected periodically throughout the juvenile migration season with a video monitoring system. If a screen is found damaged or malfunctions at any time it will be removed and either replaced with a spare ESBS or repaired and returned to service. A turbine unit shall not be operated during the juvenile bypass season with a missing, known damaged or non-operating ESBS (except as detailed below). If an ESBS fails on a weekend or at night when maintenance crews are not available, the respective turbine

[3] Project Dewatering Plans are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/

unit will be shut down and generation switched to another fully screened unit. If all screened turbine units are in service, water may be spilled until the effected ESBS can be removed and repaired or replaced.

3.2.2.2.a. If an ESBS screen cleaner fails after 1400 hours on a regular workday or any time on a weekend, and taking the unit out of service would result in spilling above TDG state standards, the unit may be operated with the failed screen cleaner up to a maximum of 110 MWs if there is evidence that the ESBS will not plug with debris (e.g., a lack of debris in the gatewell and along the face of the powerhouse). Project personnel will pull and replace the screen the next morning, weekday or weekend inclusive. If the screen cannot be pulled and repaired the next morning, the unit will be removed from service until the screen can be repaired. If there is evidence that fish are being injured under this operation, by either observing injured fish in the gatewells or injured fish appearing on the separator, the turbine unit will be removed from service immediately. This operation will not take place when daily average river flows are less than total powerhouse capacity and the turbine unit will not be operated during power peaking operations where turbine units are being turned on and off.

3.2.2.3. Gatewell Orifices. Each gatewell has two 12" orifices (gatewell slot 1A has one 14" test orifice) with air operated valves to allow fish to exit the gatewell. Under normal operation, at least one orifice per gatewell is operated. To minimize blockage from debris, orifices should be backflushed every day. If an air valve fails, the valve should be closed and the alternate orifice and air valve for that gatewell operated until repairs can be made. If both orifices are blocked with debris, damaged, or must be kept closed, the turbine unit will be taken out of service until repairs can be made. If repairs are to take longer than 48 hours, juvenile fish will be dipped from the gatewell with a gatewell dip basket.

3.2.2.4. Dewatering Structure. The dewatering structure acts as a transition from the collection channel to the corrugated metal flume. An inclined screen allows excess water to be bled off, with all fish and remaining water transitioning into the corrugated metal flume. The excess water can be either discharged into the river or added to the adult passage facilities auxiliary water supply system, and is also used as the water supply for the transportation facilities. The dewatering structure contains a trash sweep for cleaning the inclined screen of impinged debris. If the trash sweep breaks and interferes with juvenile fish passage through the structure or if the inclined screen is damaged, an emergency bypass system at the upstream end of the dewatering structure can be used, if required, to bypass juveniles while repairs are made. Operation of the emergency bypass system requires the juvenile bypass system to be dewatered and stoplogs inserted at the upstream end of the inclined screen. During this setup process, turbine units may be operated at the lower end of the 1% efficiency range. The emergency bypass is then opened and the bypass system operated with six gatewell orifices open. Orifices will then need to be routinely rotated, at a minimum of every 2 hours, to allow juveniles to emigrate from all of the gatewells. During any orifice closure, gatewells shall be monitored hourly by project personnel for signs of fish problems or mortality. Orifices shall not be closed for longer than 5 hours in an operating turbine unit with ESBSs in place. During periods of high fish passage, orifice closure times may need to be less than 5 hours depending on fish numbers and condition. If orifices are

closed, gatewells shall be monitored hourly. Spill may be used as an alternative avenue for fish passage during a collection channel outage.

3.2.2.5. Bypass Flume. The corrugated metal flume transports juveniles to either the transportation facilities or to the river below the project. If there is a problem with the flume that interferes with its operation, an emergency bypass system at the upper end of the flume can be opened and all of the fish in the bypass system diverted to the river below the project through a 30" pipe while repairs are made.

3.2.2.6. Transportation Facilities. Transportation facilities can be operated either to collect and hold juveniles for the transportation program or to bypass fish back to the river. If part of the facility malfunctions or is damaged, efforts will first be made to bypass fish around the damaged area. If this is not possible, fish will be bypassed around the transportation facility.

3.3. Maintenance - Adult Fish Facilities.

3.3.1. Scheduled Maintenance. Scheduled maintenance that requires a facility to be dewatered or maintenance that may have a significant effect on fish passage will be done during the winter maintenance period (January–February). Maintenance of facilities that will have no effect on fish passage may be conducted at any time. When facilities are not being maintained during the winter maintenance period, they will be operated according to normal criteria unless otherwise coordinated with NOAA Fisheries and other FPOM participants.

3.3.2. Unscheduled Maintenance.

3.3.2.1. Notification/Reporting. Unscheduled maintenance that will significantly affect the operation of a facility will be coordinated with NOAA Fisheries and other FPOM participants. Coordination procedures for unscheduled maintenance of adult facilities are the same as for juvenile facilities (**section 3.2.2**). If part of a facility malfunctions or is damaged during the fish passage season and the facility can still be operated within criteria without any detrimental effects on fish passage, repairs may not be conducted until the winter maintenance period or until fewer numbers of fish are passing the project. If part of a facility is damaged or malfunctions that may significantly impact fish passage, it will be repaired as soon as possible.

3.3.2.2. Fish Ladder and Counting Station. If any part of the ladder fails or is blocked with debris during the fish passage season, efforts will first be made to correct the problem without dewatering the ladder. Trashracks, picket leads, and counting stations can sometimes be repaired or maintained without dewatering the ladder. The decision to dewater the ladder and make repairs during the fish passage season or wait until the winter maintenance period will be made after coordination with the fish agencies and tribes.

3.3.2.2.a. Hazardous Materials Spill. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.

3.3.2.3. Auxiliary Water Supply (AWS). Three turbine-driven pumps on the south shore supply auxiliary water for the fish ladder and the powerhouse collection system. All three pumps are required for normal operation. Approximately 150–180 cfs of excess water from the juvenile fish passage facilities is also added to the auxiliary water supply system. If one, two, or all three pumps fail, the fishway will be adjusted in the following manner to get the best fish passage conditions possible until repairs can be made:

i. First, increase the speed of the operable pump(s).

ii. As necessary, then close NSE-2 and NPE-2 and operate NPE-1 to provide the required 1' to 2' head differential.

iii. If the desired head differential cannot be maintained at a depth of 5' or greater, then NSE-1 should be raised until a depth of 5' below tailwater is reached.

iv. If the head differential cannot be maintained at this point, SSE-1 and -2 should be raised at 1' increments until 6' below tailwater is reached.

v. If the head differential still cannot be maintained, the transportation channel to the north shore should be bulkheaded off at the end of the powerhouse collection channel. Next, NPE-1 should be closed and the powerhouse collection channel bulkheaded off at the junction pool. SSE-1 and 2 should then be operated as deep as possible to maintain the head, but not shallower than 6' regardless of the head.

3.3.2.4. Fishway Entrances. The fishway entrances consist of main entrance weirs with hoists and automatic controls. If any of the automatic controls malfunction, the weirs can be operated manually by project personnel and kept within criteria. If there is a further failure which prevents an entrance from being operated manually, the weirs can usually be left in a lowered position while repairs are being conducted or the entrance closed and the water redistributed to other entrances while repairs are made.

3.3.2.5. Diffuser Gratings. Diffuser chambers for providing auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to ensure they are in place. These inspections are done either by dewatering and physically inspecting the diffuser gratings, or by using underwater video cameras, divers, or other methods. Diffuser gratings may come loose during the fish passage season due to a variety of reasons. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings. If a diffuser grating is known or suspected to have moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway. Coordination of the problems should begin immediately through the established unscheduled maintenance coordination procedure (**section 3.2.2**). If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and

tribes through the established coordination procedure. Repairs shall be made as quickly as possible unless otherwise coordinated.

4. TURBINE UNIT OPERATION & MAINTENANCE

4.1. Turbine Unit Priority Order.

4.1.1. From March 1–November 30, turbine units will be operated in the order of priority defined in **Table LGS-5** in order to enhance adult and juvenile fish passage. If a turbine unit is out of service for maintenance or repair, the next unit in the priority order shall be operated.

4.1.1.1. During spring spill, April 3–June 20, units will be operated in a modified north order to prioritize flow through north units, as defined in **Table LGS-5.**

4.1.2. Unit priority order may be coordinated differently for fish research, construction, or project maintenance activities.

4.1.3. If more than one unit is operating, discharge will be maximized through the southernmost unit (i.e., operated in the upper 1% range) starting with Unit 1 to the extent possible, *except during spring spill when the priority order will start with northernmost units*. See **section 4.2.1.3** below for more information.

Table LGS-5. Little Goose Dam Turbine Unit Priority Order.

Season	Unit Priority Order
March 1 – November 30* (**except as noted below for Spring Spill*) Fish Passage Season	1[a], 2, 3, 4, 5, 6 *Maximize discharge through highest priority unit*
April 3 – June 20 Spring Spill North Priority Order	6, 4, 1, 5[b], then 2 or 3 any order
December 1 – end of February Winter Maintenance Period	Any Order

a. Unit 1 special operation (section 4.2.1.3): *[NOT applicable during spring spill North priority order.]* When the ASW in Bay 1 is open and total outflow > 38 kcfs, Unit 1 is operated in the upper 1% range (~16.0–17.5 kcfs) to smooth out the eddy that forms during ASW spill. Assume other units operate approximately uniformly within their full 1% ranges. When other units are operating at < 16.0 kcfs, assume Unit 1 is at the lower end of the upper 1% range (~16.0 kcfs). When average unit discharge is > 16.0 kcfs, assume all units are operating uniformly.

b. Unit 5 will likely not be available in spring 2018. The current repair schedule estimates Unit 5 will return to service in summer 2018 (July/August).

4.2. Turbine Unit Operating Range.

4.2.1. In-Season (April 1–October 31). As defined in the *BPA Load Shaping Guidelines* (**Appendix C**), all units will be operated within ±1% of peak turbine efficiency (1% range) to maximize survival of juvenile fish that pass through the turbines. Turbine unit flow and power output at the lower and upper limits of the 1% range are defined in **Table LGS-6**.

4.2.1.1. If operation outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

i. Meet BPA load requests made pursuant to BPA's policy, statutory requirements, and *Load Shaping Guidelines* (**Appendix C**);

ii. If the draft tube is to be dewatered (**section 4.3.4**), the unit will be operated at full load >1% (or at speed-no-load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs in order to flush fish from the unit;

iii. Operate a turbine unit solely to provide station service; or

iv. Comply with other coordinated fish measures.

4.2.1.2. Minimum Generation. All of the lower Snake River projects may be required to keep one generating unit online at all times to maintain power system reliability. The minimum generation flow range for each unit is defined in the FOP Table 1 (**Appendix E**), as derived from the lower limits of the 1% range and actual unit operations. During low flow, there may not be enough river flow to meet this generation requirement and the FOP spill target. Under these circumstances, the project will operate the first available priority unit at minimum generation and spill the remainder of outflow. Actual attainable minimum generation may vary depending on real-time conditions.

4.2.1.3. Unit 1 Special Operation. *[NOTE: This special Unit 1 operation DOES NOT apply during spring spill when units are operated in the North priority order (see **section 4.1 and Table LGS-5**).]* During fish passage season when the ASW is open in Bay 1 and total project outflow is greater than 38 kcfs, Unit 1 will be operated in the upper 25% of the 1% range to smooth out the eddy that forms during ASW spill. Historically, the GDACS program tended to balance flow out of all units in operation. However, this special operation will at times result in unbalanced discharge where more flow is passing through Unit 1 than other operating units. Physical modeling indicated that a higher flow out of Unit 1 is critical to disrupting the eddy that forms along the south shore downstream of the powerhouse when the ASW is operating in order to optimize tailrace conditions for both adult passage and juvenile egress. When the ASW is removed from service during summer spill, the tailrace eddy is mostly non-existent and all turbine units may be operated within the full 1% range. When total project outflow is less than 38 kcfs, Unit 1 may be operated within the full 1% range as necessary to maintain MOP and spill operations pursuant to the FOP.

4.2.2. Off-Season (November 1–March 31). While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

Table LGS-6. Little Goose Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Turbine Efficiency (Lower and Upper Limits of 1% Range) and Operating Limits. [a]

Project Head (feet)	LGS Units 1, 2, 3 - With ESBS						LGS Units 1, 2, 3 - No ESBS					
	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	69.6	11,396	111.5	18,269	140.9	24,614	70.5	11,320	124.5	20,006	140.9	23,431
86	70.3	11,381	113.7	18,402	142.9	24,614	71.3	11,305	127.0	20,152	142.9	23,442
87	71.1	11,366	115.9	18,531	144.8	24,613	72.0	11,290	129.5	20,293	144.8	23,451
88	71.9	11,351	118.1	18,657	146.7	24,610	72.8	11,276	131.9	20,431	146.7	23,458
89	72.6	11,336	120.3	18,779	148.7	24,605	73.6	11,262	134.4	20,566	148.7	23,464
90	73.4	11,322	122.5	18,898	150.6	24,598	74.4	11,247	136.9	20,696	150.6	23,467
91	74.3	11,313	122.9	18,717	151.8	24,460	75.3	11,239	137.3	20,499	151.8	23,327
92	75.1	11,304	123.2	18,540	153.0	24,319	76.1	11,230	137.7	20,306	153.0	23,185
93	76.0	11,295	123.6	18,367	154.1	24,176	77.0	11,221	138.0	20,116	154.1	23,041
94	76.9	11,285	123.9	18,197	155.2	23,961	77.9	11,212	138.4	19,931	155.2	22,934
95	77.7	11,276	124.3	18,031	155.2	23,547	78.7	11,203	138.8	19,750	155.2	22,563
96	78.8	11,294	124.4	17,841	155.2	23,210	79.8	11,222	139.0	19,541	155.2	22,267
97	79.8	11,312	124.6	17,654	155.2	22,881	80.9	11,240	139.1	19,338	155.2	21,977
98	80.9	11,329	124.7	17,472	155.2	22,559	81.9	11,257	139.3	19,138	155.2	21,693
99	81.9	11,346	124.8	17,293	155.2	22,245	83.0	11,274	139.4	18,942	155.2	21,416
100	82.9	11,361	125.0	17,117	155.2	21,937	84.0	11,290	139.6	18,751	155.2	21,144
101	83.8	11,363	126.6	17,163	155.2	21,634	84.9	11,291	141.4	18,801	155.2	20,883
102	84.7	11,364	128.3	17,207	155.2	21,337	85.8	11,293	143.3	18,850	155.2	20,627
103	85.6	11,365	129.9	17,250	155.2	21,047	86.7	11,294	145.1	18,897	155.2	20,376
104	86.5	11,367	131.6	17,293	155.2	20,762	87.6	11,295	147.0	18,944	155.2	20,131
105	87.4	11,367	133.2	17,334	155.2	20,484	88.5	11,296	148.8	18,989	155.2	19,890
	LGS Units 4, 5, 6 - With ESBS						LGS Units 4, 5, 6 - No ESBS					
85	87.1	13,880	119.6	19,076	141.3	24,621	86.4	13,479	122.2	19,052	141.3	24,411
86	88.2	13,890	121.3	19,102	143.3	24,702	87.6	13,488	123.9	19,078	143.3	24,527
87	89.3	13,899	122.9	19,127	145.4	24,781	88.7	13,497	125.6	19,104	145.4	24,642
88	90.5	13,908	124.6	19,151	147.4	24,859	89.8	13,506	127.2	19,128	147.4	24,756
89	91.6	13,916	126.3	19,174	149.4	24,936	91.0	13,514	128.9	19,151	149.4	24,868
90	92.8	13,924	127.9	19,196	151.4	25,010	92.1	13,522	130.6	19,174	151.4	24,979
91	93.9	13,925	129.4	19,193	153.5	24,931	93.2	13,523	132.1	19,171	153.5	24,840
92	95.0	13,925	130.9	19,190	155.2	24,786	94.3	13,524	133.7	19,168	155.2	24,636
93	96.1	13,926	132.4	19,186	155.2	24,377	95.4	13,524	135.2	19,165	155.2	24,172
94	97.2	13,926	133.9	19,183	155.2	23,904	96.5	13,525	136.7	19,162	155.2	23,631
95	98.3	13,926	135.3	19,179	155.2	23,421	97.6	13,525	138.2	19,158	155.2	22,957
96	99.2	13,898	135.8	19,038	155.2	23,046	98.4	13,498	138.7	19,018	155.2	21,828
97	100.0	13,871	136.3	18,900	155.2	22,679	99.3	13,472	139.2	18,880	155.2	21,378
98	100.9	13,844	136.8	18,765	155.2	22,322	100.2	13,446	139.7	18,745	155.2	20,941
99	101.8	13,818	137.3	18,633	155.2	21,973	101.1	13,420	140.2	18,613	155.2	20,518
100	102.7	13,791	137.8	18,503	155.2	21,633	101.9	13,395	140.7	18,484	155.2	20,677
101	103.9	13,821	139.1	18,503	155.2	21,335	103.2	13,423	142.1	18,484	155.2	20,436
102	105.2	13,849	140.5	18,503	155.2	21,043	104.4	13,451	143.5	18,484	155.2	20,200
103	106.4	13,878	141.9	18,503	155.2	20,758	105.7	13,478	144.9	18,484	155.2	19,969
104	107.7	13,905	143.3	18,503	155.2	20,479	106.9	13,505	146.3	18,484	155.2	19,742
105	108.9	13,932	144.6	18,503	155.2	20,206	108.1	13,532	147.7	18,484	155.2	19,520

a. Table values derived from HDC report (Jan 2004). Flow (cfs) is calculated based on turbine efficiency, head, and power output (MW). "Operating Limit" is the maximum safe operating point, based on cavitation or generator limit (added Feb 2018).

4.3. Turbine Unit Maintenance.

4.3.1. Maintenance Schedule.

4.3.1.1. Turbine unit maintenance schedules will be reviewed annually by Project and District Operations biologists for fish impacts.

4.3.1.2. Each turbine unit requires annual maintenance that may take from several days to three weeks, and is normally scheduled during the mid-July to late November time frame. Maintenance of priority units for adult passage is normally conducted in November-December, but can be conducted in mid-August.

4.3.1.3. Priority unit maintenance will be scheduled for winter maintenance period or when there are few fish passing the project, to the extent possible. Impacts to migrating adults should be minimized.

4.3.1.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator that may take over a year to accomplish.

4.3.1.5. Turbine units, governors, exciters, and control systems require periodic maintenance, calibration, and testing which may take them outside of the 1% range. This work will be scheduled in compliance with the *BPA Load Shaping Guidelines* (**Appendix C**) to minimize impacts on juvenile fish.

4.3.2. Operational Testing. Operational testing of a unit under maintenance is in addition to a unit in run status required for power plant reliability. Operational testing may deviate from FPP priority order and may require water that would otherwise be used for spill if the unit running for reliability is at its lower 1% limit (i.e., minimum generation). Water for operational testing will be used from powerhouse allocation when possible, and diverted from spill only to the extent necessary to maintain generation system reliability.

4.3.2.1. Pre-Maintenance: Before units go into maintenance status, units may be operationally tested for up to 30 minutes by running at speed-no-load and various loads within the 1% range for pre-maintenance measurements and testing, and to allow all fish to move through the unit per section **4.3.4. Dewatering Units**.

4.3.2.2. Post-Maintenance: After maintenance or repair, units may be operationally tested while remaining in maintenance or forced outage status by running the unit for up to a cumulative time of 30 minutes (within 1% range) before returning to operational status.

4.3.3. Operating Gates.[4] Turbine units are to be operated with operating gates in the stored position, as originally designed, to ensure the safety of project personnel and facilities.

4.3.4. Dewatering Units. Dewatering units (also referred to as "unwatering") should be accomplished in accordance with project *Dewatering Plans*.[3] If the draft tube is to be dewatered, operate the unit with full load for a minimum of 15 minutes prior to installing tail logs. If not

[4] Operating gates may also be referred to as "head" gates at some projects. The terms are interchangeable.

possible to load, run unit at speed-no-load for a minimum of 15 minutes. This is to reduce the number of fish in the scrollcase prior to installing stop logs. If a turbine unit is out of service for maintenance for an extended period of time without tailrace stoplogs in place, efforts should be made to not open the wicket gates if the scrollcase must be dewatered at a later date without the unit being spun beforehand.

4.3.5. Doble Testing. See **Appendix A** for yearly test schedule. Transformer Doble testing is required every three years, or more frequently if there is a known problem with a transformer, and requires the associated turbine units to be out of service for 2–3 workdays. Doble testing is normally scheduled for August or early September in conjunction with other scheduled unit maintenance to minimize impacts on fish passage. To conduct testing, the distribution lines must be disconnected from the transformers and normal generation stopped. One turbine unit will operate at speed-no-load (approximately 5 kcfs) to provide project power and operation of fish passage facilities (station service). Spill may be provided to meet minimum required project discharge during testing. If Doble testing will impact priority units for fish passage, adult passage timing should be considered to minimize impacts to migrating adults. Available units will be operated in accordance with FPP priority order and within the 1% range.

4.3.6. Turbine Unit Outages during High Flows. During high spring flows, unit outages for inspecting fish screens, repairing research equipment (e.g., hydroacoustic or radio-telemetry), and/or other fish items may cause increased spill in order to maintain reservoir levels within operating ranges. This may result in exceeding TDG standards. It is important that this work be conducted when scheduled to ensure that facilities are operating correctly and not injuring fish, and that important fish research data are collected. To facilitate this work, reservoir storage may be utilized to minimize impacts from taking turbine units out of service and increasing spill.

4.3.6.1. At Little Goose, this special operation shall take place when flow is above 120 kcfs or when increasing spill will result in TDG exceeding standards. The activities covered under these operations will be coordinated with TMT whenever possible.

4.3.6.2. For scheduled inspection or repair of research equipment, reservoirs shall be drafted to MOP and allowed to fill to 1' above the MOP range as work is accomplished. After the work, reservoirs will be drafted back to MOP. When inspection or repair work can be scheduled ahead of time, the following process will be followed:

i. By 12:00 Tuesday of the week prior to the outage, Project personnel shall schedule unit outages through the approved outage scheduling procedure and notify CENWW-OD-T and RCC of the intended work.

ii. RCC will coordinate the work activities through TMT, then issue a teletype with instructions to Project and BPA for the scheduled work.

iii. Spill will be increased by one spillbay stop setting (about 1.7 kcfs) above passing inflow to slowly lower the Little Goose pool to MOP prior to the scheduled work taking place.

iv. During the work, additional spill will not be provided and the reservoir will be allowed to refill until the reservoir is 1' above MOP (a 2' pondage from where the pool was when work started). At this point, screen inspections shall stop. (At

Snake River projects, this should allow about one normal workday for the scheduled work.)

v. After the work, the reservoir shall be drafted back down to MOP by increasing spill to one spillbay stop above passing inflow.

vi. If work is not finished (e.g., screen inspections), Project personnel shall schedule another unit outage for a date when it can be implemented again.

4.3.6.3. If the work is of an emergency nature that does not normally require the unit to be taken out of service (e.g., failed hydroacoustic transducer versus failed fish screen) and cannot wait for the above process to be implemented, project personnel shall immediately notify CENWW-OD-T and RCC to get approval to do the work. If approval is not given, the unit shall be taken out of service and the reservoir allowed to increase until it reaches 1' above MOP. At this point, the turbine unit must be returned to service and the reservoir will be drafted back to MOP using one spillbay stop setting above passing inflow.

5. FOREBAY DEBRIS REMOVAL

5.1.1. Debris at projects can impact fish passage conditions by plugging or blocking trashracks, VBSs, gatewell orifices, dewatering screens, separators, or facility piping resulting in fish impingement, injuries and/or descaling. Removing forebay debris is sometimes necessary to maintain safe and efficient fish passage conditions, navigation and other project activities. Debris can be removed from the forebay by physical removal (e.g., using boats to encircle debris with log booms and tow it to shore where it can be removed with a crane; or using a crane and scoop from the top of the dam), or by passing debris through the spillway with special spill and/or powerhouse operations. The preferred option is to physically remove debris when possible to avoid passing debris to the next downstream project. However, this is not always possible as some projects do not have forebay debris removal capability. In this case, the only viable alternative is to pass the debris via the spillway.

5.1.2. Debris Spill Coordination. All special spills (other than normal spill patterns for ongoing spill operations) and project operations for passing debris will be coordinated prior to the operations taking place. Each project shall contact CENWW-OD-T at least two workdays prior to the day they want the special project operations for spilling to pass debris. Project personnel shall provide CENWW-OD-T the reason for the debris spill request including an explanation of project facilities impacted by debris, the date and time of the requested spill, and any special powerhouse or other operations required to move the debris to the spillway. Using information provided by the project, CENWW-OD-T shall coordinate the special operations with RCC, NOAA Fisheries and FPOM. When a debris spill is coordinated and approved, RCC shall issue a teletype detailing the specifics of the special operations.

5.1.3. Emergency Debris Spill. Emergency spills may be implemented if necessary to pass woody debris that are accumulating in front of the spillbay weir(s), compromising the safe, unobstructed passage of fish. The operating project will immediately spill the woody debris to remove the obstructions to fish passage. The operating project will notify CENWW-OD-T of the emergency spill as soon as possible to provide notification to RCC, NOAA Fisheries, and other FPOM participants.

Table LGS-7. SPRING SPILL (April 3-June 20) - Little Goose Dam Spill Patterns with ASW in High Crest (ASW-Hi), Low Crest (ASW-Lo), and No ASW (Bay 1 Closed).

SPRING SPILL - # GATE STOPS PER SPILLBAY								TOTAL	TOTAL SPILL (kcfs) [a]		
Bay 1 [a]	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	STOPS	w/ ASW-Hi	w/ ASW-Lo	w/ No ASW
ASW								0	**7.2**	**11.2**	**0.0**
ASW							1	1	**8.9**	**13.0**	**1.8**
ASW	1						1	2	**10.7**	**14.7**	**3.5**
ASW	1						2	3	**12.6**	**16.6**	**5.4**
ASW	1		1				2	4	**14.3**	**18.4**	**7.2**
ASW	1		1		1		2	5	**16.1**	**20.1**	**8.9**
ASW	1		1		1	1	2	6	**17.9**	**21.9**	**10.7**
ASW	1	1	1		1	1	2	7	**19.6**	**23.7**	**12.5**
ASW	1	1	1	1	1	1	2	8	**21.4**	**25.4**	**14.2**
ASW	2	1	1	1	1	1	2	9	**23.3**	**27.3**	**16.1**
ASW	2	1	1	1	1	2	2	10	**25.2**	**29.2**	**18.0**
ASW	2	2	1	1	1	2	2	11	**27.1**	**31.1**	**19.9**
ASW	2	2	1	2	1	2	2	12	**29.0**	**33.0**	**21.8**
ASW	2	2	1	2	2	2	2	13	**30.9**	**34.9**	**23.7**
ASW	2	2	2	2	2	2	2	14	**32.8**	**36.8**	**25.6**
ASW	2	2	2	2	2	2	3	15	**34.8**	**38.8**	**27.6**
ASW	3	2	2	2	2	2	3	16	**36.8**	**40.8**	**29.6**
ASW	3	2	2	2	2	3	3	17	**38.8**	**42.8**	**31.6**
ASW	3	3	2	2	2	3	3	18	**40.8**	**44.8**	**33.6**
ASW	3	3	2	3	2	3	3	19	**42.7**	**46.8**	**35.6**
ASW	3	3	2	3	3	3	3	20	**44.7**	**48.8**	**37.6**
ASW	3	3	3	3	3	3	3	21	**46.7**	**50.8**	**39.6**
ASW	4	3	3	3	3	3	3	22	**48.7**	**52.8**	**41.6**
ASW	4	4	3	3	3	3	3	23	**50.7**	**54.7**	**43.5**
ASW	4	4	4	3	3	3	3	24	**52.6**	**56.7**	**45.5**
ASW	4	4	4	4	3	3	3	25	**54.6**	**58.7**	**47.5**
ASW	4	4	4	4	4	3	3	26	**56.6**	**60.6**	**49.4**
ASW	4	4	4	4	4	4	3	27	**58.6**	**62.6**	**51.4**
ASW	4	4	4	4	4	4	4	28	**60.5**	**64.6**	**53.4**
ASW	5	4	4	4	4	4	4	29	**62.5**	**66.5**	**55.3**
ASW	5	5	4	4	4	4	4	30	**64.5**	**68.5**	**57.3**
ASW	5	5	5	4	4	4	4	31	**66.4**	**70.5**	**59.3**
ASW	5	5	5	5	4	4	4	32	**68.4**	**72.4**	**61.2**
ASW	5	5	5	5	5	4	4	33	**70.4**	**74.4**	**63.2**
ASW	5	5	5	5	5	5	4	34	**72.3**	**76.4**	**65.2**
ASW	5	5	5	5	5	5	5	35	**74.3**	**78.3**	**67.1**
ASW	6	5	5	5	5	5	5	36	**76.2**	**80.3**	**69.1**
ASW	6	6	5	5	5	5	5	37	**78.2**	**82.3**	**71.1**
ASW	6	6	6	5	5	5	5	38	**80.2**	**84.2**	**73.0**
ASW	6	6	6	6	5	5	5	39	**82.1**	**86.2**	**75.0**
ASW	6	6	6	6	6	5	5	40	**84.1**	**88.1**	**76.9**

[a] Total Spill (kcfs) is calculated as a function of total # of gate stops in Bays 2-8 + ASW spill in Bay 1 at forebay elevation 633.5' (in MOP range). ASW spill in Bay 1 is a fixed rate dependent on crest position: High = 7.2 kcfs; Low = 11.2 kcfs; NO ASW = 0 kcfs (see **section 2.3.2.7** for ASW operating criteria).

SPRING SPILL - # GATE STOPS PER SPILLBAY								TOTAL	TOTAL SPILL (kcfs) [a]		
Bay 1 [a]	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	STOPS	w/ ASW-Hi	w/ ASW-Lo	w/ No ASW
ASW	6	6	6	6	6	6	5	41	**86.0**	**90.1**	**78.9**
ASW	6	6	6	6	6	6	6	42	**88.0**	**92.1**	**80.9**
ASW	7	6	6	6	6	6	6	43	**89.9**	**94.0**	**82.8**
ASW	7	7	6	6	6	6	6	44	**91.9**	**95.9**	**84.7**
ASW	7	7	7	6	6	6	6	45	**93.8**	**97.9**	**86.7**
ASW	7	7	7	7	6	6	6	46	**95.8**	**99.8**	**88.6**
ASW	7	7	7	7	7	6	6	47	**97.7**	**101.8**	**90.6**
ASW	7	7	7	7	7	7	6	48	**99.7**	**103.7**	**92.5**
ASW	7	7	7	7	7	7	7	49	**101.6**	**105.7**	**94.5**
ASW	8	7	7	7	7	7	7	50	**103.6**	**107.6**	**96.4**
ASW	8	8	7	7	7	7	7	51	**105.5**	**109.6**	**98.4**
ASW	8	8	8	7	7	7	7	52	**107.5**	**111.6**	**100.4**
ASW	8	8	8	8	7	7	7	53	**109.5**	**113.5**	**102.3**
ASW	8	8	8	8	8	7	7	54	**111.4**	**115.5**	**104.3**
ASW	8	8	8	8	8	8	7	55	**113.4**	**117.5**	**106.3**
ASW	8	8	8	8	8	8	8	56	**115.4**	**119.4**	**108.2**
ASW	9	8	8	8	8	8	8	57	**117.3**	**121.4**	**110.2**
ASW	9	9	8	8	8	8	8	58	**119.2**	**123.3**	**112.1**
ASW	9	9	9	8	8	8	8	59	**121.2**	**125.2**	**114.0**
ASW	9	9	9	9	8	8	8	60	**123.1**	**127.1**	**115.9**
ASW	9	9	9	9	9	8	8	61	**125.0**	**129.1**	**117.9**
ASW	9	9	9	9	9	9	8	62	**127.0**	**131.0**	**119.8**
ASW	9	9	9	9	9	9	9	63	**128.9**	**132.9**	**121.7**
ASW	10	9	9	9	9	9	9	64	**130.9**	**134.9**	**123.7**
ASW	10	10	9	9	9	9	9	65	**132.9**	**137.0**	**125.8**
ASW	10	10	10	9	9	9	9	66	**134.9**	**139.0**	**127.8**
ASW	10	10	10	10	9	9	9	67	**136.9**	**141.0**	**129.8**
ASW	10	10	10	10	10	9	9	68	**138.9**	**143.0**	**131.8**
ASW	10	10	10	10	10	10	9	69	**140.9**	**145.0**	**133.8**
ASW	10	10	10	10	10	10	10	70	**143.0**	**147.0**	**135.8**

Table LGS-8. [*pg 1 of 3*] Little Goose Dam Spill Patterns for 30% Spill with ASW in High Crest (ASW-Hi).

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							ASW-Hi 30% Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1 [a]	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
23.9	7.2	30.1%	16.7						16.7	ASW-Hi								0	Min. Q w/ SW-Hi
26.4	8.9	33.7%	17.5						17.5	ASW-Hi							1	1	1 unit + 1 stop = ~34% Spill
31.5	8.9	28.3%	11.3	11.3					22.6	ASW-Hi							1	1	2 units at min. 1% + 1 stop = ~28% Spill
35.0	10.7	30.6%	13.0	11.3					24.3	ASW-Hi	1						1	2	Min. Q w/ SW-Hi per FPP
35.6	10.7	30.1%	13.6	11.3					24.9	ASW-Hi	1						1	2	
38.0	10.7	28.2%	16.0	11.3					27.3	ASW-Hi	1						1	2	Min. Q w/ U1 in upper 1%
41.9	12.6	30.1%	16.0	13.3					29.3	ASW-Hi	1						2	3	
47.7	14.3	30.0%	17.5	15.9					33.4	ASW-Hi	1		1				2	4	
51.1	16.1	31.5%	17.5	17.5					35.0	ASW-Hi	1		1		1		2	5	2 units + 5 stops = ~31% Spill
54.7	16.1	29.4%	16.0	11.3	11.3				38.6	ASW-Hi	1		1		1		2	5	3 units + 5 stops = ~29% Spill
59.6	17.9	30.0%	16.0	12.9	12.8				41.7	ASW-Hi	1	1	1		1		2	6	
65.4	19.6	30.0%	16.0	14.9	14.9				45.8	ASW-Hi	1	1	1		1	1	2	7	
71.3	21.4	30.0%	16.6	16.7	16.6				49.9	ASW-Hi	1	1	1	1	1	1	2	8	
73.9	21.4	29.0%	17.5	17.5	17.5				52.5	ASW-Hi	1	1	1	1	1	1	2	8	Max. Q w/ 3 units = ~29% Spill
73.9	21.4	29.0%	16.0	11.3	11.3	13.9			52.5	ASW-Hi	1	1	1	1	1	1	2	8	Min. Q w/ 4 units = ~29% Spill
77.6	23.3	30.0%	16.0	12.2	12.2	13.9			54.3	ASW-Hi	2	1	1	1	1	1	2	9	
83.9	25.2	30.0%	16.0	14.3	14.2	14.2			58.7	ASW-Hi	2	1	2	1	1	1	2	10	
85.0	25.2	29.6%	16.0	14.6	14.6	14.6			59.8	ASW-Hi	2	1	2	1	1	1	2	10	Spring flow trigger for SW crest change
90.3	27.1	30.0%	16.0	15.8	15.7	15.7			63.2	ASW-Hi	2	1	2	1	2	1	2	11	
96.6	29.0	30.0%	16.9	16.9	16.9	16.9			67.6	ASW-Hi	2	2	2	1	2	1	2	12	
100.4	29.0	28.9%	17.5	17.5	17.5	18.9			71.4	ASW-Hi	2	2	2	1	2	1	2	12	Max. Q w/ 4 units+12 stops = ~29% Spill
100.4	29.0	28.9%	16.0	13.9	13.8	13.8	13.9		71.4	ASW-Hi	2	2	2	1	2	1	2	12	5 units + 12 stops = ~29% Spill
102.9	30.9	30.0%	16.0	14.0	14.0	14.0	14.0		72.0	ASW-Hi	2	2	2	2	2	1	2	13	
109.3	32.8	30.0%	16.0	15.2	15.1	15.1	15.1		76.5	ASW-Hi	2	2	2	2	2	2	2	14	
115.9	34.8	30.0%	16.3	16.2	16.2	16.2	16.2		81.1	ASW-Hi	3	2	2	2	2	2	2	15	
122.6	36.8	30.0%	17.2	17.2	17.2	17.1	17.1		85.8	ASW-Hi	3	3	2	2	2	2	2	16	

[a] Total Spill (kcfs) is calculated as a function of total # of gate stops in Bays 2-8 + ASW spill in Bay 1 at forebay elevation 633.5' (in MOP range). ASW spill in Bay 1 is a fixed rate dependent on crest position: High = 7.2 kcfs; Low = 11.2 kcfs; NO ASW = 0 kcfs (see **section 2.3.2.7** for ASW operating criteria).

[b] Turbine flow is shown as an estimate of how the special Unit 1 operation will look (see **section 4.2.1**), not a precise requirement.

[c] Spill is > 30% when Total Outflow is > 156 kcfs (assuming all turbines available and max powerhouse capacity is approx. 109 kcfs).

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							ASW-Hi 30% Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1 [a]	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
129.2	38.8	30.0%	16.0	14.9	14.9	14.9	14.9	14.8	90.4	ASW-Hi	3	3	3	2	2	2	2	17	
135.9	40.8	30.0%	16.0	15.9	15.8	15.8	15.8	15.8	95.1	ASW-Hi	3	3	3	3	2	2	2	18	
142.4	42.7	30.0%	16.7	16.6	16.6	16.6	16.6	16.6	99.7	ASW-Hi	3	3	3	3	3	2	2	19	
149.1	44.7	30.0%	17.4	17.4	17.4	17.4	17.4	17.4	104.4	ASW-Hi	3	3	3	3	3	3	2	20	
155.9	46.7	30.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	3	3	3	3	3	3	3	21	Max. PH capacity for 30% Spill.
157.9	48.7	30.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	4	3	3	3	3	3	3	22	
159.9	50.7	31.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	4	4	3	3	3	3	3	23	
161.8	52.6	32.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	4	4	4	3	3	3	3	24	
163.8	54.6	33.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	4	4	4	4	3	3	3	25	
165.8	56.6	34.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	4	4	4	4	4	3	3	26	
167.8	58.6	34.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	4	4	4	4	4	4	3	27	
169.7	60.5	35.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	4	4	4	4	4	4	4	28	
171.7	62.5	36.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	5	4	4	4	4	4	4	29	
173.7	64.5	37.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	5	5	4	4	4	4	4	30	
175.6	66.4	37.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	5	5	5	4	4	4	4	31	
177.6	68.4	38.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	5	5	5	5	4	4	4	32	
179.6	70.4	39.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	5	5	5	5	5	4	4	33	
181.5	72.3	39.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	5	5	5	5	5	5	4	34	
183.5	74.3	40.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	5	5	5	5	5	5	5	35	
185.4	76.2	41.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	6	5	5	5	5	5	5	36	
187.4	78.2	41.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	6	6	5	5	5	5	5	37	
189.4	80.2	42.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	6	6	6	5	5	5	5	38	
191.3	82.1	42.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	6	6	6	6	5	5	5	39	
193.3	84.1	43.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	6	6	6	6	6	5	5	40	
195.2	86.0	44.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	6	6	6	6	6	6	5	41	
197.2	88.0	44.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	6	6	6	6	6	6	6	42	
199.1	89.9	45.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	7	6	6	6	6	6	6	43	
201.1	91.9	45.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	7	7	6	6	6	6	6	44	
203.0	93.8	46.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	7	7	7	6	6	6	6	45	
205.0	95.8	46.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	7	7	7	7	6	6	6	46	
206.9	97.7	47.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	7	7	7	7	7	6	6	47	

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							ASW-Hi 30% Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1 [a]	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
208.9	99.7	47.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	7	7	7	7	7	7	6	48	
210.8	101.6	48.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	7	7	7	7	7	7	7	49	
212.8	103.6	48.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	8	7	7	7	7	7	7	50	
214.7	105.5	49.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	8	8	7	7	7	7	7	51	
216.7	107.5	49.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	8	8	8	7	7	7	7	52	
218.7	109.5	50.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	8	8	8	8	7	7	7	53	
220.6	111.4	50.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	8	8	8	8	8	7	7	54	
222.6	113.4	50.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	8	8	8	8	8	8	7	55	
224.6	115.4	51.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	8	8	8	8	8	8	8	56	
226.5	117.3	51.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	9	8	8	8	8	8	8	57	
228.4	119.2	52.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	9	9	8	8	8	8	8	58	
230.4	121.2	52.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	9	9	9	8	8	8	8	59	
232.3	123.1	53.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	9	9	9	9	8	8	8	60	
234.2	125.0	53.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	9	9	9	9	9	8	8	61	
236.2	127.0	53.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	9	9	9	9	9	9	8	62	
238.1	128.9	54.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	9	9	9	9	9	9	9	63	
240.1	130.9	54.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	10	9	9	9	9	9	9	64	
242.1	132.9	54.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	10	10	9	9	9	9	9	65	
244.1	134.9	55.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	10	10	10	9	9	9	9	66	
246.1	136.9	55.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	10	10	10	10	9	9	9	67	
248.1	138.9	56.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	10	10	10	10	10	9	9	68	
250.1	140.9	56.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	10	10	10	10	10	10	9	69	
252.2	143.0	56.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Hi	10	10	10	10	10	10	10	70	

Table LGS-9. [*pg 1 of 3*] Little Goose Dam Spill Patterns for 30% Spill with ASW in Low Crest (ASW-Lo).

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							ASW-Lo 30% Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1 [a]	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
37.3	11.2	30.0%	14.8	11.3					26.1	ASW-Lo								0	Min. Q at SW-Lo
38.5	11.2	29.1%	16.0	11.3					27.3	ASW-Lo								0	Min. Q w/ U1 in upper 1%
43.2	13.0	30.1%	16.0	14.2					30.2	ASW-Lo							1	1	
49.0	14.7	30.0%	17.2	17.1					34.3	ASW-Lo	1						1	2	
49.7	14.7	29.6%	17.5	17.5					35.0	ASW-Lo	1						1	2	Max. Q w/ 2 units + 2 stops = ~30% Spill
53.3	14.7	27.6%	16.0	11.3	11.3				38.6	ASW-Lo	1						1	2	Min. Q w/ 3 units + 2 stops = ~28% Spill
55.4	16.6	30.0%	16.0	11.4	11.4				38.8	ASW-Lo	1						2	3	
61.3	18.4	30.0%	16.0	13.5	13.4				42.9	ASW-Lo	1		1				2	4	
67.1	20.1	30.0%	16.0	15.5	15.5				47.0	ASW-Lo	1		1		1		2	5	
73.0	21.9	30.0%	17.1	17.0	17.0				51.1	ASW-Lo	1	1	1		1		2	6	
74.4	21.9	29.4%	17.5	17.5	17.5				52.5	ASW-Lo	1	1	1		1		2	6	Max. Q w/ 3 units + 6 stops = ~29% Spill
74.4	21.9	29.4%	16.0	11.3	11.3	13.9			52.5	ASW-Lo	1	1	1		1		2	6	Min. Q w/ 4 units + 6 stops = ~29% Spill
78.9	23.7	30.0%	16.0	12.7	12.6	13.9			55.2	ASW-Lo	1	1	1		1	1	2	7	
84.7	25.4	30.0%	16.0	14.5	14.4	14.4			59.3	ASW-Lo	1	1	1	1	1	1	2	8	Spring flow trigger for SW crest change
91.0	27.3	30.0%	16.0	15.9	15.9	15.9			63.7	ASW-Lo	2	1	1	1	1	1	2	9	
97.4	29.2	30.0%	17.1	17.1	17.0	17.0			68.2	ASW-Lo	2	1	2	1	1	1	2	10	
100.6	29.2	29.0%	17.5	17.5	17.5	18.9			71.4	ASW-Lo	2	1	2	1	1	1	2	10	Max. Q w/ 4 units+10 stops = ~29% Spill
100.6	29.2	29.0%	16.0	13.9	13.8	13.8	13.9		71.4	ASW-Lo	2	1	2	1	1	1	2	10	5 units + 10 stops = ~29% Spill
103.7	31.1	30.0%	16.0	14.2	14.2	14.1	14.1		72.6	ASW-Lo	2	1	2	1	2	1	2	11	
110.0	33.0	30.0%	16.0	15.3	15.3	15.2	15.2		77.0	ASW-Lo	2	2	2	1	2	1	2	12	
116.4	34.9	30.0%	16.3	16.3	16.3	16.3	16.3		81.5	ASW-Lo	2	2	2	2	2	1	2	13	
122.7	36.8	30.0%	17.2	17.2	17.2	17.2	17.1		85.9	ASW-Lo	2	2	2	2	2	2	2	14	
129.4	38.8	30.0%	16.0	15.0	14.9	14.9	14.9	14.9	90.6	ASW-Lo	3	2	2	2	2	2	2	15	
136.0	40.8	30.0%	16.0	15.9	15.9	15.8	15.8	15.8	95.2	ASW-Lo	3	3	2	2	2	2	2	16	
142.7	42.8	30.0%	16.7	16.7	16.7	16.6	16.6	16.6	99.9	ASW-Lo	3	3	3	2	2	2	2	17	
149.3	44.8	30.0%	17.5	17.4	17.4	17.4	17.4	17.4	104.5	ASW-Lo	3	3	3	3	2	2	2	18	

[a] Total Spill (kcfs) is calculated as a function of total # of gate stops in Bays 2-8 + ASW spill in Bay 1 at forebay elevation 633.5' (in MOP range). ASW spill in Bay 1 is a fixed rate dependent on crest position: High = 7.2 kcfs; Low = 11.2 kcfs; NO ASW = 0 kcfs (see **section 2.3.2.7** for ASW operating criteria).

[b] Turbine flow is shown as an estimate of how the special Unit 1 operation will look (see **section 4.2.1**), not a precise requirement.

[c] Spill is > 30% when Total Outflow is > 156 kcfs (assuming all turbines available and max powerhouse capacity is approx. 109 kcfs).

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							ASW-Lo 30% Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1 [a]	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
156.0	46.8	30.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	3	3	3	3	3	2	2	19	Max. PH capacity for 30% Spill
158.0	48.8	30.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	3	3	3	3	3	3	2	20	
160.0	50.8	31.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	3	3	3	3	3	3	3	21	
162.0	52.8	32.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	4	3	3	3	3	3	3	22	
163.9	54.7	33.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	4	4	3	3	3	3	3	23	
165.9	56.7	34.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	4	4	4	3	3	3	3	24	
167.9	58.7	35.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	4	4	4	4	3	3	3	25	
169.8	60.6	35.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	4	4	4	4	4	3	3	26	
171.8	62.6	36.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	4	4	4	4	4	4	3	27	
173.8	64.6	37.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	4	4	4	4	4	4	4	28	
175.7	66.5	37.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	5	4	4	4	4	4	4	29	
177.7	68.5	38.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	5	5	4	4	4	4	4	30	
179.7	70.5	39.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	5	5	5	4	4	4	4	31	
181.6	72.4	39.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	5	5	5	5	4	4	4	32	
183.6	74.4	40.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	5	5	5	5	5	4	4	33	
185.6	76.4	41.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	5	5	5	5	5	5	4	34	
187.5	78.3	41.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	5	5	5	5	5	5	5	35	
189.5	80.3	42.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	6	5	5	5	5	5	5	36	
191.5	82.3	43.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	6	6	5	5	5	5	5	37	
193.4	84.2	43.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	6	6	6	5	5	5	5	38	
195.4	86.2	44.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	6	6	6	6	5	5	5	39	
197.3	88.1	44.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	6	6	6	6	6	5	5	40	
199.3	90.1	45.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	6	6	6	6	6	6	5	41	
201.3	92.1	45.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	6	6	6	6	6	6	6	42	
203.2	94.0	46.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	7	6	6	6	6	6	6	43	
205.1	95.9	46.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	7	7	6	6	6	6	6	44	
207.1	97.9	47.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	7	7	7	6	6	6	6	45	
209.0	99.8	47.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	7	7	7	7	6	6	6	46	
211.0	101.8	48.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	7	7	7	7	7	6	6	47	
212.9	103.7	48.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	7	7	7	7	7	7	6	48	
214.9	105.7	49.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	7	7	7	7	7	7	7	49	

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							ASW-Lo 30% Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1 [a]	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
216.8	107.6	49.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	8	7	7	7	7	7	7	50	
218.8	109.6	50.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	8	8	7	7	7	7	7	51	
220.8	111.6	50.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	8	8	8	7	7	7	7	52	
222.7	113.5	51.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	8	8	8	8	7	7	7	53	
224.7	115.5	51.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	8	8	8	8	8	7	7	54	
226.7	117.5	51.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	8	8	8	8	8	8	7	55	
228.6	119.4	52.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	8	8	8	8	8	8	8	56	
230.6	121.4	52.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	9	8	8	8	8	8	8	57	
232.5	123.3	53.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	9	9	8	8	8	8	8	58	
234.4	125.2	53.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	9	9	9	8	8	8	8	59	
236.3	127.1	53.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	9	9	9	9	8	8	8	60	
238.3	129.1	54.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	9	9	9	9	9	8	8	61	
240.2	131.0	54.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	9	9	9	9	9	9	8	62	
242.1	132.9	54.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	9	9	9	9	9	9	9	63	
244.1	134.9	55.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	10	9	9	9	9	9	9	64	
246.2	137.0	55.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	10	10	9	9	9	9	9	65	
248.2	139.0	56.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	10	10	10	9	9	9	9	66	
250.2	141.0	56.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	10	10	10	10	9	9	9	67	
252.2	143.0	56.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	10	10	10	10	10	9	9	68	
254.2	145.0	57.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	10	10	10	10	10	10	9	69	
256.2	147.0	57.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	ASW-Lo	10	10	10	10	10	10	10	70	

Table LGS-10. [*pg 1 of 3*] Little Goose Dam Uniform Spill Patterns for 30% Spill with No ASW (Bay 1 Closed).

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							No ASW 30% Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1 [a]	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
11.3	0	0.0%	11.3						11.3	Closed								0	Min. Q w/ Closed and no spill
13.1	1.8	13.5%	11.3						11.3	Closed							1	1	
14.8	3.5	23.8%	11.3						11.3	Closed	1						1	2	
18	5.4	30.0%	12.6						12.6	Closed	1						2	3	Min. Q w/ no SW and 30% spill
24	7.2	29.9%	16.8						16.8	Closed	1		1				2	4	
26.4	8.9	33.8%	17.5						17.5	Closed	1		1		1		2	5	1 unit + 5 stops = ~34% spill
31.5	8.9	28.3%	11.3	11.3					22.6	Closed	1		1		1		2	5	2 units + 5 stops = ~28% spill
35.7	10.7	30.0%	13.7	11.3					25.0	Closed	1	1	1		1		2	6	
38	10.7	28.2%	16.0	11.3					27.3	Closed	1	1	1		1		2	6	Min. Q w/ U1 in upper 1%
41.6	12.5	30.0%	16.0	13.1					29.1	Closed	1	1	1		1	1	2	7	
47.4	14.2	30.0%	16.6	16.6					33.2	Closed	1	1	1	1	1	1	2	8	
51.1	16.1	31.5%	17.5	17.5					35.0	Closed	2	1	1	1	1	1	2	9	2 units + 9 stops = ~31% spill
54.7	16.1	29.5%	16.0	11.3	11.3				38.6	Closed	2	1	1	1	1	1	2	9	3 units + 9 stops = ~29% spill
60	18	30.0%	16.0	13.0	13.0				42.0	Closed	2	1	2	1	1	1	2	10	
66.4	19.9	30.0%	16.0	15.3	15.2				46.5	Closed	2	1	2	1	2	1	2	11	
72.7	21.8	30.0%	17.0	17.0	16.9				50.9	Closed	2	2	2	1	2	1	2	12	
74.3	21.8	29.4%	17.5	17.5	17.5				52.5	Closed	2	2	2	1	2	1	2	12	Max. Q w/ 3 units = ~29% spill
76.2	23.7	31.1%	16.0	11.3	11.3	13.9			52.5	Closed	2	2	2	2	2	1	2	13	Min. Q w/ 4 units = ~31% spill
79	23.7	30.0%	16.0	12.7	12.7	13.9			55.3	Closed	2	2	2	2	2	1	2	13	
85.4	25.6	30.0%	16.0	14.6	14.6	14.6			59.8	Closed	2	2	2	2	2	2	2	14	
92	27.6	30.0%	16.1	16.1	16.1	16.1			64.4	Closed	3	2	2	2	2	2	2	15	
98.7	29.6	30.0%	17.3	17.3	17.3	17.2			69.1	Closed	3	3	2	2	2	2	2	16	
105.3	31.6	30.0%	16.0	14.5	14.4	14.4	14.4		73.7	Closed	3	3	3	2	2	2	2	17	
112	33.6	30.0%	16.0	15.6	15.6	15.6	15.6		78.4	Closed	3	3	3	3	2	2	2	18	
118.7	35.6	30.0%	16.7	16.6	16.6	16.6	16.6		83.1	Closed	3	3	3	3	3	2	2	19	
125.1	37.6	30.1%	17.5	17.5	17.5	17.5	17.5		87.5	Closed	3	3	3	3	3	3	2	20	

[a] Total Spill (kcfs) is calculated as a function of total # of gate stops in Bays 2-8 + ASW spill in Bay 1 at forebay elevation 633.5' (in MOP range). ASW spill in Bay 1 is a fixed rate dependent on crest position: High = 7.2 kcfs; Low = 11.2 kcfs; NO ASW = 0 kcfs (see **section 2.3.2.7** for ASW operating criteria).

[b] Turbine flow is shown as an estimate of how the special Unit 1 operation will look (see **section 4.2.1**), not a precise requirement.

[c] Spill is > 30% when Total Outflow is > 156 kcfs (assuming all turbines available and max powerhouse capacity is approx. 109 kcfs).

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							No ASW 30% Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1 [a]	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
132	39.6	30.0%	16.0	15.3	15.3	15.3	15.3	15.2	92.4	Closed	3	3	3	3	3	3	3	21	
138.6	41.6	30.0%	16.2	16.2	16.2	16.2	16.1	16.1	97.0	Closed	4	3	3	3	3	3	3	22	
145.1	43.5	30.0%	17.0	17.0	16.9	16.9	16.9	16.9	101.6	Closed	4	4	3	3	3	3	3	23	
151.7	45.5	30.0%	17.5	17.5	17.5	17.9	17.9	17.9	106.2	Closed	4	4	4	3	3	3	3	24	
156.7	47.5	30.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	4	4	4	4	3	3	3	25	Max. PH capacity for 30% Spill
158.6	49.4	31.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	4	4	4	4	4	3	3	26	
160.6	51.4	32.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	4	4	4	4	4	4	3	27	
162.6	53.4	32.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	4	4	4	4	4	4	4	28	
164.5	55.3	33.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	5	4	4	4	4	4	4	29	
166.5	57.3	34.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	5	5	4	4	4	4	4	30	
168.5	59.3	35.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	5	5	5	4	4	4	4	31	
170.4	61.2	35.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	5	5	5	5	4	4	4	32	
172.4	63.2	36.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	5	5	5	5	5	4	4	33	
174.4	65.2	37.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	5	5	5	5	5	5	4	34	
176.3	67.1	38.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	5	5	5	5	5	5	5	35	
178.3	69.1	38.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	6	5	5	5	5	5	5	36	
180.3	71.1	39.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	6	6	5	5	5	5	5	37	
182.2	73	40.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	6	6	6	5	5	5	5	38	
184.2	75	40.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	6	6	6	6	5	5	5	39	
186.1	76.9	41.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	6	6	6	6	6	5	5	40	
188.1	78.9	41.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	6	6	6	6	6	6	5	41	
190.1	80.9	42.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	6	6	6	6	6	6	6	42	
192	82.8	43.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	7	6	6	6	6	6	6	43	
193.9	84.7	43.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	7	7	6	6	6	6	6	44	
195.9	86.7	44.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	7	7	7	6	6	6	6	45	
197.8	88.6	44.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	7	7	7	7	6	6	6	46	
199.8	90.6	45.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	7	7	7	7	7	6	6	47	
201.7	92.5	45.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	7	7	7	7	7	7	6	48	
203.7	94.5	46.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	7	7	7	7	7	7	7	49	
205.6	96.4	46.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	8	7	7	7	7	7	7	50	
207.6	98.4	47.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	8	8	7	7	7	7	7	51	

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							No ASW 30% Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1 [a]	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
209.6	100.4	47.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	8	8	8	7	7	7	7	52	
211.5	102.3	48.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	8	8	8	8	7	7	7	53	
213.5	104.3	48.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	8	8	8	8	8	7	7	54	
215.5	106.3	49.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	8	8	8	8	8	8	7	55	
217.4	108.2	49.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	8	8	8	8	8	8	8	56	
219.4	110.2	50.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	9	8	8	8	8	8	8	57	
221.3	112.1	50.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	9	9	8	8	8	8	8	58	
223.2	114	51.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	9	9	9	8	8	8	8	59	
225.1	115.9	51.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	9	9	9	9	8	8	8	60	
227.1	117.9	51.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	9	9	9	9	9	8	8	61	
229	119.8	52.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	9	9	9	9	9	9	8	62	
230.9	121.7	52.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	9	9	9	9	9	9	9	63	
232.9	123.7	53.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	10	9	9	9	9	9	9	64	
235	125.8	53.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	10	10	9	9	9	9	9	65	
237	127.8	53.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	10	10	10	9	9	9	9	66	
239	129.8	54.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	10	10	10	10	9	9	9	67	
241	131.8	54.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	10	10	10	10	10	9	9	68	
243	133.8	55.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	10	10	10	10	10	10	9	69	
245	135.8	55.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	10	10	10	10	10	10	10	70	

Table LGS-11. [*pg 1 of 3*] Little Goose Dam ALTERNATE UNIFORM Spill Patterns for use if necessary for Worker Safety in Bay 1 or 2.

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							Worker Safety Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
11.3	0	0.0%	11.3						11.3	Closed	Closed							0	Min. Q w/ no SW and no spill.
13.1	1.8	13.5%	11.3						11.3	Closed	Closed						1	1	
14.8	3.5	23.8%	11.3						11.3	Closed	Closed	1					1	2	
18	5.4	30.0%	12.6						12.6	Closed	Closed	1					2	3	Min. Q w/ no SW and 30% spill.
24	7.2	29.9%	16.8						16.8	Closed	Closed	1		1			2	4	
26.4	8.9	33.8%	17.5						17.5	Closed	Closed	1		1		1	2	5	1 unit + 5 stops = ~34% spill
31.5	8.9	28.3%	11.3	11.3					22.6	Closed	Closed	1		1		1	2	5	2 units + 5 stops = ~28% spill
35.7	10.7	30.0%	13.7	11.3					25.0	Closed	Closed	1	1	1		1	2	6	
38	10.7	28.2%	16.0	11.3					27.3	Closed	Closed	1	1	1		1	2	6	Min. Q w/ U1 in upper 1% [c]
41.6	12.5	30.0%	16.0	13.1					29.1	Closed	Closed	1	1	1	1	1	2	7	
47.6	14.4	30.2%	16.6	16.6					33.2	Closed	Closed	2	1	1	1	1	2	8	
51.3	16.3	31.7%	17.5	17.5					35.0	Closed	Closed	2	1	2	1	1	2	9	2 units + 9 stops = ~31% spill
54.9	16.3	29.6%	16.0	11.3	11.3				38.6	Closed	Closed	2	1	2	1	1	2	9	3 units + 9 stops = ~29% spill
60.2	18.2	30.2%	16.0	13.0	13.0				42.0	Closed	Closed	2	1	2	1	2	2	10	
66.6	20.1	30.1%	16.0	15.3	15.2				46.5	Closed	Closed	2	2	2	1	2	2	11	
72.9	22	30.1%	17.0	17.0	16.9				50.9	Closed	Closed	2	2	2	2	2	2	12	
74.5	22	29.5%	17.5	17.5	17.5				52.5	Closed	Closed	2	2	2	2	2	2	12	Max. Q w/ 3 units = ~29% spill
76.5	24	31.3%	16.0	11.3	11.3	13.9			52.5	Closed	Closed	3	2	2	2	2	2	13	Min. Q w/ 4 units = ~31% spill
79.3	24	30.2%	16.0	12.7	12.7	13.9			55.3	Closed	Closed	3	2	2	2	2	2	13	
85.8	26	30.3%	16.0	14.6	14.6	14.6			59.8	Closed	Closed	3	3	2	2	2	2	14	
92.3	27.9	30.3%	16.1	16.1	16.1	16.1			64.4	Closed	Closed	3	3	3	2	2	2	15	
99	29.9	30.2%	17.3	17.3	17.3	17.2			69.1	Closed	Closed	3	3	3	3	2	2	16	
105.6	31.9	30.2%	16.0	14.5	14.4	14.4	14.4		73.7	Closed	Closed	3	3	3	3	3	2	17	
112.3	33.9	30.2%	16.0	15.6	15.6	15.6	15.6		78.4	Closed	Closed	3	3	3	3	3	3	18	
119	35.9	30.2%	16.7	16.6	16.6	16.6	16.6		83.1	Closed	Closed	4	3	3	3	3	3	19	
125.4	37.9	30.2%	17.5	17.5	17.5	17.5	17.5		87.5	Closed	Closed	4	4	3	3	3	3	20	
132.2	39.8	30.1%	16.0	15.3	15.3	15.3	15.3	15.2	92.4	Closed	Closed	4	4	4	3	3	3	21	

[a] Total Spill (kcfs) is calculated as a function of total # of gate stops in Bays 2-8 + ASW spill in Bay 1 at forebay elevation 633.5' (in MOP range).
[b] Turbine flow is shown as an estimate of how the special Unit 1 operation will look (see **section 4.2.1**), not a precise requirement.
[c] Spill is > 30% when Total Outflow is > 156 kcfs (assuming all turbines available and max powerhouse capacity is approx. 109 kcfs).

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							Worker Safety Spill Patterns - # Gate Stops per Bay									
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1	2	3	4	5	6	7	8	TOTAL	Comments (see footnotes)
138.8	41.8	30.1%	16.2	16.2	16.2	16.2	16.1	16.1	97.0	Closed	Closed	4	4	4	4	3	3	22	
145.4	43.8	30.1%	17.0	17.0	16.9	16.9	16.9	16.9	101.6	Closed	Closed	4	4	4	4	4	3	23	
152	45.8	30.1%	17.5	17.5	17.5	17.9	17.9	17.9	106.2	Closed	Closed	4	4	4	4	4	4	24	
156.9	47.7	30.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	5	4	4	4	4	4	25	Max. PH capacity for 30% Spill. [c]
158.9	49.7	31.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	5	5	4	4	4	4	26	
160.8	51.6	32.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	5	5	5	4	4	4	27	
162.8	53.6	32.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	5	5	5	5	4	4	28	
164.8	55.6	33.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	5	5	5	5	5	4	29	
166.7	57.5	34.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	5	5	5	5	5	5	30	
168.7	59.5	35.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	6	5	5	5	5	5	31	
170.7	61.5	36.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	6	6	5	5	5	5	32	
172.6	63.4	36.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	6	6	6	5	5	5	33	
174.6	65.4	37.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	6	6	6	6	5	5	34	
176.5	67.3	38.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	6	6	6	6	6	5	35	
178.5	69.3	38.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	6	6	6	6	6	6	36	
180.4	71.2	39.5%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	7	6	6	6	6	6	37	
182.4	73.2	40.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	7	7	6	6	6	6	38	
184.3	75.1	40.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	7	7	7	6	6	6	39	
186.3	77.1	41.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	7	7	7	7	6	6	40	
188.2	79	42.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	7	7	7	7	7	6	41	
190.2	81	42.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	7	7	7	7	7	7	42	
192.1	82.9	43.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	8	7	7	7	7	7	43	
194.1	84.9	43.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	8	8	7	7	7	7	44	
196.1	86.9	44.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	8	8	8	7	7	7	45	
198	88.8	44.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	8	8	8	8	7	7	46	
200	90.8	45.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	8	8	8	8	8	7	47	
202	92.8	45.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	8	8	8	8	8	8	48	
203.9	94.7	46.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	9	8	8	8	8	8	49	
205.8	96.6	46.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	9	9	8	8	8	8	50	
207.8	98.6	47.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	9	9	9	8	8	8	51	
209.7	100.5	47.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	9	9	9	9	8	8	52	

Outflow	Spill [a]		Turbine Unit Outflow (kcfs) [b]							Worker Safety Spill Patterns - # Gate Stops per Bay								Comments (see footnotes)
(kcfs)	(kcfs)	(%) [c]	1	2	3	4	5	6	TOTAL	1	2	3	4	5	6	7	8	TOTAL	
211.6	102.4	48.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	9	9	9	9	9	8	53	
213.5	104.3	48.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	9	9	9	9	9	9	54	
215.6	106.4	49.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	10	9	9	9	9	9	55	
217.6	108.4	49.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	10	10	9	9	9	9	56	
219.6	110.4	50.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	10	10	10	9	9	9	57	
221.6	112.4	50.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	10	10	10	10	9	9	58	
223.6	114.4	51.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	10	10	10	10	10	9	59	
225.6	116.4	51.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	10	10	10	10	10	10	60	
227.6	118.4	52.0%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	11	10	10	10	10	10	61	
229.6	120.4	52.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	11	11	10	10	10	10	62	
231.7	122.5	52.9%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	11	11	11	10	10	10	63	
233.7	124.5	53.3%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	11	11	11	11	10	10	64	
235.7	126.5	53.7%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	11	11	11	11	11	10	65	
237.7	128.5	54.1%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	11	11	11	11	11	11	66	
239.7	130.5	54.4%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	12	11	11	11	11	11	67	
241.8	132.6	54.8%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	12	12	11	11	11	11	68	
243.8	134.6	55.2%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	12	12	12	11	11	11	69	
245.8	136.6	55.6%	17.5	17.5	17.5	18.9	18.9	18.9	109.2	Closed	Closed	12	12	12	12	11	11	70	

2018 Fish Passage Plan

Chapter 9 – Lower Granite Dam

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Lower Granite Dam

Project Acronym*	LWG
River Mile (RM)	Snake River – RM 107.5
Reservoir	Lake Lower Granite
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 0 kcfs \ Mar–Nov: 11.5 kcfs
Forebay Normal Operating Range (ft)	733’ – 738’
Tailrace Rate of Change Limit (ft/hr)	1.5’/hr
Powerhouse Length (ft)	656’
Powerhouse Hydraulic Capacity (kcfs)	130 kcfs
Turbine Units (#)	6 (Units 1-3 BLH Kaplan; Units 4-6 Allis Chalmers Kaplan)
Turbine Unit Generating Capacity (MW)	Rated: 810 MW (135 MW/unit) \ Maximum: 930 MW (155 MW/unit)
Gatewell Orifices	36 orifices (2 per gatewell = 6 per unit) - 18 w/10” diameter; 18 w/14” diameter
Spillway Length (ft)	512’
Spillway Hydraulic Capacity (kcfs)	850 kcfs
Spillbays (#)	8
Spillway Weirs (#)	1 Removable Spillway Weir (RSW) in Bay 1
Navigation Lock Length x Width (ft)	650’ x 84’ (Usable Space)
Navigation Lock Max. Lift (ft)	105’
FISH STRUCTURE/OPERATION START DATE	
Transportation Research Program – NMFS **	1975
Submersible Traveling Screens (STS)	1978
Extended-Length Submersible Bar Screens (ESBS)	1996
Juvenile Fish Transportation Program – Corps **	1981
Removable Spillway Weir (RSW)	2003
Adult Fish Counts	1969 (North Shore); 1975 (South Shore)

*Project acronym designated by US Army Corps of Engineers, Northwestern Division, Columbia Basin Water Management Division. Due to the large number of projects managed by NWD, this acronym may differ from other acronyms used in the region. For example, a common acronym for Lower Granite is **LGR**. However, that acronym is assigned to another NWD project, so the official Corps NWD acronym is **LWG**.

**Smolt transportation and research done by NMFS via truck until 1978 when barges purchased. Corps began implementing transportation program in 1981.

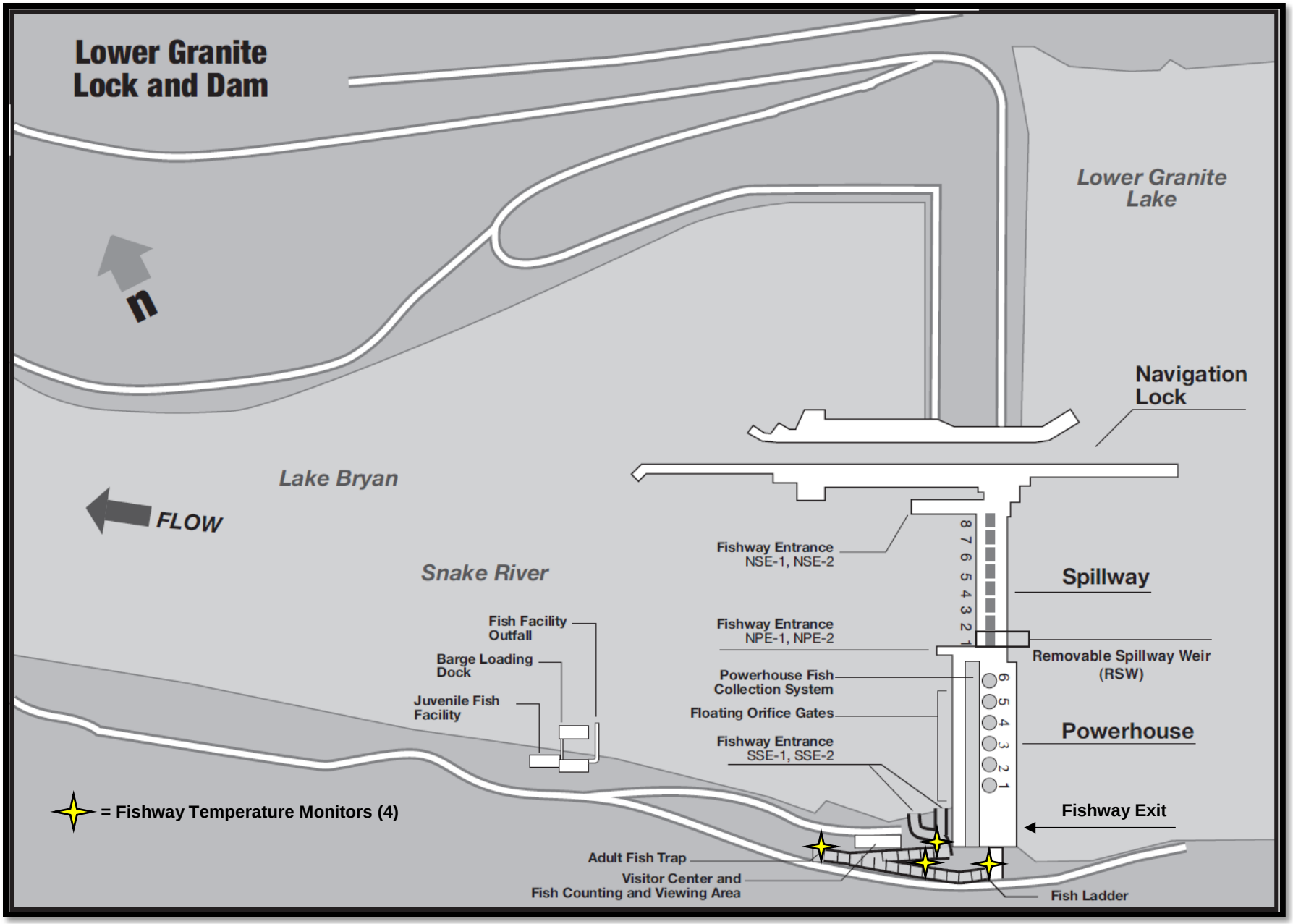
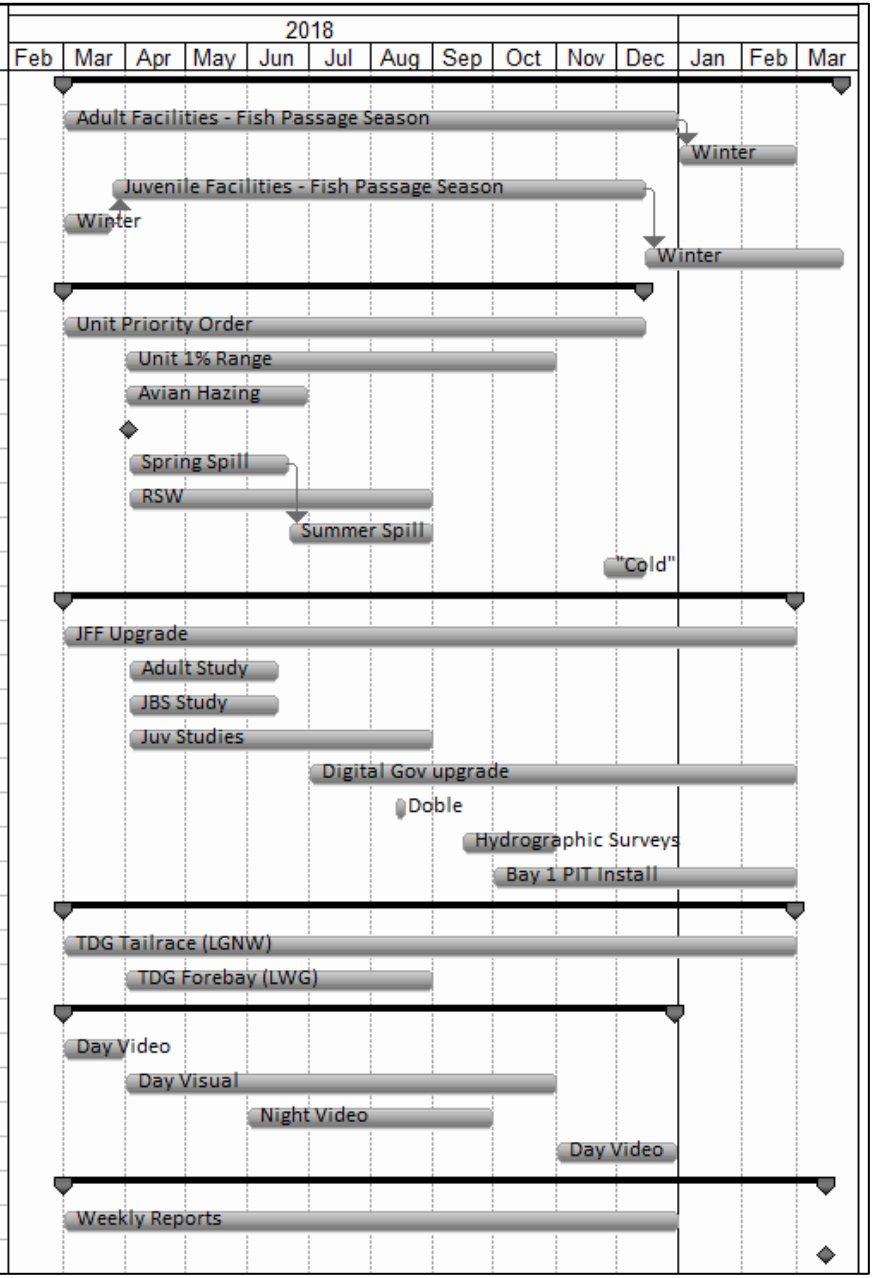


Figure LWG-1. Lower Granite Lock & Dam General Site Plan.

Table LWG-1. Lower Granite Dam Schedule of Operations and Actions Defined in the 2018 Fish Passage Plan (FPP).

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**3/1/18**	**3/23/19**	
Adult Facilities - Fish Passage Season	3/1/18	12/31/18	2.4.2
Adult Facilities - Winter Maintenance	1/1/19	2/28/19	2.4.1
Juvenile Facilities - Fish Passage Season	3/25/18	12/15/18	2.3.2
Juvenile Facilities - Winter Maintenance	3/1/18	3/24/18	2.3.1
	12/15/18	3/23/19	
PROJECT OPERATIONS FOR FISH PASSAGE	**3/1/18**	**12/15/18**	
Turbine unit priority order	3/1/18	12/15/18	Table LWG-5
Turbine unit 1% operating range	4/1/18	10/31/18	4.2
Avian hazing	4/1/18	6/30/18	App L 9.2
Avian Wires installed NLT April 3	4/3/18	4/3/18	App L 1.4
Spring Spill	4/3/18	6/20/18	App E (FOP)
Spillway weir in service (approx end date)	4/3/18	8/31/18	2.3.2.6
Summer Spill	6/21/18	8/31/18	App E (FOP)
ESBS removal during cold weather	11/24/18	12/15/18	2.3.2.2.xi
SPECIAL OPS & STUDIES (Appendix A)	**3/1/18**	**2/28/19**	
Juvenile Bypass System Upgrade	3/1/18	2/28/19	App A 9.1
Adult Passage & Behavior Study	4/3/18	6/15/18	App A 9.2
JBS Post-Construction Evaluation	4/3/18	6/15/18	App A 9.2
Juvenile Survival Studies (System & LWG)	4/3/18	8/31/18	App A 9.2
Digital Governor Upgrade	7/1/18	2/28/19	App A 9.1
Doble Testing	8/13/18	8/17/18	App A 9.1
Stilling Basin Surveys	9/15/18	10/31/18	App A 9.2
Spillbay 1 PIT Install	10/1/18	2/28/19	App A 9.1
TDG MONITORING	**3/1/18**	**2/28/19**	
TDG Monitoring - Tailrace (LGNW)	3/1/18	2/28/19	2.2.5
TDG Monitoring - Forebay (LWG)	4/1/18	8/31/18	2.2.5
ADULT FISH COUNTING	**3/1/18**	**12/30/18**	
Day Video 0400-2000 PST (0500-2100 PDT)	3/1/18	3/31/18	Table LWG-3
Day Visual 0500-2100 PDT	4/1/18	10/31/18	Table LWG-3
Night Video 2100-0500 PDT	6/1/18	9/30/18	Table LWG-3
Day Video 0400-2000 PST (0500-2100 PDT)	11/1/18	12/30/18	Table LWG-3
REPORTS	**3/1/18**	**3/15/19**	
Weekly Reports	3/1/18	12/31/18	2.5.2
Annual Report due	3/15/19	3/15/19	2.5.3



1. FISH PASSAGE INFORMATION

Lower Granite Dam fish passage facilities and other structures are shown in **Figure LWG-1**. The schedule of Lower Granite Dam operations that are described in the Fish Passage Plan (FPP) and Appendices is in **Table LWG-1**.

1.1. Juvenile Fish Passage.

1.1.1. Juvenile Fish Facilities. The juvenile fish facilities at Lower Granite Dam consist of a bypass system and juvenile transportation facilities. Maintenance of juvenile fish passage facilities that may impact juvenile fish or facility operations should be conducted during winter maintenance.

1.1.1.1. The juvenile bypass system (JBS) includes:

- Extended-length Submersible Bar Screens (ESBS) with flow vanes;
- Vertical Barrier Screens (VBS) with improved modified balanced flow;
- gatewell orifices;
- a collection channel running the length of the powerhouse;
- primary and secondary dewaterers (PDW and SDW);
- full-flow PIT-tag detection system;
- transport flume with a switch gate to direct fish to the collection and transportation facilities or directly to back to the river via the primary bypass pipe;
- an emergency bypass route at the upstream end of the PDW that allow fish to be returned to river in the event that the PDW or transport flume upstream of the switch gate become unsuitable for fish passage.

1.1.1.2. The transportation facilities include:

- water supply system and separator structure to separate juveniles from the excess water and adult fish;
- raceways for holding fish;
- distribution system to distribute fish among raceways, to the barge, or back to the river;
- sampling and marking building;
- truck and barge loading facilities;
- PIT-tag detection and diversion systems.

1.1.2. Juvenile Fish Migration Timing. Juvenile fish passage timing at Lower Granite Dam is shown in **Table LWG-2**, based on collection data from the most recent 10-year period (does not reflect Fish Guidance Efficiency or spillway passage). Salmon, steelhead, bull trout, lamprey, and other species are routinely counted.

Table LWG-2. Juvenile Salmonid Passage Timing at Lower Granite Dam for Most Recent 10 Years Based on Daily & Yearly Collection Data.

Year	10%	50%	90%	# Days	10%	50%	90%	# Days
	Yearling Chinook				Subyearling Chinook			
2008	26-Apr	9-May	18-May	22	31-May	20-Jun	28-Jul	58
2009	22-Apr	7-May	20-May	28	29-May	11-Jun	2-Jul	34
2010	24-Apr	4-May	21-May	27	2-Jun	9-Jun	14-Jul	42
2011	19-Apr	8-May	16-May	27	26-May	11-Jun	16-Jul	51
2012	14-Apr	27-Apr	17-May	33	29-May	13-Jun	11-Jul	43
2013	19-Apr	8-May	14-May	25	30-May	9-Jun	1-Aug	63
2014	19-Apr	4-May	17-May	28	28-May	1-Jun	12-Jul	45
2015	3-Apr	26-Apr	11-May	38	26-May	5-Jun	19-Jul	54
2016	13-Apr	26-Apr	9-May	26	27-May	10-Jun	4-Jul	38
2017	15-Apr	29-Apr	10-May	25	28-May	6-Jun	13-Jul	46
10-Yr MEDIAN	**19-Apr**	**4-May**	**16-May**	**27**	**28-May**	**9-Jun**	**13-Jul**	**46**
10-Yr MIN	**3-Apr**	**26-Apr**	**9-May**	**22**	**26-May**	**1-Jun**	**2-Jul**	**34**
10-Yr MAX	**26-Apr**	**9-May**	**21-May**	**38**	**3-Jun**	**20-Jun**	**1-Aug**	**63**
	Unclipped Steelhead				Clipped Steelhead			
2008	20-Apr	11-May	27-May	37	28-Apr	8-May	21-May	23
2009	22-Apr	6-May	29-May	37	21-Apr	1-May	21-May	30
2010	26-Apr	19-May	5-Jun	40	25-Apr	11-May	4-Jun	40
2011	22-Apr	13-May	31-May	39	3-Apr	6-May	20-May	47
2012	18-Apr	3-May	24-May	36	16-Apr	27-Apr	19-May	33
2013	22-Apr	13-May	19-May	27	20-Apr	9-May	17-May	27
2014	23-Apr	9-May	26-May	33	21-Apr	2-May	22-May	31
2015	16-Apr	8-May	24-May	38	11-Apr	27-Apr	18-May	37
2016	14-Apr	2-May	17-May	33	15-Apr	26-Apr	12-May	27
2017	16-Apr	8-May	24-May	38	8-Apr	26-Apr	11-May	33
10-Yr MEDIAN	**21-Apr**	**8-May**	**25-May**	**37**	**18-Apr**	**1-May**	**19-May**	**32**
10-Yr MIN	**14-Apr**	**2-May**	**17-May**	**27**	**3-Apr**	**26-Apr**	**11-May**	**23**
10-Yr MAX	**26-Apr**	**19-May**	**5-Jun**	**40**	**28-Apr**	**9-May**	**4-Jun**	**47**
	Coho				Sockeye (Wild & Hatchery)			
2008	6-May	10-May	22-May	16	17-May	20-May	8-Jun	22
2009	13-May	21-May	23-Jun	41	21-Apr	20-May	28-May	37
2010	6-Jun	21-May	5-Jul	29	19-May	30-May	5-Jun	17
2011	5-May	15-May	1-Jun	27	4-Apr	20-May	4-Jun	61
2012	28-Apr	18-May	26-May	28	5-May	19-May	26-May	21
2013	8-May	14-May	18-May	10	15-May	17-May	19-May	4
2014	3-May	19-May	26-May	23	8-Apr	3-May	19-May	41
2015	27-Apr	13-May	23-May	26	9-May	17-May	20-May	11
2016	26-Apr	8-May	15-May	19	17-May	22-May	28-May	11
2017	29-Apr	13-May	28-May	29	15-Apr	8-May	21-May	36
10-Yr MEDIAN	**4-May**	**14-May**	**26-May**	**27**	**7-May**	**19-May**	**27-May**	**22**
10-Yr MIN	**26-Apr**	**8-May**	**15-May**	**10**	**4-Apr**	**3-May**	**19-May**	**4**
10-Yr MAX	**6-Jun**	**21-May**	**5-Jul**	**41**	**19-May**	**30-May**	**8-Jun**	**61**

1.2. Adult Fish Passage.

1.2.1. Adult Fish Facilities. Adult fish passage facilities at Lower Granite Dam are made up of one south shore fish ladder with two entrances, a powerhouse collection system, north shore entrances with a transportation channel underneath the spillway to the powerhouse collection system, and an auxiliary water supply system. The powerhouse collection system is comprised of four operating floating orifices, two downstream entrances and one side entrance into the spillway basin on the north end of the powerhouse, and a common transportation channel. Four of the floating orifices and the two downstream entrances at the north end of the collection system are operated. North shore entrances are made up of two downstream entrances and a side entrance into the spillway basin with the two downstream entrances normally used. Auxiliary water is supplied from the tailrace by three electric pumps, as well as from the forebay through diffuser-14. When the juvenile bypass system is in operation, excess drainage water from the primary dewaterer (PDW) can be directed into the auxiliary water supply pump chambers. Two pumps are normally used to provide required flows. Four weirs in the upper end of the ladder were outfitted with PIT-tag detectors in early 2003. Additional temporary full and half-duplex PIT-tag detectors were installed in the lower weir section upstream of the south powerhouse entrance and in the forebay exit tunnel in 2016. The temporary detectors will be maintained for the life of the current equipment. Maintenance of adult fish facilities is scheduled for January–February to minimize impacts on upstream migrants.

1.2.2. Adult Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult fish facilities are operated year-round. Adult salmon, steelhead, shad and lamprey are counted per the schedule in **Table LWG-3**, and data are posted daily at: www.fpc.org/adultsalmon_home.html. Sturgeon and bull trout are relatively infrequent and are reported in *Miscellaneous Fish Counts* and in the *Annual Fish Passage Report*.

1.2.2.2. Yearly fish counts are used to determine the earliest and latest dates of peak adult fish passage defined in **Table LWG-4**. Time-of-day (diel) distributions of adult salmonids at Lower Granite Dam fishway entrances and exits are shown in **Figure LWG-2**.

Table LWG-3. Lower Granite Dam Adult Fish Counting Schedule, 3/1/2018 – 2/28/2019.

Count Period	Counting Method and Hours *
March 1–31	Day Video 0400–2000 hours (PST)
April 1 – October 31	Day Visual 0500–2100 hours (PDT)
June 1 – September 30	Night Video 2100–0500 hours (PDT)
November 1 – December 30	Day Video 0400–2000 hours (PST)

*PST=Pacific Standard Time. PDT=Pacific Daylight Time (in effect during Daylight Saving Time 3/11/18-11/4/18).

Table LWG-4. Lower Granite Dam Adult Fish Count Period and Peak Passage Timing (based on yearly counts from 1975 through most recent count year).

Species	Counting Period	Earliest Peak	Latest Peak
Spring Chinook	Mar 1 – Jun 17	Apr 26	Jun 17
Summer Chinook	Jun 18 – Aug 17	Jun 18	Jul 17
Fall Chinook	Aug 18 – Dec 31	Sep 5	Oct 6
Steelhead	Mar 1 – Dec 31	Sep 1	Oct 16
Sockeye	Mar 1 – Oct 31	Jul 1	Jul 19
Lamprey	Apr 1 – Oct 31	Jul 18	Aug 1

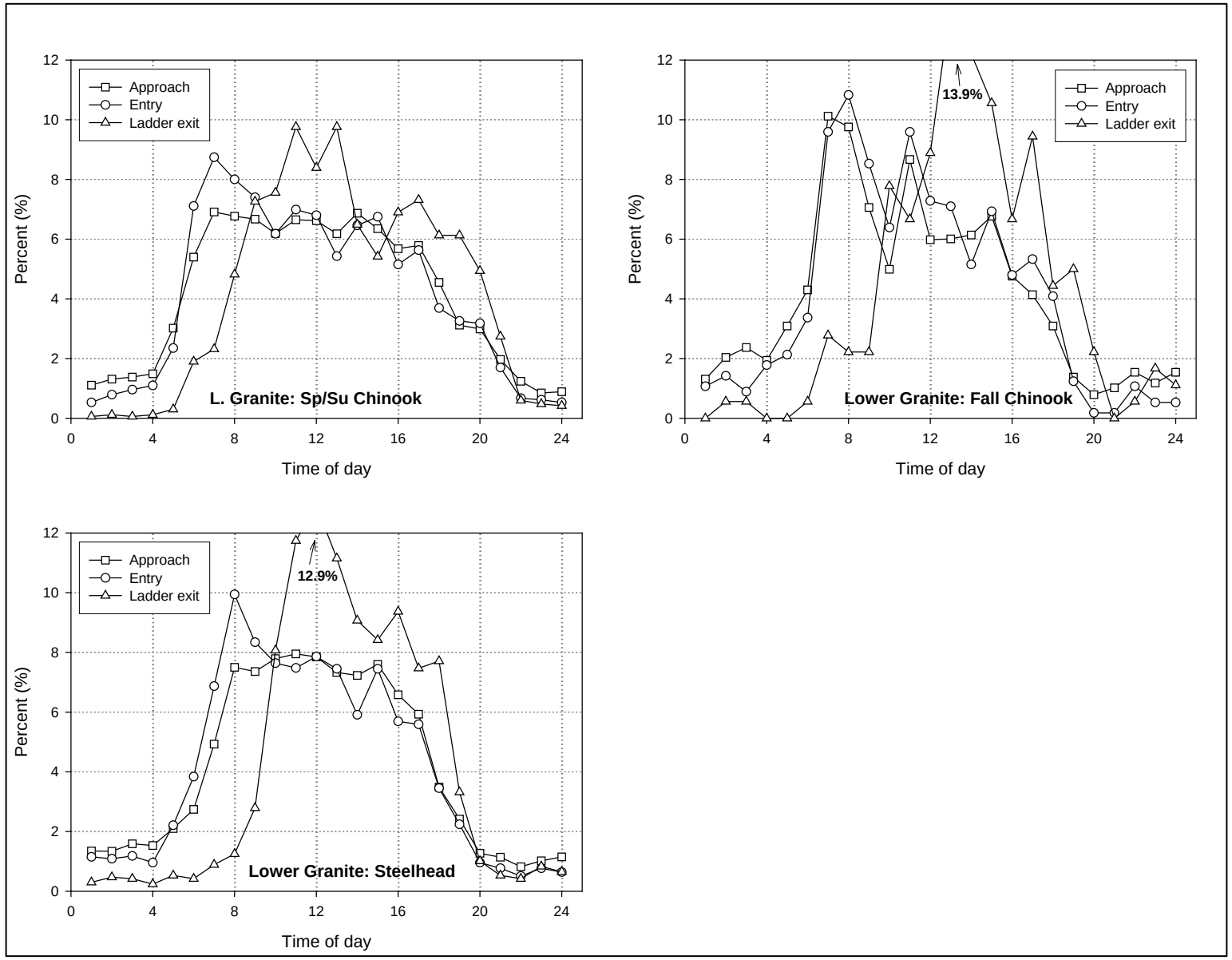


Figure LWG-2. Diel Distribution of Adult Salmonids at Lower Granite Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*).
pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATIONS

2.1. General.

2.1.1. Yearly special operations related to research are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

2.1.2. Research, non-routine maintenance activities, and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. These distances are approximate and will be updated after data are collected and analyzed to determine the threshold for adverse impacts to adult fish behavior. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

2.1.3. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed immediately following the incident of steps taken to correct the situation. On a monthly basis, as necessary, the project biologist will provide FPOM a summary of any emergency actions undertaken.

2.1.4. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least two weeks in advance, unless it is deemed an emergency (see also **FPP Chapter 1 - Overview** for coordination guidance).

2.2. Spill Management.

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the Fish Passage Plan as **Appendix E**. Spill at Lower Granite shall be distributed in patterns defined in **Table LWG-7 through LWG-9**.

2.2.2. Involuntary spill is the result of river flow above powerhouse capacity, insufficient load (lack of load), turbine unit outages (forced or scheduled), or failure of a key component of the juvenile fish passage facility which forces spill to provide juvenile fish passage.

2.2.3. Total dissolved gas (TDG) is monitored at Lower Granite Dam during the periods defined in **Table LWG-1**, pursuant to the Corps' annual *TDG Monitoring Plan* and *Dissolved Gas Monitoring Plan of Action 2015-2018*.[1]

2.2.4. To ensure navigation safety, short-term spill adjustments may be required, including spill reduction, spill pattern adjustments, and/or spill stoppages that result in forebay exceedances of the Minimum Operating Pool (MOP) range. The Corps will make short-term spill adjustments in real-time as appropriate to provide safe navigation conditions. Actual operations will vary depending on spill patterns, turbine operations, experience of boat captains, etc. See the FOP (**Appendix E**) for more information.

[1] TDG Monitoring Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/. TDG Monitoring Plan 2015-2018: pweb.crohms.org/tmt/wqnew/tdg_monitoring/2015-18.pdf

2.3. Operating Criteria – Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance (December 16–March 24).

2.3.1.1. Forebay Area and Intakes.

i. Remove debris from forebay and gatewell slots.

ii. Rake trashracks just prior to the operating season.

iii. Measure gatewell drawdown after cleaning trashracks and with ESBSs installed.

iv. Inspect and repair gatewell; dipnet as needed.

2.3.1.2. ESBS, Flow Vanes, and VBS.

i. After ESBSs are removed for winter maintenance, inspect for juvenile salmonid mortalities and all other incidental fish mortalities. Inspect ESBSs within a week after removal, or as soon as practical. All mortalities are to be counted, or otherwise estimated, for each ESBS and reported to CENWW-OD-T.

ii. Maintenance completed on all screens.

iii. Inspect ESBSs prior to installation and operate debris cleaner (dogged off on deck) to ensure proper operation.

iv. Log results of trial run.

v. Inspect VBSs with underwater video camera at least 1x/year; repair as needed.

vi. Inspect flow vanes to make sure they are in good condition and all surfaces smooth. Repair as needed.

vii. ESBSs installed in at least 4 turbine units (all 6 if possible) by March 24. Remaining ESBSs installed prior to April 1.

2.3.1.3. Collection Channel.

i. Make-up water valves and control equipment maintained and capable of operating when needed.

ii. Orifice lights operational.

iii. Orifices clean and valves operating correctly.

iv. Orifice cycling and air backflush system operational.

2.3.1.4. Primary Dewaterer (PDW) and Flume.

i. Inclined floor screens clean and in good condition with no damaged panels and no gaps between screen panels.

ii. Cleaning brush and air burst systems maintained and operating correctly.

iii. Overflow weirs should be maintained, tested, and operating correctly.

iv. All valves operating correctly.

v. Baffle boards under inclined screen in good condition, placed appropriately to balance screen approach velocity, and securely attached.

vi. Flume interior should be smooth with no rough edges and expansion joints in good operating condition.

vii. Maintain full-flow juvenile PIT-tag system as required. Coordinate with PSMFC.

~~**v.**~~**viii.** Switch gate maintained and in good operating condition.

~~2.3.1.4.~~2.3.1.5. Transportation Facilities.

i. Flume switch gate maintained and in good operating condition.

ii. Flume interior smooth with no rough edges and expansion joints in good operating condition.

iii. Secondary dewaterer (SDW) clean and in good condition with no damaged panels or gaps between screen panels, air burst system maintained and operating correctly, valves and weirs maintained, tested and operating correctly.

~~**i.**~~**iv.** Water supply throttling valve and drain sluice gate maintained and operating correctly for facility water supply requirements.

~~**ii.**~~**v.** Perforated plate for porosity control at separator smooth with no rough edges.

~~**iii.**~~**vi.** Wet separator and fish distribution system maintained and ready for operation.

~~**iv.**~~**vii.** Brushes and screens on crowders in good condition; no holes or rough edges.

~~**v.**~~**viii.** Crowders maintained, tested, and operating correctly.

~~**vi.**~~**ix.** All valves, slide gates, and switch gates maintained and in good condition.

~~vii.~~x. Raceway tail screens in place with no holes in screens or sharp wires protruding.

~~viii.~~xi. Barge and truck loading pipes should be free of debris, cracks, or blockages and barge loading boom maintained and tested.

~~ix.~~xii. All sampling equipment should be maintained and in good operating condition prior to watering up the facilities.

~~x.~~xiii. Maintain juvenile PIT-tag system as required (see *Columbia Basin PIT-tag Information System, General Gate Maintenance and Inspection, Walla Walla District*, February 2003). Coordinate with PSMFC.

~~xi.~~xiv. Mini- and midi-tanks maintained and in good operating condition.

~~2.3.1.5.~~2.3.1.6. **Barges.**

i. All engines and pumps maintained and in good operating condition.

ii. Fish release openings and related equipment in good operating condition.

iii. No rough edges or support beams protruding into compartments.

iv. No brass or galvanized fittings in circulation lines.

v. All loading hoses properly installed so fish will not hit sides of compartments or support beams when loading.

vi. Loading hoses in good shape with rubber gaskets in cam lock fittings.

vii. Inside edges of cam lock joints should be beveled to avoid sharp edges.

viii. Warning systems tested and operational.

ix. Provide net and/or deck covers.

x. Net pens maintained and installed in barge holds for transport of steelhead kelts or juveniles as required.

xi. Deck wash systems fully operational.

xii. Oxygen monitoring probes installed and tested; monitoring system operational.

~~2.3.1.6.~~2.3.1.7. **Avian Predation Areas (Forebay and Tailrace).** Inspect bird wires, water cannon, and other avian deterrent devices, and repair or replace as needed. Where possible, add additional bird wires or other deterrent devices to cover areas of known avian predation activity. Prepare avian abatement contract as needed.

~~2.3.1.7.~~2.3.1.8. **Maintenance Records.** Record all maintenance and inspections.

2.3.2. Juvenile Fish Passage Season (March 25–December 15).

Operate March 25–October 31 for juvenile bypass, collection, and transport, and November 1–December 15 for adult fallbacks. Operate according to criteria defined below and in the *Corps of Engineers Juvenile Fish Transportation Plan* (**Appendix B**). The transport program may be revised in accordance with the ESA Section 10 permit and NOAA Fisheries Biological Opinion. Project personnel shall retain authority to dewater the juvenile collection system to the extent necessary to prevent frost damage to pipes and other structures during late fall and extended winter operations.

2.3.2.1. Forebay Area and Intakes.

i. Remove debris from forebay.

ii. Inspect gatewell slots daily for debris, fish buildup, and contaminating substances (particularly oil). Clean gatewells before they become 50% covered with debris. If the volume of debris precludes the ability to keep the gatewell at least 50% clear, they should be cleaned at least once daily. If orifice flow or fish conditions are observed that indicate an orifice may be obstructed with debris, the orifice will be closed and back-flushed to remove the obstruction. If the obstruction cannot be removed, the orifice will be closed and the alternate orifice for that gatewell slot operated. If both orifices become obstructed or plugged with debris the turbine unit will not be operated until the gatewell and orifices are cleared of debris.

iii. If a visible accumulation of contaminating substances (e.g., oil) is detected in a gatewell and cannot be removed within 24 hours, the gatewell orifices shall be closed immediately and the turbine unit shut down within one hour until the material has been removed and any problems corrected. A preferred method for removing oil from the water surface is to install absorbent socks, booms, or pads capable of encapsulating the material, and tie off with a rope for later disposal. Action should be taken as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow fish to exit the gatewell. ~~Orifices shall not be closed for longer than 48 hours.~~

iv. Log drawdown differentials in bulkhead slots at least once per week.

v. Remove debris from forebay and trashracks as necessary to maintain less than 1' of additional drawdown in gate slots (relative to drawdown with a clean screen). Additional raking may be required when heavy debris loads are present in the river or if fish condition indicates an issue.

vi. Coordinate cleaning effort with personnel operating juvenile collection facilities.

vii. Dip bulkhead gatewell slots to remove fish prior to installing bulkhead for dewatering bulkhead slot.

2.3.2.2. ESBS, VBS, and Operating Gates.

i. ESBSs and flow vanes installed in all operating turbine units by March 24.

ii. Operate ESBSs with flow vanes attached to screen.

iii. Operate ESBSs with debris cleaners in automatic mode. Set cleaning frequency as required to maintain clean screens and good fish condition. Change cleaning frequency as needed.

iv. Inspect each ESBS by underwater video once per month in April, May, and June. Conduct similar inspections in August and October, focusing on at least three turbine units at the judgment of Project personnel. Spot check VBSs at the same time.

v. If an ESBS is damaged or fails during the juvenile fish passage season, follow procedures defined in **section 3.2.2**. In no case should a turbine unit be operated with a missing or a known non-operating or damaged ESBS, except as noted.

vi. Up to half of the project's ESBSs may be pulled after October 1 for maintenance as long as unscreened turbine units are not operated.

vii. Make a formal determination at the end of season as to the adequacy of ESBS bar screen panels and debris cleaner brush, and replace components as necessary.

viii. Measure VBS head differentials at least once per week April 1–June 30 (more frequently if required) and biweekly for the remainder of the operating season. When a head differential of 1.5' is reached, the respective turbine unit should be operated at a reduced loading (≤ 110 MW) to minimize loading on the VBS and potential fish impingement until the VBS can be cleaned. Clean VBSs as soon as possible after a 1.5' head differential is reached.

ix. Inspect at least two VBSs in two different turbine units between spring and summer. Both units should have been operated frequently in the spring. If a debris accumulation is noted, inspect other VBSs and clean debris as necessary.

~~**x.** Turbine units are to be operated with raised operating gates when ESBSs are installed (March 25–December 15) to improve fish guidance efficiency (FGE), except as provided in **section 4.3**.~~

~~**xi.**~~**x.** If extreme cold weather (< 20°F for ≥ 24 hours) is forecasted[2] between Thanksgiving and December 15, screens may be removed and the JBS shutdown

[2] NOAA's National Weather Service forecast for Lower Granite Dam is available at: forecast.weather.gov/MapClick.php?lat=46.658178954000505&lon=-117.43311929599969

for the remainder of the season. The project will first request permission from CENWW-OD-T who will inform NOAA Fisheries and FPOM of the action.

2.3.2.3. Collection Channel.

i. Orifices clean and operating. Operate at least one orifice per gatewell slot (preferably the south 14" orifice) unless a unit is scheduled out of service with non-operational fish screens. If the project is operating within the Minimum Operating Pool (MOP), additional orifices may be opened to increase water velocity in the collection channel and reduce passage time from the bulkhead slots to the primary dewatering structure. If orifices must be closed to repair any part of the facility, do not close orifices in operating units with ESBSs in place for longer than 5 hours. If possible, keep to less than 3 hours. Reduce turbine unit loading to the lower end of the 1% range if deemed necessary by the project biologist. Monitor fish conditions in gatewells hourly or more frequently during orifice closure periods.

ii. Orifice lights operational and operating on open orifices. Orifice lights and area lights may be turned off the evening before the channel is dewatered at the end of the season (dewatering occurs on December 16 or later) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

iii. Replace all burned out orifice lights within 24 hours of notification. Orifice lights shall remain lighted 24 hours/day.

iv. Orifice jets hitting no closer than 3' from back wall, collection channel full.

~~**v.** Rotate orifices in fish screens slots weekly (6 open).~~

~~**vi.**~~**v.** Orifice valves are either fully open or closed.

~~**vii.**~~**vi.** Backflush orifices in the bulkhead slots at least daily and more frequently if required. During periods of high fish and debris passage, April 1 through August 15, orifices should be inspected and back-flushed more frequently as determined by the project biologist, to keep orifices clean. If debris is causing continual orifice plugging problems in a particular turbine unit gatewell, the respective turbine unit generation may be restricted to the lower end of the 1% peak turbine efficiency range to minimize orifice plugging problems.

~~**viii.**~~**vii.** If utilizing the automatic orifice backflush system, inspect as determined by the project biologist (but at least once per 12-hour shift unless coordinated differently) to ensure that the orifices are opening and closing correctly and are clear of debris. The project biologist will determine the frequency of automatic orifice cycling and back-flushing to maintain clear orifices.

~~**ix.**~~**viii.** North make-up water valve and associated controls operational and maintaining stable channel flow in conjunction with primary dewaterer (PDW).

2.3.2.4. Transportation Facilities.

i. Water supply throttling valve and 42" drain sluice gate operational.

ii. Maintain stable water conditions in water supply upwell and separator. Operate separator and fish distribution system as designed.

iii. Crowder screen brushes should be maintained in good operating condition, with no holes or sharp edges on crowder screens. Crowders should be in good operating condition.

iv. All valves, slide gates, and switch gates in and around separator and raceways operational.

v. Inspect raceway and tank retainer screens to make sure they are clean with no holes or protruding wire.

vi. Barge and truck loading pipes, hoses, and related equipment free of debris, cracks, or blockages and in good condition. Barge loading boom in good operating condition. Barge loading boom remote control system fully operational.

vii. Inform PSMFC, in advance if possible, of situations that cause the PIT-tag system to become inoperable (e.g., power outages) or that could result in confounding the interpretation of PIT-tag data (e.g., bypassing fish from raceways to the river, operating in primary bypass mode without an operational full-flow detector, emergency dewatering).

2.3.2.5. Dewatering Structures (PDW and SDW).

i. Brush cleaners and air burst systems operating correctly. The frequency of screen cleaning should be set as necessary by the project biologist to maintain clean screens.

ii. If utilizing the automatic cleaning system, inspect as determined by the project biologist (but at least once per 12-hour shift unless coordinated differently) to ensure that the cleaning system is operating correctly and is clear of debris. The project biologist will determine the frequency of automatic cleaning to maintain a clean system.

iii. Hand clean side screens if necessary to maintain clean screens.

iv. Check overflow weirs to make sure they are operating correctly; perform maintenance as required.

v. There should be no gaps between screen panels or damaged panels in the floor and side screens. Screen panels in place and tightly secured.

vi. Unless needed for personnel access, lights at the dewatering structures should be turned off at night to encourage fish to move downstream volitionally.

~~2.3.2.5.~~2.3.2.6. Avian Predation Areas (Forebay and Tailrace).

i. Bird wires and avian deterrent devices monitored to ensure they are in good condition. Any broken wires or devices should be replaced as soon as possible.

ii. Harassment program in place to deter avian predation in areas actively used by birds and not covered by bird wires or other devices.

iii. Project biologists shall routinely monitor project areas to determine areas of active avian predation and, if possible, adjust harassment program to cover areas or install bird wires or other deterrent devices to discourage predation activities.

~~2.3.2.6.~~2.3.2.7. Removable Spillway Weir (RSW).

i. The RSW in spillbay 1 will be raised and operational on the first day of spill for juvenile fish passage.

ii. When the RSW is in operation, spill through Bay 1 is fixed at approximately 6.8 kcfs. The spill gate shall be raised to where it does not touch flow passing down the RSW (at least nine stops).

iii. When the RFC forecasts[3] Lower Granite inflows above 200 kcfs, coordinate with RCC and CENWW-OD-T to initiate aggressive forebay debris removal so that RSW operation will not be impeded.

iv. Complete RSW stow (complete rotation to the landing pad) when inflow exceeds 260 kcfs, upstream river gauge flows are increasing, and forecasted inflow at Lower Granite is above 300 kcfs.

v. On or after June 21 (start of summer spill), when average daily total project outflow is less than 30 kcfs and forecasted to remain below 30 kcfs for 3 or more days on a declining hydrograph[3], the RSW will be closed and spill will be distributed in patterns with no RSW in **Table LWG-8**. The RSW will be re-opened if average daily total project outflow increases above 30 kcfs and is forecasted to remain above 30 kcfs for 3 or more days.

vi. When not spilling, operation of the RSW for short durations may be requested by the Project Biologist through CENWW during low flow years if it appears the juvenile fish transportation facility and barge holding capacities will be exceeded, as described in the *Juvenile Fish Transportation Plan* (**Appendix B**).

[3] NWRFC inflow forecast for Lower Granite is at: www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?LGDW1

~~2.3.2.7.~~2.3.2.8. **Inspection and Record Keeping.**

i. Inspect fish facilities at least once every 8 hours. Inspect facilities according to fish facilities monitoring program. Record all maintenance and inspections.

2.4. Operating Criteria - Adult Fish Facilities.

2.4.1. Adult Facilities - Winter Maintenance (January 1 – end of February). Maintenance will be scheduled to target returning the adult fish ladder to service by February 15 to the extent possible, and by no later than March 1.

2.4.1.1. Inspect all staff gauges and water level indicators; repair and/or clean as necessary.

2.4.1.2. Dewater the ladder and inspect all dewatered sections of fish facilities for projections, debris, or plugged orifices which could injure fish or impede fish passage up the ladder. The fish ladder exit trashrack must have smooth surfaces where fish pass, and must have downstream edges that are adequately rounded or padded. A spare trashrack should be on hand for use as necessary. Inspect all diffuser gratings and chambers, and the fallout fence, annually by dewatering or by using divers or video inspection techniques. All diffuser gratings and chambers are to be dewatered and physically inspected at least every 3 years. Repair deficiencies.

2.4.1.3. Inspect for and clean debris from the fish ladder exit. The trashrack and picketed leads must be clean and installed correctly.

2.4.1.4. Calibrate all water level measuring devices as necessary for proper facility operation.

2.4.1.5. Inspect all spill gates and ensure that they are operable.

2.4.1.6. Fish pumps maintained and ready for operation.

2.4.1.7. Maintain adult PIT-tag system as required. Coordinate with PSMFC.

2.4.1.8. Maintain the adult fish trap as required.

2.4.1.9. Clean debris from the diffuser-14 trashrack (entrance). Check under the diffuser-14 ladder grating for debris accumulation and remove – if necessary. Check limit switch settings on diffuser-14 controller and ensure full operation.

2.4.2. Adult Fish Passage Season (March 1 – December 31). The adult fish ladder may be returned to service as early as February 15 to the extent possible, by no later than March 1.

Note: Operating Little Goose within MOP (633'–634' msl) for juvenile salmonids may result in some of the Lower Granite adult fishway entrances bottoming out on their sills prior to reaching criteria depths. Continuous operation within MOP may also result in increased pumping head on the auxiliary water supply pumps, decreasing the amount of water pumped. Fish pump #1 may be run at “slow speed” to avoid frequent tripping from an overload condition while operating within MOP.

2.4.2.1. Fishway Ladder. Water depth over weirs: 1' to 1.3'. To facilitate proper operation of adult fishway weirgate entrances, powerhouse electricians shall raise and lower individual weirgates to check the limit switch settings and make necessary adjustments and/or begin planning for necessary repairs to occur during winter maintenance (Jan 1–end of Feb). The checks must be performed while the ladder is watered up and are expected to take approximately one hour per weirgate. Checks shall be conducted near the end of the day during the period December 15-31 when adult fish passage is minimal.

2.4.2.2. Counting Window. The crowder shall be opened to full count slot width and the picketed leads shall be removed when not counting. The crowder shall be open as far as possible to allow accurate counting and shall not be closed to less than 18" while counting. This will usually occur during high turbidity conditions to allow count accuracy criteria to be achieved. The counting slot has a width range of 12-30". All equipment should be maintained in good condition. Counting window and backboard should be cleaned as needed to maintain good visibility.

2.4.2.3. Head on all Fishway Entrances. Head range: 1' to 2'.

2.4.2.4. North Shore Entrances (NSE-1&2). Elevation at top of gates on sill = 625'.

i. Operate both downstream gates.

ii. Weir depth: 7' or greater below tailwater.

2.4.2.5. North Powerhouse Entrances (NPE-1&2). Elev. at top of gates on sill= 628'.

i. Operate both downstream gates.

ii. Weir depth: 8' or greater below tailwater. At tailwater below elevation 636', weirs should be on sill.

2.4.2.6. Floating Orifice Gates (FOGs). Operate four FOGs (1, 4, 7, 10). Inspect fish fallout fence for debris buildup, holes, etc.

2.4.2.7. South Shore Entrances (SSE-1 & 2). Elevation at top of gates on sill = 625'.

i. Operate both gates.

ii. Weir depth: 8' or greater below tailwater.

iii. At tailwater below elevation 633' weirs should be on sill.

2.4.2.8. Channel Velocity. 1.5' to 4' per second, as measured by the NPE Channel Velocity meter digital display on the Adult Fishway Biologist Snap Shot or in the panel box located in the adult fish gallery on the third floor of the powerhouse.

i. The channel velocity meter has a 5-minute delay to changes in flow and readings may be influenced by fish and/or debris. Readings outside of criteria should be checked after 5 minutes to verify accuracy.

2.4.2.9. Tunnel Lights. Lights in the tunnel section under the spillway shall be on during fish passage season. The mirror that is placed so that the tunnel lights can be seen should be clean and functional.

2.4.2.10. Head on Trashracks.

i. Maximum head of 0.5' on ladder exit.

ii. Maximum head on picketed leads shall be 0.3'.

iii. Trashrack and picketed leads installed correctly.

2.4.2.11. Staff Gauges and Water Level Indicators.

i. All staff gauges should be readable at all water levels encountered during the fish passage season. Repair/clean as necessary.

ii. Inform PSMFC, in advance if possible, of situations that cause the PIT-tag system to become inoperable (e.g. power outages) or that could result in confounding the interpretation of PIT-tag data (e.g. emergency dewatering).

2.4.2.12. Facility Inspections.

i. Powerhouse operators shall inspect adult facilities once per day shift and check computer monitor information at least once during each back shift.

ii. Project biologists shall inspect adult facilities at least three times per week. Inspect all facilities according to fish facilities monitoring program.

iii. Picketed leads shall be checked during all inspections to ensure they are clean and in the correct position (all the way down).

iv. Project personnel shall check calibration of fishway control system twice per month to ensure that it is kept within calibration. This may be done as part of routine fishway inspections. Deviations in readings should be reported to the electrical crew foreman for corrective action.

v. Inspect fishways daily for foreign substances (particularly oil). If substances are found, corrective actions should be undertaken immediately.

vi. Record all inspections.

2.4.2.13. Adult Trap Holding Tanks. Protocols for operating the adult trap for research and other activities are covered in **Appendix G**. This criterion supplements that appendix and governs use of the holding tanks for research or broodstock collection and water supply. The trap has two water supply sources, one from diffuser-14 and one from the JBS main water supply line for the transportation facility. Only one water supply source shall be used at any time to avoid pressure differences between the two systems adversely impacting the other water supply source and connected systems. The diffuser-14 water supply for the trap comes from the diffuser water supply at the top of the ladder. Trap operations can affect fish ladder criteria for water depth over the weir when diffuser-14 water supply is being used. Operating all six holding tanks with the diffuser-14 source may require that modifications be made to the diffuser-14 auxiliary water supply. The JBS adult trap water supply is fed from the primary dewaterer (PDW) via the water supply pipe adjacent to the adult trap attraction pool.

i. Both water supplies should be available for use throughout the adult trap operating season. While the JBS water supply is capable of meeting adult trap water supply requirements, the historic supply from diffuser-14 is required when the juvenile bypass system is not operational.

ii. Diffuser-14 and JBS water supplies will be inspected and repaired during the fish ladder winter maintenance period or as needed during the trapping season.

~~**i.**~~**iii.** Prior to and during the period of use of any holding tanks at the Adult Trap, the COE should inspect and clean if necessary the intake to the diffuser-14 auxiliary water supply. ~~Additionally, the COE should inspect and repair potential sources of leakage in the diffuser-14 water supply.~~

~~**ii.**~~**iv.** If utilizing the diffuser-14 water supply, no holding tanks can be used prior to September 1 of each year if their usage affects the amount of water passing down the fish ladder and a water depth of less than 12 inches is maintained over the ladder weirs. JBS water supply does not impact fish ladder water depth over the weirs.

~~**iii.**~~**v.** If utilizing the diffuser-14 water supply after September 1, the two smaller of the six holding tanks only may be used to hold adult fish for hatchery broodstock or other research needs if the use of more tanks will limit the ability of the LWG fish ladder to meet its depth over ladder weir criteria. JBS water supply will be used when available to ensure adequate tank supply is available for broodstock collection without impacting fish ladder criteria.

~~**iv.**~~**vi.** Additional holding tanks may be used if the JBS water supply is used or modifications are made to the diffuser-14 water supply that allow a water depth of 12 inches or greater over the ladder weirs in addition to meeting the needs of the additional tanks.

2.4.2.14. Adult Fish Ladder Exit Pool Cooling Pumps. Operate forebay exit pool cooling pumps that spray upstream of the fish ladder exit to enhance conditions for adult fish exiting the ladder and to supplement cooler water throughout the ladder. The water supply for the

manifold at the exit pool originates from AUX pumps 1 and 2 at elevation 667' in the forebay, which is 66' below the MOP range (733'-734'). This action requires both pumps to be operational at the same time for optimal cooling.

2.4.2.14.a. Begin operation of exit pool cooling pumps when the Lower Granite fish ladder exit pool water temperature is at or above 68°F. Exit pool temperature data are online at: http://pweb.crohms.org/dd/nww/fl_temps/www/index.html

2.4.2.14.b. Continue this operation until water temperature at the exit pool and the Lower Granite forebay temperature string at 0.5 meters deep are below 68°F for 3 consecutive days; at that time, discontinue pump operation until criteria to start pump operations are met. Forebay temperature string data are online at: www.nwd-wc.usace.army.mil/ftppub/water_quality/tempstrings/.

2.4.2.14.c. The pumps may be turned on or off at the Project Biologist's discretion if adult passage delays are observed either in the forebay or within the ladder, and operation of the pumps is believed to influence the adult passage issue.

2.4.2.15. Fishway Temperature Monitoring. From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits.

i. Temperature monitors shall be placed within 10 meters of all shore-oriented entrances and exits.

ii. If possible, the entrance monitor shall be within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers to allow for sufficient mixing with surface water.

iii. The exit monitor shall be within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

iv. If an existing temperature monitoring location is proposed to be used for either the exit or entrance, it shall be verified that the site accurately reflects water temperature within 10 meters of the entrance or exit.

v. Project Fisheries will submit temperature data to the Fish Passage Center (FPC) weekly for posting online at: www.fpc.org/river/Q_ladderwatertempgraph.php

2.5. Fish Facility Monitoring & Reporting.

2.5.1. Project biologists shall inspect fish facilities at the frequencies defined in the juvenile and adult fish facilities operating criteria sections.

2.5.2. Weekly Reports. Project biologists shall prepare weekly reports March 1–December 31, summarizing project operations for Friday–Thursday and email to CENWW-OD-T by noon the following Monday. Reports shall provide an overview of how the project and fish passage facilities operated during the week and evaluate resulting fish passage conditions, and include:

i. Any out-of-criteria situations observed and subsequent corrective actions taken;

ii. Any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities;
iii. Adult fishway control calibrations;
iv. ESBS and VBS inspections;
v. Any unusual activities that occurred that may have affected fish passage.

2.5.3. Annual Reports. Project biologists shall prepare a draft annual *Adult and Juvenile Monitoring Report* by February 10 and a final report by March 15 summarizing operation of adult fish passage facilities for the previous year and giving a brief overview of the juvenile fish operations. The annual report shall also include a description of all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities.

2.5.4. Project biologists also inspect project facilities once per month and during dewaterings for the presence of zebra and Quagga mussels. Biologists shall provide a report to CENWW-OD-T on a monthly basis summarizing mussel inspections.

3. FISH FACILITIES MAINTENANCE

3.1. Dewatering and Fish Handling.

3.1.1. Project biologists should be present to provide guidance at all project activities that may involve fish handling. Dewatering (also referred to as "unwatering") shall be accomplished pursuant to approved *Dewatering Guidelines and Fish Salvage Plans* (**Appendix F**). When river temperatures are ≥ 70°F, all adult fish handling will be coordinated through CENWW-OD-T. *Dewatering Plans*[4] were reviewed and revised in 2011 to ensure they comply with **Appendix F**.

3.2. Maintenance - Juvenile Fish Facilities.

3.2.1. Scheduled Maintenance. Scheduled maintenance of juvenile facilities is conducted throughout the year. Long-term maintenance or modifications of facilities, which require extended out of service periods, are conducted during the winter maintenance period (December 16–March 24). During fish passage season, parts of the facilities are maintained on a daily, weekly, or longer interval to keep them in proper operating condition.

3.2.2. Unscheduled Maintenance. Unscheduled maintenance is the correction of any situation that prevents facilities from operating within criteria or that will impact fish passage or survival.

3.2.2.1. Notification/Reporting. Maintenance of facilities such as ESBSs, which sometimes break down during the fish passage season, will be carried out as described below. In these cases, repairs will be made as prescribed and CENWW-OD-T will be notified as soon as possible after it becomes apparent that repairs are required. The Operations Manager has the authority to initiate work prior to notifying CENWW-OD-T if a delay of the work will result in an unsafe situation for people, property, or fish. Unscheduled maintenance that will have a significant impact on fish passage shall be coordinated with NOAA Fisheries and FPOM on a case-by-case basis by CENWW-OD-T. Information required by CENWW-OD-T includes:

[4] Project Dewatering Plans are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/

i. Description of the problem;
ii. Type of outage required;
iii. Impact on facility operation;
iv. Length of time for repairs;
v. Expected impacts on fish passage and proposed measures to mitigate them.

3.2.2.1. ESBSs. The ESBSs are inspected periodically throughout the juvenile migration season with a video monitoring system. If a screen is found damaged or malfunctions at any time it will be removed and either replaced with a spare or repaired. A unit shall not be operated during the juvenile bypass season with a missing, damaged or non-operating ESBS (except as detailed below). If an ESBS fails on a weekend or at night when maintenance crews are not available, the turbine unit will be shut down and generation switched to another fully screened unit. If all screened turbine units are in service, water may be spilled until the affected ESBS can be removed and repaired or replaced.

3.2.2.1.a. If an ESBS screen cleaner fails after 1400 hours on a regular workday or any time on a weekend, and taking the unit out of service would result in spilling above TDG state standards, the unit may be operated with the failed screen cleaner up to a maximum of 110 MWs if there is evidence that the ESBS will not plug with debris (e.g., a lack of debris in the gatewell and along the face of the powerhouse). Project personnel will pull and replace the screen the next morning, weekday or weekend inclusive. If the screen cannot be pulled and repaired the next morning, the unit will be removed from service until the screen can be repaired. If there is evidence that fish are being injured under this operation, by either observing injured fish in the gatewells or injured fish appearing on the separator, the turbine unit will be removed from service immediately. This operation will not take place when daily average river flows are less than total powerhouse capacity and the turbine unit will not be operated during power peaking operations where turbine units are being turned on and off.

3.2.2.2. Gatewell Orifices. Each turbine intake slot has two orifices with air-operated valves in the bulkhead slot for allowing the fish to exit the slots. Each turbine unit intake has one 10” orifice (north side) and one 14” orifice (south side), both with air-operated valves. Under normal operation, 18 bulkhead slot orifices (one per gatewell slot) shall be operated with preference given to the 14” orifice. Additional bulkhead slot orifices may be operated to hasten fish departure and/or allow debris to exit gatewells as the hydraulic capacity of the gallery and primary dewatering structure will allow. To minimize blockage from debris, orifices should be backflushed every day. If an orifice becomes blocked with debris, it will normally be cleaned and remain in operation. If an orifice is damaged, it will be closed and the alternate orifice for that gatewell operated until repairs can be made. If both orifices are blocked with debris, damaged, or must be closed, the turbine unit will be taken out of service until repairs can be made. During any orifice closure, gatewells shall be monitored hourly by project personnel for signs of fish problems or mortality. Orifices shall not be closed for longer than 5 hours in an operating turbine unit with ESBSs in place. During periods of high fish passage, orifice closure times may need to be less than 5 hours depending on fish numbers and condition. If orifices are closed, gatewells shall be monitored hourly.

3.2.2.3. Transportation Channel. The transportation channel transitions from a concrete channel within the dam at the end of the powerhouse bypass channel to an enclosed elevated metal box outside the dam before entering the primary dewatering structure downstream. This channel is approximately 6' wide for the majority of its length before transitioning to 10 feet wide at the primary dewatering structure. The elevated metal box downstream portion of this channel should be routinely monitored to ensure expansion joints are functioning as intended and maintenance should occur as necessary to ensure a functional system.

3.2.2.4. Primary Dewaterer (PDW). The primary dewaterer (PDW) acts as a transition from the transportation channel to the corrugated metal flume. A set of inclined floor screens allows excess water to be bled off, with all fish and remaining water transitioning into the corrugated metal flume. Side screens on the downstream end of the primary dewaterer allow additional water to be removed for fine tuning the amount of water entering the corrugated metal flume. The excess water is used as the water supply for the transportation facilities with the remainder either discharged into the river via the emergency bypass outfall or added to the adult passage facilities auxiliary water supply system.

The dewaterer is fitted with mechanical brush and air bubbler systems for cleaning the floor screens of debris. If the cleaning system breaks and interferes with juvenile fish passage through the structure or if the dewatering screens are damaged, an emergency bypass system at the upstream end of the dewatering structure can be used, if required, to bypass juveniles while repairs are made. Operation of the emergency bypass system requires all orifices to be temporarily shutoff while the emergency bypass hatch is opened. A set of stoplogs are available to be inserted between the emergency bypass hatch and the upstream end of the floor screens if necessary to conduct repairs. The emergency bypass valve is then opened and the bypass system operated with the eighteen 10" gatewell orifices open. Based on initial commissioning activities in 2018, a limited number of additional 14" orifices, or a partial opening of the north water makeup valve, can provide additional flows into the emergency bypass and reduce surging at the emergency bypass outfall. The system shall be closely monitored if additional flows are added to ensure that the emergency bypass downwell is not overfilled.

~~3.2.2.3.~~3.2.2.5. **Bypass Flume.** The corrugated metal flume transports juveniles to either the transportation facilities or to the river below the project. A switchgate within the loops section is moved horizontally to determine which route is utilized. If there is a problem with the flume upstream of the switch gate that interferes with operations, the emergency bypass system at the upper end of the primary dewaterer (PDW) can be opened and all of the fish in the bypass system diverted to the river below the project through the emergency bypass while repairs are made. If there is a problem with the flume downstream of the switchgate or transportation facility, the switchgate can be moved to direct all fish back to river (primary bypass) while repairs are made.

~~3.2.2.4.~~3.2.2.6. **Transportation Facilities.** The transportation facilities can be operated to either collect juveniles for the transportation program, and/or to bypass them back to the river. If part of the facility malfunctions or is damaged, efforts will first be made to bypass the fish around the damaged area. If this is not possible, the fish will be bypassed around the

transportation facilities ~~or the entire bypass system dewatered until repairs are made~~. Spill may be used as an alternative avenue for fish passage during a bypass system outage.

3.3. Maintenance - Adult Fish Facilities.

3.3.1. Scheduled Maintenance. Scheduled maintenance of a facility that must be dewatered or where maintenance will have a significant effect on fish passage will be done during the January–February winter maintenance period. Maintenance will be scheduled to target returning the adult ladder to service by February 15 to the extent possible, and by no later than March 1. Maintenance of facilities that will have no effect on fish passage may be conducted at any time. When facilities are not being maintained during the winter maintenance period, they will be operated according to normal criteria unless otherwise coordinated with NOAA Fisheries and other FPOM participants.

3.3.2. Unscheduled Maintenance.

3.3.2.1. Notification/Reporting. Unscheduled maintenance of adult facilities will follow the same coordination procedures as for juvenile facilities in **section 3.2.2**. Unscheduled maintenance that will significantly affect the facility operation will be coordinated with NOAA Fisheries and FPOM. If part of a facility is damaged or malfunctions during fish passage season and the facility can still be operated within criteria with no detrimental effects on fish passage, repairs may be conducted during winter maintenance or when fewer numbers of fish are passing. If part of a facility is damaged or malfunctions and fish passage may be significantly impacted, it will be repaired as soon as possible.

3.3.2.2. Ladder and Count Station. If any part of the ladder fails or is blocked with debris during fish passage season, efforts will first be made to correct the problem without dewatering the ladder. Trashracks, picket leads, and counting stations can sometimes be repaired or maintained without dewatering the ladder. If the fish trap malfunctions or is damaged, fish may be passed around it until repairs are made. The decision to dewater the ladder and make repairs during fish passage season or wait until the winter maintenance period will be made after coordination with the fish agencies and tribes.

3.3.2.2.a. Hazardous Materials Spill. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.

3.3.2.3. Auxiliary Water Supply (AWS). Three electric pumps supply auxiliary water for the fish ladder and powerhouse collection system. Two pumps are capable of providing required flows during normal operations and most flow conditions.

3.3.2.3.a. If one pump fails during the two-pump operation, the pump on standby will be operated to make up flows.

3.3.2.3.b. If two pumps fail and the outage is expected to be long-term, the floating orifices will be closed and monitored in the following order: OG-4, OG-7, OG-10, OG-1.

If fishway criteria still cannot be met, NSE-2 and NPE-2 will be closed and NPE-1 raised in 1' increments to provide the required 1'–2' head differential. If head cannot be maintained by the time the top of the weir reaches 5', then SSE-1 and SSE-2 should be raised in 1' increments until 5' below tailwater is reached.

3.3.2.3.c. If all three pumps fail, NSE-1 and NPE-1 should be closed, the powerhouse collection channel bulkheaded off at the junction pool, and SSE-1 and SSE-2 operated at 6' below tailwater regardless of head.

3.3.2.3.d. If oil or other contaminants are observed in the powerhouse tailrace, the AWS pumps will be removed from service until the substance is contained and there is no risk of contamination in the ladder collection channel and transition pool. The Project Biologist will notify CENWW-OD-T as soon as possible and CENWW-OD-T will notify NOAA Fisheries and FPOM. When the problem is resolved, the Project Biologist will submit a MFR to CENWW-OD-T for distribution to FPOM (see **section 3.3.2.2.a**).

3.3.2.4. Fishway Entrances. The fishway entrances consist of main entrance weirs with hoists and automatic controls, and floating orifices which regulate themselves with tailwater fluctuations. If any of the automatic controls malfunction, the weirs can be operated manually by project personnel and kept within criteria. If there is a further failure which prevents an entrance from being operated manually, the weirs can usually be left in a lowered position while repairs are being conducted or the entrance closed and the water redistributed to other entrances while repairs are made. If a floating orifice fails, it will be pulled out of the water and the entrance bulkheaded off until it is repaired.

3.3.2.5. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to ensure they are in place. These inspections are done by either dewatering to physically inspect the diffuser gratings, or by using underwater video cameras, divers, or other methods. Diffuser gratings may come loose during the fish passage season due to a variety of reasons. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings. If a diffuser grating is known or suspected to have moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway. Coordination of problems should begin immediately through the established coordination procedure (see **section 3.2.2**). If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with fish agencies and tribes through the established coordination procedure. Repairs shall be made as quickly as possible unless coordinated differently.

3.3.2.6. Fallback Fence. The fallback fence located near the north powerhouse fishway entrances shall be inspected during winter maintenance. Loose mesh on to the frame will be reattached. If any section of the netting is severely damaged, that section will be replaced.

4. TURBINE UNIT OPERATION & MAINTENANCE

4.1. Turbine Unit Priority Order.

4.1.1. From March 1 through December 15, turbine units will be operated in the order of priority in **Table LWG-5** in order to enhance adult and juvenile fish passage. If a turbine unit is out of service for maintenance or repair, the next unit in the priority order shall be operated.

4.1.2. Turbine unit priority order may be coordinated differently for fish research, construction, or project maintenance activities.

Table LWG-5. Lower Granite Dam Turbine Unit Priority Order.

Season	Unit Priority Order
March 1 – December 15 Fish Passage Season	Start Units: 1, 3, 4–6 any order, then 2[a] Stop Units: 4–6 any order, then 3, 2, 1
December 16 – end of February Winter Maintenance Period	Any Order

a. Unit 2 has fixed blades (hydraulically locked) and operates in the upper 1% range. The priority order minimizes starts/stops and allows for the longest runtime once Unit 2 is started.

b. Stop units in reverse Start order except run Unit 2 as long as BPA load request and required spill can be met, and stop Unit 2 before Unit 1.

4.2. Turbine Unit Operating Range.

4.2.1. In-Season (April 1–October 31). As defined in the *BPA Load Shaping Guidelines* (**Appendix C**), all units will be operated within ±1% of peak turbine efficiency (1% range) to maximize survival of juvenile fish that pass through the turbines. Turbine unit flow and power output at the lower and upper limits of the 1% range are defined in **Table LWG-6**.

4.2.1.1. If operation outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

i. Meet BPA load requests made pursuant to BPA's policy, statutory requirements, and *Load Shaping Guidelines* (**Appendix C**);

ii. If the draft tube is to be dewatered (**section 4.3.4**), the unit will be operated at full load >1% (or at speed-no-load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs in order to flush fish from the unit;

iii. Operate a turbine unit solely to provide station service; or

iv. Comply with other coordinated fish measures.

4.2.1.2. Minimum Generation. All of the lower Snake River projects may be required to keep one generating unit online at all times to maintain power system reliability. The

minimum generation flow range for each unit is defined in the FOP Table 1 (**Appendix E**), as derived from the lower limits of the 1% range and actual unit operations. During low flow, there may not be enough river flow to meet this generation requirement and the FOP spill target. Under these circumstances, the project will operate the first available priority unit at minimum generation and spill the remainder of outflow. Actual attainable minimum generation may vary depending on real-time conditions.

4.2.2. Off-Season (November 1–March 31). While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

Table LWG-6. Lower Granite Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Turbine Efficiency (Lower and Upper Limits of 1% Range) and Operating Limits.[a]

Project	LWG Units 1, 2[b], 3 - With ESBS						LWG Units 1, 2[b], 3 - No ESBS					
Head	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
(feet)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	69.9	11,938	116.2	19,863	140.9	25.5	65.7	10,897	120.6	20,010	140.9	24,226
86	70.6	11,922	118.5	20,007	142.8	25.5	66.4	10,882	123.0	20,155	142.8	24,243
87	71.4	11,906	120.8	20,146	144.6	25.5	67.2	10,868	125.4	20,296	144.6	24,258
88	72.2	11,890	123.1	20,282	146.5	25.5	67.9	10,853	127.8	20,434	146.5	24,272
89	73.0	11,875	125.4	20,415	148.3	25.5	68.6	10,839	130.2	20,568	148.3	24,283
90	73.7	11,859	127.7	20,544	150.2	25.5	69.3	10,826	132.6	20,698	150.2	24,292
91	74.6	11,849	128.1	20,346	151.5	25.4	70.2	10,817	133.0	20,500	151.5	24,217
92	75.5	11,839	128.5	20,152	152.8	25.3	71.0	10,808	133.3	20,305	152.8	24,139
93	76.3	11,829	128.8	19,963	154.0	25.2	71.8	10,799	133.7	20,115	154.0	24,059
94	77.2	11,818	129.2	19,777	155.2	25.1	72.6	10,790	134.1	19,929	155.2	23,973
95	78.1	11,808	129.5	19,596	155.2	24.8	73.4	10,781	134.4	19,747	155.2	23,646
96	79.1	11,825	129.7	19,385	155.2	24.5	74.4	10,797	134.6	19,536	155.2	23,322
97	80.2	11,841	129.8	19,179	155.2	24.1	75.4	10,813	134.7	19,329	155.2	23,004
98	81.2	11,857	130.0	18,978	155.2	23.8	76.4	10,827	134.9	19,126	155.2	22,694
99	82.3	11,872	130.1	18,780	155.2	23.5	77.4	10,842	135.0	18,928	155.2	22,390
100	83.3	11,887	130.3	18,586	155.2	23.2	78.3	10,855	135.2	18,734	155.2	22,093
101	84.2	11,890	132.0	18,637	155.2	22.8	79.2	10,858	137.0	18,785	155.2	21,784
102	85.1	11,892	133.7	18,687	155.2	22.5	80.0	10,860	138.8	18,836	155.2	21,482
103	86.0	11,895	135.4	18,736	155.2	22.2	80.9	10,863	140.6	18,885	155.2	21,186
104	86.9	11,897	137.2	18,784	155.2	21.9	81.7	10,865	142.4	18,934	155.2	20,897
105	87.8	11,899	138.9	18,830	155.2	21.6	82.5	10,867	144.2	18,981	155.2	20,615
	LWG Units 4, 5, 6 - With ESBS						LWG Units 4, 5, 6 - No ESBS					
85	83.9	13,761	107.2	17,586	142.5	24,793	85.1	13,602	116.0	18,546	142.5	23,969
86	85.0	13,769	108.9	17,652	144.3	24,810	86.1	13,600	117.9	18,616	144.3	23,986
87	86.1	13,777	110.7	17,717	146.1	24,825	87.2	13,597	119.8	18,685	146.1	24,001
88	87.1	13,784	112.4	17,780	147.9	24,838	88.2	13,595	121.7	18,751	147.9	24,013
89	88.2	13,791	114.2	17,841	149.7	24,849	89.2	13,592	123.5	18,816	149.7	24,024
90	89.3	13,798	115.9	17,900	151.4	24,857	90.3	13,589	125.4	18,879	151.4	24,032
91	90.3	13,778	117.1	17,878	152.8	24,721	91.4	13,598	126.8	18,856	152.8	23,946
92	91.2	13,759	118.4	17,857	154.1	24,583	92.5	13,607	128.1	18,834	154.1	23,857
93	92.1	13,740	119.6	17,836	155.2	24,425	93.7	13,615	129.4	18,812	155.2	23,747
94	93.1	13,722	120.8	17,815	155.2	24,112	94.8	13,623	130.8	18,791	155.2	23,676
95	94.0	13,703	122.0	17,795	155.2	23,675	95.9	13,630	132.1	18,769	155.2	23,011
96	95.1	13,707	122.6	17,676	155.2	23,372	96.9	13,620	132.7	18,645	155.2	21,828
97	96.1	13,711	123.1	17,560	155.2	23,076	97.9	13,609	133.3	18,523	155.2	21,557
98	97.2	13,714	123.7	17,446	155.2	22,786	98.9	13,599	133.9	18,403	155.2	21,292
99	98.3	13,717	124.2	17,335	155.2	22,502	99.9	13,589	134.5	18,285	155.2	21,032
100	99.4	13,720	124.8	17,225	155.2	22,224	100.9	13,579	135.0	18,170	155.2	21,620
101	100.4	13,724	126.0	17,227	155.2	21,941	101.9	13,579	136.4	18,172	155.2	21,325
102	101.4	13,728	127.3	17,229	155.2	21,665	102.9	13,580	137.8	18,174	155.2	21,036
103	102.5	13,731	128.6	17,230	155.2	21,394	104.0	13,580	139.1	18,175	155.2	20,753
104	103.5	13,735	129.8	17,232	155.2	21,128	105.0	13,581	140.5	18,177	155.2	20,477
105	104.5	13,739	131.1	17,233	155.2	20,868	106.0	13,581	141.9	18,179	155.2	20,206

a. Table values derived from HDC report (Nov 2006). Flow (cfs) is calculated based on turbine efficiency, head, and power output (MW). "Operating Limit" is the maximum safe operating point based on the cavitation or generator limit (added Feb 2018).

b. Unit 2 runner blades hydraulically locked in April 2017 due to failed blade packing sleeves. Unit 2 is restricted to a smaller operating range of approximately 17-19 kcfs until the blade seals are replaced.

4.3. Turbine Unit Maintenance.

4.3.1. Maintenance Schedule.

4.3.1.1. Turbine unit maintenance schedules will be reviewed annually by Project and Operations Division biologists for fish impacts.

4.3.1.2. Each turbine unit requires annual maintenance that may take from two to five weeks, and is normally scheduled during the mid-July to late November timeframe. Maintenance of priority units for adult passage is normally conducted in late October through December when fewer adults are migrating.

4.3.1.3. Maintenance of priority units will be scheduled for winter maintenance period or when there are few fish passing the project, to the extent possible.

4.3.1.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take over one year to accomplish.

4.3.1.5. Turbine units, governors, exciters, and control systems require periodic maintenance, calibration, and testing which may operation outside of the 1% range. This work will be scheduled in compliance with *BPA Load Shaping Guidelines* (**Appendix C**) to minimize impacts on juvenile fish.

4.3.2. Operational Testing. Operational testing of a unit under maintenance is in addition to a unit in run status required for power plant reliability. Operational testing may deviate from FPP priority order and may require water that would otherwise be used for spill if the unit running for reliability is at its 1% lower limit (i.e., minimum generation). Water for operational testing will be used from powerhouse allocation when possible, and diverted from spill only to the extent necessary to maintain generation system reliability.

4.3.2.1. Pre-Maintenance: Units may be operationally tested for up to 30 minutes before going into maintenance status by running the unit at speed-no-load and various loads within the 1% range for pre-maintenance measurements and testing, and to allow all fish to move through the unit (see **section 4.3.4**).

4.3.2.2. Post-Maintenance: Units may be operationally tested after maintenance or repair while remaining in maintenance or forced outage status. Operational testing may consist of running the unit for up to a cumulative time of 30 minutes (within 1% range) before it is returned to operational status.

4.3.3. Operating Gates.[5] Turbine units may be operated with head gates either in the raised or original stored position. Once all new cylinders have been acquired, turbine units will operate with all head gates in the original design stored position to ensure the safety of project personnel and facilities.

[5] Operating gates may also be referred to as head gates. The terms are interchangeable.

4.3.4. Dewatering Units. Dewatering turbine units (also referred to as "unwatering") should be accomplished in accordance with project *Dewatering Plans*.[4] If the turbine unit draft tube is to be dewatered, operate unit with full load for a minimum of 15 minutes prior to installing tail logs. If not possible to load, run unit at speed-no-load for minimum of 15 minutes. This is to reduce the number of fish in the scroll case prior to installing stop logs. If a turbine unit is out of service for maintenance for an extended period of time without tailrace stop logs in place, efforts should be made to not open the wicket gates if the scroll case must be dewatered at a later date without the unit being spun beforehand.

4.3.5. Doble Testing. See **Appendix A** for yearly test schedule. Transformer Doble testing is required every three years, or more frequently if there is a known problem with a transformer, and requires the associated turbine units to be out of service for 3–5 workdays. Doble testing is normally scheduled for August or early September in conjunction with other scheduled unit maintenance to minimize impacts on fish passage. To conduct testing, the transmission lines must be disconnected from the transformers and normal generation stopped. One turbine unit will operate at speed-no-load (approximately 5 kcfs) to provide project power and operation of fish passage facilities (station service). Spill may be provided to meet minimum required project discharge during testing. If Doble testing will impact priority units for fish passage, adult passage timing should be considered to minimize impacts to migrating adults. Available units will be operated in accordance with FPP priority order and within the 1% range.

4.3.5.1. Lower Granite transformer T1 or T2 bank Doble testing requires daily full line outages. Unit 5 will run at speed-no-load (approximately 5 kcfs) daily to supply station service power. When T1 is tested, T2 (Units 5-6) will be returned to service at night and T1 (Units 1-4) will remain OOS for the duration of the Doble test. When T2 is tested, T1 (Units 1-4) will be returned to service at night and T2 (Units 5 and 6) will remain OOS for the duration of the Doble test. In years when Doble testing is to be performed it will normally be scheduled to begin the second full week in August from 0600-1800 hours. Details of Doble testing will be included in the Lower Granite weekly ESA report.

4.3.6. Turbine Unit Outages during High Flows. During high spring flow, unit outages for inspecting fish screens, repairing research equipment (e.g., hydroacoustic or radio-telemetry), and/or other fish items may cause increased spill in order to maintain reservoir levels within operating ranges, which may result in exceeding TDG standards. It is important that this work be conducted when scheduled to ensure that facilities are working correctly and not injuring fish, and that important fish research data are collected. To facilitate this work, reservoir storage may be utilized to minimize impacts from taking turbine units out of service and increasing spill.

4.3.6.1. At Lower Granite, this special operation shall take place when flow is above 120 kcfs or when increasing spill will result in TDG exceeding standards. The activities covered under these operations will be coordinated with TMT whenever possible.

4.3.6.2. For scheduled inspection or repair of research equipment, reservoirs shall be drafted to MOP and allowed to fill to 1' above the MOP forebay range as work is accomplished.

After the work, reservoirs will be drafted back to MOP. When inspection or repair work can be scheduled ahead of time, the following process will be followed:

i. Project personnel shall schedule unit outages through the approved outage scheduling procedure by noon Tuesday of the week prior to the outage.

ii. Project personnel shall also contact CENWW-OD-T and RCC by the same time period and inform them of the intended work.

iii. RCC will coordinate work activities through TMT, then issue a teletype with instructions to project and BPA personnel for the scheduled work.

iv. Spill will be increased by one spillbay stop setting (about 1.7 kcfs) above passing inflow to lower the level of Lower Granite pool to MOP prior to the scheduled work taking place.

v. When work takes place, additional spill will not be provided and the reservoir will be allowed to refill until the reservoir is 1' above the MOP range (a 2' pondage from where the pool was when the work started). At this point, screen inspections shall stop. (At Snake River projects, this should allow about one normal workday for the scheduled work.)

vi. At the conclusion of work, the reservoir shall be drafted back down to MOP utilizing a one spillbay stop increase in spill above passing inflow.

vii. If work (e.g., screen inspections) is not finished, project personnel shall schedule another turbine unit outage for a date where it can be implemented.

4.3.6.3. If the work is of an emergency nature that does not normally require the unit to be taken out of service (e.g., failed hydroacoustic transducer vs. failed fish screen), and cannot wait for the above process to be implemented, project personnel shall notify CENWW-OD-T and RCC for approval. If approved, the unit shall be taken out of service and the reservoir level may be operated up to 1' above the MOP range. At this point, the unit must be returned to service and the reservoir will be drafted back to the MOP range using one spillbay stop setting above passing inflows.

5. FOREBAY DEBRIS REMOVAL

Debris at projects can impact fish passage conditions. Debris can plug or block trashracks, VBSs, gatewell orifices, dewatering screens, separators, and facility piping resulting in fish impingement, injuries and/or descaling. Removing debris from the forebay is sometimes necessary to maintain safe and efficient fish passage conditions, navigation and other project activities. Debris can be removed from the forebay by physical removal (e.g., using boats to encircle the debris with log booms and tow it to shore where it can be removed with a crane, or using a crane and scoop from the top of the dam to remove forebay debris) or by passing the debris through the spillway with special spill and/or powerhouse operations. The preferred option is to physically remove debris when possible to avoid passing debris to the next

downstream project. However, this is not always possible as some projects do not have forebay debris removal capability. In this case, the only viable alternative is to pass the debris via spill.

5.1. Debris Spill Coordination.

All special spills (other than normal spill patterns for ongoing spill operations) and project operations for passing debris will be coordinated prior to the operations taking place. Each project shall contact CENWW-OD-T at least two workdays prior to the day they want the special project operations for spilling to pass debris. Project personnel shall provide CENWW-OD-T the reason for the debris spill request including an explanation of project facilities impacted by debris, the date and time of the requested spill, and any special powerhouse or other operations required to move the debris to the spillway. Using information provided by the project, CENWW-OD-T shall coordinate the special operations with RCC, NOAA Fisheries and FPOM. When a debris spill is coordinated and approved, RCC shall issue a teletype detailing the specifics of the special operations.

5.2. Emergency Debris Spills.

Emergency spills may be implemented if necessary to pass woody debris that are accumulating in front of the spillbay weir(s), compromising the safe, unobstructed passage of fish. The operating project will immediately spill the woody debris to remove the obstructions to fish passage. The operating project will notify CENWW-OD-T of the emergency spill as soon as possible to provide notification to RCC, NOAA Fisheries and FPOM.

Table LWG-7. Lower Granite Dam Spring Spill Patterns with RSW. [a, b]

LWG Spring Spill Patterns with RSW - # Gate Stops per Spillbay								Total Stops	Spill
Bay 1 [b]	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	(#)	(kcfs)
RSW		1		1	1	1	1	**5**	**15.2**
RSW		1	1	1	1	1	1	**6**	**16.9**
RSW	1	1	1	1	1	1	1	**7**	**18.6**
RSW	1	1	2	1	1	1	1	**8**	**20.4**
RSW	1	1	2	1	1	1	2	**9**	**22.2**
RSW	1	1	2	2	1	1	2	**10**	**24.0**
RSW	1	1	2	2	2	1	2	**11**	**25.8**
RSW	1	2	2	2	2	1	2	**12**	**27.7**
RSW	2	2	2	2	2	1	2	**13**	**29.5**
RSW	2	2	2	2	2	2	2	**14**	**31.3**
RSW	2	2	3	2	2	2	2	**15**	**33.2**
RSW	2	2	3	3	2	2	2	**16**	**35.0**
RSW	2	2	3	3	3	2	2	**17**	**36.9**
RSW	2	3	3	3	3	2	2	**18**	**38.7**
RSW	3	3	3	3	3	2	2	**19**	**40.6**
RSW	3	3	4	3	3	2	2	**20**	**42.4**
RSW	3	3	4	4	3	2	2	**21**	**44.3**
RSW	3	3	4	4	4	2	2	**22**	**46.2**
RSW	3	4	4	4	4	2	2	**23**	**48.0**
RSW	4	4	4	4	4	2	2	**24**	**49.9**
RSW	4	4	4	4	4	2	3	**25**	**51.7**
RSW	4	4	4	4	4	3	3	**26**	**53.6**
RSW	4	4	5	4	4	3	3	**27**	**55.5**
RSW	4	4	5	5	4	3	3	**28**	**57.3**
RSW	4	4	5	5	5	3	3	**29**	**59.2**
RSW	4	5	5	5	5	3	3	**30**	**61.0**
RSW	5	5	5	5	5	3	3	**31**	**62.9**
RSW	5	5	5	5	5	3	4	**32**	**64.8**
RSW	5	5	5	5	5	4	4	**33**	**66.6**
RSW	5	5	6	5	5	4	4	**34**	**68.5**
RSW	5	5	6	6	5	4	4	**35**	**70.3**
RSW	5	5	6	6	6	4	4	**36**	**72.2**
RSW	5	6	6	6	6	4	4	**37**	**74.1**
RSW	6	6	6	6	6	4	4	**38**	**75.9**

a. Spill (kcfs) is calculated as a function of the total number of stops + RSW spill at forebay elevation 734.0 ft.

b. RSW in Bay 1= fixed spill of ~6.8 kcfs at forebay 734.0 ft. Tainter gate does not regulate flow and should be raised ≥ 9 stops to not interfere with RSW flow. When total project outflow is < 30 kcfs, RSW will be closed and spill distributed in patterns in **Table LWG-8** (see **section 2.3.2.6** for RSW operating criteria).

Table LWG-8. Lower Granite Dam Spill Patterns with No RSW (Bay 1 Closed). [a, b]

LWG Spill Patterns with No RSW - # Gate Stops per Spillbay								Total Stops	Spill
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	(#)	(kcfs)
CLOSE							1	**1**	**1.7**
CLOSE	1						1	**2**	**3.4**
CLOSE	1			1			1	**3**	**5.1**
CLOSE	1			1		1	1	**4**	**6.8**
CLOSE	1	1		1		1	1		**8.5**
CLOSE	1	1		1		1	2	**6**	**10.3**
CLOSE	2	1		1		1	2	**7**	**12.1**
CLOSE	2	1		1	1	1	2	**8**	**13.7**
CLOSE	2	1	1	1	1	1	2	**9**	**15.4**
CLOSE	2	1	1	2	1	1	2	**10**	**17.2**
CLOSE	2	1	1	2	1	2	2	**11**	**19.0**
CLOSE	2	2	1	2	1	2	2	**12**	**20.8**
CLOSE	2	2	1	2	2	2	2	**13**	**22.6**
CLOSE	2	2	2	2	2	2	2	**14**	**24.5**
CLOSE	2	2	2	2	2	2	3		**26.4**
CLOSE	2	2	2	2	2	3	3	**16**	**28.3**
CLOSE	3	2	2	2	2	3	3	**17**	**30.2**
CLOSE	3	3	2	2	2	3	3	**18**	**32.1**
CLOSE	3	3	3	2	2	3	3	**19**	**34.0**
CLOSE	3	3	3	2	3	3	3	**20**	**35.9**
CLOSE	3	3	3	3	3	3	3	**21**	**37.8**
CLOSE	3	3	3	3	3	3	4	**22**	**39.6**
CLOSE	**3**	**3**	**3**	**3**	**3**	**4**	**4**	**23**	**41.4**
CLOSE	4	3	3	3	3	4	4	**24**	**43.2**
CLOSE	4	4	3	3	3	4	4		**45.0**
CLOSE	**4**	**4**	**4**	**3**	**3**	**4**	**4**	**26**	**46.8**
CLOSE	4	4	4	3	4	4	4	**27**	**48.6**
CLOSE	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**28**	**50.4**
CLOSE	4	4	4	4	4	4	5	**29**	**52.3**
CLOSE	**5**	**4**	**4**	**4**	**4**	**4**	**5**	**30**	**54.2**
CLOSE	5	4	4	4	4	5	5	**31**	**56.1**
CLOSE	5	5	4	4	4	5	5	**32**	**58.0**
CLOSE	**5**	**5**	**5**	**4**	**4**	**5**	**5**	**33**	**59.9**
CLOSE	5	5	5	4	5	5	5	**34**	**61.8**
CLOSE	5	5	5	5	5	5	5		**63.7**
CLOSE	5	5	5	5	5	5	6	**36**	**65.6**
CLOSE	5	5	5	5	5	6	6	**37**	**67.5**

a. Spill (kcfs) is calculated as a function of the total number of stops at forebay elevation 734.0 ft (**bold** patterns evaluated w/ Corps' LWG 1:80 physical model).

b. When total project outflow is <30 kcfs, RSW will be closed and spill distributed in patterns in this table (see **section 2.3.2.6** for RSW operating criteria).

Table LWG-9. [*pg 1 of 2*] Lower Granite Dam Summer Spill Patterns with RSW. [a, b]

LWG Summer Spill Patterns with RSW - # Gate Stops per Spillbay								Total Stops	Spill
Bay 1 [b]	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	(#)	(kcfs)
RSW								**0**	**6.8**
RSW		1						**1**	**7.9**
RSW		2						**2**	**9.6**
RSW		3						**3**	**11.4**
RSW		4						**4**	**13.1**
RSW		4				1		**5**	**14.9**
RSW		4			1	1		**6**	**16.6**
RSW		4			1	1	1	**7**	**18.4**
RSW		4		1	1	1	1	**8**	**20.1**
RSW	1	4		1	1	1	1	**9**	**21.9**
RSW	1	4	1	1	1	1	1	**10**	**23.6**
RSW	1	5	1	1	1	1	1	**11**	**25.4**
RSW	1	5	1	2	1	1	1	**12**	**27.1**
RSW	1	5	1	3	1	1	1	**13**	**28.9**
RSW	1	5	1	4	1	1	1	**14**	**30.6**
RSW	1	5	1	5	1	1	1	**15**	**32.4**
RSW	1	5	1	5	1	2	1	**16**	**34.1**
RSW	1	5	1	5	1	3	1	**17**	**35.9**
RSW	1	5	1	5	1	4	1	**18**	**37.6**
RSW	1	5	1	5	1	5	1	**19**	**39.4**
RSW	1	5	2	5	1	5	1	**20**	**41.1**
RSW	1	5	3	5	1	5	1	**21**	**42.9**
RSW	1	5	4	5	1	5	1	**22**	**44.6**
RSW	1	5	5	5	1	5	1	**23**	**46.4**
RSW	1	5	5	5	2	5	1	**24**	**48.1**
RSW	1	5	5	5	3	5	1	**25**	**49.9**
RSW	1	5	5	5	4	5	1	**26**	**51.6**
RSW	1	5	5	5	5	5	1	**27**	**53.4**
RSW	1	5	5	5	5	5	2	**28**	**55.1**
RSW	1	5	5	5	5	5	3	**29**	**56.9**
RSW	1	5	5	5	5	5	4	**30**	**58.6**
RSW	1	5	5	5	5	5	5	**31**	**60.4**
RSW	2	5	5	5	5	5	5	**32**	**62.1**
RSW	3	5	5	5	5	5	5	**33**	**63.9**
RSW	4	5	5	5	5	5	5	**34**	**65.6**
RSW	5	5	5	5	5	5	5	**35**	**67.4**
RSW	5	5	6	5	5	5	5	**36**	**69.1**
RSW	5	5	6	6	5	5	5	**37**	**70.9**
RSW	5	6	6	6	5	5	5	**38**	**72.6**
RSW	5	6	6	6	6	5	5	**39**	**74.4**
RSW	5	6	6	6	6	6	5	**40**	**76.1**
RSW	5	6	6	6	6	6	6	**41**	**77.9**
RSW	6	6	6	6	6	6	6	**42**	**79.6**
RSW	6	6	7	6	6	6	6	**43**	**81.4**
RSW	6	6	7	7	6	6	6	**44**	**83.1**
RSW	6	7	7	7	6	6	6	**45**	**84.9**
RSW	6	7	7	7	7	6	6	**46**	**86.6**

LWG Summer Spill Patterns with RSW - # Gate Stops per Spillbay								Total Stops	Spill
Bay 1 [b]	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	(#)	(kcfs)
RSW	6	7	7	7	7	7	6	**47**	**88.4**
RSW	6	7	7	7	7	7	7	**48**	**90.1**
RSW	7	7	7	7	7	7	7	**49**	**91.9**
RSW	7	7	8	7	7	7	7	**50**	**93.6**

a. Spill (kcfs) is calculated as a function of the total number of stops + RSW spill at forebay elevation 734.0 ft.

b. RSW in Bay 1= fixed spill of ~6.8 kcfs at forebay 734.0 ft. Tainter gate does not regulate flow and should be raised ≥ 9 stops to not interfere with RSW flow. When total project outflow is <30 kcfs, RSW will be closed and spill distributed in patterns in **Table LWG-8** (see **section 2.3.2.6** for RSW operating criteria)**.**

Appendix A

Special Project Operations & Studies

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1. INTRODUCTION

1.1. Purpose

This Appendix to the *Fish Passage Plan* (FPP) describes special project operations and studies planned to occur during the current year that may affect fish passage at the four Lower Snake River and four Lower Columbia River projects. All special operations and studies will be coordinated with the project and appropriate regional agencies. The Corps RCC will issue a teletype to authorize all necessary operational changes and provide guidance to project operators.

1.2. Schedule

All dates shown for special operations and studies are approximate and could shift earlier or later due to a variety of factors, including river flow, contractor schedules, equipment failures, or other real-time conditions.

Some studies in this Appendix may not be implemented. Therefore, a final description of studies and outages/operations being conducted will be regionally coordinated prior to April 1 as part of the Corps' Anadromous Fish Evaluation Program (AFEP) via the Fish Facilities Design Review Workgroup (FFDRWG) and/or the Studies Review Workgroup (SRWG).

The Action Agencies will coordinate all significant operational requests and/or schedule changes with fish agencies and tribes through the appropriate regional forum to inform the final decision.

1.3. Spill for Juvenile Fish Passage

Spring and summer spill operations for juvenile fish passage will be implemented as defined in the *Fish Operations Plan* (FOP; included in the FPP as **Appendix E**), or as otherwise coordinated in-season through TMT. Spill for juvenile fish passage will begin April 3 at the Lower Snake River projects (IHR, LMN, LGS, LWG) and April 10 at the Lower Columbia River projects (BON, TDA, JDA, MCN), and continue through August 31. Alternative spill patterns to manage total dissolved gas (TDG) and/or fish passage conditions will be coordinated through the Fish Passage Operations & Maintenance (FPOM) workgroup. During periods of high river flow, the spill rate and forebay elevation at Lower Monumental and Lower Granite may need to be adjusted daily or every-other-day if necessary to provide safe conditions for the fish transport barge in the tailrace.

1.4. Navigation Lock Maintenance

Annual lock outages are scheduled for routine maintenance and inspections, as well as some non-routine work such as repairs of gate structures, concrete, and machinery. In 2018, the annual navigation lock maintenance outage at Corps Walla Walla District projects (LWG, LGS, LMN, IHR, MCN) is scheduled to begin at 6:00am March 3, 2018. Lower Granite and Little Goose locks will be closed through March 25 (3 weeks); all other Walla Walla District projects will be closed through March 18 (2 weeks). Additional information about Corps Walla Walla District navigation lock outages is available online at: www.nww.usace.army.mil/Missions/Navigation/

1.5. Doble Testing[1]

Transformers at the Lower Snake River projects are required to undergo Doble testing[1] every three years to ensure they are functioning correctly and identify any issues that need repair. The testing must be conducted during warm, dry conditions (July–August) and requires an outage of the transformer and associated units. Testing is performed during already scheduled outages to the extent possible and timed to avoid or minimize impacts to fish. The schedule for the current year is defined below in **Table A-1**. For more information, refer to the project-specific sections below and FPP Chapters 2-8.

Table A-1. Doble Testing Schedule in 2018.*

Project	2018 Dates for Doble Testing	Outage (Transformer/Units)	Notes
MCN	Jun 4-8 Jun 11-15 Jun 18-22	T1 (Units 1-2) T6 (Units 11-12) T7 (Units 13-14)	T1 Doble will take both attraction Units 1 and 2 offline at the same time. No choice as the Power Line has to be isolated from T1.
IHR	Jul 23-27	TW5, 6 (Units 5-6)	Unit 5 OOS daily from 0700-1700. Unit 6 already OOS for annual maintenance (Jul 16-Aug 10).
LMN	Jul 27–Aug 2	T2 (Units 5-6)	All units OOS ≤ 4 hrs on first/last day for clearances. T1 (Units 1-4) RTS after clearances.
LGS	Aug 6-11	T1 (Units 1-4)	All units OOS on first/last day. T2 (Unit 6) RTS nightly 1800-0530.
LWG	Aug 13-17	T2 (Units 5-6)	All units OOS daily 0600-1800 for clearances. T1 (Units 1-4) RTS nightly 1800-0600.

*BON, TDA, JDA: No specific outage for Doble tests (testing is done concurrent with outages for maintenance).

[1] Common term referring to a power factor test of transformers to measure performance of electrical insulation. *Doble* is a manufacturer of the test equipment.

2. BONNEVILLE DAM

2.1. BON Special Operations

Special project operations that may require deviations from FPP criteria will be coordinated with FPOM via a Memo of Coordination (MOC), pursuant to **FPP Chapter 1 – Overview**. See **Introduction section 1** for special operations related to spill for juvenile fish passage and navigation lock outages for maintenance.

2.2. BON Studies

2.2.1. Juvenile Salmon and Steelhead System Survival (Lower Granite to Bonneville).

a) Dates: Spring 2018

b) Description: In spring 2018, Pacific Northwest National Laboratory (PNNL) will conduct a system-wide (Lower Granite Dam to Bonneville Dam) acoustic telemetry survival study to better understand the impacts of Gas Cap Spill on juvenile fish. Reach survival estimates will also be assessed from Lower Granite to McNary and from McNary to Bonneville. Fish tagged from the Lower Granite Survival Study (see **section 9.2**) will be used to estimate survival from Lower Granite to McNary. An additional fish collection, tagging, and release effort will take place at McNary to estimate survival from McNary to Bonneville. In addition, Little Goose will be monitored for passage distribution and tailrace delay to better understand the unintended consequences of Gas Cap Spill. Cabled JSAT hydrophones and receivers will be installed at Little Goose on the upstream face of the dam to monitor the major passage routes. At McNary and Bonneville, autonomous receivers will be deployed in the forebay and tailrace a few kilometers from the dam. This study will require access at Little Goose and McNary dams for fish collection and tagging, maintenance and service of telemetry and associated equipment, and will require assistance from the project to provide power for electronics and water supply for holding fish. Dead fish with JSATs tags will be released into all major passage routes (spill, turbine, powerhouse JBS) at McNary and Bonneville Dams to estimate probability of dead fish detections (false positives) on downstream arrays and researchers will need access to these dams for this purpose.

c) Impacts to FPP Criteria: None anticipated. Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

3. THE DALLES DAM

3.1. TDA Special Operations

Special project operations that may require deviations from FPP criteria will be coordinated with FPOM via a Memo of Coordination (MOC), pursuant to **FPP Chapter 1 – Overview**. See **Introduction section 1** for special operations related to spill for juvenile fish passage and navigation lock outages for maintenance.

3.2. TDA Studies

There are no studies scheduled for The Dalles Dam in 2018.

4. JOHN DAY DAM

4.1. JDA Special Operations

Special project operations that may require deviations from FPP criteria will be coordinated with FPOM via a Memo of Coordination (MOC), pursuant to **FPP Chapter 1 – Overview**. See **Introduction section 1** for special operations related to spill for juvenile fish passage and navigation lock outages for maintenance.

4.2. JDA Studies

There are no studies scheduled for John Day Dam in 2018.

5. McNARY DAM

5.1. MCN Special Operations

Special project operations that may require deviations from FPP criteria will be coordinated with FPOM either by inclusion in this Appendix or in-season via a Memo of Coordination (MOC), pursuant to **FPP Chapter 1 – Overview**. See **Introduction section 1** for special operations related to spill for juvenile fish passage, navigation lock maintenance, and Doble testing.

5.1.1. Fish Ladder Exit, Entrance, Regulating/Tilting Weir Maintenance.

a) Dates: January–February (Long-Term).

b) Description: The Washington shore fish ladder (WAFL) entrance diffuser gratings are being inspected during the 2018 winter outage. These diffuser gratings may need extra work done to them if substantial corrosion is identified.

WASCO will be conducting their 10-year inspection of their underwater generator tailrace weir cables and connection points. This may impact the WAFL watering up times.

The *Oil Accountability Program* identified oil leaks in the WA/OR fish ladder Tilting Weirs and prioritized repairs. McNary maintenance will be effecting repairs/replacement of leaking gear boxes on 2 weirs in the ORFL and WAFL. Maintenance efforts also revealed that the original seals and gaskets failed due to not being actively operated to prevent drying out and tearing. Now that seals and bushings have been replaced, the project needs to operate all equipment monthly and semi-annually to assess oil/grease requirements and to ensure seals do not dry out or stick to shafts. The motors for each weir can be operated during back shifts or periods of inactivity to exercise seals. The manual greasing of Zerk fittings requires a mechanic during normal working hours. McNary maintenance personnel will work with Project Biologists to perform this maintenance during low impact periods as appropriate.

c) Impacts to FPP Criteria: Minimal due to coordination of outages and use of non-peak adult fish passage times.

5.1.2. Juvenile Collection Channel Upgrade.

a) Dates: December 27, 2017 – March 19, 2018.

b) Description: Upgrading cleaning brushes, air bubbler, alarm annunciation, new PLC, new hoist, and improved air components associated with orifice gates. Upgrade will improve reliability for JCC passage.

c) Impacts to FPP Criteria: None.

5.1.3. Fish Attraction Pumps (FPs).

a) Dates: January 2018 – December 2018.

b) Description: Critical maintenance is scheduled for fish pumps (FP) 1 and 3 in 2018 due to extended operation for 7-9 years without relief from FP2. Maintenance may consist of replacing or repairing exciters, exciter brushes, lube oil systems, heat exchangers, alarm annunciation equipment, etc. This maintenance will improve reliability for attraction water for adult salmonids utilizing the Oregon fish ladder system.

c) Impacts to FPP Criteria: None during scheduled outage.

5.1.4. NERC/WECC Main Unit Reactive Limit Tests.

a) Dates: February 2018–August 2018.

b) Description: The purpose of this testing requirement is to ensure that there is accurate information on generator gross and net Real and Reactive Power capability for planning models used to assess Bulk Electric System (BES) reliability. Testing requires all Main Unit Generators to operate outside of the 1% range for at least 1 hour and will typically be performed in February. However, operational restrictions may require some units to be tested later in the year during fish passage season. Testing dates are not currently scheduled and will be coordinated with BPA and NWW NERC/WECC Engineers.

c) Impacts to FPP Criteria: None, unless operational restrictions require testing after April 1.

5.1.5. Waterfowl Nesting.

a) Dates: April–July (annually).

b) Description: Annually since 1982, McNary pool is operated for waterfowl nesting on Lake Wallula late April through early July. During this operation, the McNary pool may be restricted to an operating range of 337'–340' elevation. Pool elevations are also operated in the range of 338.5'–339.5' for 4-6 hours during daylight hours at least once every 4 days.

c) Impacts to FPP Criteria: None. Provided for informational purposes.

5.1.6. Doble Testing.

a) Dates: See schedule in Table A-1 above.

b) Description: See section 1.5 above.

c) Impacts to FPP Criteria: None. Since McNary Dam has multiple transformer banks and transmission lines and redundant switching capability, most turbine units will be available for operation during testing and operated pursuant to FPP priority order within ±1% of peak efficiency (1% range).

5.2. MCN Studies

5.2.1. Evaluation of McNary Dam Adult Fish Ladder Modifications to Improve Pacific Lamprey Passage.

a) Dates: Ongoing.

b) Description: This study will use radio telemetry (RT) and half-duplex (HD) PIT-tag systems to evaluate passage success of adult Pacific lamprey through the lower Columbia River (including McNary Dam). Adult Lamprey will be captured and tagged at Bonneville Dam. This study will continue to require electrical power for electronics and access to maintain and download data from the RT and PIT-tag detection equipment. Maintenance of equipment will occur during the winter maintenance period when adult fishways are dewatered.

c) Impacts to FPP Criteria: None.

5.2.2. Juvenile Salmon and Steelhead System Survival (Lower Granite to Bonneville).

a) Dates: Spring 2018

b) Description: In spring 2018, PNNL will conduct a system-wide (Lower Granite Dam to Bonneville Dam) acoustic telemetry survival study to better understand the impacts of Gas Cap Spill on juvenile fish. Reach survival estimates will also be assessed from Lower Granite to McNary and from McNary to Bonneville. Fish tagged from the Lower Granite Survival Study (see **section 9.2**) will be used to estimate survival from Lower Granite to McNary. An additional fish collection, tagging, and release effort will take place at McNary to estimate survival from McNary to Bonneville. In addition, Little Goose will be monitored for passage distribution and tailrace delay to better understand the unintended consequences of Gas Cap Spill. Cabled JSAT hydrophones and receivers will be installed at Little Goose on the upstream face of the dam to monitor the major passage routes. At McNary and Bonneville, autonomous receivers will be deployed in the forebay and tailrace a few kilometers from the dam. This study will require access at Little Goose and McNary dams for fish collection and tagging, maintenance and service of telemetry and associated equipment, and will require assistance from the project to provide power for electronics and water supply for holding fish. Dead fish with JSATs tags will be released into all major passage routes (spill, turbine, powerhouse JBS) at McNary and Bonneville Dams to estimate probability of dead fish detections (false positives) on downstream arrays and researchers will need access to these dams for this purpose.

c) Impacts to FPP Criteria: None anticipated. Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

5.2.3. Hydrographic Survey of Stilling Basin.

a) Dates: 2-3 days per project during the work window of September 15– October 31, 2018.

b) Description: Multi-beam hydrographic surveys of the stilling basin to assess impacts from the spring Gas Cap spring spill operation. Survey work will take an estimated 2-3 days at each project, starting in September.

c) Impacts to FPP Criteria: Units may need to operate out of priority order to accommodate the survey.

6. ICE HARBOR DAM

6.1. IHR Special Operations

Special project operations that may require deviations from FPP criteria will be coordinated with FPOM either by inclusion in this Appendix or in-season via a Memo of Coordination (MOC), pursuant to **FPP Chapter 1 – Overview**. See **Introduction section 1** for special operations related to spill for juvenile fish passage, navigation lock maintenance, and Doble testing.

6.1.1. Unit 2 and Unit 3 Turbine Runner Replacement.

a) Dates: Unit 2 through spring 2018 and Unit 3 starting in spring 2018 (after Unit 2).

b) Description: Unit 2 was taken out of service in March 2016 to replace the turbine runner and is currently scheduled to return to service in spring 2018. After the replacement is complete, Unit 2 will undergo several days of testing with STSs in place while the unit is operating. When Unit 2 has returned to service, Unit 3 will undergo pre-commission testing with STSs installed prior to being taken out of service for runner replacement.

c) Impacts to FPP Criteria: Through spring 2018 (estimated March-April), Unit 2 will be out of service and unavailable for operation as the second priority unit for fish passage. After Unit 2 returns to service, Unit 3 will be out of service and unavailable for operation as the third priority unit. The project will operate the next available unit in the FPP priority order.

6.1.2. Units 4, 5, 6 Oil Replacement.

a) Dates: April 2018 – May 2018 (approximately 3 weeks for each unit).

b) Description: Tentatively scheduled to begin April 16, 2018, Units 4, 5, 6 will be out of service for approximately 3 weeks each to replace the turbine oil. The outages will overlap one week to facilitate preparation for the next unit while the contractor replaces the turbine oil on the previous unit. Tentative schedule is Unit 4 April 16–May 4, Unit 5 April 30–May 18, and Unit 6 May 14–25.

c) Impacts to PP Criteria: None. When a unit is out of service for maintenance, the project will operate the next available unit in the FPP priority order.

6.1.3. Doble Testing.

a) Dates: See schedule in Table A-1 above.

b) Description: See section 1.5 above.

c) Impacts to FPP Criteria: None. Doble testing is conducted in conjunction with scheduled unit maintenance. Since Ice Harbor has multiple transformer banks and transmission lines and redundant switching capability, remaining units will be available and operated pursuant to FPP priority order within ±1% of peak efficiency (1% range).

6.1.4. 115 kV Disconnects and Surge Arrester Replacement.

a) Dates: August 2018 – December 2018.

b) Description: Large Capital work to replace manually operated equipment with Motor Operated Sectionalizer Switches will require outages of two or three units at a time. Tentative schedule is:

- Units 1, 2, 6: Aug 15
- Units 2, 3, 4: Sep 4–Oct 3
- Units 5, 6: Oct 4–Nov 25
- Unit 2: Nov 26-Dec 15

c) Impacts to FPP Criteria: None. When a unit is out of service for maintenance, the project will operate the next available unit in the FPP priority order.

6.2. IHR Studies

6.2.1. Adult Spring Chinook Passage and Behavior in the Lower Snake River.

a) Dates: Spring 2018

b) Description: In spring 2018, adult spring Chinook salmon will tagged with acoustic transmitters and monitored to evaluate tailrace behavior in relation to gas cap spill and turbine unit priorities at Little Goose Dam. Adult spring Chinook will be collected and acoustically tagged at the Ice Harbor Adult Fish Trap and released above the dam between early April and mid-June 2018. Study fish will be monitored for behavior (3-D) and passage at Little Goose and monitored for passage at Lower Granite. At Little Goose, a combination of cabled and autonomous JSATs acoustic telemetry receiver arrays will be deployed in the tailrace and inside the fishway entrances to study the 3-D behavior and preferred fishway entrance locations in relation to gas cap spill operations and unit priorities. Deployment of the tailrace receiver arrays will require coordination of unit outages and BRZ boat access to install equipment in January–March. Further project coordination may be required in-season to access the BRZ and service the North tailrace autonomous rays located downstream of the earthen portion of the dam. At Lower Granite Dam, a few JSATS receivers will be installed in the junction/transition pool of the adult fishway to monitor tagged fish passage. This study will require access for the collection and tagging of fish at Ice Harbor Dam, to maintain and service telemetry equipment at Little Goose and Lower Granite Dams, and will require assistance from the project to provide power for electronics and associated telemetry equipment. An adult fish transport trailer may be needed from Ice Harbor for the release of adult fish above the dam. The Ice Harbor adult trap will be operated according to FPP protocol.

c) Impacts to FPP Criteria: None anticipated. Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

6.2.2. IHR Unit 2 Direct Injury and Sensor Fish Characterization.

a) Dates: September 2018 – October 2018

b) Description: Juvenile spring Chinook salmon and Sensor Fish will be directly released into turbine unit 2 to evaluate the new fixed-blade runner. The study is expected to require approximately four weeks of total study time. Direct release pipes will be installed in all three intakes of Unit 2 for direct fish and Sensor Fish releases. Release pipes will be installed

on the STS frames. Three specific turbine operations will be tested. Project support will be provided for equipment install, removal, and turbine operations. A one-day Unit 2 outage is expected for release pipe install and removal. Another consideration will be river flow and unit priority during the study period. Specific dates for Project support, outages, and operations will be scheduled appropriately with the Project and through FPOM closer to study implementation.

c) Impacts to FPP Criteria: Any modification to unit priority order or other FPP criteria will be coordinated through FPOM.

6.2.3. Hydrographic Survey of Stilling Basin.

a) Dates: 2-3 days per project during the work window of September 15– October 31, 2018.

b) Description: Multi-beam hydrographic surveys of the stilling basin to assess impacts from the spring Gas Cap spring spill operation. Survey work will take an estimated 2-3 days at each project, starting in September.

c) Impacts to FPP Criteria: Units may need to operate out of priority order to accommodate the survey.

7. LOWER MONUMENTAL DAM

7.1. LMN Special Operations

Special project operations that may require deviations from FPP criteria will be coordinated with FPOM either by inclusion in this Appendix or in-season via a Memo of Coordination (MOC), pursuant to **FPP Chapter 1 – Overview**. See **Introduction section 1** above for special operations related to spill for juvenile fish passage, navigation lock maintenance, and Doble testing.

7.1.1. Lower Monumental Head Gate Rehab.

a) Dates: Ongoing through 2019.

b) Description: Under the BPA Large Cap Program, parts and materials have been acquired to rehabilitate the head gates at Lower Monumental Dam. To facilitate the process, units will be scheduled out-of-service to remove or replace head gates. The head gates will be serviced in the repair pit and then placed back into service. The work started in December of 2012.

c) Impacts to FPP Criteria: Deviation from unit priority will be necessary to swap head gates from the unit to the pit. The duration of the outages is expected to be one day.

7.1.2. Adult Fish Collection Channel Bulkhead Maintenance.

a) Dates: Ongoing through December 2018.

b) Description: Work began in June 2016 to rehabilitate Adult Fish Collection Channel Bulkheads along the powerhouse to support Diffuser Grating replacement during the FY19 or 20 in-water work period. This work will require short duration (≤5 hours) Fish Pump outages and adjustment of the NPE and SPEs to minimize the pressure differential to facilitate removal and replacement of bulkheads. The bulkheads will be rehabilitated on the tailrace deck, then returned to service. The work is expected to continue into the second half of 2018.

c) Impacts to FPP Criteria: None anticipated. Work would be scheduled to occur during time frames which will have minimal impact to adult passage (i.e., early in the morning or late at night when fewer adults are moving).

7.1.3. Unit 1 Rehab to Kaplan.

a) Dates: Ongoing through June 2018.

b) Description: Work started in February 2016 and is currently scheduled through June 2018. The unit will be removed from the hole to disassemble the hub, install new blade linkages, repair cavitation to the blades and scroll case, and install a new discharge ring. The unit will then be reinstalled and final machining done to achieve proper profiles of the scroll case, blades, and hub. There may be other work, not part of the contract, which will occur at this same time (e.g., replace blade packing, inspect wicket gates, refurbish servo-motor). The generator is also scheduled to be re-wound as part of the job.

c) Impacts to FPP Criteria: During the rehab, Unit 1 will be out of service and unavailable for operation as the priority unit for fish passage. The project will operate the next available unit in the FPP priority order. During commissioning, the unit will be run outside 1%.

7.1.4. Unit 3 or Unit 4 Blade Seal Replacement & Return to Kaplan.

a) Dates: February 2018 through September 2018.

b) Description: Work is scheduled to start on either Unit 3 or Unit 4 in early February 2018 to replace suspected leaking blade seals and to restore to full Kaplan. If blade seals are received for Unit 4, it will be completed first and will require re-commissioning the governor. The project currently has blade seals for Unit 3 and if work begins on it in February, additional commissioning following work completion will be required as all testing was performed with the blades fixed at approximately 26.5 degrees. Following the spring freshet, whichever Unit was not repaired will be removed from service, un-watered and the suspected leaking blade seals will be replaced, after which the digital governor for that unit will be re-commissioned.

c) Impacts to FPP Criteria: During the blade seal replacement, the Unit will be out of service and unavailable for operation. The project will operate the next available unit in the FPP priority order. During commissioning, performance testing, and model validation testing, units will run out of FPP priority and outside 1% (see model validation testing section below).

7.1.5. Model Validation Testing.

a) Dates: September 1 through March 31 (annually).

b) Description: Western Electricity Coordinating Council (WECC) requires steady state model validation testing periodically to ensure generating equipment will meet real and reactive power ratings. All units are tested on a 1–2 year cycle. Tests are also required when equipment is replaced or upgraded. Tests will require running the unit out of FPP priority and outside the 1% range. Testing can occur any time from September 1–March 31 and will not occur during peak juvenile fish passage season (April 1–August 31). Tests will preferably be conducted just after annual maintenance, but may happen at other times. Test durations will be minimized to the extent possible and will only be run for the purpose of completing required model validation testing.

c) Impacts to FPP Criteria: None anticipated. During validation testing, Units will be out of commercial service. The project will operate the next available unit in the FPP priority order.

7.1.6. Doble Testing.

a) Dates: See schedule in Table A-1 above.

b) Description: See section 1.5 above.

c) Impacts to FPP Criteria: On the first and last day of testing, clearance procedures will require a total powerhouse outage for up to 4 hours and all project outflow will be spilled except approximately 5 kcfs for station service. During testing, available units will be operated pursuant to FPP priority order within ±1% of peak efficiency (1% range).

7.1.7. Digital Governor Installation & Commissioning.

a) Dates: Mid to Late 2018.

b) Description: Digital Governors have been installed on Units 2–6 with the governors on Units 4 and 6 commissioned as a Kaplan Unit. Unit 3 was commissioned with fixed blades and is scheduled to have index testing performed in late January 2018. Unit 5 is scheduled to be commissioned as a Kaplan Unit in late January 2018 and Unit 2 will be commissioned as a fixed bladed unit similar to Unit 3 also in late January 2018. The digital governor on Unit 1 will be scheduled to occur as soon as possible after the peak of the adult passage season, but it will not occur unless Unit 2 is available.

c) Impacts to FPP Criteria: None anticipated. During work, the unit will be out of service and the project will operate the next available unit in the FPP priority order.

7.2. LMN Studies

7.2.1. Hydrographic Survey of Stilling Basin.

a) Dates: 2-3 days per project during the work window of September 15– October 31, 2018.

b) Description: Multi-beam hydrographic surveys of the stilling basin to assess impacts from the spring Gas Cap spring spill operation. Survey work will take an estimated 2-3 days at each project, starting in September.

c) Impacts to FPP Criteria: Units may need to operate out of priority order to accommodate the survey.

8. LITTLE GOOSE DAM

8.1. LGS Operations

Special project operations that may require deviations from FPP criteria will be coordinated with FPOM either by inclusion in this Appendix or in-season via a Memo of Coordination (MOC), pursuant to **FPP Chapter 1 – Overview**. See **Introduction section 1** above for special operations related to spill for juvenile fish passage, navigation lock maintenance, and Doble testing.

8.1.1. Fish Ladder Cooling Water Pump Install.

a) Dates: March 26 and March 30, 2018

b) Description: Support for this work will require connection of electrical components to XJ-O7 in March 2018. This will require a powerhouse line outage in order to isolate the breaker to safely conduct this work. During the switching operations, all Units 1-6 will be out of service on March 26 and again on March 30. The JFF will be on emergency diesel generator during this time. This schedule is also dependent on flows from the spring freshet and could be delayed if flows are too high. The schedule continues to be refined.

c) Impacts to FPP Criteria: On March 26 and March 30, all units are scheduled to be out of service and all project outflow will be passed via the spillway.

8.1.2. Doble Testing.

a) Dates: See schedule in Table A-1 above.

b) Description: See section 1.5 above.

c) Impacts to FPP Criteria: None. Doble testing is conducted in conjunction with scheduled unit maintenance. Available units will be operated pursuant to FPP priority order within ±1% of peak efficiency (1% range).

8.2. LGS Studies

8.2.1. Adult Spring Chinook Passage and Behavior in the Lower Snake River.

a) Dates: Spring 2018

b) Description: In spring 2018, adult spring Chinook salmon will tagged with acoustic transmitters and monitored to evaluate tailrace behavior in relation to gas cap spill and turbine unit priorities at Little Goose Dam. Adult spring Chinook will be collected and acoustically tagged at the Ice Harbor Adult Fish Trap and released above the dam between early April and mid-June 2018. Study fish will be monitored for behavior (3-D) and passage at Little Goose and monitored for passage at Lower Granite. At Little Goose, a combination of cabled and autonomous JSATs acoustic telemetry receiver arrays will be deployed in the tailrace and inside the fishway entrances to study the 3-D behavior and preferred fishway entrance locations in relation to gas cap spill operations and unit priorities. Deployment of the tailrace receiver arrays will require coordination of unit outages and BRZ boat access to install equipment in January–March. Further project coordination may be required in-season to access the BRZ and service the North tailrace autonomous rays located downstream of the

earthen portion of the dam. At Lower Granite Dam, a few JSATS receivers will be installed in the junction/transition pool of the adult fishway to monitor tagged fish passage. This study will require access for the collection and tagging of fish at Ice Harbor Dam, to maintain and service telemetry equipment at Little Goose and Lower Granite Dams, and will require assistance from the project to provide power for electronics and associated telemetry equipment. An adult fish transport trailer may be needed from Ice Harbor for the release of adult fish above the dam. The Ice Harbor adult trap will be operated according to FPP protocol.

c) Impacts to FPP Criteria: None anticipated. Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

8.2.2. Juvenile Salmon and Steelhead System Survival (Lower Granite to Bonneville).

a) Dates: Spring 2018

b) Description: In spring 2018, PNNL will conduct a system-wide (Lower Granite Dam to Bonneville Dam) acoustic telemetry survival study to better understand the impacts of Gas Cap Spill on juvenile fish. Reach survival estimates will also be assessed from Lower Granite to McNary and from McNary to Bonneville. Fish tagged from the Lower Granite Survival Study (see **section 9.2**) will be used to estimate survival from Lower Granite to McNary. An additional fish collection, tagging, and release effort will take place at McNary to estimate survival from McNary to Bonneville. In addition, Little Goose will be monitored for passage distribution and tailrace delay to better understand the unintended consequences of Gas Cap Spill. Cabled JSAT hydrophones and receivers will be installed at Little Goose on the upstream face of the dam to monitor the major passage routes. At McNary and Bonneville, autonomous receivers will be deployed in the forebay and tailrace a few kilometers from the dam. This study will require access at Little Goose and McNary dams for fish collection and tagging, maintenance and service of telemetry and associated equipment, and will require assistance from the project to provide power for electronics and water supply for holding fish. Dead fish with JSATs tags will be released into all major passage routes (spill, turbine, powerhouse JBS) at McNary and Bonneville Dams to estimate probability of dead fish detections (false positives) on downstream arrays and researchers will need access to these dams for this purpose.

c) Impacts to FPP Criteria: None anticipated. Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

8.2.3. Hydrographic Survey of Stilling Basin.

a) Dates: 2-3 days per project during the work window of September 15– October 31, 2018.

b) Description: Multi-beam hydrographic surveys of the stilling basin to assess impacts from the spring Gas Cap spring spill operation. Survey work will take an estimated 2-3 days at each project, starting in September.

c) Impacts to FPP Criteria: Units may need to operate out of priority order to accommodate the survey.

9. LOWER GRANITE DAM

9.1. LWG Special Operations

Special project operations that may require deviations from FPP criteria will be coordinated with FPOM either by inclusion in this Appendix or in-season via a Memo of Coordination (MOC), pursuant to **FPP Chapter 1 – Overview**. See **Introduction section 1** above for special operations related to spill for juvenile fish passage, navigation lock maintenance, and Doble testing.

9.1.1. Head Gate Repair.

a) Dates: Bi-Monthly (long-term).

b) Description: This is a long-term program to return head gates to a safe operating condition by adding new roller chain, seals, anodes, and other miscellaneous components. The plan will require brief unit outages throughout the year while transporting rebuilt gates from the turbine units to the repair pit and back. Each swap will take 4–6 hours to complete and occur approximately every 2 months.

c) Impacts to FPP Criteria: None anticipated. Head gate movements are expected to take place concurrently with other outages. As the program progresses and fewer head gates need repair, it may require an occasional outage on a priority unit. Available units will be operated pursuant to FPP priority order within ±1% of peak turbine efficiency.

9.1.2. ESBS Repair.

a) Dates: Bi-Monthly (long-term).

b) Description: This is a long-term program to return ESBSs to a safe operating condition by tearing down, repainting and rebuilding the screens. The plan will require brief unit outages throughout the year while transporting rebuilt ESBSs from the turbine units to the repair pit and back. Each swap will take 4–6 hours to complete and occur approximately every 2 months.

c) Impacts to FPP Criteria: None anticipated. ESBS movements are expected to take place concurrently with other outages. As the program progresses and fewer screens need repair, it may require an occasional outage on a priority unit. Available units will be operated pursuant to FPP priority order within ±1% of peak turbine efficiency.

9.1.3. Juvenile Fish Bypass System Upgrade.

a) Dates: Ongoing through March 2019.

b) Description: Construction activities associated with the Lower Granite Dam juvenile bypass system (JBS) upgrade began in 2014 and are expected to continue through March 2019. Initial project commissioning activities are expected to occur in January-March 2018 (FPOM MOC: 16LWG10) for the 2018 fish passage season. Due to time necessary to complete construction efforts, some final construction and commissioning activities are anticipated to continue into April 2018 in order to provide a functional JBS for the 2018 fish passage season by mid-April. Construction and commissioning efforts not required for the 2018 fish passage season will be completed by March 2019. All fish salvage operations will

follow standard dewatering procedures and will be coordinated through Lower Granite's fisheries staff in accordance with standard operation procedures.

c) Impacts to FPP Criteria: Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

9.1.4. Lower Granite Digital Governor Upgrade.

a) Dates: July 2018 – March 2019.

b) Description: Lower Granite will be updating Digital Governors during 2018 with relay valve inspections beginning the first two weeks in February. Outages for replacement are scheduled to begin July 2, 2018 and continue through March 29, 2019. Replacement outages will be one unit at a time and require about six weeks to complete work and commissioning. The current plan is to schedule replacement of priority units outside the fish passage season. Commissioning will require starts, stops, and load rejections to verify proper governor operation and may require operating units out of FPP priority order.

c) Impacts to FPP Criteria: Commissioning may require operating units out of FPP priority order. Activities that may impact FPP compliance will be coordinated with FPOM via MOC.

9.1.5. Doble Testing.

a) Dates: See schedule in Table A-1 above.

b) Description: See section 1.5 above.

c) Impacts to FPP Criteria: On the first and last day of testing, clearance procedures will require a total powerhouse outage for up to 4 hours and all project outflow will be spilled except approximately 5 kcfs for station service. During testing, available units will be operated pursuant to FPP priority order within ±1% of peak efficiency (1% range).

9.1.6. Lower Granite Spillbay 1 PIT-Tag Detector Installation.

a) Dates: Fall 2018 through March 2019.

b) Description: Construction activities associated with PIT-tag detection system installation at Lower Granite Dam will begin in fall 2018 and are expected to continue through winter 2019, with project completion expected in March 2019. Construction activities will primarily be in, or near, spillbay 1 and will include reshaping of the ogee, installation of a new spillway flow deflector, and installation of a PIT-tag detection system installation. To facilitate these construction activities, including concrete removal and installation of new equipment, the Corps anticipates needing to request an extended in-water work window of November 15, 2018, to February 28, 2019. The type of work and level of effort is expected to be similar to what was needed for the reshaping of the ogee and new flow deflector for the Ice Harbor Dam spillbay 2 during the winter of 2015/16. An MOC will be distributed to FPOM once sufficient project details are available.

c) Impacts to FPP Criteria: Activities that require special project operations, FPP deviations, or outages will be coordinated with FPOM via MOC.

9.2. LWG Studies

9.2.1. Adult Spring Chinook Passage and Behavior in the Lower Snake River.

a) Dates: Spring 2018

b) Description: In spring 2018, adult spring Chinook salmon will tagged with acoustic transmitters and monitored to evaluate tailrace behavior in relation to gas cap spill and turbine unit priorities at Little Goose Dam. Adult spring Chinook will be collected and acoustically tagged at the Ice Harbor Adult Fish Trap and released above the dam between early April and mid-June 2018. Study fish will be monitored for behavior (3-D) and passage at Little Goose and monitored for passage at Lower Granite. At Little Goose, a combination of cabled and autonomous JSATs acoustic telemetry receiver arrays will be deployed in the tailrace and inside the fishway entrances to study the 3-D behavior and preferred fishway entrance locations in relation to gas cap spill operations and unit priorities. Deployment of the tailrace receiver arrays will require coordination of unit outages and BRZ boat access to install equipment in January–March. Further project coordination may be required in-season to access the BRZ and service the North tailrace autonomous rays located downstream of the earthen portion of the dam. At Lower Granite Dam, a few JSATS receivers will be installed in the junction/transition pool of the adult fishway to monitor tagged fish passage. This study will require access for the collection and tagging of fish at Ice Harbor Dam, to maintain and service telemetry equipment at Little Goose and Lower Granite Dams, and will require assistance from the project to provide power for electronics and associated telemetry equipment. An adult fish transport trailer may be needed from Ice Harbor for the release of adult fish above the dam. The Ice Harbor adult trap will be operated according to FPP protocol.

c) Impacts to FPP Criteria: None anticipated. Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

9.2.2. Lower Granite Dam Juvenile Bypass System (JBS) Post-Construction Evaluation.

a) Dates: Spring 2018

b) Description: In spring 2018, researchers will conduct a biological post-construction evaluation of the new Juvenile Bypass System (JBS) at Lower Granite Dam. Lab-reared fish, and run-of-river fish if necessary, will be PIT-tagged and released into the gatewell/collection channel and recaptured via the Separation-by-Code (SbC) system to estimate survival, travel time, and fish condition after passage through the new system. Sensor fish will also be released into various sections of the JBS to characterize hydraulic data of the new system. JSATs-tagged fish from the Lower Granite Dam survival study (separate effort described in **section 9.2.3**) will also provide estimates of survival through the new system. This study will require access to the dam for holding and release of study fish, access to the SbC tanks, JFF wet lab, and most components of the JBS from the gatewell to the JFF. This project will need assistance from the project to provide power for electronics and water supply for holding release and recovery fish.

c) Impacts to FPP Criteria: None anticipated. Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

9.2.3. Juvenile Salmon and Steelhead System Survival (Lower Granite to Bonneville).

a) Dates: Spring 2018

b) Description: In spring 2018, PNNL will conduct a system-wide (Lower Granite Dam to Bonneville Dam) acoustic telemetry survival study to better understand the impacts of Gas Cap Spill on juvenile fish. Reach survival estimates will also be assessed from Lower Granite to McNary and from McNary to Bonneville. Fish tagged from the Lower Granite Survival Study (see below) will be used to estimate survival from Lower Granite to McNary. An additional fish collection, tagging, and release effort will take place at McNary to estimate survival from McNary to Bonneville. In addition, Little Goose will be monitored for passage distribution and tailrace delay to better understand the unintended consequences of Gas Cap Spill. Cabled JSAT hydrophones and receivers will be installed at Little Goose on the upstream face of the dam to monitor the major passage routes. At McNary and Bonneville, autonomous receivers will be deployed in the forebay and tailrace a few kilometers from the dam. This study will require access at Little Goose and McNary dams for fish collection and tagging, maintenance and service of telemetry and associated equipment, and will require assistance from the project to provide power for electronics and water supply for holding fish. Dead fish with JSATs tags will be released into all major passage routes (spill, turbine, powerhouse JBS) at McNary and Bonneville Dams to estimate probability of dead fish detections (false positives) on downstream arrays and researchers will need access to these dams for this purpose.

c) Impacts to FPP Criteria: None anticipated. Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

9.2.4. Juvenile Salmon and Steelhead Passage and Survival at Lower Granite Dam.

a) Dates: Spring and Summer 2018

b) Description: In 2018, PNNL will conduct a passage and survival study at Lower Granite Dam. This evaluation will utilize JSATs acoustic telemetry to estimate dam passage survival for spring and summer run-of-river salmon and steelhead. Cabled hydrophones will be deployed on the upstream face of the dam to monitor all major routes of passage available to juvenile salmon. In addition, autonomous receiver arrays will be deployed in both the forebay and tailrace a few kilometers from the dam. Fish collection will occur at Little Goose Dam. Dead fish with JSATs tags will be released into all major passage routes (spill, turbine, powerhouse JBS) to estimate probability of dead fish detections (false positives) on downstream arrays. This study will require access to Little Goose Dam to collect and tag the fish and access to Lower Granite dam for holding and releasing tagged fish, to maintain and service telemetry equipment, and will need assistance from the Projects to provide power for electronics and water supply for holding fish. No spillway or turbine outages are anticipated at Lower Granite Dam.

c) Impacts to FPP Criteria: None anticipated. Activities that require special project operations, FPP deviations, or outages will be coordinated through FPOM and/or FFDRWG, as appropriate.

9.2.5. Hydrographic Survey of Stilling Basin.

a) Dates: 2-3 days per project during the work window of September 15– October 31, 2018.

b) Description: Multi-beam hydrographic surveys of the stilling basin to assess impacts from the spring Gas Cap spring spill operation. Survey work will take an estimated 2-3 days at each project, starting in September.

c) Impacts to FPP Criteria: Units may need to operate out of priority order to accommodate the survey.

2018 Fish Passage Plan

Appendix B

Corps of Engineers Juvenile Fish Transportation Plan (JFTP) [1]

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1. If any provisions herein conflict with the current Corps' *Fish Operations Plan* (FOP; included in the Fish Passage Plan as **Appendix E**), the latter shall prevail.

1. INTRODUCTION

1.1.1. The *Juvenile Fish Transportation Plan* (JFTP) describes operations and establishes criteria for the collection and transportation of juvenile salmon and steelhead from Lower Granite, Little Goose, and Lower Monumental dams (collector dams) to release below Bonneville Dam. The JFTP supplements operating criteria presented in the project-specific chapters of the current *Fish Passage Plan* (FPP).[2]

1.1.2. The JFTP is conducted by the Corps of Engineers' Walla Walla District (CENWW) under Endangered Species Act (ESA) Section 7 (a)(2) consultation as an integral component for Federal Columbia River Power System (FCRPS) under Reasonable and Prudent Alternatives (RPA) Actions 30 and 31; Section 3.3.3.4. From 1992 to 2013, this activity was implemented under ESA Section 10 (a)(1)(A) incidental take permit issued by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries, formerly referred to as NMFS).

1.1.3. On-site biological assistance is provided through contracts procured through BPA and the Corps Corps. The BPA arranges biological assistance provided by fishery agencies through a contract with the Pacific States Marine Fisheries Commission (PSMFSC). The PSMFC sub-contracts with Washington Department of Fish & Wildlife (WDFW) and Oregon Department of Fish & Wildlife (ODFW). On-site biological assistance is provided by WDFW at Lower Granite and Lower Monumental dams while ODFW provides biological assistance at Little Goose Dam. The Corps contract provides additional services in direct support of the juvenile fish transportation program at Lower Granite, Little Goose, and Lower Monumental dams.

1.1.4. The transport program will be coordinated with other fishery monitoring, research, and management activities by CENWW. Coordination will be achieved with the fishery agencies and tribes through the appropriate regional forums, such as the Fish Passage Operations and Maintenance (FPOM) Coordination Team and the Technical Management Team (TMT), and with other agencies as required.

2. OBJECTIVE

2.1.1. The objective of CENWW and the transportation program is to transport juvenile fish when the best scientific information indicates doing so will increase adult return rates. This can be achieved by:

- **a.** Providing safe and efficient collection and barge or truck transport of juvenile salmon and steelhead from collector dams to release areas below Bonneville Dam;

- **b.** Identifying and recommending programs or facility changes that would benefit fish collection and transportation or bypass operations;

[2] The annual Fish Passage Plan (FPP) is available online at: pweb.crohms.org/tmt/documents/fpp/

c. Assuring that collection, transport, and release site facilities are ready for operation prior to the beginning of transport operations;

d. Assuring that collection, transport, and release site facilities are properly maintained throughout the transport season;

e. Establishing operating criteria for facilities, barges, and trucks including fish holding and transport densities, sampling rates, and facility operations and maintenance;

f. Coordinating changes needed to accommodate fluctuations in the outmigration with projects, NOAA Fisheries, PSMFC, FPOM, and TMT personnel;

g. Coordinating transport evaluation and other research with the transportation program;

h. Providing the training of new personnel associated with collection and transport facilities and equipment;

i. Providing all parties involved a list of emergency points of contact and appropriate telephone numbers so that any emergency can be coordinated and corrected efficiently;

j. Preparing annual reports detailing transportation activities and results for the previous year, and identifying maintenance, replacement, or modifications needed for the next transport season.

3. TRANSPORT PROGRAM DURATION

3.1. Starting Operations.

3.1.1. Consistent with the Fish Operations Plan (FOP; included in FPP as **Appendix E**) and guidance provided by the Regional Implementation Oversight Group (RIOG), the best transport operation for fish will be determined upon review of data on fish survival, adult returns, current in-river conditions, and water supply forecasts. TMT will review transport studies and provide a recommendation each year to CENWW on how to operate the juvenile transport program to achieve the goal of transporting approximately 50% of juvenile steelhead.

3.1.2. Planning dates to initiate juvenile transport at Lower Granite Dam will be April 21–25, unless the Corps adopts a recommendation by TMT that proposes a later start date (no later than May 1) and accompanying alternative operation in their annual recommendation to achieve the goal of transporting approximately 50% of juvenile steelhead.

3.1.3. Transport at Little Goose and Lower Monumental dams may begin simultaneously with the start of juvenile transport at Lower Granite Dam, or may begin up to 4 days and up to 7 days, respectively, after the Lower Granite start date.

3.2. Summer Transport Operations.

3.2.1. At Lower Granite, Little Goose, and Lower Monumental dams, summer operations will begin in coordination and discussions with TMT. Fish collected during summer operations will

be held in shaded raceways or holding tanks. Sampling may convert to 100% when fish numbers are below 500 fish per day (per PSMFC sampling guidelines) and smaller pick-up mounted transport tanks may be used. Steelhead that are determined by State biologists to be in poor condition or reverting to the parr stage may be bypassed to the river.

3.3. Ending Operations.

3.3.1. Transport operations are anticipated to continue through approximately September 30 at Lower Monumental and through October 31 at Lower Granite and Little Goose. Transport may be stopped earlier at any of the projects due to *columnaris* disease (see **section 4.6.5**) or at Lower Monumental due to low fish abundance (see **section 4.6.6**).

3.4. Emergency Notification Criteria.

3.4.1. Project Biologists will report to the CENWW Transportation Coordinator when high water temperatures or other factors increase collection mortality to 6 percent of daily collection (when sample sizes are ≥ 20 fish) for 3 consecutive days, and provide early notice if mortality rates are increasing at such a rate that these criteria are likely to be met. The Transportation Coordinator will evaluate the situation and shall notify NOAA Fisheries and may arrange a conference call, if needed, with TMT to discuss options to provide adequate fish protection measures. In the event of a fish loss exceeding conditions considered in the incidental take statement of the FCRPS BiOp which included the transportation program, the Corps shall notify NOAA Fisheries and reopen consultation as needed. If icing conditions threaten facility integrity or present unsafe conditions on the transport route, transport operations may be terminated early by the project's Operations Manager. Emergency termination or modification of the transportation program will be coordinated by the CENWW Transportation Coordinator with NOAA Fisheries and TMT.

4. OPERATING CRITERIA

4.1. Early Season Non-Transport Operations.

4.1.1. Prior to initiation of transport in flow years when fish are not being transported from the Snake River projects, fish collection facilities will be operated as described below.

4.1.2. Lower Granite: Juvenile fish will be bypassed via normal separator operations and routed to the mid-river release outfall and PIT-tag detection system. Normal 24-hour sampling for the SMP shall occur.

4.1.3. Little Goose: Juvenile fish will be bypassed and routed to the mid-river release outfall and full flow PIT-tag detection system, except during condition sampling as described below.

**In 2018, the Little Goose bypass system will begin operations on March 1 and screens will be installed in at least the first three available priority units. Additional units may be screened before April 1 if maintenance schedules allow.*

a. Condition sampling will begin April 1, *except in 2018 when it will begin March 1,* to monitor fish descaling and other fish condition parameters, to ensure sampling systems are operating correctly prior to the start of transport, and to train personnel on facility operations and sampling protocol.

b. Starting on April 1, *except in 2018 starting on March 1,* until the start of transport, condition sampling will occur every other day.

c. The sample goal should be 100 fish of the predominant salmonid species.

d. When not sampling, the facility will return to primary (full-flow) bypass.

e. Sampling frequency may be increased if injuries are observed or suspected (e.g., during high debris conditions).

f. Full 24-hour samples may be taken to determine species composition to inform a decision on starting transport at this project.

g. Fish condition reporting will follow the standardized SMP protocol and sent to FPC within 12 hours of sampling.

4.1.4. Lower Monumental: Juvenile fish will be bypassed and routed to the primary outfall and full flow PIT-tag detection system, except during condition sampling as described below.

a. Condition sampling will begin April 1 to monitor fish descaling and other fish condition parameters, to ensure sampling systems are operating correctly prior to the start of transport, and to train personnel on facility operations and sampling protocol.

b. From April 1 through April 15, condition sampling will occur at least twice per week, with no more than three days between samples. From April 15 until the start of transport, sampling will occur every other day.

c. The sample goal should be 100 fish of the predominant salmonid species.

d. When not sampling, the facility will return to primary (full-flow) bypass.

e. Sampling frequency may be increased if injuries are observed or suspected (e.g., during high debris conditions).

f. Full 24-hour samples may be taken to determine species composition to inform a decision on starting transport at this project.

g. Fish condition reporting will follow the standardized SMP protocol and sent to FPC within 12 hours of sampling.

4.2. Collection & Transportation.

4.2.1. During transport operations, collected juvenile fish will be bypassed back to the river if the number of collected fish exceeds or is expected to exceed the facility and barge holding capacities. Holding for transportation will resume when adequate capacities are available to hold and transport fish according to transportation program criteria. Maximum holding time and loading criteria will not be exceeded without CENWW review and approval. Marked or PIT tagged fish will be released to the river if they are part of an approved research study or Smolt Monitoring Program (SMP) travel time evaluation. Specifics of the transportation program may be altered during the transportation season based on recommendations from the TMT.

4.2.2. Lower Granite, Little Goose, Lower Monumental: All juvenile fish collected, with the exception of those marked for in-river studies, shall be transported once transport operations begin (paragraph **3.1**.).

4.2.3. The collection of fish for transport will commence on the agreed-to start dates at Lower Granite, Little Goose and Lower Monumental dams. Barging of fish will begin the following day and collected juvenile fish will be transported by barge from each facility on a daily or every-other-day basis (depending on the number of fish) throughout the migration season. Transportation operations will be carried out at each project in accordance with all relevant FPP operating criteria.

4.3. Collection Facility Operations.

4.3.1. Once transport operations begin, collection facilities will be staffed 24 hours per day until transport operations cease.

4.3.2. Flows and fish passage at juvenile fish separators will be monitored at least every 15 minutes throughout separator operations.

4.3.3. When collection systems are not providing safe fish passage or meeting operating criteria, project operations managers and biologists will make operational changes that are in the best interests of the fish, and then notify CENWW as soon as possible. The CENWW Transportation Coordinator will coordinate changes with NOAA Fisheries and TMT.

4.3.4. Fish collection at Lower Granite, Little Goose, and Lower Monumental dams may exceed facility and barge capacities for short periods of time. If it appears that holding capacity may be exceeded on a given day, the project biologist shall immediately inform CENWW with a report of the hourly fish collection numbers, barge arrival time or holding capabilities, along with facility descaling and mortality information. The CENWW Transportation Coordinator shall promptly coordinate this information with RCC and NOAA Fisheries. Additional spill at the affected project may be requested if it appears that holding capacity will be exceeded or fish condition information indicates that spill passage is a better passage route than bypassing through the facility. If it is determined that the best course of action is to increase spill, spill operations shall begin prior to the facility reaching its holding capacity (around when the 8th of 10 raceways is filled). This level of spill may continue until holding capacity becomes available or fish condition improves.

4.3.5. To avoid attracting predatory birds, mortalities should be returned to the river at night if deemed necessary by the project biologist.

4.3.6. At Little Goose and Lower Monumental dams, lamprey-friendly tailscreens will be installed for the entire fish collection season. Fishery staff at these projects have never observed salmon fry being impinged on these screens. At Lower Granite Dam, lamprey-friendly tailscreens will be installed as needed at the discretion of Project Biologists based on the presence of lamprey in the raceways, while considering the risk of impingement of salmon fry on the lamprey friendly tailscreens. Project biologists will switch back to salmon-criteria screens at the first sign of impingement of salmon fry on the lamprey-friendly tailscreens or when there are fry observed in the sample. The salmon-criteria screens will be left in place until salmon fry are no longer present in the sample.

4.3.7. Juvenile lamprey are sometimes found in dewatered raceways after truck/barge loading operations. If debris is not a problem, lamprey should be promptly and safely flushed or

otherwise returned to the river. If debris is a problem, and when practicable, lamprey should be removed by hand and put in a container with water and later returned to the river.

4.4. Sampling Procedures.

4.4.1. When sampling is being conducted, it will normally be accomplished in accordance with SMP sampling guidelines recommended by the PSMFC. Sampling guidelines may occasionally be altered if transportation program or fish research activities require it. Normal alterations of sampling guidelines are to adjust the number of fish sampled to meet approved research needs, to minimize the handling of fish during warm water temperature periods, or to meet deadlines for loading fish transport vehicles.

4.4.2. Sampled fish will be counted by electronic counting tunnels, then verified and adjusted by manual counts. All estimates of fish numbers, rates and loading densities in raceways, trucks, and barges will be based on a sample of collected fish. Samples will be taken hourly 24 hours/day at sample rates set by project biologists as coordinated with SMP personnel.

4.4.3. Species composition and weight samples will be taken to determine loading densities for raceways, barges, and trucks. Project personnel will keep a running total of hourly estimates of fish numbers, raceway totals, and direct loading totals for barges based on these estimates. Daily samples for monitoring descaling will include a minimum of 100 fish of the predominant group(s) for which descaling information is recorded. During periods of low fish passage, descaling will be monitored for facility operations. Full sample descaling may be conducted instead of 100 fish subsamples as long as it does not impact other facility operations. During extended transport operations (after August 15 at Snake River projects), samples may be evaluated every other day to minimize handling stress and to allow all collected fish to be held in the sample holding tanks.

4.4.4. Where SMP activities are conducted at collector dams, project biologists may utilize daily total information gathered by those personnel.

4.5. Loading Criteria.

4.5.1. Raceway Capacity: Maximum raceway capacity is 0.5 pounds (lbs) of fish per 1 gallon of water. Inflow to raceways is approximately 1,200 gallons per minute (gpm) at Lower Granite and Little Goose dams, and 2,400 gpm at Lower Monumental. Individual raceway volume is approximately 12,000 gallons of water at Lower Granite and Little Goose, and 24,000 gallons at Lower Monumental. The 0.5 lbs/gallon criterion shall not be exceeded without CENWW review and approval through coordination with NOAA Fisheries and TMT. Project biologists will provide the following information to the CENWW Transportation Coordinator to inform the joint decision whether to exceed capacity criteria or to bypass fish to the river:

- **a.** species composition;
- **b.** total anticipated collection during the critical holding period;
- **c.** in-river fish passage conditions; and
- **d.** fish condition.

4.5.2. Raceway Distribution: Collected fish will be distributed among available raceways in a manner that minimizes crowding, stress and risk of disease transmission. Additional fish will be added to each raceway at the discretion of the project biologist until holding capacity is reached. Whenever possible, small fish will be held in separate raceways from large fish.

4.5.3. Raceway Holding Time: Maximum raceway holding time is 2 days. An exception to this criterion is instances when additional holding time is needed to collect sufficient fish for tagging to conduct research studies.

4.5.4. Truck & Barge Capacity: Maximum loading capacity is 5 lbs of fish per 1 gpm inflow for barges, and 0.5 lbs per 1 gallon of water for trucks (**Table B-1**).

Table B-1. Juvenile Fish Transportation Program Transport Vehicle Capacity.

Transport Vehicle	Capacity (gal)	Inflow (gpm)	Fish Capacity (lbs)
Barge 2127 - "*SOCKEYE*"	85,000	4,600	23,000
Barge 2817 - "*BLUEBACK*"	85,000	4,600	23,000
Barge 4382 - "*STEELHEAD*"	100,000	10,000	50,000
Barge 4394 - "*COHO*"	100,000	10,000	50,000
Barge 8105 - "*CHINOOK*"	150,000	15,000	75,000
Barge 8106 - "*KING SALMON*"	150,000	15,000	75,000
Barge 8107	150,000	15,000	75,000
Barge 8108	150,000	15,000	75,000
Truck	3,500	n/a	1,750
Truck - Midi-tank	300	n/a	150
Truck - Mini-tank	150	n/a	75

4.6. Summer Transport Operations.

4.6.1. During the summer, all fish collected will be routed to raceways with the most effective shading for holding. Sampling efforts should be minimized, if possible, to limit handling stress on fish. Facility samples may be processed every-other-day if necessary.

4.6.2. All collected fish may be routed to sample tanks when fish numbers drop to an acceptable handling level. At that time, all collected fish will be handled as part of the daily sample per SMP guidelines (see **Appendix J**). To minimize handling stress, facility samples may be processed every other day. When large trucks are used, fish may be loaded from either raceways or labs. When mini or midi-tankers are used, Corps and agency project biologists will select the best method of transferring fish from the lab to the tankers.

4.6.3. During summer trucking, if fish collection numbers begin increasing to where it appears the project will have difficulty transporting the fish with available equipment, the project shall notify the CENWW Transportation Coordinator immediately. The Transportation Coordinator will arrange for an additional transport vehicle if possible, joint fish transportation between two or more operating projects, or prioritize transport/bypass operations between the projects.

4.6.4. When water temperatures are above 68^0F, all personnel handling fish shall take extra care to minimize stress and other impacts on fish.

4.6.5. When mortality from columnaris disease (*Flavobacterium columnare*) in the condition sample exceeds 10% for three consecutive days after August 17, collection for transport will end and the system will be placed in primary bypass with a condition sample taken every third day. The collection of fish for condition sampling will end after one 24-hour sample period, or when 100 juvenile salmonids are collected for examination. The FPC will be notified and FPAC will review available data for future recommendations.

4.6.6. At Lower Monumental Dam, collection of fish for *truck* transport will stop when daily collection is less than 50 fish per day for 3 consecutive days. The facility will continue to collect fish for condition sampling through September 30. If collection numbers increase substantially, TMT will be notified and will determine whether to recommend resuming transport.

4.7. Facility and Equipment Logbooks, Records, and Reports.

4.7.1. To document transportation activities at Snake River collector dams, the following items will be logged at each dam by either project personnel or state biologists:

4.7.1.1. Juvenile Fish Facilities: Records will be maintained recording fish counts by hour, by day, and by species, numbers and species of fish trucked or barged, number and species of fish sampled, descaling rates, and mortality rates. Records will be transmitted daily to CENWW for consolidation and transmittal to CENWD. Facility personnel will follow standard operating procedures (SOP's), and will note in facility logbooks accomplishment of SOP's at various stations at the collection facilities. General observations of fish condition and juvenile fish passage will be documented in facility logbooks by state biologists.

4.7.1.2. Truck & Barge Logbooks: Each truck and barge shall have a logbook to record fish loading rates, fish condition, estimated mortality, release site, equipment malfunctions, and accomplishment of scheduled work under the SOPs. When consecutive loading of trucks or barges occurs at downstream projects, truck drivers or barge riders will record numbers and condition of fish loaded. Towboat captains will keep logbooks on towboat activities. Barge riders will be authorized as inspectors by the Contracting Officer's Representative to initial entries noting towboat passage, loading, or fish release activities, and comments on barging operations. State biologists will report truck and barge mortality information in their weekly reports.

4.7.1.3. Weekly Reports: Contracted biologists shall prepare weekly reports documenting daily and weekly collection and transportation numbers, sampling information, facility and sampling mortality, descaling rates, and adult fallbacks. The weekly reports will be used by CENWW for any weekly reports to inform consultations with NOAA Fisheries on the status of project operations. Contract biologists shall distribute the weekly reports to other regionally interested parties as directed by the CENWW Transportation Coordinator.

5. TRUCK AND BARGE OPERATIONS

5.1. Truck Operations.

5.1.1. Trucks. Two 3,500-gallon fish transport trailers and one tractor, three 300-gallon midi-tanks, and three 150-gallon mini-tanks are available for hauling fish. One midi-tank and one mini-tank will be provided at each Snake River collector project. Mini- and midi-tanks are small units that can be mounted onto pickup trucks. During trucking operations, a transport truck/trailer is based at Lower Granite Dam, with the second transport trailer held in reserve. The truck/trailer combination may be redistributed to meet transport demands and when smaller transport vehicles begin operating in late summer.

5.1.2. Truck Release Sites: The normal early spring release site for trucked fish will be a truck pad behind the Bonneville Dam Smolt Monitoring Facility (SMF). Fish released from the truck pad pass through the SMF outfall into the Columbia River. From August 15 through the end of the transport season, trucks, midi-tanks and mini-tanks will also release fish into the Bonneville SMF outfall flume. Dalton Point will be utilized as an alternate release site in the case of an emergency or if unsafe conditions exist at the Bonneville facility.

5.1.3. Operation of Truck Life Support Systems: Truck drivers will be trained by project biologists and maintenance personnel on the operation of truck life support systems, the requirements of fish to be met, and signs of stress for which to watch. Routine checks will be made on support systems and fish condition at check points identified by project biologists. Life support system data and information on fish condition will be entered into the truck driver's logbook at each check point and at the release point. The truck driver's logbook will be reviewed by the project biologist upon the truck driver's return after each trip.

5.1.4. Truck Loading Schedules: If required to maintain transport schedules at the Snake River projects, transport trucks, midi-tanks, and mini-tanks leaving Lower Granite may take on additional fish at Little Goose Dam, or trucks leaving Little Goose may take on additional fish at Lower Monumental Dam. Loading schedules will be coordinated so that fish will be kept separated by size as much as possible.

5.2. Barge Operations.

5.2.1. Barges: Eight fish barges and four towboats will be available for use.

5.2.2. Barge Scheduling: Barges with 75,000 pound capacity will operate from Lower Granite Dam. It takes approximately 79 hours to make a trip from Lower Granite Dam to the release area near the Skamania light buoy below Bonneville Dam and return. One barge will leave Lower Granite Dam every-other-day or daily, beginning on or about the second day after the initiation of collection. The FOP (**Appendix E**) specifies the date collection will start for transportation in coordination and discussion with RIOG. When fish numbers increase during the course of every-other day barging operations, the transport program will switch to one barge leaving Lower Granite daily. When fish numbers decline in late spring, operations will change to or return to every-other-day barging from Lower Granite Dam, with barging operations continuing through August 14 or 15. During spring operations, barges will take on additional fish at Little Goose, and Lower Monumental dams as barge capacity allows. The two medium and two small barges

may also be used from Lower Granite Dam for additional barging capacity or they will be used for direct loading of fish at Little Goose Dam. When daily collection exceeds barge capacity, juvenile fish may be spilled per **section 4** above or will be bypassed to the river until collection numbers drop to where juvenile fish can be barged within barge carrying capacity criteria.

5.2.3. Barge Loading: Whenever possible, small and large fish will be loaded in separate compartments in barges.

5.2.4. Barge Riders: Project barge riders will accompany each barge trip, supervising all loading and release operations, and barge operations en-route. Barge riders will be trained on barge operation, maintenance, and emergency procedures by project biologists and maintenance personnel. Barge riders will also be cross-trained in facility operations, and may rotate with facility operators as decided by project management. Barge riders shall be responsible for monitoring fish condition, barge equipment operations, and water quality (temperature and dissolved oxygen levels) at regular intervals during downriver trips. Barge riders shall maintain logbooks and forms recording loading activities and times, loading densities by barge compartment, information on equipment operations, and release locations. Standard operational procedure forms shall be filled out during routine monitoring of equipment operation and shall include fish mortality and water quality data. At each subsequent dam where fish are loaded onto the barge, the barge rider shall make appropriate notations in the logbook and/or appropriate form. The barge rider shall also serve as an inspector for the towboat contract, and record information required by the Contracting Officer's Representative, and shall initial the towboat captain's logbook confirming operational information and lockage times. Any unresolved differences between barge riders and towboat crews shall be reported immediately to the Contracting Officer's Representative.

5.2.5. Barge Release Area: The barge schedule is based on releasing fish between river miles 138 and 141 with arrival at that point pre-determined to occur during nighttime hours to minimize predation impacts. As a reference point, Bonneville Dam is at RM 146. Barge travel time is affected by weather and river flows. Each towboat will be assigned a designated river mile for fish releases to ensure fish are not released in the same area on consecutive trips. Lower Granite project biologists will furnish maps of the release site and clearly designate the assigned river mile for fish release on each trip. As warranted, barge riders may randomly select a barge release site between river miles 138 and 141 to further decrease the ability of predators to prey on fish released from the barge. The alternate release site should be coordinated with the Lower Granite project biologist, if possible.

5.2.6. Barge Lockage Priority: During the fish barging season, April 8 to August 18, fish barges as Government vessels should be provided priority lockage over commercial and recreational traffic when locking through navigation locks, per *33 CFR 207.718(f)*. However, safety will not be compromised during lockages.

6. EMERGENCY PROCEDURES

6.1.1. Emergency procedures will be followed at any time an emergency occurs, 24 hours per day, 7 days per week during the transport season. Emergencies will be reported to the CENWW Transportation Coordinator as soon as possible.

6.1.2. In the event of an emergency (e.g., equipment failure at a facility or on a truck or barge, emergency lock outage, chemical spill in the river, etc.), facility workers, truck drivers, and barge riders will be expected to take immediate appropriate actions to protect fish. If time allows, the worker, driver, or rider should consult with his/her supervisor by phone or radio to jointly make emergency decisions. If time does not allow consultation, the worker, driver, or rider must take appropriate action on his/her own initiative, then report to his/her supervisor as soon as possible after the action has been completed.

6.1.3. A complete listing of persons to be notified in case of emergencies with business and home phone numbers will be provided to each person involved in the transport program. Facility operators, truck drivers and barge riders will be trained on emergency notification procedures by project biologists and CENWW. For the purpose of reporting an emergency, the person involved will immediately notify his/her supervisor, or the next person up the line until the emergency has been properly reported and corrective action has been initiated. In addition to phone reporting, barge riders will report emergencies by the towboat radio to the nearest Corps dam. The operator on duty will relay the message to the person or persons identified by the barge rider.

7. FISHERY AGENCY ROLES & RESPONSIBILITIES

7.1.1. The fishery agencies provide biological assistance at collector dams for transportation. CENWW contracts for fish biologists to work at each collector facility. Contracts specify that state agency personnel at collector dams accomplish specific tasks for the Corps, including:

a. Reviewing or conducting handling, inspection, and recording of data from fish sampled at the collection facility;

b. Evaluating and recording fish condition, and recommending operational changes or inspection of facilities if fish condition indicates a problem;

c. Providing hand counts of sampled fish, assisting the project biologist in adjusting electronic fish counts, checking hourly and daily fish counts for accuracy, and coordinating facility counts with PSMFC SMP counts where appropriate;

d. Conducting quality control inspections of collection facilities and transport equipment including visits to other collection facilities when work schedules allow;

e. Monitoring the effects of smolt monitoring and research projects on fish condition and transportation activities and reporting impacts, including numbers of fish handled for research purposes and the disposition of those fish, to the project biologist;

f. Participating in gatewell dipping as required to monitor fish condition;

g. Preparing weekly reports summarizing fish numbers and transport activities, and;

h. Preparing accurate text and tabular data in correct format for project annual reports.

8. REPORTING

8.1. Daily Reports.

8.1.1. Project biologists or contract biologists at each collector dam will be responsible for entering all pertinent information into the computer database and for transmitting daily reports to CENWW. Weekday information will be transmitted by 1500 hours on the day collected. Weekend information will be transmitted to CENWW by 1200 hours on the following Monday.

8.2. Weekly Reports.

8.2.1. Contract biologists will provide weekly reports detailing fish collection and transportation numbers, descaling estimates, and facility and transportation mortality estimates. The reports will also contain a narrative on project activities and compliance with operating criteria. If research or smolt monitoring activities are occurring at the project, the weekly reports will include information on the number of fish sampled and sacrificed also. Corps biologists shall provide the reports to interested parties within the region.

9. REQUIREMENTS FOR FISHERY AGENCY ACTIVITIES AND RESEARCH

9.1. Coordination.

9.1.1. Agencies and tribes requesting to work at Corps dams will provide early coordination including work proposals, evidence of CBFWA approval, copies of ESA permits, and project needs and requirements through written correspondence to CENWW, Operations Division Chief. Work shall not start until written approval is received. The Corps expects the PSMFC to coordinate SMP sampling guidelines with the Corps annually.

9.2. Protocol.

9.2.1. To maintain good working relationships and safe working conditions, fishery agencies, tribes, and research organizations will be required to follow courtesy, security, and safety protocols as follows:

- **a.** Have agency picture identification and present it to project security on arrival;
- **b.** Check in with the Operations Manager upon first arrival at the project to receive information on who will be the project point of contact, and what courtesy and safety requirements must be followed;
- **c.** Notify the point of contact whenever arriving or departing from the project so they will know where personnel will be working and when they will be on the project;
- **d.** Adhere to project clearance, safety, security, and work procedures, including preparing an Activity Hazard Analysis as specified in the Corps Safety Manual, 385-1-1.;
- **e.** Notify the Operations Manager or his/her representative of unscheduled or non-routine work and activities, and;
- **f.** Notify the point of contact of expected guests or changes in personnel and assure that these individuals are aware of safety and work procedures.

2018 Fish Passage Plan

Appendix C

Bonneville Power Administration's System Load Shaping Guidelines Regarding Turbine Operation & Peak Efficiency

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1. INTRODUCTION

1.1.1. Out-migrating juvenile salmonids have several potential routes of passage past hydroelectric dams on the mainstem Columbia and Snake rivers, including turbines, mechanical bypass, sluiceways and spillways. Fish passage survival varies depending on the route of passage. As a result of reported higher mortality rates for fish passage through turbines (Iwamoto and Williams 1993), regional efforts have focused on providing non-turbine passage routes for juvenile fish as a means to improve fish survival through the Federal Columbia River Power System (FCRPS). Nevertheless, substantial numbers of juvenile fish will continue to pass through turbines, thus efforts to minimize turbine-related mortality is a priority of fishery agencies and Indian Tribes, the National Oceanic & Atmospheric Administration's Fisheries Service (NOAA Fisheries, formerly National Marine Fisheries Service [NMFS]), U.S. Army Corps of Engineers (Corps), and Bonneville Power Administration (BPA).

1.1.2. Kaplan turbine operating efficiency has a relatively direct effect on fish passage survival. The relationship between survival of juvenile fish passing through Kaplan turbines is positively correlated and roughly linear to the efficiency at which the turbines are operated. Bell (1981) recommended making every effort to operate turbines at peak efficiency at a given head during periods of peak fish passage to minimize fish mortality.

2. TURBINE EFFICIENCY

2.1.1. For the purposes of this document, peak turbine efficiency operation shall be based on tables of operating ranges within ±1% of peak efficiency (1% range) provided by the Corps for each project in the Fish Passage Plan (FPP). The Corps shall ensure that 1% ranges are based on the best available information and that updates are coordinated with BPA, the Fish Passage Operations & Maintenance (FPOM) Coordination Team, and operating agencies. The tables will be distributed to all operating agencies prior to implementation, allowing up to two weeks after receipt of the tables for implementation.

2.1.2. Operating efficiency of turbines is a result of wicket gate opening and blade angle for a given head (Bell 1981). As a result, there is a family of turbine efficiency curves for each project (or turbine design) for various head differentials. Operational decisions affecting turbine operations are based on efficiency curves for incremental changes in head, as provided by turbine manufacturers or empirical testing.

3. GUIDELINES

3.1. Objective.

3.1.1. To reduce mortality of out-migrating juvenile salmonids, BPA will provide the Corps hydrosystem projects with generation requests that allow turbines at the Lower Snake (LSN) and Lower Columbia (LCOL) projects to operate within ±1% of peak turbine efficiency (1% range), or as otherwise specified, during the Peak Efficiency Operating Period of April 1 through October 31, in accordance with the guidelines below.

3.2. In-Season Peak Efficiency Operating Period (April 1–October 31).

3.2.1. During this period, 24 hours/day, BPA will maintain generation requests at all Lower Columbia (LCOL) and Lower Snake (LSN) hydroelectric projects to allow turbines to operate within the 1% range in accordance with these guidelines. Excursion outside of the 1% range during this period will be tracked using the codes in **Table C-1**.

3.3. Off-Season (November 1–March 31).

3.3.1. While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs. For more information on the 1% operation, see the project-specific chapters of the FPP for *Turbine Unit Operation & Maintenance*. There are no reporting requirements for this period.

3.4. Unit Priorities.

3.4.1. The Corps should make every effort to adhere to unit operating priorities specified in the FPP (the order in which turbines are put on- or taken off-line). The Corps shall follow a unit priority list that specifies which units at each LSN and LCOL project should be operated within the range of peak efficiency to minimize impact to salmon stocks. The Corps through the FPOM process will develop a sequence for operating units outside of the 1% peak efficiency range if necessary during the fish migration season. Both unit priority sequences will be based on the best available fish passage and turbine efficiency information in the FPP.

3.5. Project Priorities.

3.5.1. If units must be operated outside of the 1% range, BPA will make every effort to assure that generation requests to Corps projects adhere to project priorities (emergencies, spill management, research, etc). These priorities may be developed weekly, based on in-season fish passage information, by the Action Agencies through the Technical Management Team (TMT).

3.6. Coordination.

3.6.1. Coordination will occur through existing interagency mechanisms, such as the in-season management process described in the 2004 Updated Proposed Action prepared by the Corps, U.S. Bureau of Reclamation, and BPA (Action Agencies).

3.6.2. Coordination is also intended to allow the Action Agencies sufficient time to include system operational changes in their planning activities. Sufficient time is defined as the time needed to enter the information into GDACs (COE) and the Columbia Vista model (BPA). This can take up to two weeks to accomplish. If an emergency situation exists, implementation will begin as soon as practical given concurrent operations, hydraulic situations and loads.

3.6.3. Reasonable and prudent operations outside of the 1% range for limitations listed in **sections 4.1** (**System Reliability**) and **4.2** (**Routine Starting**) are at the discretion of BPA and

the Corps. BPA and the Corps will coordinate with NOAA Fisheries when operation of turbines outside of the 1% range may be appropriate under provisions in **section 4** below. Additional coordination may also occur during the next scheduled TMT meeting.

3.6.4. Emergency situations described in **4.1** that require an immediate change in FCRPS operation will be coordinated directly by the Action Agencies with NOAA Fisheries as soon as practicable. If coordination of an emergency change in FCRPS operation cannot be completed immediately, information will be supplied to TMT as soon as practicable. The Action Agencies shall establish points of contact with the appropriate agencies to allow such emergency coordination to occur.

3.7. Grand Coulee (GCL) and Chief Joseph (CHJ) Flexibility.

3.7.1. Within system reliability and firm load limitations, flexibility at GCL and CHJ will be fully used whenever possible before generation requests to LCOL and LSN projects are outside the 1% range.

4. IN-SEASON LIMITATIONS (APRIL 1 – OCTOBER 31)

Occurrence of the conditions described below may limit the ability of the Action Agencies to operate turbines continuously within the 1% peak efficiency range.

4.1. System Reliability.

4.1.1. BPA's ability to operate the power system in a manner that enables the Corps to maximize operation of turbines within the1% range will be constrained by requirements to maintain system reliability (including requirements necessary for transient and voltage stability of the transmission system), and the ability to meet system response criteria. Additionally, it is necessary to maintain a margin of resource generation on-line to fulfill Northwest Power Pool (NWPP), Western Electricity Coordinating Council (WECC) and the North American Electric Reliability Council (NERC) reliability requirements. If BPA overrides BiOP operations for system reliability, BPA will provide an automated e-mail to the Corps. For longer term emergencies, see the current *Water Management Plan,* Appendix 1 (Emergency Protocols).

4.1.2. System response criteria and margin of resource generation are defined in the following documents: *Reliability Criteria for Operations (BPA)*, *Northwest Power Pool Operating Manual*, *Western Systems Coordinating Council Operations Committee Handbook*, and *North American Electric Reliability Council Operating Manual*. According to the Regional Act, the Power Sales Contract with the DSIs and *House Report 96-976*, dated September 16, 1980, "the total DSI load will be considered firm for purposes of resource operation."

4.1.3. Predictable instances of deviation from the 1% range as a consequence of prudent utility operation for control of short-term system dynamics include:

> **(i)** Routine responses to loss of generation, load or transmission within the interconnection including delivery of “Operating Reserve Obligation” to NWPP members

upon request. The duration of these deviations is minimal but dependent upon recovery by the interconnection member with the problem.

(ii) Deliberate dropping of generation (i.e., instantaneous interruption of output) to preserve system integrity. This dropping could cause a brief excursion.

4.2. Routine Starts and Stops.

4.2.1. Routine starting and stopping of generation units are unavoidable deviations, usually short duration but on occasion can extend beyond the 5 minute reporting window (see **section 5**).

4.2.2. Operations in **sections 4.3–4.8** will include notification to NOAA Fisheries at least 2 working days before implementation to allow sufficient time to evaluate effects of proposed actions (non-emergency situations).

4.3. Total Dissolved Gas (TDG) Supersaturation.

4.3.1. TDG levels will be monitored at each project during the fish passage season. Signs of gas bubble disease will be monitored at all Smolt Monitoring Program sampling sites and selected in-river sites. Peak turbine efficiency operation may be modified if representative monitoring data indicate that TDG is affecting fish survival. Necessary operational modifications will be coordinated through the process outlined in **section 3.6**.

4.4. Coordinated Fishery Operations.

4.4.1. In the event that coordinated fishery operations and approved fish research are not in accord with operating turbines in 1% ranges, operational modifications will be coordinated through processes outlined in **section 3.6**.

4.5. Flow Augmentation Operations.

4.5.1. Flow augmentation requests for flows at McNary (MCN) are primarily met by water releases from GCL. The decision whether to use GCL flexibility to provide MCN inflow at the level necessary to meet the week's LCOL flow request when fish collection is maximized for transport during the flow augmentation period shall be made through coordination processes outlined in **section 3.6**. The TMT flow augmentation requests may exceed the 1% range at LCOL/LSN projects. Meeting this flow request will take precedence over 1% operations.

4.6. Transport Projects.

4.6.1. Resolution of conflicts between spill management and turbine operation within 1% ranges at transport projects during transport season shall be determined through the coordination process in **section 3.6**, and in accordance with transportation guidelines based on in-season flow and fish passage information. Care should be taken during transition periods close to the upper flow boundary to avoid frequent switching of priorities between spill and generation.

4.7. Routine Maintenance and Testing.

4.7.1. All units at all projects must undergo maintenance and associated testing. The testing necessitates deviation from the 1% ranges for periods of 15 minutes to 8 hours. Scheduling of maintenance testing will be coordinated through the process outlined in **section 3.6** to ensure that it is conducted during times of low fish passage within a day to minimize impacts on fish.

4.8. Flood Control.

4.8.1. The FCRPS provides multiple regional benefits and flood control is the primary function of many of the projects on the Columbia River. In the event that river flow conditions require flood control operations, operation of turbines within the 1% ranges may be modified or suspended based on the Corps' direction. Allowing excursions outside the 1% ranges for flood control operations would facilitate transportation, reduce excessive TDG levels, and lower the risk of gas bubble disease in fish. Coordination of flood control operations will occur as outlined in **section 3.6**. See also **sections 4.3** (**TDG**) and **3.7** (**GCL and CHJ Flexibility**).

4.9. Other.

4.9.1. In the event that the excursion was not explainable or caused by human error.

5. QUALITY CONTROL

5.1.1. Significant deviations outside of the 1% range will be recorded. Data on unit status will be compiled by BPA during the 1% operating season and provided to the COE monthly. Documentation will be kept when excursions:

(i) exceed 15 minutes in duration; and/or

(ii) occur 5 or more times exceeding 5 minutes within 1 calendar day.

5.1.2. The reason (limitation or other factor) for the excursions will be kept in project logs at each dam as well as inserted into the spreadsheet provided by BPA using the reason codes listed in **Table C-1**. The COE will annually provide a report to NOAA Fisheries of reportable excursions from the 1% operating range during the 1% operating season.

5.1.3. Upon request of TMT, a case-by-case brief explanation of the reason(s) for unit operation outside the 1% range, the date and length of time of the excursion, will be provided by the appropriate parties. For the report, the following numerical codes will be used to explain excursions outside the 1% range. The codes provide a more simplified method of tracking excursions than using the listed limitations in **section 4**.

Table C-1. Codes for Reporting Excursions Outside the 1% Peak Efficiency Range.

Code	Reason
1	Equipment reporting errors, including lack of data (GDAC or AGC not operating correctly and not recording readings, dead-band and precision issues, etc.)
2	Modified spill operations in support of BiOp or court order (requested flow augmentation, coordinated fish operation)
3	O&M requirements (fish screen inspection, trash raking, Doble testing, dam safety, etc.)
4	Operational tests (index testing, testing or calibrating new or repaired equipment)
5	BPA requested operation (request operation via AGC)
6	Turbine start-up or stops longer than 5 minutes
7	Emergency conditions or system failures, including transmission system emergencies, remedial action schemes (RAS), or others as described in 4.1. *System Reliability*.
8	Fish research
9	Human error
10	Unknown causes
11	Other (Please specify)
12	Flood control
13	TDG reduction

2018 Fish Passage Plan

Appendix D

Operations for Non-Listed Species (Lamprey, etc.)

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1. INTRODUCTION

This Appendix describes structural improvements and special operations for lamprey and other non-listed fish species that may pass a project via the juvenile or adult passage facilities. These operations are regionally coordinated with the Fish Passage Operations & Maintenance (FPOM) workgroup and supplement operations for ESA-listed salmonids described in the current *Fish Passage Plan* (FPP) [1].

2. BONNEVILLE DAM

2.1. Lamprey Passage Improvements.

2.1.1. Several adult lamprey passage improvements have been made to Bonneville Dam fish ladders, including:

2.1.1.a. Bradford Island: In 2004, a Lamprey Passage System (LPS) was installed to the FV 3-9 AWS channel and expanded with PIT-tag detection in 2006. In 2011, counting improvements, including video verification at the exit flume and 1" picket lead spacers were added. In 2012, these spacers were upgraded and improved to ensure sufficient lamprey passage while not interfering with adult salmonid passage. In 2014, NOAA Fisheries installed a picket lead sill ramp and ¾" spaced picket leads in the crowder slot. The remaining picket leads were raised with new spacers to 1.5" off the sill.

2.1.1.b. Cascades Island: In 2006, half-duplex PIT-tag detectors were installed along the picket leads to help track lamprey. In 2009, an LPS was installed with a bollard floor guidance path and a variable-width entrance weir. In 2013, the LPS was extended to allow fully volitional passage to the forebay with PIT-tag detection and video verification at the new exit, adjacent to FV 5-9.

2.1.1.c. Washington Shore: In 2001, guidance plates were installed over the diffuser grates. In 2005, a lamprey ramp and trap box were installed at the North Downstream Entrance (NDE). In 2008, an LPS was added to the FV 6-9 AWS channel, similar to the LPS at the Bradford Island FV 3-9 AWS. In 2010, 1" picket lead spacers were installed to provide lamprey passage under the leads. Beginning in 2010, Fish Unit output is reduced at night during lamprey passage season (June 1–August 31) in order to operate the Washington Shore ladder entrances at a head of 0.5 feet and encourage lamprey to enter (see **FPP Chapter 2 - Bonneville Dam, section 2.5.4**). In 2011, NOAA Fisheries installed a picket lead sill ramp as well as ¾" crowder picket leads in the crowder slot. In 2013, the picket lead spacers were modified to provide a 1.5" gap off the sill. Additionally, the NDE lamprey trap was removed and replaced with a Lamprey Flume System (LFS) for attraction and guidance from the NDE area to an LPS that terminates in a trap box on the +55 deck.

[1] The annual Fish Passage Plan (FPP) is available online at: http://pweb.crohms.org/tmt/documents/fpp/

2.2. Adult Lamprey Passage Facilities.

2.2.1. Powerhouse One (PH1): At the Bradford Island ladder, the FV 3-9 AWS channel is equipped with an LPS that allows lamprey to bypass the serpentine section of the ladder and exit directly into the forebay adjacent to the ladder exit. The picket leads that block passage of adult salmonids into the AWS channel are raised 1" off the ladder floor, allowing lamprey to pass under the leads and into the AWS channel.

2.2.2. Spillway. The Cascades Island ladder entrance is equipped with a variable-width weir entrance gate. This entrance is coupled with a bollard field on the ladder floor, leading to an LPS located in the entrance bay. This LPS bypasses the overflow weirs and provides a direct route to the forebay. This LPS is currently being converted into a fully volitional passage route with an exit directly into the forebay, adjacent to the Cascades Island fish ladder exit**.**

2.2.3. Powerhouse Two (PH2). The Washington Shore ladder FV 6-9 AWS channel is equipped with an LPS that allows lamprey to bypass the serpentine section of the ladder and exit directly into the exit channel of the ladder. The picket leads that block passage of adult salmonids into the AWS channel are raised 1.5" off the ladder floor, allowing lamprey to pass under the leads and into the AWS channel.

2.3. Adult Lamprey Migration Timing and Counting.

2.3.1. Adult lamprey migration season at Bonneville Dam is March 1–November 30 with the majority of the run passing in June and July. LPS maintenance is scheduled December 1 through the end of February.

2.3.2. Adult lamprey counting is conducted in conjunction with other adult fish counting. The count schedule for each year is defined in the **FPP Chapter 2 - Bonneville Dam**, **Table BON-3.** In addition to count window operations, each volitional passage LPS is equipped with a mechanical counting system and video verification in the exit sections.

2.4. Lamprey Passage System (LPS) Operation & Maintenance.

2.4.1. General. Maintain adequate water depth for lamprey passage in all LPS flumes.

2.4.2. Dewatering. When adult lamprey are recovered during dewaterings, they will be transported and released into the Bonneville forebay whenever possible. Fish recovered during dewaterings, including lamprey, will not be held for other uses.

2.4.3. Cleaning Criteria. When water level in an LPS flume drops below the required level, the water supply pump intakes must be cleaned and debris removed.

2.4.4. Trapping. All LPSs are designed for volitional passage; however, LPSs may be temporarily set up with a trap box at the terminus while new potential locations are tested for usage by fish. These trap boxes are operated solely by research groups who are responsible for monitoring, handling, and transportation of lamprey from the boxes.

2.4.5. Water Temperature. Temperatures will be monitored in each LPS. When water temperature reaches 70°F, all fish handling activities will be coordinated through FPOM to verify protocols that will be followed prior to any action. Fish handling activities in the Adult Fish Facility (AFF) will implement protocols in **Appendix G – Adult Trap Protocols**.

2.4.6. Winter Maintenance Season. LPS maintenance will be scheduled from December 1 through the end of February, including: remove and winterize water supply pumps; inspect all pumps and repair/replace where necessary; power-spray flumes and rest boxes to remove excess algal growth and any debris; inspect all joints and re-caulk where necessary.

3. THE DALLES DAM

3.1. Adult Lamprey.

3.1.1. Passage improvements were made in the east fish ladder by installing four orifice ramps to eliminate 90° edges. Several concrete 90° edges were also rounded with 2" radius. Picket leads were raised 1.5" for both north and east count stations. Steel plates for lamprey attachment substrate were installed in the lower 14 weir orifices.

3.2. Juvenile Lamprey.

3.2.1. Data are being collected in the powerhouse turbine cooling water strainers for informational purposes. These data will not be available as the strainers are now being replaced with self-cleaning mechanisms.

3.3. Dewatering Collections.

3.3.1. Lamprey are collected and returned to the forebay during fishway dewaterings. Tribal restocking efforts collect lamprey from some dewaterings. These lamprey are held for no longer than 10 hours.

4. JOHN DAY DAM

4.1. Adult Lamprey Facility.

4.1.1. The South Ladder Lamprey Trap was installed in the winter of 2013 behind the count station picketed leads of John Day Dam's south fish ladder.

4.2. General Facility Protocols.

4.2.1. The following protocols will be implemented by agencies operating the trap in order to ensure safe access for personnel, minimize handling stress to lamprey, and reduce impacts to salmonids migrating past the trap. These protocols will be coordinated with fish agencies and tribes through FPOM.

4.2.2. Users must have appropriate documentation for conducting research at the dam, including valid state transportation permits and federal and/or tribal permits that cover species targeted during the trapping period. Users shall comply with all fish handling conditions in the permits. If permit conditions are more restrictive than the protocols herein, users must follow the more restrictive directive. The U.S. Army Corps of Engineers (Corps) reserves the right to terminate trapping operations at any time.

4.2.3. Hard hats, long pants or raingear, steel-toed shoes or rubber boots are to be worn at all times. Shorts, tennis shoes, or sandals will not be permitted when operating the trap.

4.2.4. Users must be trained in the proper operation of the jib crane and hoist prior to operating the equipment in order to ensure fish and personnel safety. Currently, the John Day Project Safety Office, in conjunction with the Project rigging crew, have offered to provide training. Users may request training through the John Day Project Biologists.

4.2.5. Undesired fish will be released back into the fish ladder. In the unfortunate event of mortalities, see reporting requirements below.

4.2.6. Researchers shall perform no maintenance on Corps owned/installed equipment. Please contact the on-duty Project Biologist or Biotech to alert them of any problems.

4.2.7. Users must use a cotton mesh net or water retaining refuge net large enough to safely handle the largest fish passing the project during the trapping period.

4.2.8. Fish ladder water temperatures should be measured and recorded upon arrival and departure. Transport water should be within 2°F of the fish ladder water temperature and provided with aeration or oxygenation when needed.

4.2.9. Upper Temperature Limit. Currently there is no published literature to guide the determination of an appropriate upper temperature limit, above which the trap should not be operated. Trapping data for John Day Dam from 2008-2012 (Aaron Jackson, CTUIR) indicated an average mortality rate of 0.8% within the temperature range of 14.8–22.8°C (58.6–73.0°F) and no relation between mortality and water temperature (WQM tailrace). Therefore, there is a need for trap operators to collect additional water temperature and mortality data to inform the determination of upper thermal limit.

4.3. Notification & Documentation.

4.3.1. Users will sign in and out of at the Project Fisheries office and notify them when they set up and close down the trap.

4.3.2. Users will record the times the trap is lowered and raised and which agency they are representing on the sheet provided by the Project Biologists.

4.3.3. Lamprey may be held up in the juvenile fish facility for to 48 hours. Researchers will notify Project Fisheries and the Control Room whenever lamprey are held.

4.3.4. Users will scan all collected lamprey for full- and half-duplex PIT-tags and provide code information of previously tagged animals to appropriate Corps personnel and interested parties. Because of their research value, tagged fish must be returned to the forebay.

4.3.5. Any and all mortalities must be immediately reported to a Project Biologist. The Project Biologist will examine the mortality and should take photos and file a memorandum for the record (MFR). The researcher shall give a detailed report including:

i) Species;
ii) Origin;
iii) Length (cm);
iv) Weight (g);
v) Tags: recovery of radio or acoustic tags, scanning for full and half-duplex PIT-tags;
vi) Injuries;
vii) Cause and time of death or discovery;
viii) Future preventative measures.

4.3.6. All mortalities are included in the Project Fisheries weekly report submitted to FPOM.

4.3.7. When trapping is complete for the season, users will properly shut down the trap. For example the basket should be placed in pass through mode by removing the upstream side panel or removing the entire basket from the fishway.

5. NWW PROJECTS

5.1. Improvements for Lamprey.

5.1.1. During the 2009-10 winter maintenance period at McNary Dam, horizontal slots were cut at the bottom of the stem walls in the upper section of the Oregon shore ladder to allow adult lamprey attachment along a level pathway through the weir. Plating was also attached on the diffuser gratings near the ladder walls to create a continuous path for lamprey attachment. It was determined that the plating was not being used by adult lamprey and it was removed in the 2016-17 winter maintenance period from diffuser gratings except in the immediate vicinity of the submerged orifices.

5.1.2. At all projects in 2011, picketed leads were raised and secured 1.5” off the ladder floor at the count stations to enable adult lamprey passage through a low-velocity passage route under the picketed leads around the adult fish count slot.

5.1.3. During the 2011-12 winter maintenance period at Ice Harbor and Lower Monumental dams, improvements were made to the upper fish ladder weirs for adult lamprey, including:

5.1.3.a. Horizontal slots were cut into weirs at the floor to allow adult lamprey attachment along a level pathway through the weir.

5.1.3.b. Ramps were installed in the upper ladder weirs from the ladder floor to the bottom of elevated salmon orifices to assist lamprey in maintaining attachment as they maneuver through these areas.

5.1.3.c. Plates were installed on diffuser grating adjacent to orifices in the Ice Harbor north ladder to provide attachment surfaces for lamprey in higher-velocity areas.

5.1.3.d. Similar lamprey orifices and plating were installed in the Little Goose and Lower Granite ladders during the 2012-13 winter maintenance period. Three of the weirs at Lower Granite had lamprey orifices cut during the 2013-14 winter maintenance period.

5.1.4. By 2012, lamprey-friendly raceway tailscreens were installed at all of the juvenile fish facilities that collected for transportation (Lower Granite, Little Goose, Lower Monumental, and McNary dams) to allow collected lamprey to be returned to the river rather than transported. The tailscreen wire mesh diameter is 16.0 mm (0.063") with an open width/height of 8.6 mm (0.337"), open diagonal dimension of 12.1 mm (0.477") and overall screen open area of 71.0%.

5.1.5. Lower Monumental tested a perforated plate tailscreen that can be cleaned with brushes without entangling lamprey. The plate is $^1/_4$" thick with 0.312" x 1.0" slots spaced $^1/_4$" apart oriented vertically in a side-staggered pattern. With consensus of regional partners, the remaining mesh tailscreens at Lower Monumental were replaced with these perforated plate tailscreens in the 2012-13 winter maintenance season.

5.2. Operations for Lamprey.

5.2.1. At McNary Dam, unit trash racks will be raked during the winter maintenance period prior to January 16 to minimize the potential for lamprey entanglement in built-up debris when river flow increases. See **FPP Chapter 7 (MCN), section 2.3.1.1**.

5.2.2. At McNary Dam, ESBSs will be installed and operating between April 5 and April 15 (two weeks later than other NWW projects) to allow juvenile lamprey passage directly through turbines without bypass collection. See **FPP Chapter 7 (MCN), section 2.3.2.2**.

5.2.3. At Lower Monumental, Little Goose, and Lower Granite, fallback adult lamprey collected off fish separators and other areas of the juvenile fish facilities will be released into the forebay rather than being bypassed back into the tailrace or transported downstream.

5.2.4. Turbine cooling water strainer inspections will be conducted once per month from mid-December until mid-June at the four lower Snake River dams, and from mid-December to mid-July at McNary Dam. If 10 or more juvenile lamprey are collected during the last sample date in June/July, an additional month of inspections should be made.

Appendix E

2018 Fish Operations Plan (FOP)

SPRING

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IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF OREGON

NATIONAL WILDLIFE FEDERATION, *et al.*, Plaintiffs, and STATE OF OREGON, Intervenor-Plaintiff, v. NATIONAL MARINE FISHERIES SERVICE, *et al.*, Defendants and NORTHWEST RIVERPARTNERS, *et al.*, Intervenor-Defendants.	Case No. 3:01-CV-00640-SI ORDER FOR 2018 SPRING SPILL OPERATIONS AND 2018 PIT MONITORING

Pursuant to the Court's April 3, 2017, Amended Opinion and Order (ECF 2194), regional sovereigns and their staff engaged in technical work with the aim of reaching consensus on a 2018 spring fish passage spill operation at the four lower Snake River and four lower Columbia River projects. Based on the recommendations resulting from this technical work, party conferral processes took place on a 2018 spring fish passage spill implementation plan and proposed order (*see, e.g.*, ECF 2197, 2201, 2215, 2216, 2234, 2235).

Between May and November 2017, the Regional Implementation Oversight Group (RIOG) charged various technical teams, including the spill operations team, with evaluating and developing recommended spill levels, and aiming to avoid unintended negative consequences at each of the eight lower Snake River and lower Columbia River dams. *See* ECF No. 2215; ECF

No. 2234-1; ECF Nos. 2234-2 to 2234-5. In October and November 2017, the spill operations team recommended that the RIOG support the technical team's proposed 2018 Spring Spill Operations. On November 2, 2017, RIOG members were polled and unanimously supported the technical team's recommendation for a 2018 spring fish passage spill operation that is responsive to the Court's injunction ruling.

In addition, the sovereign collaborative process addressed March 1 PIT monitoring, *see* ECF 2215 at 3-4, where the sovereign representatives evaluated different options and considerations for March 1 PIT monitoring, *see, e.g.*, ECF 2214-1 at 136-154; ECF 2234-2 at 18-63. On October 10, 2017, the Fish Passage Advisory Committee (FPAC)—through representatives of the Columbia River Inter-Tribal Fish Commission, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Idaho Department of Fish and Game, the Confederated Tribes of the Colville Reservation, the Nez Perce Tribe, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service—recommended that the Fish Passage Operations and Maintenance (FPOM) team consider recommending that the U.S. Army Corps of Engineers (Corps) begin PIT monitoring at Little Goose Dam, John Day Dam, and Bonneville Dam on March 1, 2018. FPOM reviewed and endorsed this recommendation on October 12, 2017. RIOG addressed the recommendation on October 18, 2017, and no sovereign objected.

In view of the foregoing, the National Wildlife Federation, *et al*. Plaintiffs, Plaintiff-Intervenor the State of Oregon, amicus Nez Perce Tribe, and Federal Defendants (hereinafter, "parties")[1] propose the following provisions be entered as an order:[2]

[1] A copy of this proposed order was circulated to the remaining parties and *amici*; with the exception of Columbia Snake River Irrigators Association, no party or *amici* indicated an objection to the proposed order. Northwest RiverPartners states that it has appealed the Court's April 3, 2017 order and expresses no opinion as to the specifics of this Proposed Order, as RiverPartners was not part of the technical process that led to its development.

[2] In addition to the terms of Section II, Paragraph 7, Federal Defendants object to entry of any order governing 2018 spring fish passage spill operations or March 1 PIT monitoring that in any way adjusts or modifies the terms set forth herein and request notice and the opportunity to be heard if the Court considers modifications to the terms of this proposed order.

MARCH 1 PIT MONITORING

The parties agree and propose that the following provisions be entered as an order governing the Corps' March 1 PIT monitoring and, upon review and good cause appearing, IT IS ORDERED that:

1. Unless modified or vacated by this Court or modified or vacated by the U.S. Court of Appeals for the Ninth Circuit, the Corps shall commence PIT-tag monitoring at Little Goose Dam, John Day Dam, and Bonneville Dam according to the criteria endorsed by RIOG on October 18, 2017, and as set forth in the Proposed March 2018 Juvenile Bypass System Operations (Exhibit 1). This paragraph of this Order takes effect on March 1, 2018.

2018 SPRING FISH PASSAGE SPILL OPERATIONS

The parties propose the following provisions be entered as an order governing 2018 spring fish passage spill operations, where the following provisions are based on the intent of the parties that: (1) Federal Defendants may make adjustments in planned 2018 spring fish passage spill operations, as described in more detail below, without violating this Order; (2) the Federal Defendants will maximize fish passage spill to the extent feasible in a manner consistent with the state water quality standards for TDG during the 2018 spring fish passage spill period; and (3) Federal Defendants will aim to restore planned fish passage spill operations as soon as practicable after the condition or unintended biological consequence requiring adjustment to planned operations is addressed. Upon review, and good cause appearing, IT IS ORDERED that:

I. DEFINITIONS

1. "RIOG Recommendation" refers to the document providing recommendations for 2018 spring fish passage spill operations developed by the spill operations team and presented to RIOG on November 2, 2017, where all RIOG members present supported the technical team's recommendation. The document is entitled "Summary of Current 2017 Fish Operations Plan

Spring Spill and Spill Operations Team Recommendation to RIOG on Proposed 2018 Spring Spill Operations" and is attached as Exhibit 2.[3]

2. "2018 Spring FOP" refers to the U.S. Army Corps of Engineers' (Corps) 2018 Fish Operations Plan, which is attached as Exhibit 3.

3. "Gas cap" refers to the applicable State Total Dissolved Gas (TDG) water quality standards (in percent TDG). The TDG standard for the states of Washington and Oregon is 110%. Both states have provided exceptions to the TDG standard for juvenile fish passage spill operations on the lower Snake and lower Columbia Rivers.[4] Each state has different calculation methodologies for the different standards, and the Corps applies the more stringent standard when operating under all applicable state TDG standards.

4. As used in the RIOG Recommendation and herein, "Gas cap spill" means spill to the maximum spill level that meets, but does not exceed, the TDG criteria allowed under state

[3] The RIOG Recommendation includes four columns for each of the eight lower Snake River and lower Columbia River projects. The first column identifies the 2017 Fish Operations Plan spring spill operations. The second column identifies the estimated spill cap range derived from the Corps' SYSTDG modeling for a TDG gas cap operation; the Corps will develop actual spill caps in 2018 following the process and procedures set forth in the 2018 Fish Operations Plan and attachment, and actual spill caps may be within, above, or below the estimated spill cap range displayed in the second column. The third column describes constraints, concerns, or comments identified by the spill operations team based on existing information during the regional collaboration processes, where "constraint" identified a biological or safety condition that may warrant spill below gas cap spill levels and "concern" and "comment" identified conditions that do not rise to the level of "constraint" but should be monitored for potential in-season adaptive management. The fourth column identifies the proposed 2018 spring fish passage spill operation.

[4] The current Washington Criteria Adjustment: TDG must not exceed an average of 115% as measured in the forebays of the next downstream dams and must not exceed an average of 120% as measured in the tailraces of each dam (these averages are measured as an average of the 12 highest consecutive hourly readings in any one day, relative to atmospheric pressure); and a maximum TDG one hour average of 125% must not be exceeded during spillage for fish passage. WASH. ADMIN. CODE §173-201A-200(l)(f)).

The current Oregon Standard Modification: Spill must be reduced when the average TDG concentration of the 12 highest hourly measurements per calendar day exceeds 120% of saturation in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations, and spill must be reduced when instantaneous TDG levels exceed 125% of saturation for any 2 hours during the 12 highest hourly measurements per calendar day in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations. OR. ADMIN. R. 340-041-0031 and 340-041-104(3).

law, and gas cap spill is a 24-hour operation at each lower Snake River and lower Columbia River project.

5. As used in the RIOG Recommendation and herein, "Spill cap" means the spill level (flow through the spillway measured in kcfs) at each project that is estimated to maximize spill to a level that meets, but does not exceed, the gas cap in the tailrace and the next downstream forebay. As set forth in Section 2 of the 2018 Spring FOP and the attachment entitled "Procedure for Setting 2018 Spring Spill Caps," the Corps manages "Gas cap spill" by establishing spill caps for each project (which constitute the "target spill" levels for each project) and operates each project to achieve the target spill levels to the extent feasible.

6. "Lower Snake River projects" refers to Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams.

7. "Lower Columbia River projects" refers to McNary, John Day, The Dalles, and Bonneville dams.

8. "FPP spill patterns" means the project-specific spillbay gate openings reflected in the 2017 Fish Passage Plan (FPP) tables, as modified by approved change request forms coordinated through the Fish Passage Operations and Maintenance (FPOM) team, to incorporate the results of the spill pattern development team modeling at the Engineer Research and Development Center (ERDC). The modified FPP spill patterns will be reflected in the 2018 FPP, and the Corps will implement the 2018 spring fish passage spill patterns consistent with the 2018 FPP.

II. INJUNCTION

1. Spill Operations: Except as provided in Paragraphs 3 and 4 below, and as set forth in the RIOG Recommendation, the Corps shall implement a gas cap spill operation at each of the lower Snake River projects (from April 3 through June 20) and lower Columbia River projects (from April 10 through June 15) by using the FPP spill patterns and the process and procedures set forth in the 2018 Spring FOP to establish spill caps and target spill levels.

2. 2018 Spring FOP: The 2018 Spring FOP sets forth the Corps' operational plans for managing juvenile fish passage spill during the 2018 spring fish passage spill season, and the Corps will implement the gas cap spill operation by following the provisions of the 2018 Spring FOP. The parties have not stipulated to the 2018 Spring FOP but agree that the 2018 Spring FOP can be implemented consistently with the terms of this Order. As set forth in Section II, Paragraph 8, however, any party may challenge an action taken by Federal Defendants in implementing the 2018 Spring FOP that it views as inconsistent with this order or not warranted by the circumstances.

3. In-Season Adjustments: The Corps may adjust the gas cap spill operation set forth in Section II, Paragraph 1 to address conditions set forth in Section 4.1 of the 2018 Spring FOP. Any adjustments to gas cap spill taken under this paragraph shall be limited to addressing the condition(s) at issue and shall not otherwise modify the provisions of Section II, Paragraph 1.

4. Adaptive Management: The Corps shall utilize the existing RIOG coordination and adaptive management processes to address any unintended biological consequences that may arise in-season as a result of implementing the gas cap spill operations. The Corps' plans for adaptive management are described in Section 4 of the 2018 Spring FOP. Federal Defendants may adjust the gas cap spill operation set forth in Section II, Paragraph 1 to address an unintended biological consequence, and they may do so without consensus among all regional forum members. Any adjustments to the gas cap spill operation taken under this paragraph shall be limited to addressing the unintended consequence at issue and shall not otherwise modify the provisions of Section II, Paragraph 1. As set forth in Section II, Paragraph 8, any party may challenge an action taken by Federal Defendants under this paragraph that it views as inconsistent with this order or not warranted by the circumstances.

5. Reporting Requirement: Federal Defendants shall file with the Court a written monthly report describing the implementation of the gas cap spill operations set forth in Section II, Paragraphs 1-4 ("FOP Implementation Reports"). Sections 4.1 and 8.0 of the 2018 Spring FOP identify the information and events that will be included in monthly FOP Implementation

Reports, and Federal Defendants shall include that information in each report. In addition, for adjustment to planned gas cap spill operations during the 2018 spring fish passage spill season occurring under conditions 4-6 in the "Planned and Routine Operational Adjustments" portion of Section 4.1 of the 2018 Spring FOP, the FOP Implementation Reports shall include the project, parameter, date, time, hours, type, and reason for the adjustment (as those terms are used in the 2017 monthly FOP Implementation Reports' Spill Variance Tables). Federal Defendants shall file monthly FOP Implementation Reports on or before: May 18, 2018 (for April spill operations); June 15, 2018 (for May spill operations), and July 20, 2018 (for June spill operations).

6. Starting and Termination Dates: For 2018 spring fish passage spill operations, and unless vacated or modified by this Court or modified or vacated by the U.S. Court of Appeals for the Ninth Circuit, this Order shall take effect on April 3, 2018, at 0001 hours, or shortly after midnight, for the Lower Snake River projects and on April 10, 2018, at 0001 hours, or shortly after midnight, for the Lower Columbia River projects, and this Order shall automatically terminate on June 20, 2018, at 2359 hours, or shortly before midnight, for the Lower Snake River projects and on June 15, 2018, at 2359 hours, or shortly before midnight, for the Lower Columbia River Projects.

7. Reservations: Federal Defendants propose this Order to comply with the Court's April 3, 2017 Amended Opinion and Order. In doing so, Federal Defendants do not waive their right to contest any aspect of the Court's April 3, 2017 Order or subsequent orders on appeal, and no party waives their rights under the Federal Rules of Civil Procedure, including Federal Rule of Civil Procedure 60(b), to seek to modify any order.[5]

[5] The other parties that have appealed the Court's April 3, 2017 Order—including the Kootenai Tribe of Idaho and the Confederated Salish and Kootenai Tribes—likewise do not waive their right to contest any aspect of the Court's April 3, 2017 Order or subsequent orders on appeal.

8. Conferral: Prior to bringing any dispute regarding this Order to the Court, the parties shall meet and confer and make reasonable efforts to resolve the dispute or show good cause why such conferral was not possible.

DATED this 8th day of January, 2018.

/s/ Michael H. Simon
Michael H. Simon
United States District Judge

EXHIBIT 1

Proposed March 2018 Juvenile Bypass System Operations
October 17, 2017

After ongoing discussions within the Fish Passage Operations and Maintenance (FPOM) group and in response to the latest Fish Passage Advisory Committee (FPAC) memo dated October 10, 2017 on the subject, the FPOM recommendation to the RIOG on operating juvenile bypass systems in March, 2018 is as follows:

- Little Goose Dam
  - Three priority units will be screened by March 1, 2018.
  - The additional three lower priority units will be screened by April 1, as specified in the Fish Passage Plan.
  - Unscreened units may be operated between March 1 and April 1 if circumstances require.
- John Day Dam
  - Four priority units will be screened by March 1, 2018.
  - The remaining units will be screened by April 1, as specified in the Fish Passage Plan.
  - Unscreened units may be operated between March 1 and April 1 if circumstances require.
- Bonneville Dam
  - All Powerhouse II units will be screened by March 1, 2018 as currently specified in the Fish Passage Plan.
- All other projects will adhere to Fish Passage Plan criteria regarding the installation of bypass screens and operation of units in 2018.

EXHIBIT 2

Summary of Current 2017 Fish Operations Plan Spring Spill and Spill Operations Team Recommendation to RIOG on Proposed 2018 Spring Spill Operations

October 31, 2017

PROJECT	2017 FISH OPERATIONS PLAN SPRING SPILL (day/night)[2]	2018 ESTIMATED 120/115% TDG SPILL CAP RANGE (SYSTDG)	CONSTRAINT/CONCERN /COMMENT	2018 PROPOSED SPRING SPILL[1, 2]
LOWER GRANITE	20 kcfs/20 kcfs	20-60 kcfs (28-51%)	Constraint: None Concern: Potential for adult delay with day spill >40–45% due to powerhouse eddy[3]. Comment: FPP patterns are adequate.	120/115% Gas Cap[4, 5]

[1] Uncertainty remains about how the system will respond to these new operations, therefore existing adaptive management processes will be employed to help address any unintended consequences that may arise in-season as a result of implementing these proposed spill operations.

[2] Spill may be temporarily reduced at any project if necessary to ensure navigation safety.

[3] Not unanimous regional consensus.

[4] 120/115% Gas Cap spill is spill up to the maximum level that meets, but does not exceed, the Total Dissolved Gas (TDG) criteria allowed under state law.

[5] If adult delay at Lower Granite is observed, existing adaptive management processes will be used to address the issue (e.g. reducing daytime spill to 40–45% for eight hours daily (0400-1200 hours)).

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PROJECT	2017 FISH OPERATIONS PLAN SPRING SPILL (day/night)[2]	2018 ESTIMATED 120/115% TDG SPILL CAP RANGE (SYSTDG)	CONSTRAINT/CONCERN /COMMENT	2018 PROPOSED SPRING SPILL[1, 2]
LITTLE GOOSE	30%/30%	8-45 kcfs (29-43%)	Constraint: Higher risk of adult delay with day spill >30% under current FPP unit priority order. Concern: Proposed operation has not been implemented and uncertainty remains concerning adult delay. Comment: Model observations show that north unit priority may alleviate concerns with hydraulic conditions that often are associated with adult delay[3]. Unit 5 will be out of service for repair in spring 2018[6].	120/115% Gas Cap[4, 7] (modified north unit priority[6])
LOWER MONUMENTAL	Gas Cap/Gas Cap (app. range 20-29 kcfs)	30-44 kcfs (uniform spill pattern) (31-50%)	Constraint: None Concern: None Comment: FPP uniform spill patterns adequate.	120/115% Gas Cap[4] (uniform spill pattern)
ICE HARBOR	**April 3-28:** 45 kcfs/Gas Cap; **April 28-June 20:** 30%/30% and 45 kcfs/Gas Cap (app. range: 75-95 kcfs)	65-105 kcfs (59-82%)	Constraint: None Concern: None Comment: FPP spill patterns adequate, although some modification to patterns at low flow may improve tailwater hydraulics/egress.	120/115% Gas Cap[4]

[6] Additional modeling of Little Goose unit priority and spill patterns will occur December 4-8, 2017 at ERDC.

[7] If adult delay at Little Goose is observed, existing adaptive management processes will be used to address the issue (e.g., reduce daytime spill to 30% for 8 hours daily (0400-1200 hours) to provide adequate adult passage).

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PROJECT	2017 FISH OPERATIONS PLAN SPRING SPILL (day/night)[2]	2018 ESTIMATED 120/115% TDG SPILL CAP RANGE (SYSTDG)	CONSTRAINT/CONCERN /COMMENT	2018 PROPOSED SPRING SPILL[1, 2]
MCNARY	40%/40%	145-190 kcfs (40-68%)	Constraint: None Concern: None Comment: FPP patterns adequate.	120/115% Gas Cap[4]
JOHN DAY	**Apr 10-28:** 30%/30% **Apr 28 to June 15:** 30%/30% and 40%/40%	95-145 kcfs (33-60%)	Constraint: None anticipated[8] Concern: None anticipated[8] Comment: Pending ERDC model observations.	120/115% Gas Cap[4]
THE DALLES	40%/40%	65-135 kcfs (37-45%)	Constraint: Gas Cap spill will be contained within spillbays 1-8 (north of spillwall). Concern: None. Comment: FPP spill patterns adequate. Gas Cap spill likely to be contained within the wall.	120/115% Gas Cap[4]

[8] Unless constraints/concerns identified during physical model observations.

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PROJECT	2017 FISH OPERATIONS PLAN SPRING SPILL (day/night)[2]	2018 ESTIMATED 120/115% TDG SPILL CAP RANGE (SYSTDG)	CONSTRAINT/CONCERN /COMMENT	2018 PROPOSED SPRING SPILL[1, 2]
BONNEVILLE	100 kcfs/100 kcfs	85-130 kcfs (40-56%)	Constraint: Corps constraint not to exceed 150 kcfs spill during Gas Cap spill operation to avoid pulling rocks into stilling basin and causing erosion. Gas Cap spill expected to be below 150 kcfs. Concern: None. Comment: FPP spill patterns adequate; patterns at 150-200 kcfs spill are under review and may be modified to improve egress.	120% Gas Cap[4, 9] (no downstream forebay)

[9] Spill to the 120% Gas Cap, not to exceed 150 kcfs.

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EXHIBIT 3

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND OR 97208-2870

2018 Spring Fish Operations Plan

1. INTRODUCTION

The 2018 Spring Fish Operations Plan (2018 Spring FOP) describes the U.S. Army Corps of Engineers' (Corps) planned operations for fish passage at its four lower Snake River and four lower Columbia River dams during the 2018 spring fish migration season, generally April 3 through June 20. The 2018 Spring FOP is responsive to the U.S. District Court for the District of Oregon's Order for 2018 spring fish passage spill operations and the Corps will implement the 2018 Spring FOP consistent with these orders, and it is otherwise consistent with 2014 NOAA Fisheries FCRPS Supplemental Biological Opinion (2014 Supplemental BiOp)[1] including the regional forum process for adaptive management and in-season management,[2,3] the Corps' Record of Consultation and Statement of Decision (ROCASOD) adopting actions recommended in the 2014 Supplemental BiOp, and the Columbia Basin Fish Accords (Accords). Other project operations and water management actions not specifically addressed in this document will be consistent with the 2014 Supplemental BiOp and other guiding operative documents, including the 2018 Water Management Plan (WMP), seasonal WMP updates, and the 2018 Fish Passage Plan (FPP).

In addition to discussing project specific fish passage spill operations, the 2018 Spring FOP identifies factors that the Corps, the U.S. Bureau of Reclamation, and the Bonneville Power

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[1] The 2014 Supplemental BiOp states: "*Specific spill levels will be provided for juvenile fish passage at each project, not to exceed established TDG levels (either 110 percent TDG standard, or as modified by State water quality waivers, currently up to 115 percent TDG in the dam forebay and up to 120 percent TDG in the project tailwater….*"

[2] The 2014 Supplemental BiOp considered the Action Agencies' 2014-2018 Implementation Plan (2014-2018 IP) and incorporates the 2008 NOAA BiOp and Reasonable and Prudent Alternative (RPA), and the 2010 Supplemental BiOp.

[3] The Corps, in coordination with the other Action Agencies, and National Marine Fisheries Service (NMFS), employs the Regional Implementation Oversight Group (RIOG) and technical teams including the Technical Management Team (TMT) and Fish Passage Operations & Maintenance (FPOM), to coordinate with state, tribal and other federal experts for recommendations for implementing operations consistent with the 2014 Supplemental BiOp.

Administration (BPA) (collectively referred to as the "Action Agencies") must address in the context of operating this complex system of fourteen multiple purpose projects. The 2018 Spring FOP includes a discussion of how the Corps manages fish passage spill and total dissolved gas (TDG), identifies Planned and Routine Operational Adjustments that influence fish passage spill, addresses adaptive management and in-season management processes for fish passage spill and other fish operations including the juvenile fish transportation program, and describes the Corps' monthly implementation reports.

2. MANAGEMENT OF SPILL FOR FISH PASSAGE AND TDG

2.1. State Water Quality Standards for TDG

The Corps will manage spill for fish passage in spring 2018 consistent with the State of Washington and the State of Oregon's TDG water quality standards (WQS).[4] [5] Both states have accommodated levels of TDG above 110% for fish passage spill operations for ESA-listed juvenile salmonids at the Corps' projects on the lower Snake and lower Columbia rivers as follows:

Washington Criteria Adjustment:

- TDG must not exceed an average of 115% as measured in the forebays of the next downstream dams and must not exceed an average of 120% as measured in the tailraces of each dam (these averages are measured as an average of the 12 highest consecutive hourly readings in any one day, relative to atmospheric pressure); and
- A maximum TDG one hour average of 125% must not be exceeded during spillage for fish passage.

Oregon Standard Modification:

- Spill must be reduced when the average TDG concentration of the 12 highest hourly measurements per calendar day exceeds 120% of saturation in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations.
- Spill must be reduced when instantaneous TDG levels exceed 125% of saturation for any 2 hours during the 12 highest hourly measurements per calendar day in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations.

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[4] WASH. ADMIN. CODE §173-201A-200(l)(f)) provides the maximum TDG criteria for each of the aquatic life use categories and displays Table 200 (I)(f) that states: "Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection." The code also addresses exceptions and adjustments, including a provision allowing for an adjustment of the TDG criteria to aid fish passage over hydroelectric dams when consistent with an approved gas abatement plan.

[5] OR. ADMIN. R. 340-041-0031 provides in part: "the concentration of TDG relative to atmospheric pressure at the point of sample collection may not exceed 110 percent of saturation." OR. ADMIN. R. 340-041-104(3) identifies findings the Environmental Quality Commission must make for the purpose of allowing increased spill for salmon migration. *See* http://pweb.crohms.org/tmt/wqnew/state_tdg_waivers/or/2015_5yr.pdf

The terminology that has been adopted to refer to these higher State TDG WQS for fish passage spill are referred to as the "gas cap." Through the RIOG process to develop recommended spill levels for spring 2018 to comply with the District Court order, the regional sovereigns described the 2018 spring "gas cap spill" as spill to the maximum level that meets, but does not exceed, the TDG criteria allowed under state law. In its implementation of "gas cap spill," the Corps will operate its fish passage projects in accordance with the State TDG standards described above, including applying the different state calculation methodologies. When the standards vary or conflict, the Corps will apply the more stringent standard.

2.2. Spill Caps

The Corps' Reservoir Control Center (RCC) is responsible for daily management of spill operations responsive to changing conditions to manage TDG within all applicable State standards. To accomplish this, the RCC sets "spill caps" for each of the Corps' lower Columbia and lower Snake River projects on a daily basis throughout the fish passage spill season. Spill caps are the maximum spill level or "target spill" at each project that is estimated to meet, but not exceed, the gas cap in the tailrace and the downstream forebay. [6] In spring 2018, the RCC will establish spill caps to implement the target spill level that is defined in section 6 for all lower Snake and lower Columbia River fish passage projects.

To calculate spill caps, the Corps evaluates observed and forecasted variables that influence TDG levels, including (1) environmental conditions (e.g., total flow, wind, ambient temperature, barometric pressure, incoming TDG from upstream, and travel time[7] from the upstream project tailrace to the next downstream project forebay); and (2) project operations (e.g. spill level, spill pattern, tailwater elevation, proportion of flow through the turbines, and project configuration). These data are used as input variables into the System TDG (SYSTDG) model in order to estimate TDG levels several days into the future. The Corps runs SYSTDG as a real-time operations tool, when appropriate, to forecast TDG levels at the Corps' projects. As warranted, the Corps will cross-check projected spill caps with SYSTDG results and consider observed data to make appropriate spill cap adjustments.

The Corps reviews spill caps on a daily basis and adjusts as necessary to maximize spill while maintaining TDG within applicable State standards. Because spill caps will be set to meet, but not exceed, the gas cap at both the tailrace and forebay fixed monitoring stations (FMS) (except at Bonneville Dam), the observed TDG may be at or near the applicable standard at one FMS, but below at the other. At several projects, for a given spill cap, TDG levels may approach the standard in the next downstream forebay prior to that project's tailrace reaching the standard (i.e., the next downstream forebay is at or near 115%, but the project tailrace is below 120%).

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[6] The terms "spill caps" and "target spill" are typically synonymous and both mean the maximum spill level at each project that is estimated to meet, but not exceed, the gas cap in the tailrace and the downstream forebay; however, in the event the spill cap is constrained (e.g. 150 kcfs maximum spill for Bonneville Dam or containing fish passage spill within the spillwall (bays 1-8) at The Dalles), the monthly FOP Implementation Reports plots will display this level of spill rather than the gas cap spill level. In these specified instances in which the target spill differs from the spill cap, the Corps will provide the spill cap information at the regularly scheduled TMT meetings and reflected in the monthly FOP Implementation Reports.

[7] Water travel time between projects varies depending on flow and can range from 1-5 days on the lower Snake River and from 1-3 days on the lower Columbia River.

Given these situations and because of the observed and forecasted variables that affect TDG production (such as the environmental conditions and project operations, defined above), spill caps, or target spill levels, will not always achieve the gas cap, and could result in TDG above or below the gas cap. Additional information about how the Corps will manage TDG is described in the "Procedure for Setting 2018 Spring Spill Caps."

The fish passage projects may spill more than the target spill level due to high river flow that exceeds powerhouse hydraulic capacity. The fish passage projects may also spill more than the target spill level due to a lack of power demand (load). The Corps will attempt to manage excess TDG on a system-wide basis under lack of power demand conditions by incrementally increasing spill at projects throughout the system in the order of priority defined in the Spill Priority List. For this purpose, the RCC also defines spill levels to target TDG in project tailraces of 122%, 125%, 127%, 130%, and 135%. The order of priority is coordinated with regional sovereigns in the TMT to allocate spill to projects to best manage system TDG while also considering how best to protect fish and other aquatic biota.

3. SPILLWAY OPERATIONS AND SPILL LEVEL PRECISION

The Corps plans to achieve the spill cap to the extent feasible; however, actual hourly spill levels at each dam may vary slightly depending on the precision of the spillbay gate settings, real-time fluctuations in flow and/or project head, or automatic load following**.** At each project, spill is distributed across the spillway according to patterns defined in the project-specific chapters of the FPP[8] to provide favorable fish passage conditions. Spillbay gates are opened to the settings identified in the FPP spill pattern table that correspond to the spill level that is closest to, but may be slightly higher or lower than, the target spill level. Due to these limitations in spill level precision, the observed hourly average spill level may range up to ±2 kcfs from the target spill level (or ±3 kcfs at The Dalles and Bonneville dams, as described in the project-specific sections below).[9]

4. MODIFICATIONS TO PLANNED OPERATIONS AND IN-SEASON MANAGEMENT

For planning purposes, the operations described in the 2018 Spring FOP assume average runoff conditions. Actual runoff varies in magnitude and timing, and observed river flow may be higher or lower than average at any time such that modifications to the planned operations may be required. To accommodate these varying runoff conditions and other routinely observed conditions as they arise, the Corps, in conjunction with the other Action Agencies and NOAA Fisheries, coordinates with regional sovereigns on these conditions and other planned operations through the review of the FOP prior to spring spill operations (see section 4.1). The Corps responds in real-time to these routine conditions and planned operations by implementing adjustments as conditions require without additional coordination.

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[8] The FPP is coordinated annually with regional sovereigns through the FPOM.

[9] In the event a project operation is adjusted through adaptive management such that target spill is a percentage of total outflow, the hourly spill level is calculated to be within ±1% of the target percentage for the following hour (or more than ±1% as specified in FPP Chapters 3 and 8 spill pattern tables, respectively).

For unanticipated and unplanned conditions that are not pre-coordinated, the Corps will respond as necessary to redress the condition, and when possible, will use the existing regional coordination process[10] to adaptively manage and make necessary in-season adjustments in spill and other fish operations (e.g., spill levels, spill caps, spill patterns, juvenile fish transportation, and minimum operating pool or "MOP" operations).

4.1. Conditions that May Require Adjustments to Planned Operations

Under certain conditions or circumstances, the Corps may be required to adjust spill higher or lower than the target spill level at one or more projects.

Planned and Routine Operational Adjustments:[11]

1. High flow conditions that exceed powerhouse hydraulic capacity and require spilling more than the target spill level.
2. Low flow conditions that require adjustments in spill level while maintaining project minimum generation requirements (see section 4.3.1. below).
3. Lack of power demand (load) resulting in increased spill.
4. Scheduled turbine unit and/or transmission outages that reduce powerhouse hydraulic capacity and require spilling more than the target spill level.*
5. Standard operations for transmission reliability (see section 4.4.1. below)*
6. Navigation safety concerns (see section 4.6. below).*

Non-routine or Unplanned Operational Adjustments:[12]

1. Contingency operations for transmission reliability (see section 4.4.2 below).
2. Fish emergencies (e.g., high river temperatures that exceed levels safe for fish).

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[10] In-season adaptive management changes in spill levels could include adjustments that address unintended biological consequences caused by gas cap spill (e.g., adult passage delays), for the juvenile fish transportation program, for research activities for studies to evaluate fish passage facilities, survival, or other fish-related issues. Spill patterns and biological testing protocols that have not been coordinated to-date will be considered through the regional coordination process using the Corps' Anadromous Fish Evaluation Program (AFEP) subcommittees, which include the TMT, the Studies Review Workgroup (SRWG), Fish Facility Design Review Work Group (FFDRWG), and FPOM.

[11] Planned and Routine Operational Adjustments are spill adjustments due to (1) conditions that occur routinely every year (e.g., high or low flow), or (2) planned operations (e.g., scheduled maintenance, transit of fish transport barge in the tailrace). These are considered pre-coordinated through regional sovereign review of the FOP and the FPP, and are implemented by the Action Agencies as conditions require and without additional coordination through the regional forum processes. Spill adjustments due to routine or planned operations are included in the monthly FOP Implementation Report in the hourly spill and flow charts (plots), and conditions with an (*) are reported in the "Pre-Coordinated Operations" Table. The FPP (Appendix A) identifies actions with pre-coordinated dates.

[12] Spill adjustments that occur due to non-routine or unplanned conditions or operations are implemented by the Action Agencies as conditions require and/or as coordinated with regional sovereigns through the in-season adaptive management process. Non-routine or Unplanned Operational Adjustments that affect spill levels are reported in the FOP Implementation Report Variance Table (and when warranted, a description may also be included in the Operational Adjustments section). When a Non-routine or Unplanned Operational Adjustment does not affect spill levels, information about this is provided in the Operational Adjustments section. If an adjustment continues into the next month, the adjustment is reported in the Pre-Coordinated Operations Table.

3. Conditions related to project safety (e.g., erosion), health and human safety, navigation, or other unforeseen events that require spilling more or less than the target spill level.
4. Other circumstances including human or programming error, unscheduled maintenance or outage, operational limitations (e.g., physical limitations of gate settings and spill patterns outside of the level of precision defined in section 3 above, forebay elevations), and other unanticipated events or emergencies.
5. In-season adjustments following adaptive management coordination through the existing regional coordination process (see section 4 & footnote 9).

4.2. TMT Emergency Protocols

The Corps, and the other Action Agencies, will operate the fourteen Columbia River System (or FCRPS) projects in emergency situations in accordance with the 2018 WMP Emergency Protocol (WMP Appendix 1). This protocol identifies the process the Action Agencies, in coordination with NOAA Fisheries, will use in the event of an emergency concerning project operations that impact planned fish protection measures. The emergency protocols also address the process for coordination with regional sovereigns. The most recent version of the Emergency Protocols is located at:
http://pweb.crohms.org/tmt/documents/wmp/2018/Final/emerproto/

4.3. Low Flow Operations

4.3.1. Minimum Generation

All lower Snake and lower Columbia River dams have a minimum generation requirement that has been established to support power system reliability (see section 4.4.). The Corps has identified minimum generation powerhouse outflow values derived from actual generation records (see Table 1). Values stated in Table 1 are approximations that account for varying head or other small adjustments in turbine unit operation that may result in variations from the reported minimum generation flow and spill amount. Conditions that may result in minor variations include:

1. Varying pool elevation: as reservoirs fluctuate within the operating range, flow rates through the generating unit change.
2. Generating unit governor “dead band”: the governor controls the number of megawatts the unit should generate, but cannot precisely control a unit flow; variations may be 1-2% of unit flow. These variations can affect minimum generation ranges included in Table 1.
3. System disturbances: once a generator is online and connected to the grid, it responds to changes in system voltage and frequency. These changes may cause the unit to increase or decrease flow and generation slightly within an hour. Individual units operate differently from each other and often have unit specific constraints.
4. Generation control systems regulate megawatt (MW) generation only; not flow through individual turbine units.

All of the lower Snake River powerhouses may be required to keep one generating unit on line at all times for power system reliability under low river flow conditions, which may result in a reduction of spill at that project if there is insufficient flow in the river. Generally, units 1–3 are the first priority units for operation during the fish passage season for adult fish attraction flow to

the fish ladders, but unit priority is also based on availability. During low river flow conditions, the Corps will operate the lower Snake River projects to the unit priority specified in the FPP and minimum generation ranges identified in Table 1.

Table 1. Minimum generation flow ranges for turbine units at Corps hydropower projects on the lower Snake and lower Columbia rivers.[13]

Project	Turbine Unit	Minimum Generation Flow Range [a] (kcfs)
Lower Granite	1, 3	11.8 – 12.9
	2[b]	17 – 19
	4, 5, 6	13.7 – 14.8
Little Goose	1, 2, 3	11.3 – 11.8
	4, 6	13.8 – 14.4
	5[c]	16.2 – 17.3
Lower Monumental	1, 2b	10.8 – 12.3
	3[b]	18.3 - 19.2
	4, 5, 6	14.1 – 14.9
Ice Harbor	1	8.4 – 9.8
	2[d]	TBD
	3[b]	11.4 – 12.5
	4, 6	9.4 – 10.6
	5[b]	13.1 – 14.1
McNary	N/A	50 – 60
John Day	N/A	50 – 60
The Dalles	N/A	50 – 60
Bonneville	N/A	30 – 40

a. "Minimum Generation" is the minimum number of megawatts (MW) that must be generated at each project in order to support power system reliability. This table defines the resulting flow range (kcfs) through turbines, which is a function of power output (MW), turbine efficiency, and project head.
b. Lower Granite Unit 2, Lower Monumental Units 2 and 3, and Ice Harbor Units 3 and 5 are restricted due to runner blades that are fixed at a set angle (non-adjustable).
c. Little Goose Unit 5 is restricted to the upper 1% range due to vibration issues at operating points <120 MW. Unit 5 is scheduled to be out of service for spring 2018 spill season.
d. Ice Harbor Unit 2 is being rebuilt with a runner design that reduces impacts to fish, scheduled for completion in spring 2018. At that time, testing will be performed to determine the operating range.

There may be situations when river flows are insufficient to maintain minimum generation in Table 1 and the target spill level identified in Table 2 in every hour. Under these conditions, the lower Snake River projects will operate one turbine unit at minimum generation and spill the remainder of outflow. The lower Columbia River projects will also operate at minimum generation and pass the remaining outflow as spill down to minimum spill levels. Additionally,

[13] The table is accurate as of December, 2017, but may change in-season, as coordinated through FPOM (see the FPP).

inflow provided by non-Federal projects upstream is often variable and uncertain, and in combination with low flow conditions, may result in instances where forebay elevations go outside of the normal MOP ranges for Snake River projects as provided for in the 2014 Supplemental BiOp.

4.3.1.1. Navigation Lock Operation During Low Flows

In the event that a project operation has been adjusted to a target spill level that is a percentage of total outflow through adaptive management during the 2018 spring migration season, emptying the navigation lock during low flow conditions may temporarily result in a reduced percentage of outflow that is reported as spill. During this time, the spill rate remains constant, but the spill reported as a percent of total outflow may be temporarily reduced below the target percentage. This occurs because the volume of water needed to empty the navigation lock during periods of low flow is a greater percentage of the total project outflow than during periods of higher flow.

4.4. Operations for Transmission System Reliability

In managing the fish passage spill operations, the Corps and BPA plan to allocate generation and spill at the eight Corps projects on the lower Columbia and Snake rivers in accordance with the 2018 Spring FOP. Periodically, to ensure the reliability of the transmission system when system conditions warrant, it is necessary to increase or decrease the amount of water flowing through a project's turbines and spillbays at one or more of these projects.

Consistent with past practice, if any of the transmission system conditions listed below are present and can be alleviated by temporarily modifying generation levels at one or more federal projects, the Action Agencies will adjust generation and spill levels to avoid the transmission system impact. These events could result in actual spill being temporarily higher or lower than the target fish passage spill level. Such events may occur coincident with the transmission system event or in subsequent hour(s) should the event impact water balance at a specific hydro project or river reach. The Corps and BPA will work to restore conditions to support target spill operations as soon as practicable. These actions are taken to minimize the risk and/or scope of a transmission system emergency and will be reported in the monthly FOP Implementation Report (see section 8 below).

4.4.1. Standard Operations for Transmission Reliability

Consistent with past practice, the Action Agencies manage the fourteen Columbia River System projects to be prepared to provide electric reliability support as follows:

1. Ensuring sufficient range of generation capability is available to provide the BPA balancing authority[14] area with contingency reserves required by North American

[14] A balancing authority is the responsible entity that maintains load-interchange-generation balance within a Balancing Authority Area, and supports interconnection frequency in real time. Balancing authority area is the collection of generation, transmission, and loads within the metered boundaries of the designated balancing authority. The balancing authority maintains load-resource balance within this area.

Electric Reliability Corporation (NERC) and Western Electricity Coordination Council (WECC) reliability standards.[15]

2. Ensuring generation is available to increase or decrease in order to balance load and generation within the BPA balancing authority area to support reliability.
3. Ensuring enough generating units are online and have sufficient capability to increase or decrease generation to meet the BPA balancing authority area frequency response obligations, consistent with reliability standard requirements.
4. Ensuring that there is generation operating at projects in specific locations sufficient for arming for Remedial Action Schemes (RAS).[16] RAS schemes allow the transmission system to automatically respond to unplanned events on the power system by immediately dropping or reducing generation at those specified locations.
5. Maintaining minimum generation levels (see Table 1) at generators in specific locations to maintain correct voltage levels on the power system to ensure reliability.
6. Maintaining enough generation units online in diverse locations on the electrical grid to ensure system stability through rotating inertia.

4.4.2. Contingency Operations for Transmission Reliability

If the routine reliability tools described above are insufficient to resolve the transmission condition, the Action Agencies will implement the preemptive actions detailed in the Power System Emergency Action Plan (Attachment 1 to the TMT Emergency Protocols referenced in section 4.2 above) if time permits. Where necessary, the fourteen Columbia River System projects will be called upon to relieve the following conditions:

1. Increasing or decreasing generation at projects (redispatch) in specific geographic locations to relieve heavily loaded transmission lines if required by system conditions. This includes adjusting generation that flows over specific transmission facilities in order to keep flows over those paths within the requirements of NERC and WECC reliability standards.
2. Increasing or decreasing generation to ensure transmission system stability and/or reliable load service in local areas under specific system conditions. (For example, increasing generation at Ice Harbor Dam to support transmission stability, including providing load service to the Tri-Cities area of Washington, when system conditions require.)
3. Responding to unanticipated significant events, including NERC Energy Emergency Alerts or other system emergencies, consistent with the Power System Emergency Action Plan included as Attachment 1 to the TMT Emergency Protocols.
4. Other unanticipated significant events (e.g. powerhouse fires, earthquakes, etc.)

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[15] The Federal Energy Regulatory Commission has certified the NERC as the Electric Reliability Organization responsible for establishing and enforcing national reliability standards. NERC has delegated some of its authority to the WECC as the regional entity responsible for monitoring reliability standards compliance and enforcement in the Western Interconnection.

[16] Remedial Action Schemes are sets of automatic control circuits that switch various types of power system components on or off in response to disturbances on the interconnected transmission system.

These actions will be implemented consistent with the TMT Emergency Protocols (see section 4.2 above).

4.5. Turbine Unit Testing for Maintenance

Turbine units may be operationally tested prior to maintenance and prior to return to service for up to 60 minutes by running the unit at speed no load, various loads within the 1% of peak efficiency range, and, if necessary, up to full load, to allow for measurements and testing. Testing of a unit under maintenance is in addition to a unit operating at minimum generation required for power system reliability. Testing may deviate from unit operating priorities specified in FPP Chapters 2-9 and may use water that would otherwise be used for spill if the running unit for reliability is at the bottom of the ±1% of best efficiency range. Water will be used from the powerhouse outflow allocation if possible, and water diverted from spill for operational testing will be minimized. The Corps coordinates this testing with the region through the FPOM, which is included in Chapters 2-9 of the FPP. Unit outages for required maintenance are described in FPP Appendix A. Maintenance dates are subject to change.

4.6. Navigation Safety

Short-term adjustments in spill or MOP may be required at any of the fish passage projects to address navigation safety concerns.[17] This may include changes in spill patterns, reductions in spill, short-term spill curtailment, or operating above MOP. For instance, some flow conditions may require a 2 ft. operating range at Ice Harbor to accommodate barge traffic in order to provide conditions for navigation safety at the Ice Harbor forebay navigation lock exit. These adjustments may be necessary for both commercial traffic and fish barges.

Additionally, during low flow conditions, adjustments in spill and MOP operations have been necessary at several fish passage projects. For example, unsteady or low flow at Little Goose and Ice Harbor dams (approximately 50 kcfs or less) may impact reservoir elevations and cause inadequate navigation depths at the downstream entrances to the Lower Granite and Lower Monumental navigation locks, respectively. As addressed in the 2014-2018 IP, adjustments to pool elevations at Little Goose and Ice Harbor of up to 1.0 ft. above the MOP range may be necessary to accommodate safe entrance to the upstream navigation locks at Lower Granite and Lower Monumental dams.

High spill levels may create unsafe hydraulic conditions for commercial, non-commercial, and fish transportation barges entering and exiting the tailrace and/or while moored at the fish loading facility. Under these conditions, spill may be reduced temporarily as necessary to maintain safe navigation conditions for commercial, non-commercial, or fish transportation barges, which may result in temporarily filling the pool above the MOP range, depending on river flow.

[17] The Corps conducts annual surveys to assess sedimentation in the reservoirs and under certain conditions. To ensure safe navigation, there may be a need to operate the pools above the MOP range.

5. JUVENILE FISH TRANSPORTATION PROGRAM

The 2014 Supplemental BiOp calls for an annual review of the previous year's fish survival information, recent transport rates, and available smolt to adult return rates (SARs) (for both inriver and transport smolts) for discussion with the RIOG to inform transport/spill operations for the subsequent year. The best available information will be considered in the Corps' implementation of the juvenile fish transportation program operations at the Snake River collector projects in 2018. Should regional sovereigns recommend adjustments in transportation start dates that differ from those stated herein, the Corps will use the existing regional adaptive management process to make a determination on recommended operational changes.

The following describes the proposed transportation operations for the lower Snake River projects. Detailed descriptions of project and transport facility operations to implement the juvenile fish transportation program are contained in the FPP Appendix B.

5.1. Lower Snake River Dams – Transport Operation and Timing

Transportation will be initiated at Lower Granite, Little Goose, and Lower Monumental dams no later than May 1, or as coordinated with the TMT and RIOG.

The collection of fish at lower Snake River projects for transportation will commence no later than May 1. Barging of fish will begin the following day and collected juvenile fish will be transported from each facility on a daily or every-other-day basis (depending on the number of fish) throughout the migration season. Transportation operations will be carried out at each project in accordance with all relevant FPP operating criteria.

Transportation and spill operations may be adjusted due to research, conditions at fish collection facilities (e.g. overcrowding or temperature extremes), or through the adaptive management process with FPOM and/or the TMT (e.g., to respond to expected environmental conditions, to respond to recent transport vs in-river research results, to better match juvenile outmigration , or to achieve/maintain performance standards).

5.2. Transport Research - Seasonal Effects of Transport

An ongoing annual study will be conducted again in 2018 to determine seasonal effects of transporting fish from the Snake River to optimize a transportation strategy. At Lower Granite, fish will be collected for this study starting on April 2, with marking beginning on April 3.

Depending on the number of fish available, fish will be collected 1-2 days each week with tagging occurring on the day following collection. A barge will leave each Thursday morning with all fish collected during the previous 1-3 days. By barging all fish (minus the in-river group) during 1 to 3 days of collection, barge densities will be maintained at a level similar to what would occur under normal transport operations that time of year. This pattern will occur in the weeks preceding general transportation and will be incorporated into general transportation once that operation begins. The desired transported sample size is 6,000 wild Chinook, 4,000-6,000 wild steelhead, and 4,000-6,000 hatchery steelhead weekly for approximately eight weeks.

6. 2018 SPRING FISH PASSAGE SPILL OPERATIONS

Spring spill operations will occur April 3–June 20 at the four lower Snake River projects, and April 10–June 15 at the four lower Columbia River projects. The Corps will initiate spill at 0001 hours, or shortly after midnight, at each of the projects on the start date. Target spill levels for spring 2018 at each project are defined in Table 2.

Table 2. Summary of 2018 spring spill levels at lower Snake and Columbia River projects.

PROJECT	2018 SPRING SPILL[1, 2, 3]
Lower Granite	120/115% Gas Cap[4]
Little Goose	120/115% Gas Cap[5] (modified north unit priority)[6]
Lower Monumental	120/115% Gas Cap (uniform spill pattern)
Ice Harbor	120/115% Gas Cap
McNary	120/115% Gas Cap
John Day	120/115% Gas Cap[7]
The Dalles	120/115% Gas Cap[8]
Bonneville	120% Gas Cap[9] (no downstream forebay)

1. Uncertainty remains about how the system will respond to these new operations, therefore existing adaptive management processes will be employed to help address any unintended consequences that may arise in-season as a result of implementing these proposed spill operations.
2. Spill may be temporarily reduced at any project if necessary to ensure navigation safety or transmission reliability.
3. 120/115% Gas Cap spill is spill to the maximum level that meets, but does not exceed, the TDG criteria allowed under state law.
4. If adult delay at Lower Granite is observed, existing adaptive management processes will be used to address the issue (e.g. reducing daytime spill to 40–45% for eight hours daily (0400-1200 hours)).
5. If adult delay at Little Goose is observed, existing adaptive management processes will be used to address the issue (e.g., reduce daytime spill to 30% for 8 hours daily (0400-1200 hours) to provide adequate adult passage).
6. Additional modeling of Little Goose unit priority and spill patterns will occur December 4-8, 2017 at ERDC.
7. Unless constraints/concerns identified during physical model observations.
8. Gas cap fish passage spill restricted to spillbays 1-8.
9. Spill to the 120% Gas Cap, not to exceed 150 kcfs.

7. PROJECT-SPECIFIC OPERATIONS

The following sections describe 2018 spill operations for each project. The Corps will implement established spill patterns for all projects as described in the FPP.

7.1. Lower Granite Dam

7.1.1. Spring Spill April 3–June 20: Gas Cap (see section 2.1), 24 hours/day.

7.1.2. Operational Considerations: None known for spring 2018.

7.2. Little Goose Dam

7.2.1. Spring Spill April 3–June 20: Gas Cap (see section 2.1), 24 hours/day.

7.2.2. Operational Considerations: None known for spring 2018

7.3. Lower Monumental Dam

7.3.1. Spring Spill April 3–June 20: Gas Cap (see section 2.1), 24 hours/day using the uniform spill pattern.

7.3.2. Operational Considerations:

- Transit of the juvenile fish barge across the Lower Monumental tailrace, docking, and departure from the collection facility, may require a reduction in spill below the target spill level for safety concerns. The towboat captain may request spill be reduced or eliminated during transit. During juvenile fish loading operations, spill is typically reduced to 15 kcfs, but can be reduced further if necessary for safety reasons. Barge loading duration can be up to 3.5 hours. Reducing spill may cause the Lower Monumental pool to briefly operate outside of MOP elevations.[18]

7.4. Ice Harbor Dam

7.4.1. Spring Spill April 3–June 20: Gas Cap (see section 2.1), 24 hours/day.

7.4.2. Operational Considerations: None known for spring 2018.

7.5. McNary Dam

7.5.1. Spring Spill April 10–June 15: Gas Cap (see section 2.1), 24 hours/day. A spillway weir will be operated in both spillbay 19 and spillbay 20 for the period April 10 through June 7. As in past years, both spillway weirs will be removed from service on June 8 (or next business day as coordinated through the FPOM) for the benefit of subyearling Chinook. This operational change will be coordinated through the FPOM. Temporary spill pattern changes to allow removal of the spillway weirs will occur, however spill will continue at gas cap during the spillway weir removal process using the spill pattern identified in FPP Table MCN-10. Following removal of the spillway weirs, the spill

[18] With spill levels in 2018 targeting TDG spill caps, reducing spill for long durations could pose problems staying within MOP at Ice Harbor Dam -- the downstream project.

pattern contained in Table MCN-9 in FPP Chapter 5 will be used for the remainder of the spring.

7.5.2. Operational Considerations: None known for spring 2018.

7.6. John Day Dam

7.6.1. Spring Spill April 10–June 15: Gas Cap (see section 2.1), 24 hours/day.

7.6.2. Operational Considerations: None known for spring 2018.

7.7. The Dalles

7.7.1. Spring Spill April 10–June 15: Gas Cap (see section 2.1), 24 hours/day.

7.7.2. Operational Considerations:

- Actual hourly average spill levels at The Dalles may range up to ±3 kcfs according to the spill pattern tables in FPP Chapter 3.
- Gas cap spill will be contained within spillbays 1-8.
- Spill bays 9, 10, 11, 13, 16, 18, 19, and 23 are operationally restricted due to wire rope, structural and concrete erosion concerns.
- The sluiceway is operated for fish passage Mar 1-Nov 30 pursuant to FPP Chapter 3.

7.8. Bonneville Dam

7.8.1. Spring Spill April 10–June 15: Gas Cap (see section 2.1), 24 hours/day.

7.8.2. Operational Considerations:

- Maximum fish passage spill level is 150 kcfs. This constraint is based on physical model observations indicating an increased incidence of rock deposition into the spillway stilling basin at spill ≥ 150 kcfs, which has caused erosion to the structure in the past.
- Minimum spill level is 50 kcfs;[19] however, as observed in past years, to provide acceptable juvenile fish egress conditions in the tailrace under extreme low flow conditions, lower spill levels may be considered and coordinated through the TMT and/or FPOM.
- In April, the TMT will consider the possible effects of TDG on emerging chum salmon downstream of Bonneville Dam. The TMT may request special operations such as flow increases or spill reductions to protect ESA-listed fish.
- Actual hourly average spill levels at Bonneville Dam may range up to ±3 kcfs according to spill pattern tables in FPP Chapter 2.

[19] Flows at this level are unlikely to occur in during the spring.

- The second powerhouse Corner Collector (5 kcfs flow) will begin operation no later than the morning of April 10 and continue through the remainder of the spill season as coordinated through the FPOM.

8. FOP IMPLEMENTATION REPORTING

The Corps posts monthly FOP Implementation Reports on the following website: http://pweb.crohms.org/tmt/documents/FOP_Implementation_Reports/. The updates will include monthly project plots containing the following information:

- total flow: the total hourly river flow rate;
- generation flow: the hourly flow through the powerhouse units;
- target spill: the spill target for that hour, i.e. the spill cap (see footnote 5);
- adjusted spill: the hourly spill level that can be achieved taking into consideration that spill may vary as a function of total river flow, forebay elevation and generator capacity, and is subject to routine operational adjustments that limit the ability to spill to the target spill (see section 4.1 above);
- actual spill: the hourly flow over the spillway; and,
- the resultant 12-hour average TDG for the tailwater at each project and for the next project's forebay downstream.

The reports will also provide information on substantial issues that arise as a result of the spill program (e.g. Little Goose adult passage issues), and will address any emergency situations, including spill adjustments for contingency operations for transmission reliability.

The Corps will continue to provide the following data to the public regarding project flow, spill rate, TDG level, and water temperature.

- Hourly flow, generation, and spill quantity data for the lower Snake and Columbia River dams are posted to the following website:
  - http://www.nwd-wc.usace.army.mil/report/projdata.htm (web reports with the most recent 8 days of hourly project data and the current month of daily project data)
  - http://pweb.crohms.org/tmt/wq/historical/ (links to historic hourly project data files in csv-format organized by month back to 2004 including temperature and TDG information).
- Water Quality: Water quality data are received via satellite from FMS in the Columbia and Snake rivers every hour, and placed on a Corps public website upon receipt. Hourly TDG and water temperature data are posted to the following websites:
  - http://pweb.crohms.org/report/total.html (web reports with hourly TDG, project outflow and spill for the previous 3 days)
  - http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/ (links to historic hourly water quality data files for each FMS including barometric and total gas pressure, TDG and project outflow and spill in csv-format organized by month back to 2005)
  - Using the hourly TDG readings for each station in the lower Snake and Columbia rivers, the Corps will calculate both the highest 12-hour average TDG levels

(Oregon method) and the highest consecutive 12-hour average TDG levels (Washington method) on a daily basis. These averages are reported at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/

- Spill cap information will be posted to the following site each day: http://pweb.crohms.org/tmt/documents/ops/spill/caps/.

In addition to the monthly FOP Implementation Reports, as represented to RIOG throughout the development of the 2018 spring spill plan, during the 2018 spring fish passage spill season, the Corps will continue to provide status updates at the regularly scheduled TMT meetings about the 2018 spring fish passage spill operations, including reasonably detailed information that is relevant to the Corps' process for implementing spring fish passage spill. At these meetings, the Corps will respond to questions regarding the Corps' process for setting spill caps and the assumptions made in that process.

ATTACHMENT

Procedure for Setting 2018 Spring Spill Caps

U.S. Army Corps of Engineers, Northwestern Division
Columbia Basin Water Management - Reservoir Control Center

In its April 3, 2017, Amended Opinion and Order, the U.S. District Court for the District of Oregon ordered increased spill (spill to the maximum spill level that meets, but does not exceed, the Total Dissolved Gas (TDG) criteria allowed under state law,[1] referred to as "gas cap" hereafter) to begin in the spring 2018 migration season at the U.S. Army Corps of Engineers' (Corps) four lower Snake River and four lower Columbia River fish passage projects. Consistent with the Court's order, the Corps, the other Action Agencies, and NOAA Fisheries, in coordination with regional sovereigns, developed fish passage spill operations for the 2018 spring migration season at the eight fish passage projects.

Although the Corps has implemented fish passage spill to meet performance standards in the 2008 NOAA Fisheries Biological Opinion, as supplemented in 2010 and 2014, including up to gas cap levels at certain fish passage projects, the Corps has never operated to the gas cap spill level at all fish passage projects throughout the spring migration season. In order to successfully implement gas cap spill for the spring 2018 migration season, the Corps will apply the following procedures.

1. TDG Water Quality Standards (WQS).
   a. Each day from April 3 to June 20 (lower Snake River projects) and from April 10 to June 15 (lower Columbia River projects), project spill caps[2] will be reviewed and adjusted so as not to exceed the applicable State TDG water quality standards (WQS). Daily 12-hour TDG concentrations will be calculated using hourly TDG data from fixed monitoring stations (FMS) placed in the tailrace and next downstream forebay of each project, in accordance with the applicable state's methodology, which includes rounding TDG levels to the nearest whole number.
   b. At the four lower Snake River projects, only the State of Washington TDG WQS of 120/115% TDG apply.
   c. The lower Columbia River borders the states of Washington and Oregon, therefore both states' TDG WQS apply to McNary, John Day, The Dalles, and Bonneville projects. The

[1] Washington Criteria Adjustment: TDG must not exceed an average of 115% as measured in the forebays of the next downstream dams and must not exceed an average of 120% as measured in the tailraces of each dam (these averages are measured as an average of the 12 highest consecutive hourly readings in any one day, relative to atmospheric pressure); and a maximum TDG one hour average of 125% must not be exceeded during spillage for fish passage. WASH. ADMIN. CODE §173-201A-200(l)(f)).
Oregon Standard Modification: Spill must be reduced when the average TDG concentration of the 12 highest hourly measurements per calendar day exceeds 120% of saturation in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations, and spill must be reduced when instantaneous TDG levels exceed 125% of saturation for any 2 hours during the 12 highest hourly measurements per calendar day in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations. OR. ADMIN. R. 340-041-0031 and 340-041-104(3).

[2] Spill cap is the maximum spill level (flow through the spillway measured in kcfs) at each project that is estimated to meet, but not exceed, the gas cap in the tailrace and the downstream forebay. The Corps manages "gas cap spill" by establishing spill caps for each project (which constitute the "target spill" levels for each project) and operates each project to achieve the target spill levels to the extent feasible.

Corps will operate to the more restrictive state TDG WQS at these projects in order to maintain TDG within all applicable state standards.

2. Spill Caps.
   a. Spill caps will be set starting at Lower Granite Dam (the most upstream fish passage project) and adjusted in downstream order to Bonneville Dam in response to resulting TDG levels.
   b. pill caps at a project will be set at the maximum level to meet, but not exceed, TDG criteria allowed under state law in the tailrace and the downstream forebay; therefore the Corps will set each project's spill cap using whichever FMS is most likely to exceed the gas cap at each project on a given day. At many projects, the downstream forebay often limits spill caps, rather than the tailrace (i.e., the next downstream forebay is at or near 115%, but the project tailrace is below 120%).
   c. Spill cap estimates are influenced by several factors that cannot be precisely predicted, including (1) environmental conditions, such as total flow, wind, ambient temperature, barometric pressure, incoming TDG from upstream projects, and travel time from the upstream project tailrace to the next downstream project forebay[3]; and (2) project operations, such as spill level, spill pattern, tailwater elevation, proportion of flow through the turbines, and project configuration. As a result, in many instances, spill caps will not always meet gas cap (i.e., actual TDG levels may be above or below the gas cap).
   d. Specifically, maintaining gas cap spill at all eight projects will be challenging as water travel time to the next downstream project must be factored into making spill cap adjustments. Observed TDG responses to spill cap adjustments at a project will be evident within 24 hours in the tailrace, however it can take up to 5 days, depending on water travel time, to reach the next downstream forebay.

3. Daily Process used to Set Spill Caps.
   a. Daily data review. Each day Corps staff will review observed spill levels and resulting TDG data, flow and weather forecast information, tailwater elevation, unit outage information, and other water quality data. In addition, staff will assess the need for a spill cap adjustment.
   b. Run SYSTDG Model.[4] The SYSTDG model will be used when appropriate as a real-time operations tool to forecast the TDG production levels for all the projects. As warranted, Corps staff will cross-check projected spill caps with SYSTDG model simulation results to make appropriate spill cap adjustments. It may be necessary to run several simulations until the appropriate spill caps for all projects are determined, since a change at one project affects projects downstream.
   c. Determine spill cap. Corps staff will use the data review and SYSTDG modeling steps described above to determine the appropriate spill caps based on their best professional judgment. Initially, the Corps anticipates making relatively small adjustments in spill

[3] Water travel time between projects varies depending on flow and can range from 1-5 days on the lower Snake River and from 1-3 days on the lower Columbia River during gas cap spill operations.
[4] Comprehensive spill review, which includes SYSTDG modeling when appropriate, will occur during regular work week hours. The Corps will continue the current spill review process for holidays and weekends, i.e., a condensed spill review process will be implemented considering observed data and applied engineering judgment. SYSTDG model runs are not likely to occur for the condensed review.

caps to allow TDG levels to equilibrate because large and frequent adjustments at multiple projects could lead to overcompensation in setting spill caps and result in fluctuations of high or low TDG levels.

d. Notification. Spill cap adjustments will be provided to each project and BPA duty schedulers daily or as changes are made. Corps staff will typically complete the daily spill cap process by 1400 hours.
e. Coordination with regional sovereigns. Spill caps will be posted to the Corps website each day. Updates on spill operations will be provided at Technical Management Team (TMT) meetings.

4. Other Considerations. In addition to the factors described above that may influence spill levels, there are other considerations described in the 2018 Fish Operations Plan that may result in adjustments to spill levels that are different than gas cap spill. See Section 4.1 for a list of these considerations.

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2018 Summer Fish Operations Plan

1. INTRODUCTION

The 2018 Summer Fish Operations Plan (2018 Summer FOP) describes the U.S. Army Corps of Engineers' (Corps) planned operations for fish passage at its four lower Snake River and four lower Columbia River dams during the 2018 summer fish migration season, generally June 16 through August 31. The 2018 Summer FOP is consistent with the 2014 NOAA Fisheries FCRPS Supplemental Biological Opinion (2014 Supplemental BiOp)[1] including the regional forum process for adaptive management and in-season management,[2,3] the Corps' Record of Consultation and Statement of Decision (ROCASOD) adopting actions recommended in the 2014 Supplemental BiOp, and the Columbia Basin Fish Accords (Accords). Other project operations and water management actions not specifically addressed in this document will be consistent with the 2014 Supplemental BiOp and other guiding operative documents, including the 2018 Water Management Plan (WMP), seasonal WMP updates, and the 2018 Fish Passage Plan (FPP).

In addition to discussing project-specific fish passage spill operations (Table 2), the 2018 Summer FOP identifies factors that the Corps, the U.S. Bureau of Reclamation, and the Bonneville Power Administration (BPA) (collectively referred to as the "Action Agencies") must address in the context of operating this complex system of fourteen multiple purpose projects. The 2018 Summer FOP includes a discussion of how the Corps manages fish passage spill and total dissolved gas (TDG), identifies Planned and Routine Operational Adjustments that influence fish passage spill, addresses adaptive management and in-season management processes for fish passage spill and other fish operations including the juvenile fish transportation program, and describes the Corps' monthly implementation reports.

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[1] The 2014 Supplemental BiOp states: "*Specific spill levels will be provided for juvenile fish passage at each project, not to exceed established TDG levels (either 110 percent TDG standard, or as modified by State water quality waivers, currently up to 115 percent TDG in the dam forebay and up to 120 percent TDG in the project tailwater….*"

[2] The 2014 Supplemental BiOp considered the Action Agencies' 2014-2018 Implementation Plan (2014-2018 IP) and incorporates the 2008 NOAA BiOp and Reasonable and Prudent Alternative (RPA), and the 2010 Supplemental BiOp.

[3] The Corps, in coordination with the other Action Agencies and NOAA Fisheries, utilizes the Regional Implementation Oversight Group (RIOG) and technical teams including the Technical Management Team (TMT) and Fish Passage Operations & Maintenance (FPOM), to coordinate with state, tribal and other federal experts for recommendations for implementing operations consistent with the 2014 Supplemental BiOp.

2. MANAGEMENT OF SPILL FOR FISH PASSAGE AND TDG

2.1. State Water Quality Standards for TDG

The Corps will manage spill for fish passage in summer 2018 according to the project spill levels identified in Table 2 and consistent with the State of Washington and the State of Oregon's TDG water quality standards (WQS).[4, 5] Both states have accommodated levels of TDG above 110% for fish passage spill operations for ESA-listed juvenile salmonids at the Corps' projects on the lower Snake and lower Columbia rivers as follows:

Washington Criteria Adjustment:

- TDG must not exceed an average of 115% as measured in the forebays of the next downstream dams and must not exceed an average of 120% as measured in the tailraces of each dam (these averages are measured as an average of the 12 highest consecutive hourly readings in any one day, relative to atmospheric pressure); and
- A maximum TDG one-hour average of 125% must not be exceeded during spillage for fish passage.

Oregon Standard Modification:

- Spill must be reduced when the average TDG concentration of the 12 highest hourly measurements per calendar day exceeds 120% of saturation in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations.
- Spill must be reduced when instantaneous TDG levels exceed 125% of saturation for any 2 hours during the 12 highest hourly measurements per calendar day in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations.

These limits are referred to as "gas caps." The Corps will operate its fish passage projects in accordance with the project spill levels identified in Table 2 and in a manner that is consistent with the State TDG standards described above, including applying the different state calculation methodologies. When the standards vary or conflict, the Corps will apply the more stringent standard.

2.2. Spill Caps

The Corps' Reservoir Control Center (RCC) is responsible for daily management of spill operations responsive to changing conditions to manage TDG consistent with the project spill levels in Table 2 and in a manner that is consistent with all applicable State standards. To accomplish this, the RCC sets "spill caps" for each of the Corps' lower Columbia and lower

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[4] WASH. ADMIN. CODE §173-201A-200(l)(f)) provides the maximum TDG criteria for each of the aquatic life use categories and displays Table 200 (I)(f) that states: "Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection." The code also addresses exceptions and adjustments, including a provision allowing for an adjustment of the TDG criteria to aid fish passage over hydroelectric dams when consistent with an approved gas abatement plan.

[5] OR. ADMIN. R. 340-041-0031 provides in part: "the concentration of TDG relative to atmospheric pressure at the point of sample collection may not exceed 110 percent of saturation." OR. ADMIN. R. 340-041-104(3) identifies findings the Environmental Quality Commission must make for the purpose of allowing increased spill for salmon migration. *See* http://pweb.crohms.org/tmt/wqnew/state_tdg_waivers/or/2015_5yr.pdf

Snake River projects on a daily basis throughout the fish passage spill season to ensure that the maximum spill level at each project is estimated to meet, but not exceed, the gas cap in the tailrace and the downstream forebay. There may be instances when flow conditions in the river result in target spill exceeding the state water quality standards. In summer 2018, the RCC will establish target the spill levels identified in Table 2 or the spill cap, whichever is lower. The spill caps for all lower Snake and lower Columbia River fish passage projects are the upper limit for voluntary fish passage spill.

There may also be instances in which fish passage projects may spill more than the target spill level defined in Table 2 due to high river flow that exceeds powerhouse hydraulic capacity. The fish passage projects may also spill more than the target spill level due to a lack of power demand (load). The Corps will attempt to manage excess TDG on a system-wide basis under lack of power demand conditions by incrementally increasing spill at projects throughout the system in the order of priority defined in the Spill Priority List. For this purpose, the RCC also defines spill levels to approximately achieve TDG levels in project tailraces of 122%, 125%, 127%, 130%, and 135%. The order of priority is coordinated with regional sovereigns in the TMT to allocate spill to projects to best manage system TDG while also considering how best to protect fish and other aquatic biota.

To calculate spill caps, the Corps evaluates observed and forecasted variables that influence TDG levels, including: (1) environmental conditions (e.g., total river flow, wind, ambient temperature, barometric pressure, incoming TDG from upstream, and travel time from the upstream project tailrace to the next downstream project forebay[6]); and (2) project operations (e.g. spill level, spill pattern, tailwater elevation, proportion of flow through the turbines, and project configuration). These data are used as input variables into the System TDG (SYSTDG) model in order to estimate TDG levels several days into the future. The Corps runs SYSTDG as a real-time operations tool, when appropriate, to forecast TDG levels at the Corps' projects. As warranted, the Corps will cross-check projected spill caps with SYSTDG results and consider observed data to make appropriate spill cap adjustments.

3. SPILLWAY OPERATIONS AND SPILL LEVEL PRECISION

The Corps plans to achieve the target spill levels identified in Table 2 to the extent feasible; however, actual hourly spill levels at each dam may vary slightly depending on the precision of the spillbay gate settings, real-time fluctuations in flow and/or project head, or automatic load following**.** At each project, spill is distributed across the spillway according to patterns defined in the project-specific chapters of the FPP[7] to provide favorable fish passage conditions. Spillbay gates are opened to the settings identified in the FPP spill pattern table that correspond to the spill level that is closest to, but may be slightly higher or lower than, the target spill level.

Due to these limitations in spill level precision, the observed hourly average spill level may range up to ±2 kcfs from the target spill level (or ±3 kcfs at The Dalles and Bonneville dams, as described in the project-specific sections below). At projects where the target spill level is a

[6] Water travel time between projects varies depending on flow and can range from 1-5 days on the lower Snake River and from 1-3 days on the lower Columbia River.
[7] The FPP is coordinated annually with regional sovereigns through the FPOM.

proportion of total outflow, the hourly spill level is calculated to be within ±1% of the target spill percentage (except at The Dalles and Little Goose dams when spill may vary more than ±1% at certain flow ranges, as described in FPP Chapters 3 and 8, respectively). In the event that the hourly percentages are not within ±1% of the target spill, project operators and schedulers will adjust spill levels later in the day with the objective of ending the day with a daily average spill percentage that achieves the target.

4. MODIFICATIONS TO PLANNED OPERATIONS AND IN-SEASON MANAGEMENT

For planning purposes, the operations described in the 2018 Summer FOP assume average runoff conditions. Actual runoff varies in magnitude and timing, and observed river flow may be higher or lower than average at any time such that modifications to the planned operations may be required. To accommodate these varying runoff conditions and other routinely observed conditions as they arise, the Corps, in conjunction with the other Action Agencies and NOAA Fisheries, coordinates with regional sovereigns on these conditions and other planned operations through the review of the FOP prior to summer spill operations (see section 4.1). The Corps responds in real-time to these routine conditions and planned operations by implementing adjustments as conditions require without additional coordination.

For unanticipated and unplanned conditions that are not pre-coordinated, the Corps will respond as necessary to address the condition, and when possible, will use the existing regional coordination process to adaptively manage and make necessary in-season adjustments in spill and other fish operations (e.g., spill levels, spill caps, spill patterns, juvenile fish transportation, and minimum operating pool or "MOP" operations).

4.1. Conditions that May Require Adjustments to Planned Operations

Under certain conditions or circumstances, the Corps may be required to adjust spill higher or lower than the target spill level at one or more projects.

Planned and Routine Operational Adjustments:[8]

1. High flow conditions that exceed powerhouse hydraulic capacity and require spilling more than the target spill level.
2. Low flow conditions that require adjustments in spill level while maintaining project minimum generation requirements (see section 4.3.1. below).
3. Lack of power demand (load) resulting in increased spill.
4. Scheduled turbine unit and/or transmission outages that reduce powerhouse hydraulic capacity and require spilling more than the target spill level.*
5. Standard operations for transmission reliability (see section 4.4.1. below).*

[8] Planned and Routine Operational Adjustments are spill adjustments due to: (1) conditions that occur routinely every year (e.g., high or low flow); or (2) planned operations (e.g., scheduled maintenance, transit of fish transport barge in the tailrace). These are considered pre-coordinated through regional sovereign review of the FOP and the FPP, and are implemented by the Action Agencies as conditions require and without additional coordination through the regional forum processes. These adjustments are included in the monthly FOP Implementation Report in the hourly spill and flow charts (plots) , and conditions with an (*) are reported in the "Pre-Coordinated Operations" Table. The FPP Appendix A identifies actions with pre-coordinated dates.

6. Navigation safety concerns (see section 4.6. below).*

Non-routine or Unplanned Operational Adjustments:[9]

1. Contingency operations for transmission reliability (see section 4.4.2 below).
2. Fish emergencies (e.g., high river temperatures that exceed levels safe for fish).
3. Conditions related to project safety (e.g., erosion), health and human safety, navigation, or other unforeseen events that require spilling more or less than the target spill level.
4. Other circumstances including human or programming error, unscheduled maintenance or outage, operational limitations (e.g., physical limitations of gate settings and spill patterns outside of the level of precision defined in section 3 above, forebay elevations), and other unanticipated events or emergencies.
5. In-season adjustments following adaptive management coordination through the existing regional coordination process (see section 4).

4.2. TMT Emergency Protocols

The Corps and the other Action Agencies will operate the fourteen Columbia River System (or FCRPS) projects in emergency situations in accordance with the 2018 WMP Emergency Protocol (WMP Appendix 1). This protocol identifies the process the Action Agencies, in coordination with NOAA Fisheries, will use in the event of an emergency concerning project operations that impact planned fish protection measures. The emergency protocols also address the process for coordination with regional sovereigns. The most recent version of the Emergency Protocols is located at:
http://pweb.crohms.org/tmt/documents/wmp/2018/Final/emerproto/

4.3. Low Flow Operations

4.3.1. Minimum Generation

All lower Snake and lower Columbia River dams have a minimum generation requirement that has been established to support power system reliability (see section 4.4). In Table 1, the Corps has identified minimum generation powerhouse outflow values derived from the turbine unit operating ranges defined in the project-specific chapters of the 2018 FPP and actual generation records. Values in Table 1 are approximations that account for varying head or other small adjustments in turbine unit operation that may result in variations from the reported minimum generation flow and spill amount. Conditions that may result in minor variations include:

1. Varying pool elevation: as reservoirs fluctuate within the operating range, flow rates through the generating unit change.

[9] Non-routine or Unplanned Operational Adjustments are implemented by the Action Agencies as conditions require and/or as coordinated with regional sovereigns through the in-season adaptive management process. Adjustments that affect spill levels are reported in the FOP Implementation Report Variance Table (and, when warranted, a description may also be included in the Operational Adjustments section). When an adjustment does not affect spill levels, information is provided in the Operational Adjustments section. Adjustments that continue into the next month are reported in the Pre-Coordinated Operations Table.

2. Generating unit governor "dead band": the governor controls the number of megawatts the unit should generate, but cannot precisely control a unit flow; variations may be 1-2% of unit flow. These variations can affect minimum generation ranges included in Table 1.
3. System disturbances: once a generator is online and connected to the grid, it responds to changes in system voltage and frequency. These changes may cause the unit to increase or decrease flow and generation slightly within an hour. Individual units operate differently from each other and often have unit specific constraints.
4. Generation control systems regulate megawatt (MW) generation only; not flow through individual turbine units.

All of the lower Snake River powerhouses may be required to keep one generating unit online at all times for power system reliability under low river flow conditions, which may result in a reduction of spill at that project if there is insufficient flow in the river. Generally, units 1–3 are the first priority units for operation during the fish passage season for adult fish attraction flow to the fish ladders, but unit priority is also based on availability. During low river flow conditions, the Corps will operate the lower Snake River projects to the unit priority specified in the FPP and minimum generation ranges identified in Table 1.

There may be situations when river flow is insufficient to maintain minimum generation within the ranges identified in Table 1 and spill to the target spill levels identified in Table 2 every hour. Under these conditions, the lower Snake River projects will operate one turbine unit (according to unit priority operating criteria at each project) at minimum generation and spill the remainder of outflow. The lower Columbia River projects will also operate at minimum generation and pass the remaining outflow as spill down to minimum spill levels. Additionally, inflow provided by non-Federal projects upstream is often variable and uncertain, and in combination with low flow conditions, may result in instances where forebay elevations go outside of the normal MOP ranges for lower Snake River projects as provided for in the 2014 Supplemental BiOp.

Table 1. Minimum generation flow ranges for turbine units at Corps hydropower projects on the lower Snake and lower Columbia rivers.[10]

Project	Turbine Unit	Minimum Generation Flow Range [a] (kcfs)
Lower Granite	1, 3	11.8 – 12.9
	2[b]	17.5 – 18.5
	4, 5, 6	13.7 – 14.8
Little Goose	1, 2, 3	11.3 – 11.8
	4, 5, 6	13.8 – 14.4
Lower Monumental	1	11.1 – 12.3
	2[b]	11.8 – 13.9
	3[b]	17.4 - 19.7
	4[b]	17.9 – 19.0
	5, 6	14.1 – 14.9
Ice Harbor	1	8.4 – 10.1
	2[c]	TBD
	3[b]	11.4 – 12.5
	4, 6	9.4 – 10.6
	5[b]	13.1 – 14.1
McNary	N/A	50 – 60
John Day	N/A	50 – 60
The Dalles	N/A	50 – 60
Bonneville	N/A	30 – 40

a. "Minimum Generation" is the minimum number of megawatts (MW) that must be generated at each project in order to support power system reliability. This table defines the resulting flow range (kcfs) through turbines, which is a function of power output (MW), turbine efficiency, and project head.
b. Lower Granite Unit 2, Lower Monumental Units 2, 3, and 4, and Ice Harbor Units 3 and 5 are restricted due to runner blades that are fixed at a set angle (non-adjustable).
c. Ice Harbor Unit 2 is being rebuilt with a runner design that reduces impacts to fish, scheduled for completion in summer 2018. At that time, testing will be performed to determine the operating range.

4.3.2. Navigation Lock Operation During Low Flow

At projects where the target spill level is a percentage of total outflow, emptying the navigation lock during low flow conditions may temporarily result in a reduced percentage of outflow that is reported as spill. During this time, the spill level remains constant, but the spill reported as a percent of total outflow may be temporarily reduced below the target percentage. This occurs because the volume of water needed to empty the navigation lock during periods of low flow is a greater percentage of the total project outflow than during periods of higher flow.

4.3.3. Low Flow Operations at Little Goose

At Little Goose Dam, when daily average flow in the lower Snake River is ≤32 kcfs, achieving 30% spill would require switching powerhouse operations between operating two units at the low end of the ±1% of best efficiency range to operating one unit at the high end of the ±1% of

[10] The table is accurate as of April 2018 but may change in-season as coordinated through FPOM (see the FPP).

best efficiency range. This operation, in combination with constant inflow from Lower Granite Dam, often makes it difficult to achieve the FOP prescribed spill level downstream at Lower Monumental Dam and to also maintain MOP operations. In years past, through coordination with TMT during low flow periods, Little Goose spill operations changed from 30% to a constant spill level of approximately 7-11 kcfs to smooth out Little Goose outflow, meet Lower Monumental FOP specified spill levels, and maintain the MOP elevation at Little Goose. A similar operation will be implemented in 2018, if necessary, depending on river flow.

4.4. Operations for Transmission System Reliability

In managing fish passage spill operations, the Corps and BPA plan to allocate generation and spill at the eight Corps projects on the lower Columbia and Snake rivers in accordance with the 2018 Summer FOP. Periodically, to ensure the reliability of the transmission system when system conditions warrant, it is necessary to increase or decrease the amount of water flowing through a project's turbines and spillbays at one or more of these projects.

Consistent with past practice, if any of the transmission system conditions listed below are present and can be alleviated by temporarily modifying generation levels at one or more federal projects, the Action Agencies will adjust generation and spill levels to avoid the transmission system impact. These events could result in actual spill being temporarily higher or lower than the target fish passage spill level. Such events may occur coincident with the transmission system event or in subsequent hour(s) should the event impact water balance at a specific hydro project or river reach. The Corps and BPA will work to restore conditions to support target spill operations as soon as practicable. These actions are taken to minimize the likelihood and/or scope of a transmission system emergency and will be reported in the monthly FOP Implementation Report (see section 8 below).

4.4.1. Standard Operations for Transmission Reliability

Consistent with past practice, the Action Agencies manage the fourteen Columbia River System projects to be prepared to provide electric reliability support as follows:

1. Ensuring sufficient range of generation capability is available to provide the BPA balancing authority[11] area with contingency reserves required by North American Electric Reliability Corporation (NERC) and Western Electricity Coordination Council (WECC) reliability standards.[12]
2. Ensuring generation is available to increase or decrease in order to balance load and generation within the BPA balancing authority area to support reliability.

[11] A balancing authority is the responsible entity that maintains load-interchange-generation balance within a Balancing Authority Area, and supports interconnection frequency in real time. Balancing authority area is the collection of generation, transmission, and loads within the metered boundaries of the designated balancing authority. The balancing authority maintains load-resource balance within this area.

[12] The Federal Energy Regulatory Commission has certified the NERC as the Electric Reliability Organization responsible for establishing and enforcing national reliability standards. NERC has delegated some of its authority to the WECC as the regional entity responsible for monitoring reliability standards compliance and enforcement in the Western Interconnection.

3. Ensuring enough generating units are online and have sufficient capability to increase or decrease generation to meet the BPA balancing authority area frequency response obligations, consistent with reliability standard requirements.
4. Ensuring that there is generation operating at projects in specific locations sufficient for arming for Remedial Action Schemes (RAS).[13] RAS schemes allow the transmission system to automatically respond to unplanned events on the power system by immediately dropping or reducing generation at those specified locations.
5. Maintaining minimum generation levels (see Table 1) at generators in specific locations to maintain correct voltage levels on the power system to ensure reliability.
6. Maintaining enough generation units online in diverse locations on the electrical grid to ensure system stability through rotating inertia.

4.4.2. Contingency Operations for Transmission Reliability

If the routine reliability tools described above are insufficient to resolve the transmission condition, the Action Agencies will implement the preemptive actions detailed in the Power System Emergency Action Plan (Attachment 1 to the TMT Emergency Protocols referenced in section 4.2 above) if time permits. Where necessary, the fourteen Columbia River System projects will be called upon to relieve the following conditions:

1. Increasing or decreasing generation at projects (redispatch) in specific geographic locations to relieve heavily loaded transmission lines if required by system conditions. This includes adjusting generation that flows over specific transmission facilities in order to keep flows over those paths within the requirements of NERC and WECC reliability standards.
2. Increasing or decreasing generation to ensure transmission system stability and/or reliable load service in local areas under specific system conditions (for example, increasing generation at Ice Harbor Dam to support transmission stability, including providing load service to the Tri-Cities area of Washington, when system conditions require).
3. Responding to unanticipated significant events, including NERC Energy Emergency Alerts or other system emergencies, consistent with the Power System Emergency Action Plan included as Attachment 1 to the TMT Emergency Protocols.
4. Other unanticipated significant events (e.g. powerhouse fires, earthquakes, etc.).

These actions will be implemented consistent with the TMT Emergency Protocols (see section 4.2 above).

4.5. Turbine Unit Testing for Maintenance

Turbine units may be operationally tested prior to maintenance and prior to return to service for up to 60 minutes by running the unit at speed no load, various loads within the ±1% of peak efficiency range, and, if necessary, up to full load, to allow for measurements and testing. Testing of a unit under maintenance is in addition to a unit operating at minimum generation required for power system reliability. Testing may deviate from unit operating priorities

[13] Remedial Action Schemes are sets of automatic control circuits that switch various types of power system components on or off in response to disturbances on the interconnected transmission system.

specified in FPP Chapters 2-9 and may use water that would otherwise be used for spill if the unit operating for reliability is at the bottom of the ±1% of best efficiency range. Water will be used from the powerhouse outflow allocation if possible, and water diverted from spill for operational testing will be minimized. The Corps coordinates this testing with the region through the FPOM, in accordance with Chapters 2-9 of the FPP. Unit outages for required maintenance are described in FPP Appendix A to the extent practicable. Maintenance dates are subject to change.

4.6. Navigation Safety

Short-term adjustments in spill or MOP may be required at any of the fish passage projects to address navigation safety concerns.[14] This may include changes in spill patterns, reductions in spill, short-term spill curtailment, or operating the forebay above MOP. For instance, some flow conditions may require a 2-foot forebay operating range at Ice Harbor in order to provide conditions for navigation safety at the Ice Harbor forebay navigation lock exit. These adjustments may be necessary for both commercial traffic and fish barges.

Additionally, during low flow conditions, adjustments in spill and/or MOP have been necessary at several fish passage projects for navigation safety. For example, unsteady or low flow at Little Goose and Ice Harbor dams (approximately 50 kcfs or less) may impact forebay elevations and cause inadequate navigation depths at the upstream navigation lock entrances in the Lower Granite and Lower Monumental tailraces, respectively. As addressed in the 2014-2018 IP, adjustments to forebay elevations at Little Goose and Ice Harbor of up to 1.0 foot above the MOP range may be necessary to accommodate safe entrance to the upstream navigation locks at Lower Granite and Lower Monumental dams.

High spill levels may create unsafe hydraulic conditions for commercial, non-commercial, and fish transport barges entering and exiting the tailrace and/or while moored at the fish loading facility. Under these conditions, spill may be reduced temporarily as necessary to maintain safe navigation conditions for commercial, non-commercial, or fish transportation barges, which may result in temporarily filling the pool above the MOP range, depending on river flow.

Due to sediment deposition in the confluence area of the Snake and Clearwater rivers near Lewiston, Idaho, the Action Agencies began implementing a "variable MOP" operation at Lower Granite Dam in April 2018 to provide the required federal navigation channel depth of 14 feet. This operation will remain in place through the time period covered by the 2018 Summer FOP. At high flows (≥ 120 kcfs), the required navigation channel depth is able to be maintained with Lower Granite operating in the MOP range of 733-734 feet. However, at flows below 120 kcfs,

[14] The Corps conducts annual surveys to assess sedimentation in the reservoirs and under certain conditions. To ensure safe navigation, there may be a need to operate the pools above the MOP range.

the Lower Granite forebay must be operated higher in order to maintain the navigation channel depth, as follows:

- Inflow 80-119 kcfs = Lower Granite forebay operating range 734-735 feet (MOP+1);
- Inflow 50-79 kcfs = Lower Granite forebay operating range 734.5-735.5 feet (MOP+1.5);
- Inflow below 50 kcfs = Lower Granite forebay operating range 735-736 feet (MOP+2).

5. JUVENILE FISH TRANSPORTATION PROGRAM

The 2014 Supplemental BiOp calls for an annual review of the previous year's fish survival information, recent transport rates, and available smolt-to-adult return rates (SARs) for both in-river and transported smolts for discussion with the RIOG to inform transport/spill operations for the subsequent year. The best available information will be considered in the Corps' implementation of the juvenile fish transportation program at the lower Snake River collector projects in 2018. Should regional sovereigns recommend adjustments in transportation that differ from those stated herein, the Corps will use the existing regional adaptive management process to make a determination on recommended operational changes. Detailed descriptions of project and transport facility operations to implement the juvenile fish transportation program are contained in the FPP Appendix B.

5.1. Lower Snake River Dams – Transport Operation and Timing

Fish collection for transport began on April 23, with the first barge leaving Lower Granite Dam on April 24. Starting on or about August 15 (depending on numbers of subyearling Chinook collected for transport), fish will be collected at Lower Granite, Little Goose, and Lower Monumental and transported by truck for release below Bonneville Dam. Transport operations are anticipated to continue through approximately September 30 at Lower Monumental and through October 31 at Lower Granite and Little Goose. Transport may be stopped earlier at any of the projects due to columnaris disease or at Lower Monumental due to low fish abundance as specified in FPP Appendix B.

6. 2018 SUMMER FISH PASSAGE SPILL OPERATIONS

Summer spill operations will occur June 21–August 31 at the four lower Snake River projects, and June 16–August 31 at the four lower Columbia River projects. The Corps will initiate spill at 0001 hours, or shortly after midnight, at each of the projects on the start date. Target spill levels for summer 2018 at each project are defined in Table 2.

Table 2. Summary of 2018 summer target spill levels at lower Snake and lower Columbia River projects.

PROJECT	2018 SUMMER SPILL[1] (24 hrs/day except as noted at Ice Harbor and Bonneville)
Lower Granite	18 kcfs
Little Goose	30%
Lower Monumental	17 kcfs
Ice Harbor	**June 21-July 13:** 30% vs. Day 45 kcfs/Night Gas Cap[2] **July 13-August 31:** Day 45 kcfs/Night Gas Cap[2]
McNary	50%
John Day	**June 16-July 20:** 30% vs. 40% **July 20-August 31:** 30%
The Dalles	40%
Bonneville	Day 85 kcfs/Night 121 kcfs[3] vs. 95 kcfs

1. Spill may be temporarily reduced below the FOP target summer spill level at any project if necessary to ensure navigation safety or transmission reliability, or to avoid exceeding State TDG standards.
2. Ice Harbor Night Hours = 2100-0800; Day Hours = 0800-2100.
3. Bonneville Day/Night hours defined in the 2018 FPP Chapter 2.

7. PROJECT-SPECIFIC OPERATIONS

The following sections describe 2018 summer spill operations for each project. The Corps will implement established spill patterns for all projects as described in the 2018 FPP.

7.1. Lower Granite Dam

7.1.1. Summer Spill June 21–August 31: 18 kcfs, 24 hours/day.

7.1.2. Operational Considerations: None known for summer 2018.

7.2. Little Goose Dam

7.2.1. Summer Spill June 21–August 31: 30%, 24 hours/day.

7.2.2. Operational Considerations:

- Daily average flows in the lower Snake River of ≤32 kcfs can result in incompatible operations with Lower Monumental Dam and cause spill level fluctuations. Alternative Little Goose operations to resolve this issue are described in the Low Flow Operations for Little Goose Section 4.3.3 above and will be coordinated through the FPOM/TMT.

7.3. Lower Monumental Dam

7.3.1. Summer Spill June 21–August 31: 17 kcfs, 24 hours/day.

7.3.2. Operational Considerations:

- Transit of the juvenile fish barge across the Lower Monumental tailrace, docking, and departure from the loading facility, may require a reduction in spill below the target spill level for safety concerns. The towboat captain may request spill be reduced or eliminated during transit. During juvenile fish loading operations, spill is typically reduced to 15 kcfs, but can be reduced further if necessary for safety reasons. Barge loading duration can be up to 3.5 hours. Reducing spill may cause the Lower Monumental pool to briefly fill above MOP.[15]

7.4. Ice Harbor Dam

7.4.1. Summer Spill June 21–August 31: Target spill will alternate between two-day treatments of 30%, 24 hours per day and 45 kcfs day/Gas Cap night until July 13 at 0800 hours, then 45 kcfs day/Gas Cap night through August 31 (see section 2.1).

7.4.2. Operational Considerations:

- Spill operation treatments may be rearranged within a week throughout the season. If rearrangement of treatments occurs, the total number of each spill treatment for the summer season will not change. The flexibility to rearrange treatments during periods of higher power demand may alleviate the need to declare a power emergency.

7.5. McNary Dam

7.5.1. Summer Spill June 16–August 31: 50%, 24 hours/day, without spillway weirs (removed for summer in early June).

7.5.2. Operational Considerations: None known for summer 2018.

7.6. John Day Dam

7.6.1. Summer Spill June 16–August 31: 30% vs. 40%, 24 hours/day from June 16 through July 20. Spill levels will alternate in a four-day block with two-day treatments (30% or 40% spill). Spill treatment changes will occur at 2100 hours. A single-treatment operation of 30%, 24 hours/day will begin July 20 and continue through August 31.

[15] Reducing spill for long durations could pose problems staying within MOP at Ice Harbor Dam, the downstream project.

7.6.2. Operational Considerations:

- Spill operation treatments may be rearranged within a week throughout the season. If rearrangement of treatment occurs, the total number of each spill treatment for the summer season will not change. The flexibility to rearrange treatments during periods of higher power demand may alleviate the need to declare a power emergency.

7.7. The Dalles

7.7.1. Summer Spill June 16–August 31: 40%, 24 hours/day.

7.7.2. Operational Considerations:

- If total river flow is between 92 and 161 kcfs, the spill percentage could range from 38.6% to 41.4%. Actual hourly average spill levels at The Dalles may range up to ±3 kcfs according to the spill pattern tables in FPP Chapter 3.
- At no time is spill recommended on the south side of the spillway (Bays 9-23) as this creates poor tailrace egress conditions for spillway-passed fish.
- Spillbays 9, 10, 11, 13, 16, 18, 19, and 23 are operationally restricted due to wire rope, structural and concrete erosion concerns.
- Spill gate changes will be limited to one change per hour to minimize wear and tear on gates and wire ropes.

7.8. Bonneville Dam

7.8.1. Summer Spill June 16–August 31: 85 kcfs day/121 kcfs night vs. 95 kcfs, 24 hours/day. Spill levels will alternate in a four-day block with two-day treatments. Hours for day and night spill operations are defined in FPP Chapter 2.

7.8.2. Operational Considerations:

- Minimum spill level is 50 kcfs; however, as in past years, to provide acceptable juvenile fish egress conditions in the tailrace under extreme low flow conditions, lower spill levels may be considered and coordinated through the TMT and/or FPOM.
- Actual hourly average spill levels at Bonneville Dam may range up to ±3 kcfs according to spill pattern tables in FPP Chapter 2.

8. FOP IMPLEMENTATION REPORTING

The Corps posts monthly FOP Implementation Reports on the following website: http://pweb.crohms.org/tmt/documents/FOP_Implementation_Reports/. The updates will include monthly project plots containing the following information:

- total flow: the total hourly river flow rate;
- generation flow: the hourly flow through the powerhouse units;
- target spill: the spill target for that hour;

- adjusted spill: the hourly spill level that can be achieved taking into consideration that spill may vary as a function of total river flow, forebay elevation and generator capacity, and is subject to routine operational adjustments that limit the ability to spill to the target spill (see section 4.1 above);
- actual spill: the hourly flow over the spillway; and,
- the resultant 12-hour average TDG for the tailwater at each project and for the next project's forebay downstream.

The reports will also provide information on substantial issues that arise as a result of the spill program (e.g. Little Goose adult passage issues), and will address any emergency situations, including spill adjustments for contingency operations for transmission reliability.

The Corps will continue to provide the following data to the public regarding project flow, spill rate, TDG level, and water temperature.

- Hourly flow, generation, and spill quantity data for the lower Snake and Columbia River dams are posted to the following website:
    - http://www.nwd-wc.usace.army.mil/report/projdata.htm (web reports with the most recent 8 days of hourly project data and the current month of daily project data).
    - http://pweb.crohms.org/tmt/wq/historical/ (links to historic hourly project data files in csv-format organized by month back to 2004 including temperature and TDG information).
- Water Quality: Water quality data are received via satellite from FMS in the Columbia and Snake rivers every hour, and placed on a Corps public website upon receipt. Hourly TDG and water temperature data are posted to the following websites:
    - http://pweb.crohms.org/report/total.html (web reports with hourly TDG, project outflow and spill for the previous 3 days).
    - http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/ (links to historic hourly water quality data files for each FMS including barometric and total gas pressure, TDG and project outflow and spill in csv-format organized by month back to 2005).
    - Using the hourly TDG readings for each station in the lower Snake and Columbia rivers, the Corps will calculate both the highest 12-hour average TDG levels (Oregon method) and the highest consecutive 12-hour average TDG levels (Washington method) on a daily basis. These averages are reported at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/
- Spill cap information will be posted to the following site each day: http://pweb.crohms.org/tmt/documents/ops/spill/caps/.

2018 Fish Passage Plan

Appendix F

Dewatering Guidelines & Fish Salvage Plans

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1. INTRODUCTION

1.1. Each Corps mainstem project on the Columbia and Snake rivers has dewatering and fish handling/salvage plans which describe procedures for any handling or salvaging of fish within a facility or project area when it is dewatered.[1] All dewatering and fish handling plans should be reviewed and revised where appropriate to reflect new information and guidelines listed below as coordinated by the Fish Passage Operations & Maintenance (FPOM) workgroup.

2. COORDINATION

2.1. The dewatering and fish handling/salvage plan for each project shall include coordination procedures for planned and emergency fish salvage activities. The Project Biologist shall coordinate all fish salvage activities with Project and District personnel.

3. DEWATERING & FISH HANDLING PERSONNEL

3.1. The plans shall specify the number and specialty of personnel required for each type of dewatering activity, including the Project Biologist, fisheries staff, crane operators, riggers, winch operators, forklift operators and maintenance workers. Adequate personnel must be available for fish salvage activities to avoid or minimize fish stress and mortality.

3.2. The plans shall include a requirement that *all participants* involved in a dewatering activity attend a fish salvage briefing prior to dewatering in order to define responsibilities for each participant.

3.3. All emergency fish salvage operations will be coordinated and overseen by the Project Biologist or fisheries staff if possible.

4. FACILITIES

4.1. Salvage plans shall be project-specific and contain step-by-step dewatering and fish salvaging procedures for all facilities and project features which may contain fish, most commonly the adult fish ladders and collection channels, juvenile bypass systems, juvenile fish sampling facilities, turbine unit scroll cases and draft tubes, gatewell slots and navigation locks. Individual projects may have other facilities or features that contain fish.

4.2. The plans shall specify how the facility is to be dewatered, where and how fish are to be salvaged, and the location of designated release sites for the various types of fish expected to be encountered during each dewatering activity.

4.3. Fish Safety Pools. The fish salvage plans shall identify areas for "safety pools" in each facility that pond enough water to hold fish temporarily. The plan shall specify whether the safety pools are usually maintained by leakage or a controlled water flow. The plans shall specify

[1] Project Dewatering Plans and annual schedules are available online at: pweb.crohms.org/tmt/documents/FPOM/2010/Plans%20lists%20charts/

how long and under what conditions each safety pool can be used to hold fish safely. If there is potential for the safety pools to freeze or lose their water source, the fish should be evacuated as soon as possible.

5. EQUIPMENT

5.1. The plans shall specify where equipment is required for use during a dewatering, where certain equipment should be pre-positioned before work begins, and any heavy equipment needed for fish salvage activities.

5.2. Fish Handling Equipment. The plans shall specify all fish handling equipment required during each type of dewatering activity, including gloves, hand-held fish nets, seines, fish buckets, gatewell dip baskets, and fish transport tanks and vehicles. All equipment should be in good condition and pre-positioned before dewatering begins.

5.3. Support Equipment. The plans shall include a detailed list of all support equipment required for each dewatering activity, including items such as hard-hats, boots, safety harnesses, flashlights, portable radios, ladders, cranes, man-baskets, pumps, forklifts, and any other equipment required for a dewatering activity.

6. FISH HANDLING PROCEDURES

6.1. The plans shall include procedures to minimize fish mortality and stress. The primary fish handling objective will be to collect and transport fish to release sites with minimal stress and without injury or mortality to any fish.

6.2. Plans shall specify the details of all fish handling activities including how to crowd and handle fish within each facility, specifics on the number of fish that can be hauled or transported in containers or transport tanks at varying water temperatures, and how and where to release fish at each project.

6.3. The plans should reflect the following general fish handling guidelines:

(a) Adult salmonids and other large adult fish should be salvaged first.

(b) Netting of fish should be minimized whenever possible.

(c) Fish should not be crowded in the holding containers.

(d) Fish will be less stressed in larger containers ($\geq$ 300 gallons preferred), in colder water, and with supplemental oxygen or aeration.

(e) If fish are transported in warmer water (>65^{o} F), reduce fish loading density and holding times.

(f) All fish will be returned to the river as soon as possible at predetermined release sites.

(g) Fish should not be held in holding tanks or containers for more than two hours under any circumstances.

(h) Fish should be released from the holding tanks into the river as soon as the fish salvage operation stops for any reason.

(i) Fish should be carefully released into the tailwater or forebay with a short vertical drop to the river. Fish release slides are desirable.

(j) Water temperature in the transport tank should be monitored and maintained within 2^{o}F of the river water at the release site.

(k) Fish should be removed prior to debris removal if possible.

7. FISH SALVAGE REPORT

7.1. The fish salvage plan should include a report template for fish salvage operations that should be completed for all fish salvage activities and kept permanently on file at each project.

2018 Fish Passage Plan

Appendix G

Adult Fish Facility Operating Protocols at Bonneville, Ice Harbor, and Lower Granite Dams

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1. BONNEVILLE DAM ADULT FISH FACILITY

The following protocols will be implemented by agencies conducting research in the Bonneville Dam second powerhouse Adult Fish Facility (AFF). These protocols were coordinated with fish agencies and tribes through the Fish Passage Operation and Maintenance Coordination Team (FPOM). The purpose of these protocols is to provide measures to limit mortality resulting from stress when handling fish.

1.1. General Facility Protocols.

1.1.1. Users must have appropriate documentation for conducting research at the dam (see *Guide for Researchers at Bonneville Dam*). This includes valid state and federal permits that cover all listed species passing the project during the trapping period. Users shall comply with all fish handling conditions in the permits. *If permit conditions are more restrictive than the following protocols, users must follow permit conditions.*

1.1.2. The Corps reserves the right to terminate trapping operations at any time.

1.1.3. Users will be trained in the proper operation of the AFF to insure fish and personnel safety. Users may request training through the Project Biologists.

1.1.4. Bridge crane certification is required prior to operating the overhead crane. Training will not be provided by the Corps of Engineers.

1.1.5. Hard hats, long pants or raingear, steel-toed shoes or rubber boots are to be worn at all times. Shorts, tennis shoes, or sandals will not be permitted in the lab.

1.1.6. Water temperatures should be observed upon arrival and periodically during the day.

1.1.7. Personnel conducting research are required to be present in the AFF to divert desired fish into the anesthetic tank using the flume swing gates. While the AFF is in operation, flumes shall be open and a researcher must be on-site.

1.1.8. Undesired fish will be bypassed to the return pool.

1.1.9. Researchers shall perform no maintenance on Corps owned/installed equipment. Nets may be mended as necessary.

1.1.10. Qualified users may lower the main ladder picket leads and downstream exit bulkhead when they arrive, and must raise the picket leads when they are completed for the day. The downstream exit bulkhead may be left down when shad and lamprey are attempting to pass.

1.1.11. Users will be permitted to operate valves 9 and 10 to control flow down the flumes at their discretion and to operate the raw water booster pump. Users may operate valve 12 to provide flow in the holding pool and valve 15 to drain water at the return pool.

1.1.12. Users must use a sanctuary net large enough to safely handle the largest fish passing the project during the trapping period.

1.1.13. Fish greater than 100 cm forklength may be diverted into the main anesthetic tank or returned to the ladder untouched. These fish will not be diverted into any auxiliary anesthetic tanks.

1.2. Notification & Documentation.

1.2.1. Users will notify the control room when they set up and close down the lab.

1.2.2. Users will record the times picket leads are lowered and raised and which agency they are representing on the sheet provided by the project biologists.

1.2.3. Lamprey may be held up to 48 hours in the AFF. Researchers will notify Project Fisheries and the Control Room whenever lamprey are held.

1.2.4. Any and all mortalities must be immediately reported to a Project Biologist. The Project Biologist will examine the mortality and take any photos. The researcher shall give a detailed report including:

- **(a)** Species;
- **(b)** Origin;
- **(c)** Length;
- **(d)** Weight;
- **(e)** Marks and injuries;
- **(f)** Cause and time of death;
- **(g)** Future preventative measures.

1.2.5. All mortalities are included in Project Fisheries weekly reports submitted to FPOM.

1.3. Trapping Protocols – Ladder Water Temperatures < 70°F.

1.3.1. There will be no start time restriction for trapping operations.

1.3.2. There will be no more than 4 Chinook, or 4 steelhead, or 6 sockeye, or any combination of 4 adult salmonids allowed in the anesthetic tank at any one time. This assumes that users can effectively track the length of time fish stay in the anesthetic tank.

1.3.3. There will be no more than two adult fish in any one observation tank at any one time. The brail pool is the primary and preferred recovery area.

1.3.3.1. Observation tanks will primarily be used for fish in "*distress*", defined as fish that have sustained injury during the trapping and sampling process; fish that have a previous injury (e.g., fish in "*fair*" or "*poor*" condition upon trapping due to marine mammal injuries or similar) fish that are showing symptoms of heavy sedation (e.g., diminishing gill movement, reduced gasp response when out of water).

1.3.3.2. Fish will be released from the observation tanks when they are in the state of "*Partial Equilibrium*," defined as: gilling normally, making weak tailing movements, cannot swim upright and swims off course without avoiding obstacles; fish will not strongly try to break free of handlers.

1.3.3.3. All fish in an observation tank must be continuously observed by a dedicated observer to ensure adult fish do not recover beyond partial equilibrium prior to return to the brail pool. No lid or restraining device shall be installed on top of the observation tanks.

1.3.3.4. Observation tanks may be used for study objectives such as monitoring recovery time from anesthetic, if approved by FPOM and USACE.

1.3.4. Anesthetic tank water will be replaced at least two times per day. Water temperatures in the anesthetic tank will be maintained within 2°F of the fish ladder water temperature. *If anesthetic tank water temperature exceeds 70°F, criteria in* ***section 4*** *will go into effect.*

1.3.5. Water in the observation tanks will be running continuously to allow a constant exchange of water through the tank.

1.3.6. Personnel shall ensure fish are sampled as quickly as possible. It is recommended that it take no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the return ladder or transportation tank.

1.3.7. Personnel shall ensure that fish are fully recovered from anesthetization prior to release into the return ladder. Fish may volitionally leave the brail pool when they are ready.

1.3.8. When trapping is completed for the day, users will properly shut down the lab.

1.3.9. Four picket leads will be allowed during trap operations for up to four hours. After all picketed leads are raised, fish already in the AFF can be sampled for an additional one hour. The picketed lead operations are as follows[1]:

(a) 0–6,000: All 4 picket leads can be lowered for 4 continuous hours.

(b) 6,000–12,000: All 4 picket leads down for 3 hours. At the 3rd hour, raise at least 1 picket lead for ½ hour, and then continue sampling for additional 1 hour.

(c) 12,000–25,000: All 4 picket leads down for 2 hours. At the 2nd hour, raise at least 2 picket leads for ½ hour, and then continue sampling for an additional 2 hours.

(d) 25,000–35,000: Two picket leads down for four hours.

(e) > 35,000: No picket leads down.

1.3.10. Researchers will also be required to monitor the ladder every hour to ensure there is no crowding. If evidence of crowding is occurring at least two picket leads will be raised.

[1] All counts are of adult salmonids (including jacks) as enumerated the previous day at the Washington Shore count station. Assumes 4 shad = 1 salmonid (e.g., 6,000 salmonids + 4,000 shad = 7,000 total).

1.3.11. Project Fisheries will notify FPOM as soon as Weir 37 violates FPP criteria.

1.3.12. Project biologists retain the authority to raise additional picket leads depending on fish densities and ladder conditions.

1.4. Trapping Protocols – Ladder Water Temperatures >= 70°F.

1.4.1. Trapping will not occur when fish ladder water temperatures meet or exceed 70°F as measured in the brail pool. The only exception is for *US v Oregon* requirements and for nighttime lamprey trapping. Nighttime is defined as official sunset to sunrise.

1.4.1.1. Project Biologists will use the Corps temperature probe reading as the official temperature.

1.4.1.2. Temperatures are both instantaneous readings and 24-hour (0000–2400) averages. Researchers can review daily average, minimum, and maximum temperatures[2] to determine if the trap is within temperature criteria prior to traveling to BON. Instantaneous temperatures will be used to determine if trapping operations will continue for the day.

1.4.1.3. Project biologists will collect temperature data weekly from the data logger in the exit ladder. Daily checks may be requested when temperatures approach 70°F.

1.4.2. At water temperatures of 70–72°F, sampling will be permitted as defined below for up to four days per week from 0600-1030 hours to allow for *U.S. v Oregon* requirements. This operation will remain in effect until daily average water temperature drops to ≤ 69.9°F. All sampling will cease when temperature reaches 72°F. No sampling may resume until daily average water temperature drops to ≤ 71.9°F. An exception is that nighttime lamprey trapping will be permitted up to 73.9°F for tagging and transport purposes. All nighttime trapping for lamprey will cease when temperatures reach 74°F.

1.4.3. Researchers may continue to work through fish in the holding pool for one hour after picket leads have been raised.

1.4.4. Project Fisheries will notify FPOM as soon as Weir 37 consistently violates FPP criteria.

[2] Temperature data for Lower Columbia River projects at: pweb.crohms.org/tmt/documents/ops/temp/

1.4.5. The density criteria for picket lead operations will be altered and the operations will be as follows (density criteria and adult ladder monitoring outlined above in **1.3.9** also apply[1]):

(a) 0–3,000: All 4 picket leads can be lowered for 4 continuous hours.

(b) 3,000–6,000: All 4 picket leads down for 3 hours. At the 3rd hour, raise at least 1 picket lead for ½ hour and then continue sampling for an additional 1 hour.

(c) 6,000–9,000: All 4 picket leads down for 2 hours. At the 2nd hour, raise at least 1 picket lead for ½ hour and then continue sampling for an additional 2 hours.

(d) 9,000–18,000: 2 leads down for 4 hours. All picket leads raised by 10:30 am.

(e) > 18,000: No picket leads down.

1.4.6. There will be no more than 3 adult Chinook or steelhead or 4 sockeye in the anesthetic tank at a time. A combination of salmonids is allowed, with the maximum of either 2 Chinook or steelhead and 1 sockeye, or 1 Chinook or steelhead and 2 sockeye. This assumes users can effectively track the length of time fish stay in the anesthetic tank.

1.4.7. The brail pool is the primary and preferred recovery pool.

1.4.8. The observation tanks will be used for fish in distress under guidelines established in 3.3.1 through 3.3.4.

1.4.9. If used, water in the observation tanks will be running continuously allowing a constant exchange of water through the tank.

1.4.10. Assure oxygen levels are maintained at saturation in the anesthetic and recovery tanks. There will be no depression in oxygen levels in the anesthetic or recovery tanks. To assure this, water in the anesthetic tank will be replaced at least every three hours.

1.4.11. Maintain the anesthetic and recovery tank water temperatures 1-2°F lower than the ladder water temperature. If ice is used to cool the anesthetic or recovery tank water, the ice should be from river water or from an un-chlorinated water source and should be added in individual sealed containers. Do not exceed a 2°F difference between the anesthetic or recovery tank water and fish ladder water.

1.4.12. Personnel shall ensure fish are sampled as quickly as possible. It is recommended that it take no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the return ladder or transportation tank.

1.4.13. Personnel shall ensure fish are fully recovered from anesthetization prior to release. Fish may volitionally leave the brail pool when they are ready.

1.4.14. Project biologists retain the authority to raise additional picket leads depending on fish densities and ladder conditions.

1.5. Winter Trapping Protocols (December 1 – March 14).

The purpose of these protocols is to provide measures to limit passage delay and stress from overcrowding in the brail pool. Personnel conducting research during this time are not required to be present in the AFF. Users are allowed to activate the flume swing gates to divert all fish into the brail pool.

1.5.1. Fish will not be permitted to remain in the brail pool longer than 24 hours. It is recommended that handling of fish occurs daily by 1800 hours. This assures that if fish are sampled at the end of the day, most of the fish captured are only held from the morning until afternoon since passage at night is minimal, thus reducing delay.

1.5.2. During sampling, the brail pool should be raised and one adult salmonid netted, via a sanctuary net, and placed into the anesthetic tank at a time. After removing fish from the brail pool into the anesthetic tank, the brail pool will be lowered back to its full depth.

1.5.3. There will be no more than three adult salmonids in the anesthetic tank at a time. This assumes users can effectively track the length of time fish are in the anesthetic tank.

1.5.4. There will be no more than two adult salmonids in the recovery tank at a time.

1.5.5. Water in the recovery tank will be running continuously, allowing a constant exchange of water through the tank.

1.5.6. Personnel shall ensure fish are sampled as quickly as possible. It is recommended that it take no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the return ladder or transportation tank.

1.5.7. Personnel shall ensure fish are fully recovered from anesthesia prior to release.

1.5.8. If daily sampling is not to occur within 24 hours, the main ladder picket leads and downstream exit gate will be raised. The lab will be properly returned to bypass mode.

2. ICE HARBOR DAM ADULT FISH FACILITY

2.1. General.

2.1.1. Personnel conducting research at the adult fish trapping facility at Ice Harbor Dam will implement the following protocols. These protocols were coordinated with fisheries agencies and tribes through the Fish Passage Operations and Maintenance (FPOM).

2.2. Administrative Requirements. All researchers and managers working at the facility will adhere to the following requirements:

2.2.1. The facility will not be operated unless there is an approved Corps-funded research project that requires its use, or the user has a letter from the Corps that permits use of the facility. Users not funded by the Corps should request permission to use the trap by sending a letter to: *Chief, Operations Division, U.S. Army Corps of Engineers, 201 North Third Avenue, Walla Walla, WA 99362*. Appropriate authorizations from the relevant federal and state fishery agencies, as indicated in paragraph b below, should be included with the letter. Upon approval of the user's request, the Corps will provide copies of the user's letter and authorizations to the Corps' project biologist at Ice Harbor Dam.

2.2.2. Users must have the proper federal authorization (e.g., ESA Section 10 permit) from the U.S. Fish & Wildlife Service and/or NOAA Fisheries if their activity may or will affect listed species, as well as any required state authorization from the Washington Department of Fish & Wildlife for listed or unlisted species. *Note: If federal or state fishery agency requirements are more restrictive than the following protocols, users must follow the fishery agency requirements.*

2.2.3. Hard hats will be worn if so required by the Corps' Operations Manager at Ice Harbor (509-543-3256).

2.2.4. Long pants worn at all times.

2.2.5. Steel-toed shoes or steel-toed rubber boots worn at all times.

2.2.6. Notification Required For Work during Regular Business Hours (Monday–Thursday, 0630–1700 hours). Users will notify the project biologist when they arrive on site and when they depart (509-543-3208). The Project Biologist will determine daily availability of the transport tank trailer. Project Biologist needs for fish rescue or emergencies will be priority over the trap user needs for the project transport trailer. If users supply the project biologist with a season schedule, it may not be necessary to notify project biologist upon arrival and departure.

2.2.7. Notification Required For Work during All Other Hours (Monday–Thursday, 1700–0630 hours, or anytime Friday–Sunday). If users are on site during times other than regular business hours, specific notification procedures must be worked out with the Operations Manager at Ice Harbor *in advance*. Users *may* be required to contact the control room (509-543-3231) upon arrival and departure.

2.2.8. Users must present a safety plan to the project biologist, who can provide guidance for developing the plan.

2.3. Trapping Protocols (Mar 1-Dec 15) – Ladder Water Temperatures <70°F.

2.3.1. Since the trap is operated manually, personnel conducting research are required to be present at the facility to divert desired fish.

2.3.2. The trap will be tested for proper operation before trapping begins. After each day's use the trap will be promptly removed from the water by either dogging it off above the water or completely removing it from the fish ladder for subsequent days of trap use. On days when users will not be trapping, the trap will be completely removed and stored on the ladder deck.

2.3.3. Trapping operations can take place between 0600 and 1400 hours, operating in the water not to exceed 4 hours per day or until the designated number of desired fish are obtained, whichever occurs first. Trapping operations shall limit the number of fish lifted from the trap to the powerhouse deck to two per lifting cycle.

2.3.4. Netting of fish is not recommended. If transfer of fish is necessary, fish should stay in water at all times through the use of a water-filled bag, sanctuary net, or other means. The device used should be large enough to safely handle the largest fish.

2.3.5. Non-target fish will be released to the ladder.

2.3.6. Oxygen levels in fish handling tanks will be maintained at saturation by replacing the water and providing aeration as necessary.

2.3.7. Water temperatures in all fish handling tanks will be maintained within 2°F of the fish ladder water temperature but less than 70°F. Frozen river water or chillers may be used to regulate water temperature in the anesthetic, recovery, and transportation tanks as long as the temperatures do not deviate more than 2°F from the ladder temperature and the tank temperature remains less than 70°F. Note: If anesthetic tank water temperature exceeds 70°F, criteria in **section 4** will go into effect.

2.3.8. Personnel shall sample fish as quickly as possible. It should require no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the ladder or transportation tank. If practical, river water shall be cycled through anesthetic, recovery and/or transportation tanks while holding fish at the dam until transported to the river for release or returned to the ladder. If flow-through water cannot be provided in the transportation tank, water will be recirculated within the tank and oxygen added to maintain the tank at oxygen saturation level.

2.4. Trapping Protocols (Mar 1-Dec 15) – Ladder Water Temperatures 70°F–72°F.

2.4.1. The trap may be operated when water temperatures are within the range of 70–72°F, provided that researchers closely adhere to the restrictions below. Trapping operations will not be allowed, and trapping must cease immediately, if fish ladder water temperatures exceed 72°F. Water temperature in each tank and the ladder will be logged when each fish is handled or tagged. Due to the narrow temperature range involved, researchers must use reliable digital thermometers.

2.4.2. Researchers must notify the Corps project biologist in advance when trapping is to occur in this temperature range. The project biologist will occasionally monitor trapping operations.

2.4.3. The trap will be tested for proper operation before trapping begins. After each day's use, the trap will be promptly removed from the water by either dogging it off above the water or completely removing it from the fish ladder. On days when users will not be trapping, the trap will be completely removed and stored on the ladder deck.

2.4.4. Trapping operations can take place between 0600 and 1200 hours, operating in the water not to exceed 4 hours per day or until the designated number of desired fish are obtained, whichever occurs first. The period from 0600 to 1000 hours is preferred. Trapping operations shall limit the number of fish lifted from the trap to the powerhouse deck to two per lifting cycle.

2.4.5. Between 70°F and 72°F, sampling will be permitted as defined here in **section 4** for up to four days per week until the 1200 hour when the trap will be removed from the water. This 70-72°F operation will remain in effect until daily average water temperatures drop to ≤ 69.9°F when the <70°F criteria in **section 3** apply. All sampling will cease when ladder water temperatures reach 72°F. No sampling may resume until daily average ladder water temperatures drop to ≤ 71.9°F.

2.4.6. Netting of fish is not recommended. If transfer of fish is necessary, fish should stay in water at all times through the use of a water-filled bag, sanctuary net, or other means. The device used should be large enough to safely handle the largest fish.

2.4.7. Non-target fish will be released to ladder.

2.4.8. Oxygen levels in fish handling tanks will be maintained at saturation by replacing the water and providing aeration as necessary.

2.4.9. Water temperature in the anesthetic tank will be maintained within 1-2°F of the ladder water temperature (not to exceed 72°F). Frozen river water or chillers may be used to regulate water temperature in the anesthetic, recovery, and transportation tanks as long as the temperatures do not deviate more than 1-2°F from the ladder temperature. If practical, flow-through water should be running continuously through these tanks. If flow-through water cannot be provided in the transportation tank, water will be recirculated within the tank and oxygen added to maintain the tank at oxygen saturation level. Water in all tanks shall not exceed 72°F at any time. Water temperature in each tank and the ladder will be logged when each fish is handled or tagged.

2.4.10. Personnel shall sample fish as quickly as possible. It should require no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the ladder or transportation tank.

2.4.11. Fish must be adequately recovered from anesthetization prior to the next step in the handling process, whether placed in the ladder or transported.

3. LOWER GRANITE DAM ADULT FISH FACILITY

3.1. General.

3.1.1. Personnel conducting research at the adult fish trapping facility at Lower Granite Dam will implement the following protocols. These protocols were coordinated with fisheries agencies and tribes through the Fish Passage Operations and Maintenance (FPOM).

3.2. Administrative Requirements.

3.2.1. NOAA Fisheries is the primary user of the facility and employs personnel that are permanently based there. These and all other researchers and managers working at the facility will adhere to the following requirements.

3.2.2. The facility will not be operated unless there is an approved Corps-funded research project that requires its use, or the user has a letter from the Corps that permits use of the facility. Users not funded by the Corps should request permission to use the trap by sending a letter to: *Chief, Operations Division, U.S. Army Corps of Engineers, 201 North Third Avenue, Walla Walla, WA 99362*. Appropriate authorizations from the relevant federal and state fishery agencies, as indicated in paragraph b below, should be included with the letter. Upon approval of the user's request, the Corps will provide copies of the user's letter and authorizations to the Corps' project biologist at Lower Granite Dam.

3.2.3. Users must have the proper federal authorization (e.g., ESA Section 10 permit) from the U.S. Fish & Wildlife Service and/or NOAA Fisheries if their activity may or will affect listed species, as well as any required state authorization from the Washington Department of Fish & Wildlife for listed or unlisted species. *Note: If federal or state fishery agency requirements are more restrictive than the following protocols, users must follow the fishery agency requirements.*

3.2.4. Hard hats will be worn if so required by the Corps' Operations Manager at Lower Granite (509-843-1493 x258).

3.2.5. Long pants are to be worn at all times.

3.2.6. Steel-toed shoes or steel-toed rubber boots are to be worn at all times.

3.2.7. Notification Required For Work during Regular Business Hours (Monday–Thursday, 0630–1700 hours). Users will notify the project biologist when they arrive on site and when they depart (509-843-1493 x263 or x264). If users supply the project biologist with a season schedule, it will not be necessary to notify project biologist upon arrival and departure.

3.2.8. Notification Required For Work during All Other Hours (Monday–Thursday, 1700–0630 hours, or anytime Friday–Sunday). If users are on site during times other than regular business hours, specific notification procedures must be worked out with the Operations Manager at Lower Granite *in advance*. Users *may* be required to contact the control room (509-843-1493 x231) upon arrival and departure.

3.2.9. Users must present a safety plan to the project biologist, who can provide guidance for developing the plan.

3.3. Trapping Protocols (Mar 1-Dec 15) – Ladder Water Temperatures <70°F.

3.3.1. During years prior to 2003, the trap was operated automatically 24 hours/day during much of the fish passage season. Personnel conducting research during this time were therefore not always required to be present at the facility to divert desired fish. Automatic operation and the temporary absence of on-site personnel can continue as required. However, PIT-tag detectors were installed in the upper end of the fish ladder in early 2003. As a result, the new detectors will collect PIT-tag data normally collected at the trap. It is therefore anticipated that trap operation will be minimized in future years. For further information on the adult fish trap operation, refer to the current **FPP Chapter 9 - Lower Granite Dam**.

3.3.2. During lengthy periods of non-use (two days or more), the facility shall be dewatered or the water supply will be shut down. The trap should be operated with water supply from the juvenile bypass system to the extent possible rather than diffuser-14 to avoid out-of-criteria flows in the ladder. In the event trap temperatures deviate significantly (>2°C) from fishway temperatures when using water from the juvenile bypass system, the facility should switch to using water from diffuser-14, provided flow criteria in the ladder is maintained. If freezing weather may cause damage during such a non-use period, the facility will be dewatered.

3.3.3. There will be no time-of-day restrictions for trapping operations.

3.3.4. Adult fish generally do not need to be netted due to the layout of the facility. Netting of fish is not recommended. If transfer of fish is necessary, fish should stay in water at all times through the use of a water-filled bag, sanctuary net, or other means. The device used should be large enough to safely handle the largest fish.

3.3.5. Non-target fish will be released to the return pool.

3.3.6. There will be no more than 12 adult salmonids allowed in the anesthetic tank at any one time. This assumes that users can effectively track the length of time fish stay in the anesthetic tank.

3.3.7. There will be no more than 12 adult salmonids allowed in the recovery tank at any one time.

3.3.8. Oxygen levels in fish handling tanks will be maintained at saturation by replacing the water and providing aeration as necessary.

3.3.9. Water temperatures in fish handling tanks will be maintained within 2°F of the fish ladder water temperature but less than 70°F.

3.3.10. Personnel shall sample fish as quickly as possible. It should require no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the return ladder or transportation tank.

3.3.11. Fish must be adequately recovered from anesthetization prior to the next step in the handling process, whether placed in the return ladder or transported. In the case of the return ladder, full recovery is not desirable because fish may jump onto a grating.

3.3.12. Fish must be released or transported from the trap within four days.

3.3.13. Researchers and managers conducting studies or obtaining broodstock are responsible for ensuring the wellbeing of their fish at all times. Twenty-four hour monitoring by personnel on-site is advised but not required.

3.4. Trapping Protocols (Mar 1-Dec 15) – Ladder Water Temperatures 70°F–72°F.

3.4.1. The trap may be operated when water temperatures are within the range of 70–72°F, provided that researchers closely adhere to the restrictions below. Trapping operations will not be allowed, and trapping must cease immediately, if fish ladder water temperatures exceed 72°F. Due to the narrow temperature range involved, researchers must use reliable digital thermometers.

3.4.2. Researchers must notify the Corps project biologist in advance when trapping is to occur in this temperature range. The project biologist will occasionally monitor trapping operations.

3.4.3. During lengthy periods of non-use (two days or more), the facility shall be dewatered or the water supply will be shut down. The trap should be operated with water supply from the juvenile bypass system to the extent possible, rather than diffuser-14, to avoid out-of-criteria flows in the ladder. In the event trap temperatures deviate significantly (>2°C) from fishway temperatures when using water from the juvenile bypass system, the facility should switch to using water from diffuser-14, provided flow criteria in the ladder is maintained.

3.4.4. Trapping operations can take place between 0600 and 1200 hours, for up to 4 hours per day or until the designated number of desired fish are obtained, whichever occurs first. During the summer months, the period from 0600 to 1000 hours is preferred.

3.4.5. Trapping operations may take place up to 4 days per week.

3.4.6. Adult fish generally do not need to be netted due to the layout of the facility. Netting of fish is not recommended. If transfer of fish is necessary, fish should stay in water at all times through the use of a water-filled bag, sanctuary net, or other means. The device used should be large enough to safely handle the largest fish.

3.4.7. Non-target fish will be released to the return pool.

3.4.8. There will be no more than 3 adult salmonids allowed in the anesthetic tank at any one time. This assumes that users can effectively track the length of time fish stay in the anesthetic tank.

3.4.9. There will be no more than 3 adult salmonids allowed in the recovery tank at any one time.

3.4.10. Oxygen levels in fish handling tanks will be maintained at saturation by replacing the water and providing aeration as necessary.

3.4.11. Water temperature in the anesthetic tank will be maintained 1-2°F lower than the ladder water temperature. If ice is used, the ice should be from river water or from an un-chlorinated water source. If practical, water temperature in the recovery tank should also be maintained 1-2°F lower than the ladder water temperature; otherwise flow-through water should be running continuously.

3.4.12. Personnel shall sample fish as quickly as possible. It should require no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the return ladder or transportation tank.

3.4.13. Fish must be adequately recovered from anesthetization prior to the next step in the handling process, whether placed in the return ladder or transported. In the case of the return ladder, full recovery is not desirable because fish may jump onto a grating.

3.4.14. Fish must be released or transported from the holding tanks as soon as possible, preferably by 1000 hours the following day but no later than 1700 hours the following day. This provision applies to all situations but mostly involves fish held for hatchery broodstock.

3.4.15. Researchers and managers conducting studies or obtaining broodstock are responsible for ensuring the wellbeing of their fish at all times. Twenty-four hour monitoring by personnel on-site is advised but not required.

DEPARTMENT OF THE ARMY
CHIEF JOSEPH DAM PROJECT OFFICE, CORPS OF ENGINEERS

SEATTLE DISTRICT
BRIDGEPORT, WASHINGTON 98813

CENWS-OD-CJ 13 Aug 02

EFFECTIVE UNTIL SUPERSEDED OR RESCINDED

PROJECT STANDING OPERATING PROCEDURE NO. 406

CHIEF JOSEPH DAM

SUBJECT: Fish Protection Procedures for Turbine Maintenance

To: Operations, Maintenance, and Resource Management Sections

Purpose: Outline key criteria and operational constraints intended to protect, and provide for the recovery of, any fish, which may become trapped in generator draft tubes at the Chief Joseph Dam Project.

1. This procedure provides a general outline of the dewatering process itself, and includes details for only those constraints specifically intended to promote fish survival. It is not intended to address the details of personnel safety policy or procedures, or any detailed operational instructions for the actual dewatering process. Personnel safety provisions are detailed in the appropriate activity hazard analyses. Details of the operational steps for dewatering are covered by separate Operating Procedures and, to some extent, may be dictated by circumstances unique to each dewatering. However, all dewatering efforts will adhere to the fish protection provisions outlined in this procedure.

2. Hydroelectric turbines and water passages must be inspected and serviced periodically. This requires draining the water passages between the intake bulkhead gates and the tailrace stoplogs. After the water reaches tail water level, the remaining water is drained to an dewatering sump and then pumped out into the river. Any fish trapped in the draft tube area must be removed before being stranded or lost through drains. It is therefore desirable to minimize numbers of fish involved in the draining process and then to quickly salvage any fish that may have been trapped.

3. Natural Resource Management section personnel will carry out fish protection and recovery operations with the help of maintenance personnel. During the dewatering process they will be present at the draft tube entry door, and will direct and monitor it through the final stages of the draft tube dewatering.

4. The Project's Natural Resource Management personnel will direct and coordinate the fish protection procedures and the recovery and release process. The Maintenance and Operations

Sections will provide Natural Resource Management advance notice of planned unit dewatering as soon as possible prior to the date of dewatering. Natural Resource Management personnel will conduct meetings and briefings as necessary to ensure all dewatering team members are familiar with the required fish recovery process.

5. Natural Resource Management personnel will coordinate with the National Marine Fisheries Service, Hydro Program Office, 503-231-6855, gary.fredricks@noaa.gov, to provide notification at least two weeks, if possible, in advance of any maintenance requiring dewatering or otherwise potentially affecting fish. In addition, the Fish Passage Operations and Maintenance Group will be notified with an annual schedule, contact USACE Portland District Office, Operations Div., 503-808-4304.

6. Several hours before the unit is to be dewatered the Operations Section will contact BPA to get final approval for the outage and make sure all the clearance tags are ready to be placed. Early on the day of the dewatering, the mechanics and operators will coordinate to lower the intake service gate and/or install the intake bulkhead. This will isolate the intake water passage from the forebay.

7. Operators will prepare to drain the water out of the penstock down to tailrace water elevation while mechanics prepare to install the intake bulkhead and tailrace stoplogs. The mechanics will place the tailrace stoplogs as soon as possible after the unit is flushed out. This entire process from flushing remaining water out of the penstock through complete installation of bulkheads and stoplogs should be completed within 3 hours, barring complications.

8. Operators will open the draft tube dewatering valve and start draining the draft tube to the dewatering sump. At the same time the sump dewatering pump or pumps will be started but the dewatering sump will not be allowed to go below an elevation of 733 feet above sea level. The draft tube is drained by gravity to this dewatering sump, so by restricting the dewatering sump to a minimum elevation of 733 feet, the draft tube is also restricted to this minimum elevation. The bottom of the draft tube is at an elevation of 725 feet above sea level, so this leaves a large area of water eight feet deep for any trapped fish. The water level in the draft tube will be monitored remotely from this dewatering sump. At no time will the water level in the dewatering sump drop below 733 feet without all aspects of the fish recovery plan in place including recovery devices, insulated transport device, etc. Project personnel will have the dip net, lifting sling, insulated fish carrying tank, and all required safety equipment at the unit during the final dewatering process. Fish can survive four days in the draft tube at a water level of 733 feet and above.

9. For safety reasons, the draft tube entry door will not be opened until confirmation that the tailrace stoplogs are sealed, i.e.: the water level is verified to be below the draft tube man door petcock and a maximum of one dewatering pump is maintaining the water level in the sump. Once Operations has declared a satisfactory seal has been achieved, the mechanics will then open the draft tube access door. General Maintenance personnel will either install safety gear at this time for access to the bottom of the draft tube, or, if the suspended work platform is to be required during this unit outage, it will be installed first. Once the draft tube door is open, the work platform can be installed when necessary and the water level in the draft tube can be monitored from the draft tube man door.

10. When satisfied all fish recovery preparations are in place, the designated Natural Resource Management Section person will authorize the Maintenance Section clearance holder to request the water level in the draft tube be lowered below the 733-foot elevation to a level that allows for safe entry into the draft tube. Upon authorization, the Maintenance Section clearance holder will request the Chief Operator lower the water level in the sump/draft tube below an elevation of 733 feet. Upon receiving the clearance holder's request to go below 733 feet, the Chief Operator shall contact the designated Natural Resource Management Section person to confirm that all fish recovery preparations are complete, and lowering the water level below 733 feet is authorized. After receiving this confirmation, the Chief Operator will authorize journeymen operators to operate the sump as required to control the water level in the draft tube as requested by the designated Natural Resource Management Section person. Once the level in the sump drops below 733 feet, the designated Natural Resource Management Section person will visually monitor the draft tube water level.

11. When the water is down to a level where entry is safe, approximately two to four feet in depth, personnel will enter the draft tube through the draft tube access door at 747-foot level to inspect for trapped fish. Any live fish will be netted out with a dip net and placed in a rubber-lifting sling that is sized to hold the fish and water. The sling will then be lifted vertically to the 747-foot level and then to the 785-foot level generator floor through a series of hatches and stairways. This should take less than five minutes, during which time the fish will be in water. They will be placed in a large insulated fish carrying tank full of river water located on a cart which will be transported to the freight elevator, from which it will be loaded into a truck for eventual release of fish at the downstream boat ramp, using a flume if necessary. The fish will be handled only once during the netting process. At all other times the fish will be kept in water.

12. When the designated Natural Resource Management Section person has determined that either there are no fish in the draft tube or that all the fish have been safely removed, he will notify the Chief Operator that all fish recovery operations are complete. He will also notify the clearance holder that all fish protection restrictions on water levels in the draft tube and dewatering sump have been released.

13. Other considerations for fish protection include the following:

a. Tailrace logs have structural cross-members that form shelves, which may trap fish. These will be screened off as the bulkheads are removed for maintenance in 2002, but will be inspected for fish as applicable prior to screen installation.

b. Work windows intended to minimize likelihood of trapping endangered species will be investigated, although BPA power demands somewhat limit the timing of unit outages. Initially, avoidance of the month of October is suggested; adjustments may be considered according to experience.

c. Units 1 through 16 have floor drains with a grate with 2.5 inch spacing. It is possible for fish smaller than about ten inches to slip through these draft tube floor drains before they can be salvaged. Units 17 through 27 have side drains with small grate spacing. If necessary, smaller-mesh grating will be added or substituted on the floor drains to prevent entrapment of fish.

14. Equipment required for performing this procedure:

a. Two water hoses to supply water to gallery tank as well as transport tank..

b. Waders.

d. Two 5 gallon buckets to fill water tanks.

e. Large dip nets.

f. Fish bags/large fish stretcher.

g. Rope access ladder and anchors.

h. Rope to assist in hauling fish up ladder.

i. Life vests.

j. Safety belts, 1 per person; also anchored rope or cable for attachment to safety belt during entry and exit.

k. Dollies, one for gallery fish tank and one for transport tank used to take fish up the elevator.

l. Truck with fish transport tank (and possibly flume), to be procured as necessary.

15. Personnel required for performing this procedure:

a. Biologist or other trained personnel to advise on fish handling.

b. Personnel to net and transport fish in draft tube. Fish removal from draft tube requires a minimum of two people, however, three are preferred.

MARK C. JENSON, P. E.
Operations Project Manager

CJD FLOW DEFLECTOR CONSTRUCTION SPECIFICATIONS: (Provided By J. Laufle 2006)

1 Fish Salvage Operations

The contractor shall provide 5 working days notice prior to initial dewatering of each work area to allow for a Government Fisheries Biologist to be on site to perform fish salvage operations. During dewatering, if fish become trapped within the work area, the Contractor shall stop dewatering activities at a time directed by the Government Fisheries Biologist to allow the trapped fish to be removed from the work area. Removal of trapped fish will require the use of on-site equipment provided by the contractor to access the bottom of the dewatering caisson (e.g. ladder) and to lift a tank or sling containing fish and water out of the dewatering caisson and to place it into the river (e.g. crane or pulley system). Government personnel will capture and remove the trapped fish, following which the Contractor may resume dewatering activities.

2 Bubble Curtain

To exclude fish from work areas and to attenuate potentially harmful underwater vibrations, the Contractor shall design, furnish, install, and operate a bubble curtain to help minimize impacts of work on fish. The bubble curtain shall consist of one or more air compressors and air distribution piping. The distribution piping shall have a pipe installed on the river bottom and encircling the work area. The distribution pipe shall have holes drilled at 6 inches on center maximum along the top side of the pipe. The system shall be designed to provide a minimum of 0.25 cfm of air from each hole in the pipe. The pipe shall be weighted sufficiently to maintain its position on the river bottom and to maintain the upward orientation of the holes. The bubble curtain shall be operated whenever the dewatering caissons are being placed to begin work on a new flow deflector. The bubble curtain may be removed upon successful sealing of the dewatering caisson. In addition, a bubble curtain must be used during any pile driving activities, and may be required during drilling activities. Use of the bubble curtain may be required during any activities that are identified as having the potential to cause harm to fish.

The Contractor may propose the use of a proven alternative method to the Contracting Officer. Any alternative method must be approved by the Contracting Officer.

Note that the contractor was allowed to elect to use strobes instead of a bubble curtain, and has also employed a diver to sweep the area enclosed by the cofferdam prior to sealing.

OPERATING GUIDANCE #14

Dworshak Dam Fish Protection Procedures for Turbine Maintenance

Dworshak O&M Section	Date of Issue: March 2012	Last Revision: 17 November 2011

1. PURPOSE: Define operational procedures to minimize the number of fish that can become trapped when unwatering a penstock/scrollcase for annual maintenance, repairs, or overhaul of a power unit. If any fish are trapped, define proper handling procedures and documentation requirements. **These activities will be followed to completion including the fish protection and recovery provisions outlined in this procedure, regardless of overtime requirements**.

2. This procedure provides a general outline of the unwatering process itself and includes details for only those constraints specifically intended to promote fish survival. It is not intended to address the details of personnel safety policy or procedures, or any detailed operational instructions for the actual unwatering process. Personnel safety provisions are detailed in the appropriate activity hazard analysis. Details of the operational steps for unwatering are covered by separate Operating Procedures. All unwatering efforts will be adhered to in reducing the time incurred throughout the unwatering process.

3. Hydroelectric turbines and water passages must be inspected and serviced periodically. This requires draining the water passages between the emergency (headgate) gates and the tailrace stoplogs. After the water reaches tail water level, the remaining water is drained to an unwatering sump and then pumped out into the river. Any fish trapped in the draft tube area must be removed before being stranded or lost through drains. It is therefore desirable to minimize the numbers of fish involved in the draining process and then to quickly salvage any fish that may have been trapped.

4. The DWR Operations & Maintenance (O&M) Section will coordinate with NWW District Operations Technical Support Branch and provide notification at least two weeks if possible in advance of any maintenance requiring unwatering or otherwise potentially affecting fish. District Operations will inform NOAA and other regional fishery agencies through Fish Passage Operations and Maintenance (FPOM) Team standard coordination process when any fish salvage operations are to occur.

5. DWR O&M Section will notify LWG of the need to provide the LWG Fisheries Biologist to lead the planned turbine unit unwatering as soon as possible prior to the date of unwatering. LWG Fisheries Biologist will direct and coordinate the fish protection procedures and the recovery and release process. The exact location for any fish release will be identified and visited just before fish salvage operations begins. If a flume is used, there will need to be flushing flow and the impact velocity with the tailrace will need to be at a level that does not harm fish of the size anticipated in this salvage operation. The LWG Fisheries Biologist will conduct meetings and briefings as necessary to ensure all unwatering team members are familiar with this Operating Guidance, documenting entrapped fish, and the required ESA safe fish handling and recovery process.

6. LWG Fisheries Biologist directs fish protection and recovery operations with the help of operations and maintenance personnel from the operating project. The LWG Fisheries Biologist may request additional personnel from USFWS Dworshak hatchery personnel to work in concert with and assist with the activity at the discretion of the Dworshak Operations Manager. During the unwatering process, the LWG Fisheries Biologist will be present at the draft tube entry door and will direct and monitor water levels, and fish condition through the final stages of the draft tube unwatering.

7. The night before a unit is to be unwatered, the operator will turn off the lights overlooking the tailrace to reduce the attraction of smaller fish. Several hours before the unit is to be unwatered the DWR Operations Section will contact BPA to get final approval for the outage and make sure all the clearance tags are ready to be placed. Early on the day of the unwatering, the mechanics and operators will coordinate to lower the emergency gate and/or install the intake bulkhead. This will isolate the intake water passage from the forebay. A least one day in advance the LWG Fisheries Biologist will ensure that adequate fish recovery equipment and personnel trained in fish handling are available for the unwatering and fish recovery event. Trained personnel to assist in the salvage procedure may come from local fish facilities and/or district operations division.

8. When the turbine unit draft tube is to be unwatered, the operator will coordinate with local agencies (e.g., USFWS personnel from Dworshak Hatchery), RCC, and BPA to run the unit with a full load for 15 minutes to flush the scroll case and the draft tube of fish. In the case of unit 3, full load will not be achieved and 2.5 kcfs will be used to stay within the river rate-of-change restrictions. At pool elevation of 1520’ minimum discharge of 3.5kcfs is required to obtain stable operation and reduce gassing, at the same time a small unit would be cut back to allow for the rate of change which is still limited to 1’/hr on ramp up and down. The operator will close the penstock emergency gate (hydraulic headgate) to drain the water out of the penstock down to tailrace water elevation. Once a seal is confirmed by closing the unit wicket gates and monitoring penstock pressure and flow, the mechanics will place the tailrace stoplogs. The process from flushing the remaining water out of the penstock and confirmation of a seal through complete installation of tailrace stoplogs is estimated to take 4-6 hours barring any complications. All efforts in this step will be made to reduce the time involved from flushing to the installation of stop logs via staging equipment, support supplies material and crews. (Units 1&2 have 2 stop logs each and unit 3 has 4 each). If a seal is not obtained, the process, *including flushing*, must be repeated. Installation of the penstock maintenance bulkhead may be accomplished after the tailrace stoplogs are installed.

9. Once seal is confirmed, the operator will open the penstock drain and the draft tube unwatering valve and start draining the draft tube thorough the unwatering sump. At the same time the sump unwatering pumps will be initially reprogrammed to maintain water level in the draft tube to an elevation between 936 to 938 feet, depending on the unit to provide a sanctuary pool. The draft tube is drained by gravity to the unwatering sump, so by restricting the unwatering sump to a minimum elevation of 936 to 938 feet, the draft tube is also restricted to this minimum elevation. The bottom of the draft tube is at an elevation of 929’ for unit 3 and 933’ for units 1 and 2, creating a large sanctuary pool between 3 to 7 feet deep for any trapped fish. The water level in the draft tube will be monitored remotely from the draft tube access

door. At no time will the water level in the unwatering sump drop below 936’ or 938’ depending on the unit, without all aspects of the fish recovery plan in place to include; recovery devices, insulated transport device, etc. Project personnel will have dip nets, lifting sling, and insulated fish carrying tank, and all other required fish recovery equipment and safety equipment at the unit during the final unwatering process.

10. For safety reasons, the draft tube entry door will not be opened until confirmation that the tailrace stoplogs are sealed, i.e.: the water level is verified to be below the draft tube man door petcock and a maximum of two unwatering pumps maintaining the water level in the sump. Once Operations has declared a satisfactory seal has been achieved, the mechanics will then open the draft tube access door, maintenance personnel will place a tube with a bubbling device turned on to provide additional oxygen to any trapped fish. The biologist will deploy sonar into the draft tube capable of viewing fish to determine if a large number of fish are present. If a large number of fish are present, the process will be reversed and the turbine will be readied to be re-run at night when fish are less likely to move into the unit. If an unusually large number of fish are not identified, maintenance personnel will prepare for access into the draft tube.

11. When satisfied all fish recovery preparations are in place, the LWG Fisheries Biologist will authorize the clearance holder to request the water level in the draft tube be lowered to 935 feet for units 1 and 2, and 931.5’ for unit 3, a level that allows for safe entry into the draft tube. Upon receiving the clearance holder’s request to lower the draft tube water elevation, the shift operator shall contact the LWG Fisheries Biologist to confirm that all fish recovery preparations are complete, and lowering the water level that allows safe entry is authorized. Once the level in the draft tube drops below 935 to 938 feet, the LWG Fisheries Biologist and project maintenance personnel will visually monitor the draft tube water level.

12. When the water is down to a level where entry is safe, approximately two feet in depth, personnel should enter the draft tube through the draft tube access door to inspect for trapped fish. Any live fish will be netted one at a time with a knotless dip net and placed in a lifting sling that is sized to hold the fish and water. The sling will then be lifted vertically to the entry door then transferred directly to large insulated fish carrying tank full of river water with no more than ½ pound of fish per gallon of water in the tank at one time. The container will then be transported to the freight elevator, and be taken to the 1005-foot level erection floor, transferred to the release site as determined by the LWG Fisheries Biologist earlier and released into the tailwater, using a flume if necessary, as determined previously in **section 5**. All fish handling only once during the process. At all other times the fish transfer will be water to water. Adequate flushing flow must be maintained throughout each step the fish salvage process. If a large number of fish are involved, it may be necessary to remove the salvage personnel, allow a sanctuary pool to refill, allowing the fish to recover from the activity and low oxygen levels.

13. When the LWG Fisheries Biologist has determined that either there are no fish in the draft tube or that all the fish have been safely removed, he will notify the shift operator that all fish recovery operations are complete. He will also notify the clearance holder that all fish protection restrictions on water levels in the draft tube and unwatering sump have been released.

14. Other considerations for fish protection include the following:

a. Annual routine maintenance work windows intended to minimize likelihood of trapping endangered species will be investigated to determine if work can be shifted to a time with less migration of endangered species, although BPA power demands and requirements to control TDG, provide temperature to the river and hatchery along with providing flow augmentation somewhat limit the timing of unit outages. Initially, avoidance of the peak adult fish migration from October thru February. Unwatering work is recommended to occur as soon as possible during the month of September. Adjustments may be considered according to experience.

b. A routine annual maintenance schedule will be submitted to NWW Operations, Technical Support Branch, Adult Fish Passage Coordinator for review.

c. Within 24 hours of completion of Operation & Maintenance activities, fish salvage activities should be documented with a *Record of Fish Salvage Operations* (see template at end of this Appendix). Records should be maintained with helpful information to predict the number of fish to be salvaged in a forthcoming unwatering activity. The records should also contain comments on how well the unwatering and fish recovery activities proceeded, any problems encountered, and observations on fish and holding conditions. Submit this report to NWW-OD-T Adult Fish Passage Coordinator.

15. Equipment required for performing this procedure:

a. Hose attached to tailrace deck wash system (river water) to fill fish transfer tanks as needed.

b. Two large fish nets, knotless, one for each worker.

c. Two small fish nets, knotless, one for each worker.

d. Two vinyl slings sized to hold fish and water

e. Headlamps for workers in draft tube.

f. One radio.

g. Waders for workers.

h. Rubber or neoprene gloves for workers.

i. Wristwatches.

j. Thermometers.

k. Hard hats, waders/rubber boots, neoprene gloves, and rain gear for personnel entering draft tube.

l. Fish bucket lifting gear (station at entry door).

m. Two 4-wheel carts with 150-gallon fish tanks, approximately 1/3 full of water on each return from the tailrace or industrial water supply. Have supplemental oxygen system, air lines and air stones standing by at same location. The 4-wheel carts should have a portable source of oxygen and air lines during transport to the release location.

n. Hazardous atmosphere monitoring device for sensing inside draft tube (at entry door).

o. *Record of Fish Salvage Operations* (see template at end of this Appendix).

16. Personnel required for performing this procedure:

a. Operators for lift line (lowers and raises fish).

b. LWG Fisheries Biologist.

c. Shift operator (ensures slow and proper timing of draft tube drainage).

d. Four laborers (two inside draft tube to net fish into rubber lifting slings and at least two outside draft tube to transfer fish to release site).

17. Fish Handling Procedures:

a. Establish an unwatering coordinator, usually the LWG Fisheries Biologist.

b. Roll the unit for about 15 minutes before lowering the emergency gate and tailrace stoplogs. (all done within 4-6 hours)

c. Attend a safety meeting and discuss safe operating and Walla Walla District ESA fish handling policy and procedures. Be sure proper clearance procedures are discussed. Also, the draft tube area should be treated as a confined space.

d. Begin draining the draft tube as described above. This requires several hours.

e. Obtain a tailrace river temperature, draft tube reading.

f. Allow the deck wash system to run until the water temperature matches within $2^{o}F$ of the river temperature, then fill the fish transport tanks with this water.

g. Ensure that unwatering is done very slowly once the water is about two feet deep. Mechanics and LWG Fisheries Biologist will monitor water level throughout the unwatering process.

h. Two workers enter the draft tube.

i. Net fish into fish slings and lift them out of the draft tube via the rope hoist. Nets should be knotless and no more than one fish should be in a net at one time. When it is necessary to transport fish in sanctuary bags, ensure the bags contain a sufficient amount of water and

that fish return to fresh water as soon as possible. Pour fish into the fish transfer tank. The LWG Fisheries Biologist will determine if water should be refreshed and if oxygen is needed by monitoring the overall fish condition. Generally from the draft tube to release in the river tailrace, it should take no more than 6 to 8 minutes to capture, transport and release a fish.

j. The LWG Fisheries Biologist monitors the number of fish in the transfer tank and, considering the water temperature and holding time, determines when the fish should be taken to the tailrace to be released to the river. Fish placed in tanks and containers will not exceed ½ pound per gallon of water and will be released as soon as possible.

k. When the fish transfer tank exits the powerhouse, use the deck wash system to refresh the water and/or adjust the water temperature as needed. Ensure that the water temperature in the tank, the deck wash system, flume flushing water is within 2^{o}F of the river temperature. May use frozen river ice in maintenance of water conditions during the transport of fish to the tailrace.

l. Fish should not be netted twice (once in the salvage location and not again at the release site). The preferred method of releasing fish should to the tailrace flume or river via water to water transfer.

m. Complete the Record of Fish Salvage Operations (attached at end of this document). This is a permanent record.

RECORD OF FISH SALVAGE OPERATIONS - DWORSHAK DAM

LWG Fisheries Biologist in Charge: Other Personnel:	Activity	Date	Time
	Emergency Gate in Place		
	Tailrace Stoplogs Installed		
	Draft Tube Door Open		
	Fish Recovery Begins		
	Fish Recovery Complete		

Purpose of un-watering:

River Temperature:
(Note: Temperature of containers to be maintained within 2°F of river temperature.)

Problems/Comments:

SPECIES AND COUNTS OF FISH RELEASED TO TAILRACE

Species	Female		Male		Comments
	Clipped	Un-clipped	Clipped	Un-clipped	

SPECIES AND COUNTS OF FISH MORTALITIES

Species	Female		Male		Comments
	Clipped	Un-clipped	Clipped	Un-clipped	

**Submit this report to NWW-OD-T Adult Fish Passage Coordinator within 24 hours of fish recovery. FPOM must be notified immediately of any fish mortalities.

Appendix J

Smolt Monitoring Facility Operating Protocols at Bonneville, John Day and McNary Dams

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1. BONNEVILLE DAM JUVENILE MONITORING FACILITY (JMF)

This Appendix describes operating protocols that will be implemented by agencies conducting research in the Bonneville Dam (BON) Juvenile Monitoring Facility (JMF) to avoid or minimize delayed fish mortality resulting from stress during handling. These protocols were coordinated with fish agencies and tribes in the Fish Passage Operations & Maintenance (FPOM) workgroup.

1.1. General Facility Protocols.

1.1.1. Sample rates should not exceed 25% unless collecting research fish when water temperatures are < 70°F.

1.1.2. Personnel conducting research or monitoring must be present at the facility to monitor the separator bars for debris and stranded fish.

1.1.3. The Corps reserves the right to terminate trapping operations at any time.

1.1.4. Project Biologists will use the Corps temperature probe reading as the official temperature. Temperatures are taken in the general holding tank and are both instantaneous readings and 24-hour averages (0000-2400 hours).

1.2. BON JMF Requirements for Users.

All personnel conducting research or monitoring in the JMF will implement the following:

1.2.1. Users must have appropriate documentation for conducting research at the dam (see *Guide for Researchers at Bonneville Dam*).

1.2.2. Users must have valid State and Federal permits that cover all ESA-listed species that may occur at the project during the collection period. Users shall comply with all permit conditions, even if more restrictive than protocols herein.

1.2.3. JMF personnel will be trained in the proper operation of the JMF to insure fish and personnel safety. Users may request training through the Project Biologists.

1.2.4. Hard hats worn outside at all times.

1.2.5. Long pants or raingear worn at all times. Shorts not permitted in the lab.

1.2.6. Steel-toed shoes or rubber boots worn at all times. Tennis shoes or sandals not permitted.

1.2.7. If JMF users supply the Project Biologists with a season schedule, it will not be necessary to notify Project Biologists upon arrival and departure.

1.2.8. Users may coordinate sample rates with Smolt Monitoring Program (SMP) personnel.

1.2.9. Users are permitted to routinely operate flushing valves, fish lifts, and release pipes/valves within the monitoring building.

1.2.10. Any modifications to the building or equipment will first be approved by Bonneville Project through Project Fisheries.

1.2.11. All anesthetic water will be emptied into the sewage lift station after running through the activated charcoal filters.

1.2.12. Project Biologists will operate the upper switchgate at the start and end of each season. Users may operate the upper switchgate as necessary when separator bar monitoring is not available.

1.2.13. The lower switchgate is in automatic control. Users will monitor and report to Project biologists any problems with the lower switchgate.

1.2.14. On seasonal ascending tailwater elevations, the transition from low to high outfall should be between tailwater elevations at the upper end of 16’ to 18’ range.

1.2.15. On seasonal descending tailwater elevations, the transition from high to low outfall should be between tailwater elevations at the lower end of 18’ to 16’ range.

1.2.16. Avian cannons will be operated 24 hours per day from March 1 through November 1.

1.2.17. Project operators and mechanics are responsible for starting/stopping avian cannons.

1.3. BON JMF Sample Mode Operations (typically Fish Passage Season Mar 1 – Nov 30).

1.3.1. In August, SMP avian personnel will operate the sampling facility as part of the SMP and to collect fish for regionally-approved research.

1.3.2. Research updates and equipment or sampling trouble reports will go through Project Biologists to FPOM.

1.3.3. JMF personnel will monitor the JMF continuously while in sample mode to ensure proper functioning and to provide quick response to an emergency while JMF is in sample operation.

1.3.4. JMF personnel will perform a walk-through inspection of the entire facility (except the 2-mile transport flume) every two hours to ensure safe fish passage conditions.

1.3.5. During August, avian cannons may be shut off if Project Biologists observe no predatory birds at the outfall and coordinate through FPOM.

1.3.6. To prevent injury and/or mortality to passing fish, particular attention will be paid to the following: dewatering facilities including the PDS, SDS, PDS screen cleaner system, adult transport flume, juvenile hopper, all valves and auxiliary water systems, flushing water systems and their perforated plates, all gates including switch and diverter gates, PIT-tag detectors, and all monitoring building systems including holding tanks, valves and conduits.

1.3.7. JMF personnel will observe video monitors at least every $^1/_2$ hour or continuously, and manually inspect every 2 hours or more frequently according to trash sweep operation or other debris potential.

1.3.8. JMF personnel shall monitor kelt passage over the separator.

1.4. BON JMF Sampling at Water Temperatures > 70°F.

1.4.1. Daily average river temperatures will be obtained from the Corps website for Lower Columbia River projects[1]. Project Fisheries will use the Project thermometer in the sample holding tank for official reporting requirements, instantaneous temperatures and when online data are unavailable.

1.4.2. Daily index sampling will be reduced to every-other-day index/condition monitoring.

1.4.3. The upper switchgate is used to select between sample and bypass mode.

1.4.4. Sample sizes will be reduced to approximately 100 fish per day.

1.4.5. Monitoring for gas bubble trauma (GBT) symptoms will continue.

1.4.6. An instantaneous temperature of ≥ 70°F taken from 0630–0700 hours will trigger a change in sampling mode after Project Fisheries notify SMP Biologists.

1.4.7. Normal index sampling may resume when daily average temperatures are ≤ 69.5°F.

1.4.8. If there is a research need to sample at temperatures > 70°F, coordination with FPOM will be initiated by the researcher through the Corps District POC.

1.4.9. If the SMP and Project Fisheries Biologists suspect a bypass system problem during a high temperature sampling period, additional sample collection may occur. FPOM will be notified ASAP and provided with updates as problem resolution attempts proceed.

1.5. BON JMF Bypass Mode Operation (or when no PDS Monitors).

1.5.1. The upper switchgate will be in bypass mode.

1.5.2. The Emergency fish release valve will be open.

1.5.3. All rotating gates will be set to bypass.

1.5.4. The bypass flume gate will be raised.

1.5.5. Project Biologists will inspect the facility daily.

[1] Temperature data for Lower Columbia River projects at: pweb.crohms.org/tmt/documents/ops/temp/

1.6. BON JMF System Failure Protocols.

1.6.1. Any system failure or abnormality will be reported to a Project Biologist immediately. If a Project Biologist is unavailable, the control room will be contacted at ext. 2221 or 2222.

1.6.2. If a high or low water situation occurs in the PDS area, operate as follows:
- **(a)** Contact the control room immediately;
- **(b)** Switch the upper switchgate to bypass mode until the problem is corrected;
- **(c)** Immediately open the emergency fish release valve;
- **(d)** Raise bypass flume gate. *DO NOT ADJUST ANY WEIRS***.**

1.6.3. If a monitoring facility failure occurs, operate as follows:
- **(a)** Open the emergency fish release valve;
- **(b)** Switch the upper switchgate to bypass mode until the problem is corrected;
- **(c)** Raise the bypass flume gate;
- **(d)** Begin fish salvage operations.

1.6.4. If a lower switchgate failure occurs and releases are sent to the wrong high or low outfall, and repairs cannot be made within 24 hours, a special operation will be coordinated via FPOM.

1.6.5. In the event of a problem with either the 2-way or 3-way rotating gates (e.g., stuck open or partially open), the response protocol is as follows:
- **(a)** Switch the upper switchgate to bypass;
- **(b)** Open the emergency fish release valve;
- **(c)** Turn off air to rotating gate and manually rotate half-round pipe section to bypass position;
- **(d)** Inspect the affected areas for stranded fish and return them to the flume. *Dead fish should be held in a bucket for processing by research personnel.*
- **(e)** Contact the Project Biologist, or if that is not possible, the control room operator. Project personnel will request maintenance crews. Repairs should commence within 4 hours of discovering the problem.

1.6.6. Once all fish safety issues have been addressed and repairs requested, document the problem in an e-mail to Project Biologists prior to sending to other interested parties.

2. JOHN DAY DAM SMOLT MONITORING FACILITY (SMF)

The following protocols will be implemented by agencies conducting research in the John Day Dam (JDA) Smolt Monitoring Facility (SMF) as precautionary measures to avoid or minimize delayed fish mortality resulting from stress during handling. These protocols were coordinated with fish agencies and tribes in the Fish Passage Operations & Maintenance (FPOM) workgroup.

2.1. General Facility Protocols.

2.1.1. Sample rates should not exceed 25% unless collecting research fish at water temperatures < 70°F.

2.1.1. The Corps reserves the right to terminate trapping operations at any time.

2.2. JDA SMF Requirements for Users.

All personnel conducting research or monitoring in the JDA SMF will implement the following:

2.2.1. Users must have appropriate documentation for conducting research at the dam (see *Guide for Researchers at John Day Dam*).

2.2.2. Users must have valid State and Federal permits that cover all ESA-listed species that may occur at the project during the collection period. Users shall comply with all permit conditions, even if more restrictive than protocols herein.

2.2.3. Hard hats are to be worn outside at all times.

2.2.4. Long pants or raingear worn at all times. No shorts or sweats permitted.

2.2.5. Steel-toed shoes or rubber boots worn at all times. No tennis shoes, sandals permitted.

2.2.6. If users provide Project Biologists with a schedule, it will not be necessary to notify Project Biologists upon arrival and departure.

2.2.7. Users may coordinate sample rates with Smolt Monitoring Program (SMP) personnel.

2.2.8. Users are permitted to routinely operate SMF flushing valves and release pipes/valves.

2.2.9. Any modifications to the building or equipment will first be approved by The Dalles/John Day/Willow Creek Project through Project Fisheries.

2.2.10. All anesthetic water will be emptied into the activated charcoal filters tanks.

2.3. JDA SMF Sample Mode Operations (typically Fish Passage Season Mar 1 – Nov 30).

2.3.1. SMP personnel will operate the facility as part of the SMP and to collect fish for regionally-approved research.

2.3.2. Research updates and trouble reports will go through the Project Biologists to FPOM.

2.4. JDA SMF Sampling at Water Temperatures > 70°F.

2.4.1. Daily average river temperatures will be obtained from the Corps website for Lower Columbia River projects[1]. Project Fisheries will use the Project thermometer in the sample holding tank for official reporting requirements, instantaneous temperatures and when online data are unavailable.

2.4.2. Daily 24-hour index sampling will be reduced to twice per week (preferably Mondays and Thursdays) index/condition monitoring from 0700–1300 hours.

2.4.3. The switchgate is used to select between sample and bypass mode.

2.4.4. Sample sizes will be reduced to approximately 100 fish per day.

2.4.5. An instantaneous temperature of ≥ 70°F taken between 0630–0700 hours will trigger a change in sampling mode after Project Fisheries notifies SMP Biologists.

2.4.6. Normal index sampling may resume when daily average temperatures are ≤ 69.5°F.

2.4.7. If there is a research need to sample at temperatures > 70°F, coordination with FPOM will be initiated by the researcher through the Corps District POC.

2.4.8. If the SMP and Project Fisheries biologists suspect a bypass system problem during a high temperature sampling period, additional sample collection may occur. FPOM will be notified ASAP and provided with updates as problem resolution attempts proceed.

2.5. JDA SMF Bypass Mode Operation.

2.5.1. All rotating gates will be set to bypass.

2.5.2. Project Biologists will inspect the facility every two hours.

2.5.3. If the full-flow PIT-tag detector is effective, the switch gate will be moved to bypass.

2.6. JDA SMF System Failure Protocols.

2.6.1. Any system failure or abnormality will be reported to a Project Biologist immediately. If a Project Biologist is unavailable, the control room will be contacted at ext. 4211.

2.6.2. In the event of a problem with either the 2-way or 3-way rotating gates (e.g., stuck open or partially open), the response protocol is as follows:

- **(a)** Contact the Project Biologist, or if unavailable, the control room. Project personnel (SMF Biologist) will request maintenance crews. Repairs should commence within 4 hours of discovering the problem;
- **(b)** Once all fish safety issues have been addressed and repairs requested, document the problem in an e-mail to Project Biologists prior to sending to other parties.

3. McNARY DAM JUVENILE FISH FACILITY (JFF)

Agencies conducting research in the McNary Dam (MCN) Juvenile Fish Facility (JFF) will implement the following protocols as precautionary measures to avoid or minimize delayed fish mortality resulting from stress during handling. The Fish Passage Operations & Maintenance (FPOM) workgroup coordinated these protocols with fish agencies and tribes.

3.1. General Facility Protocols.

3.1.1. Sample rates should not exceed 25% unless collecting research fish at water temperatures < 68.0°F.

3.1.2. The Corps reserves the right to terminate trapping operations at any time.

3.2. MCN JFF Requirements for Users.

All personnel conducting research or monitoring in the MCN JFF shall:

3.2.1. Have appropriate documentation for conducting research at the dam;

3.2.2. Have valid State and Federal permits that cover all ESA-listed species that may occur at the project during the collection period;

3.2.3. Comply with all permit conditions, even if more restrictive than protocols herein;

3.2.4. Wear hard hats at all times when outside, in, under or around the JFF or the dam;

3.2.5. Wear long pants or raingear at all times. No shorts or sweats permitted; and

3.2.6. Wear steel-toed shoes (or rubber boots when likely to enter water) at all times. No tennis shoes or sandals permitted.

3.2.7. If users provide the project biologists with a schedule, it will not be necessary to notify them upon arrival and departure.

3.2.8. Users shall coordinate sample rates with Smolt Monitoring Program (SMP) or MCN project biologists.

3.2.9. Users are not permitted to routinely operate JFF flushing valves and release pipes/valves without the permission of project biologists.

3.2.10. The Project Biologist must approve any proposed modifications to the building or equipment.

3.3. MCN JFF Sample Mode Operations (typically April 6 – September 30).

3.3.1. Sampling Procedures:

3.3.1.a. Personnel will normally conduct sampling in accordance with smolt monitoring program guidelines recommended by the PSMFC. Project and SMP personnel may occasionally alter sampling guidelines if fish research activities require it. Normal alterations of sampling guidelines are to adjust the number of fish sampled to meet approved research needs or to minimize the handling of fish during warm water temperature periods.

3.3.1.b. Electronic counting tunnels count sampled fish and staff verify and adjust the counts by hand counts. Staff will base all fish number estimates and rates on the size of the sample of fish collected. Staff will take samples hourly for 24-hours every-other-day. Project biologists will coordinate with SMP personnel to set sample rates.

3.3.1.c. SMP and project personnel will take and use species composition and weight samples to determine loading densities for raceways (if fish are being collected for research needs). Project personnel will keep a running total of hourly estimates of fish numbers and raceway totals. Daily samples for monitoring descaling will include a minimum of 100 fish of the dominant group(s) for which descaling information is recorded. SMP and project personnel will monitor descaling every-other-day for facility operations. SMP and project personnel may conduct full sample descaling instead of 100 fish subsamples as long as it does not adversely affect other facility operations.

3.3.1.d. Where SMP activities are conducted at collector dams, project biologists may utilize daily total information gathered by those personnel.

3.3.1.e. Research updates and trouble reports will go through project biologists to FPOM.

3.4. MCN JFF Sampling at Water Temperatures >68.0°F.

3.4.1. Personnel will obtain daily average river temperatures from the Corps website at: www.nwd-wc.usace.army.mil/ftppub/water_quality/tempstrings/.

3.4.2. Staff will conduct daily 24-hour index sampling every-other-day, 0700–0700 hours. If juvenile salmonid populations experience high mortality after personnel implement the above procedures, the project will cease fish collection for regular sampling, but SMP and project staff shall continue to collect for fish condition sampling for up to 8 hours per day.

3.4.3. The switchgate selects between sample and bypass mode.

3.4.4. If populations experience high mortality, staff will reduce sample sizes to approximately 100 fish per day, within sampling limitations.

3.4.5. Project or SMP personnel will use a thermometer in the sample holding tank for official reporting requirements, instantaneous temperatures or when online data are unavailable.

3.4.6. An instantaneous temperature of 68.0°F or greater taken between 0630 and 0700 hours will trigger a change in sampling mode after a project biologist notifies SMP biologists.

3.4.7. Normal index sampling may resume when daily average temperatures are ≤ 68.0°F.[1]

3.4.8. If there is a research need to sample at temperatures >68.0°F, the Corps District POC will initiate coordination with FPOM.

3.4.9. If the SMP and project fisheries biologists suspect a bypass system problem during a high temperature sampling period, additional sample collection may occur. Project or District biologists will notify FPOM as soon as possible and provide updates as they attempt to resolve the problem.

3.4.10. For additional measures to take when sampling at water temperatures > 68.0°F, see **FPP Chapter 5 - McNary Dam**.

3.5. MCN JFF Bypass Mode Operation.

3.5.1. Project personnel will set the switchgate to the appropriate bypass mode.

3.5.2. Project personnel will inspect the facility as necessary.

3.6. MCN JFF System Failure Protocols.

3.6.1. Personnel shall immediately report any system failure or abnormality to a project biologist, or if unavailable, the control room at ext. 231.

ACRONYMS	
ADCP	Acoustic Doppler Current Profiler
ADV	Acoustic Doppler Velocimeter
AFF	Adult Fish Facility
AFEP	Anadromous Fish Evaluation Program
AWS	Auxiliary Water Supply
BGS	Behavioral Guidance Structure
BI	Bradford Island (BON)
BON	Bonneville Lock and Dam
BPA	Bonneville Power Administration
BRZ	Boat Restricted Zone
CBFWA	Columbia Basin Fish and Wildlife Authority
CBT	Columbia Basin Teletype
CENWP	Corps of Engineers (CE), Northwestern Division (NW), Portland District (P)
CENWW	Corps of Engineers (CE), Northwestern Division (NW), Walla Walla District (W)
CENWW-OD-T	Walla Walla District (W), Operations Division (OD), Technical Support Branch (T)
CFS	Cubic Feet per Second
CI	Cascades Island (BON)
COE	Corps of Engineers
CRITFC	Columbia River Inter-Tribal Fish Commission
DSM	Downstream Migrant (Channel)
DST	Daylight Savings Time
DWR	Dworshak Dam
E	East
EPA	Environmental Protection Agency
ERG	Emergency Relief Gate
ESA	Endangered Species Act
ESBS	Extended-Length Submersible Bar Screen
EW	East Weir
FDS	Fish-Debris Separator
FERL	Fish Engineering Research Laboratory
FFDRWG	Fish Facilities Design Review Work Group

ACRONYMS	
FFU	Fisheries Field Unit
FG	Fish Gate
FGE	Fish Guidance Efficiency
FPC	Fish Passage Center
FPE	Fish Passage Efficiency
FPOM	Fish Passage Operations & Maintenance Coordination Team
FPP	Fish Passage Plan
fps	Feet Per Second
FV	Fish Valve
IHR	Ice Harbor Lock and Dam
IDFW	Idaho Department of Fish and Game
ISO	International Standardization Organization
JBS	Juvenile Bypass System
JDA	John Day Lock and Dam
JFTP	Juvenile Fish Transportation Plan
JMF	Juvenile Monitoring Facility (BON)
JP	Junction Pool
JSAT	Juvenile Salmon Acoustic Telemetry
kcfs	One-thousand cubic feet per second
LCRAS	Lower Columbia River Adult Study
LGS	Little Goose Lock and Dam
LWG	Lower Granite Lock and Dam
LMN	Lower Monumental Lock and Dam
MCN	McNary Lock and Dam
MOP	Minimum Operating Pool
MU	Main Unit
MW	Megawatts
N	North
NDE	North Downstream Entrance
NE	North Entrance
NFE	North Fishway Entrance

ACRONYMS	
NFH	National Fish Hatchery
NOAA Fisheries	National Oceanic & Atmospheric Administration's National Marine Fisheries Service (also referred to as NMFS)
NPE	North Powerhouse Entrance
NSE	North Shore Entrance
NUE	North Upstream Entrance
O&M	Operations and Maintenance
ODFW	Oregon Department Of Fish And Wildlife
OFC	Outlet Flow Control
OG	Orifice Gate
OOS	Out of Service
OPE	Orifice Passage Efficiency
PDS	Primary Dewatering Structure
PIES	Project Improvements for Endangered Species
PIT	Passive Integrated Transponder (PIT-tag)
PLC	Program Logic Controller
PSMFC	Pacific States Marine Fisheries Commission
PST	Pacific Standard Time
PUD	Public Utility District
RCC	Reservoir Control Center (COE)
RSW	Removable Spillway Weir
S	South
SBC	Surface Bypass Collector
SDE	South Downstream Entrance
SE	South Entrance
SFE	South Fishway Entrance
SG	Sluice Gate
SLED	Sea Lion Exclusion Device
SMF	Smolt Monitoring Facility
SO	Sluice Oregon
SPE	South Powerhouse Entrance

ACRONYMS	
SPO	Special Project Operations
SSE	South Shore Entrance
STS	Submersible Traveling Screen
SUE	South Upstream Entrance
SW	Sluice Washington
SWI	Simulated Wells Intake
TDA	The Dalles Lock and Dam
TDG	Total Dissolved Gas
TIE	Turbine Intake Extension
TMT	Technical Management Team
TSW	Temporary or Top Spillway Weir
UMT	Upstream Migrant Transportation (Channel)
USFWS	U.S. Fish & Wildlife Service
VBS	Vertical Barrier Screen
W	West
WDFW	Washington Department of Fish & Wildlife
WECC	Western Electricity Coordinating Council

2018 Fish Passage Plan

Appendix L

US Army Corps of Engineers Avian Monitoring and Deterrence Action Plans at Lower Columbia & Lower Snake River Dams

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1. OVERVIEW – ALL PROJECTS

1.1. This Appendix includes the avian monitoring and deterrence action plans implemented at Corps hydropower projects on the lower Columbia and lower Snake rivers, in accordance with NOAA Fisheries' 2014 Supplemental FCRPS Biological Opinion RPA Action 48.[1] Also included are actions implemented at Bonneville Dam to monitor and deter pinnipeds, in accordance with RPA Action 49. These plans were coordinated with regional Federal, State and Tribal fish agencies in the Fish Passage Operations & Maintenance (FPOM) coordination team.

1.2. Hazing techniques are defined in the approved *Operating Plans*. The program objective is to reduce piscivorous bird predation on juvenile salmonids and lamprey and pinniped predation on adult salmonids, sturgeon and lamprey, by hazing in a manner that impedes their ability to forage on fish and/or forces them to leave the area.

1.3. Hazing activities are implemented by the U.S. Department of Agriculture's Animal & Plant Health Inspection Service (USDA APHIS).

1.4. Avian wires shall be installed each year at Lower Snake River projects prior to April 3 and at Lower Columbia River projects prior to April 10.

1.5. Avian hazing shall occur primarily near dam locations where predation risk is high (e.g., tailrace areas where fish may be disoriented after passing the project and/or forebay areas where fish may be delayed from passing the project).

1.6. Birds shall be hazed near spillway and powerhouse discharge areas, juvenile bypass outfall(s) and where birds congregate or feed, ranging up to approximately 2,000 feet downstream of the dam and outfall site. Roosting and actively foraging birds shall also be hazed within the forebay boat restricted zones (BRZ).

1.7. During juvenile lamprey outmigration, hazers may be requested to focus hazing at specific areas of the project where juvenile lamprey are known to pass.

2. BONNEVILLE DAM

2.1. Monitoring. Bird numbers are accessed daily during fishway inspections by a Project Biologist. Due to low bird populations at the dam during winter months, bird numbers are recorded 7 days a week from April 1 through October 31. Avian monitoring occurs as often as possible outside of these dates and during the non-fish passage season.

2.1.1. Piscivorous birds of interest: gulls & cormorants, though other birds such as mergansers, grebes, osprey and eagles may occasionally be denoted.

[1] See 2014 Supplemental FCRPS BiOp (pg 39) at: www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp.aspx

2.1.2. Zones demarcated: Powerhouse (PH) 1 forebay, PH1 tailrace, Spillway forebay, Spillway tailrace, B2CC outfall, PH2 forebay, PH2 tailrace and smolt monitoring facility (SMF) outfall.

2.2. Action Plan. Measures for avian deterrence at BON are listed below. While gulls and cormorants are present to a significant degree during peak summer months, relative avian abundance is low and no further actions are being considered at this time.

2.2.1. Avian wires are installed each year prior to April 10 in the tailrace areas of PH1, PH2, Spillway and B2CC outfall.

2.2.2. Avian hazers are present at the dam from April 1 through July 31, 8 hours per day, 7 days per week from 0800 to 2000 hours. Hours of hazing vary so birds do not acclimate to long periods of no hazing.

2.2.3. A hydro-cannon operates continuously on the top JBS outfall flume.

2.2.4. A propane cannon was tested for use during fish transport releases at the JBS and may be considered for use if avian predation risk is found to exist during truck releases of juveniles.

2.3. Incident Response. A trigger for additional action is 150 piscivorous birds in a single zone during a single observation.

2.3.1. When the trigger is met, increase USDA APHIS hazing efforts in those areas and increase the number of long-range pyrotechnic devices. A propane cannon may be useful in some zones, (e.g., JBS outfall, B2CC, PH2 tailrace) but application must be limited to avoid impacting project visitors and nearby public areas and towns. Lethal removal would likely work, but is not approved. Lethal removal would require approval and additional funding.

2.3.2. The trigger is only reached a few times a year, usually from mid-September through early October. Unfortunately, USDA APHIS hazing concludes on 31 July. If the trigger is consistently being met in September and October, adjustment of hazing dates could be pursued.

2.4. Reporting. Avian predation will be documented in the Project Weekly Report, including daily predation by species and zone. If warranted, a summary could be included in the Annual Report as well.

2.5. Pinnipeds. California Sea Lions and Stellar Sea Lions shall be hazed at Bonneville Dam March 31–May 31 daily (7 days/week) for 8 hours/day between the hours of 0600–2000. Hours should vary so that pinnipeds do not acclimate to long periods with no hazing, unless otherwise coordinated with the POC.

2.5.1. Pinniped hazing techniques are defined in the approved *Operating Plan* and in accordance with the *Marine Mammal Protection Act of 1972, Section 109 h.1.c*.

2.5.2. Pinnipeds hazing shall occur in the tailrace of the dam and spillway, Tanner Creek and areas where pinnipeds haul-out (unless otherwise coordinated for trapping efforts), ranging to approximately 1,500 feet downstream of the dam and outfall site.

2.5.3. Special activities will be coordinated each year as necessary with Federal, State and Tribal boat hazing, trap/take efforts and/or special evaluations or tests.

2.5.4. Sea Lion Exclusion Devices (SLEDs) will be installed at all adult fishway entrances no earlier than October 1 and no later than February 1 and will be removed by August 1 each year. All floating orifice gates (FOGs) can be left installed year-round.

3. THE DALLES DAM

3.1. Monitoring. Monitoring will be done by Project Fisheries staff daily April 1–September 30, 7 days per week. The standardized form provided by the Avian Task Group will be used to record numbers of gulls, terns and cormorants foraging and non-foraging. A database will be used at the project and can be shared as the Avian Task Group determines.

3.1.1. Zones include forebay, powerhouse tailrace, sluiceway outfall tailrace and spillway tailrace outside of the spillwall, spillway tailrace inside the spillwall, spillway tailrace upstream of bridge and spillway tailrace downstream of bridge.

3.2. Action Plan. Avian hazing will be contracted to USDA as in prior years. Corps NWP employees are not allowed to haze gulls as was successfully done in the past.

3.2.1. Contracted hazing will occur April 15–July 31, 7 days per week, 14 hours/day between the hours of 0600–2000 to cover most daylight hours.

3.2.2. Hazing will consist of launching pyrotechnics as gull numbers increase within any of the zones.

3.2.3. Almost all hazing occurs in SW4 immediately downstream of the bridge. Hazing will not occur from the Navigation Lock peninsula when barge traffic is present.

3.2.4. Avian lines are not in place downstream of the bridge where predation is most prevalent. However, 13 avian lines are upstream of the bridge which tends to keep gull numbers low in that area and 61 avian lines are across the entire powerhouse tailrace as well as half of the channel over the ice/trash sluiceway outfall. Any gulls within the avian line grid are immediately hazed.

3.3. Incident Response. A trigger for additional action should be around 250 gulls, based on recent numbers. This number is reached once to twice per year. Unfortunately NWP has few options available if gull numbers reach a trigger. Lethal removal at this trigger would likely work, but unlike NWW district, is not approved by NWP district. Lethal removal would require a boat crew and additional funding. If for some reason hazing is not available, propane cannon, distress calls and other recent bird replant technology will be tried in attempts to abate gulls.

Investigation of cost savings for Corps NWP employee hazing program should also be investigated.

3.4. Discussion. Fish Field Unit (FFU) studies have shown that gulls are not highly efficient predators. Predation rates were calculated at an average 0.75 fish/gull/hour in the zone (SW4) in 2010 and 0.58 fish/gull/hour in 2011. This zone requires almost all of the hazing. The zones upstream of the bridge have a much higher predation success rate per gull, but gull numbers are effectively held low due to avian lines. If funding is limited, a cost benefit analysis should be made for the hazing program relative to other fish passage improvements and maintenance.

4. JOHN DAY DAM

4.1. Monitoring. Avian monitoring is done throughout the year at JDA. During the adult and juvenile fish passage seasons inspections are made twice daily. These numbers for the week are included in the weekly status report to the region, along with a brief assessment of the effectiveness of the avian deterrent program. During the winter months bird numbers are collected once daily due to only one inspection needed during the maintenance season. An annual summary will be provided in the fish facility annual report.

4.1.1. Birds most commonly observed at JDA are gulls, cormorants, grebes and American white pelicans. Their presence and distribution differ from each other throughout the season. Their foraging and non-foraging numbers along with Caspian terns will be monitored.

4.1.2. There are 3 powerhouse tailrace zones and 3 spillway tailrace zones along with a forebay zone for both the powerhouse and spillway. Birds are counted in each of these zones during the fisheries inspections at 0800 and 1600.

4.2. Action Plan. Measures for avian deterrence at JDA are listed below. With the current configuration of the avian abatement array and boat hazing, JDA project fisheries feels this is sufficient for deterring gulls, the primary predator at JDA, from feeding in the tailrace.

4.2.1. Avian Array: 125 lines stretched across the tailrace below JDA expanding 2,200’ below the dam.

4.2.2. Boat Hazing: 8-hour shift, 7 days per week during fish passage season Apr 10–July 31. In the event weather and/or other conditions preclude safe boat operation, hazing shall occur from dam structures and/or adjacent shorelines.

5. MCNARY DAM

5.1. Introduction. McNary Lock & Dam has one of the largest piscivorous bird populations on the Columbia River due to the number of juvenile fish descending on McNary from both the Snake and upper Columbia rivers and due to the project’s close proximity to several significant bird nesting colonies.

5.1.1. McNary has a large mix of piscivorous bird species, including California and ring-billed gulls, western grebes, Caspian terns, white pelicans, double-crested cormorants, mergansers and other piscivorous waterfowl. The most numerous and troublesome are the two gull species and they typically are found in the spillway tailrace, which is the most difficult area to reach with shore-based pyrotechnic devices, propane cannons and electronic bird alarm calls.

5.1.2. In addition to regular USDA APHIS hazing activities, APHIS will be conducting experimental boat hazing, 3 days a week, in the powerhouse tailrace during the busiest months of the bird predation season. If this effort is successful, it may be expanded in future years, depending on funding levels.

5.1.3. Much of what the McNary project does to control predatory birds is determined months in advance, when the project helps establish the predatory bird control contract with APHIS, so there is very little additional that the project can do during times of unusually high avian predation, other than to shift USDA hazers around to different spots around the project. Early in the season, we will have already deployed the appropriate number of propane cannons and bird alarms, so more would not be appropriate. In addition to adding boat hazing, the project will continue with the two-shift hazing effort during the busiest months of the year.

5.1.4. Propane cannons, electronic bird alarms and other noise-makers are problematic, because they disturb nearby homeowners, fishers, park users and tugboat crews, so they must be used with discretion. They are of limited effectiveness and propane cannons in particular must be restricted to near-dam areas and away from recreational and navigational traffic.

5.2. Monitoring. McNary biologists and biological technicians monitor the dam populations of gulls, grebes, Caspian terns, white pelicans and double-crested cormorants at least once per day, seven days a week, from April 1 through September 30, the juvenile fish bypass season at McNary. The project may monitor populations more frequently, as needed, during bird population surges or outside this time window. We will include observations of hazing activity, hazing hours, boat hazing, monitoring times, foraging/nonforaging activity, etc.

5.3. Action Plan. USDA APHIS bird hazers typically start on the last Sunday in March and continue to haze birds through the first Saturday in August. Double shifts (16 hours per day) are used during the period of the greatest bird activity, typically beginning on the third Sunday in April and ending the second Saturday in July. Boat hazing is also used during that same period, typically 3 days per week, initially. APHIS crews may at their discretion deploy limited lethal take of gulls and cormorants, particularly if hazing by itself loses its effectiveness. Project personnel may deploy a limited number of propane cannons and electronic bird alarms from time-to-time, typically early in the season. Overhead avian deterrent wires are located along the powerhouse tailrace. A hydrocannon is situated at the juvenile fish bypass outfall.

5.4. Incident Response. When surges of predatory birds become apparent, the project will conduct the following actions based on the number of birds present:

5.4.1. When predacious bird numbers at any particular location exceed 50-100 foraging birds, focus APHIS hazers on those locations;

5.4.2. When predacious bird numbers at any particular location (most usually the spillway outfall) exceed 100 - 200 foraging birds, increase APHIS hazing efforts in those areas and increase the number of long-range pyrotechnic devices. Focus boat hazing in those areas. If APHIS has not already initiated lethal take, deploy limited lethal take;

5.4.3. When predacious bird numbers at any particular location exceed 200-300 foraging birds, increase hazing efforts. Continue to focus boat hazing in those areas. Place more emphasis on lethal take. Lethal take is a critical part of these predatory bird control efforts. Without it, hazing will likely have only a limited effect on local bird congregations.

5.5. Reporting. As noted in the "Monitoring" section above, McNary biologists and technicians monitor birds from April 1 through September 30, the juvenile fish bypass season at McNary. We maintain records of this monitoring on an Excel spreadsheet. Regular updates will be provided in a table in the fish facility weekly report, along with a brief statement on the effectiveness of the bird deterrent program for that week. A summary of seasonal bird abundance and the overall effectiveness of the bird deterrent program will be provided in the fish facility annual report. Reporting is by zone, with the project divided into the following zones: Forebay; Bypass Pipe Outfall; Powerhouse Tailrace; Spillway Tailrace. Reporting is by bird species, when clear identification is possible. We do not differentiate between gull species, due to the difficulty in determining gull species from a distance. We also have hazing data from APHIS personnel working on the project.

6. ICE HARBOR DAM

6.1. Monitoring. Bird monitoring dates are April 1 to July 31. Gull, cormorant, Caspian tern, grebe and pelican numbers are counted once per day, 6 or 7 days a week from April 1 to June 30, and 4 days (Monday through Thursday) a week from July 1 to July 31.

6.2. Hazing. Ice Harbor Dam utilizes the U.S. Department of Agriculture's Animal & Plant Health Inspection Service (APHIS) for hazing of piscivorous birds to reduce predation on ESA-listed fish passing the dam. Bird hazing occurs from April 1 through June 30, 7 days per week, and is focused on gulls, terns and cormorants observed to be feeding on passing fish. Land-based hazing is conducted by a Wildlife Specialist 8 hours per day April 1–11 and June 21–30, and 16 hours per day April 12–June 20. Boat-based hazing is conducted 3 days per week April 12–25 and May 31–June 20, and 5 days per week April 26–May 30.

6.3. Action Plan. Birds are actively hazed in the immediate forebay of the dam to the Boat Restrictive Zone (BRZ). In the tailrace, birds are actively hazed from the immediate tailrace of the dam downstream to Eagle Island. Data that are noted are the time, avian zone, the species of the bird, number of birds, if they are foraging or not foraging and control action taken.

6.3.1. Birds are hazed daily using propane cannons, bird distress calls, pyrotechnics and lasers. In addition, there are bird wires across the turbine discharge area and the spillway area below the Dam. A water cannon is located on the juvenile fish bypass pipe terminus. Wire spikes are installed on light poles, forebay buoys, and other bird perching areas.

6.4. Incident Response. When a bird (gull or cormorant) becomes unresponsive to hazing and is leading other birds to feed on juvenile fish (instigator bird) who are also unresponsive to hazing, lethal take of the instigator bird or a bird in the group of unresponsive birds will occur at the discretion of the APHIS agent. This action will occur most sparingly after all other efforts have failed to move the birds. In the event that the daily count of gulls, cormorants, and terns increases to twice the most recent 3-year average daily count for the same week, Corps personnel will assist APHIS agents in hazing.

6.5. Reporting. Bird observations will be reported weekly on the Project's ESA Weekly Report and will include a brief statement on the effectiveness of the bird deterrent program for that week. A summary of the season will be included in the Annual Fish Report.

7. LOWER MONUMENTAL DAM

7.1. Monitoring. Bird monitoring as part of standard fish ladder inspections will occur from March 1 to December 31. Fish ladder inspections will be conducted 4 days per week, once per day at random times from April 1 to June 30 (crew size permitting, 3 inspections per week minimum if crew size is compromised). Additionally, Wildlife Services (APHIS) will collect this data on the three days per week not covered by COE. This will cover 97% of the typical juvenile salmonid outmigration. Fish ladder inspections will continue (July 1 to December 31) to collect this data at the required rate of 3 inspections per week.

7.1.1. The annual high daily bird numbers by species including resting, flyby and foraging birds for the past ten years are as follows. For years 2004 through 2008 only gull numbers were required so the records are so limited. Also of note, is the fact that binoculars were not used on these inspections until 2012. Numbers prior to 2012 should be considered as reduced by some factor relating to the visual acuity of the inspector conducting the inspection.

Species	Year									
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Gull	74	155	86	360	445	37	59	101	104	247
Terns	N/A	N/A	N/A	N/A	N/A	2	1	6	37	1
Cormorants	N/A	N/A	N/A	N/A	N/A	29	3	9	44	22

7.1.2. Additionally, bird hazing effectiveness inspections will take place once daily from April 1 through June 30. These will consist of flying gull and tern counts and floating cormorant counts in the tailrace and at the juvenile fish bypass outfall. These inspections will be conducted from the river end of the raceway structure and will occur between 1100 and 1300 hours.

7.1.3. Data collected during fish ladder inspection will be recorded in a standardized excel spreadsheet and will be limited to: gulls, cormorants, terns, grebes and pelicans. There will be five zones monitored including: Forebay (FB1), Spillway (SWT1), Power house outflow under birdwires (PH1), Power house outflow downstream of birdwires (PH2) and the juvenile bypass outfall (JFOF). There will be two bird activities monitored; Act of Foraging (flying, diving or feeding) and Act of Non-foraging (resting in/on water, on debris, structures or land or while scavenging).

7.1.4. Data collected during bird hazing effectiveness inspections will be recorded in a standardized excel spreadsheet and will be limited to: gulls, cormorants and terns.

7.2. Action Plan. Lower Monumental Dam will have an active hazing program consisting of one 8-hour shift per day from April 2 through May 5 and two 8-hour shifts (non-concurrent) from May 6 through June 2. Gulls, Cormorants and Terns will be the major focus of this hazing effort.

7.2.1. Hazing shifts and zones to be emphasized will be adjusted to maximize deterrent effect on feeding bird populations.

7.2.2. Lethal take may occur as part of the hazing program and would exclusively be performed and regulated by licensed agencies and/or companies.

7.2.3. Bird wires will be maintained across the turbine discharge area (see zone photo). The addition of bird wires across the spillway is not practical or safe as the fish transport barge and tug would run through them.

7.2.4. Bird aversion water cannons will be in operation from April 1 through October 1 at the bypass outfall.

7.2.5. Boat hazing is not needed at Lower Monumental as the river is sufficiently narrow to allow effective hazing from the dam structure and shore.

7.3. Incident Response. In response to operational trigger numbers observed during bird hazing effectiveness inspections the following action toolbox items will be utilized. The timing of the introduction of these additional hazing methods will be dependent on available trained staff to carry them out:

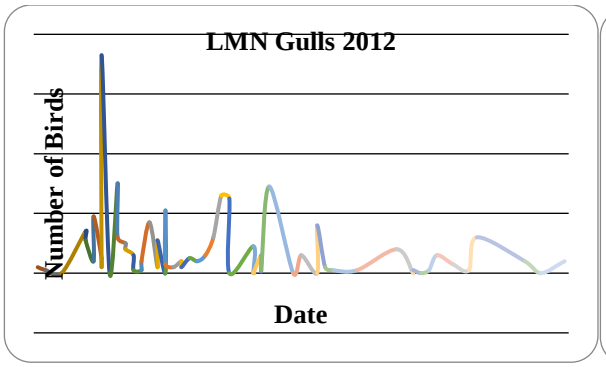
- **a.** Propane cannon placement.
- **b.** COE employee (added) hazing with screamers and poppers fired from shore.

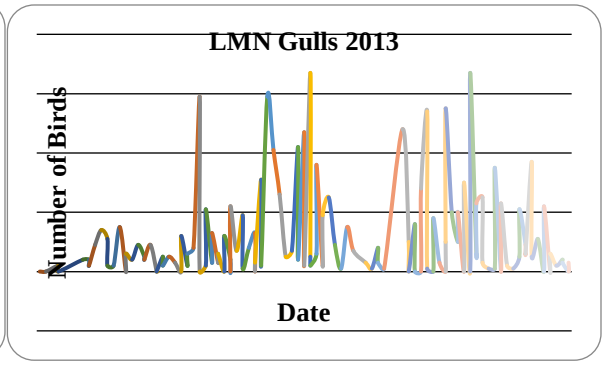
7.3.1. Operational Trigger Numbers. When the following operational trigger criteria are met then (depending on the conditions) one of the toolbox items will be put into service. Available staff will likely be a factor in which item is selected. Re-evaluation of the item causing the action will occur daily in regard to stepping up, terminating or randomizing use of the operations from the Action Toolbox. Items will be added to the toolbox as they are tested and proved effective.

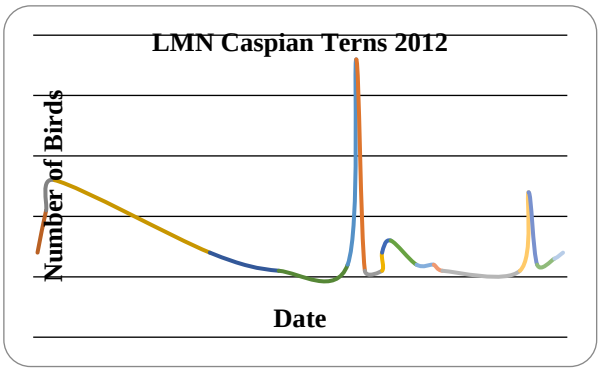
7.3.2. The following action point numbers based on foraging birds are proposed as a starting point for this process. As more years of data are collected with the benefit of binoculars then these action points will be adjusted accordingly.

- **a.** Action point Gulls = 86.
- **b.** Action point Terns = 43.
- **c.** Action point Cormorants = 15.

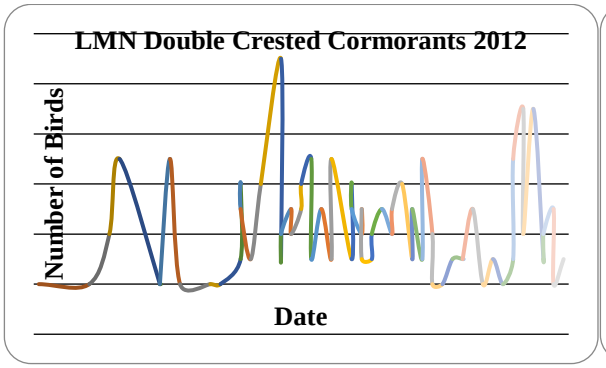
7.3.3. The graphs below show the average daily foraging bird numbers by species for the 2012 and 2013 operating year. Foraging bird numbers can be highly variable during the juvenile fish outmigration. The high foraging gull numbers, tern numbers and cormorant numbers for these two years were 72, 37 and 9, respectively.

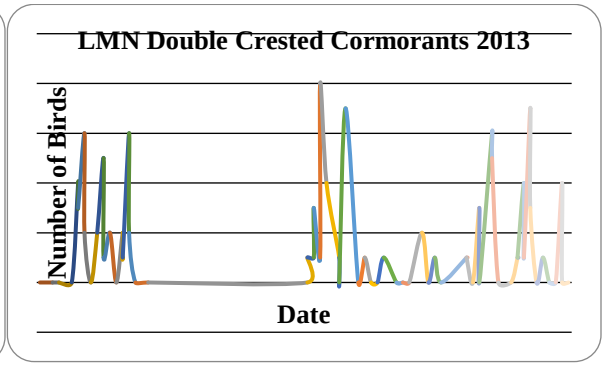






LMN Caspian Terns 2013 – Only 1 Caspian Tern recorded feeding during 2013 inspections (on April 14, 2013).





7.4. Reporting.

7.4.1. Annual Reporting of fish ladder inspection bird monitoring results will be included in the "Adult and Juvenile Fish Facility Monitoring Report" focusing on bird activities from April 1 through June 30.

7.4.2. Weekly Reporting of bird hazing effectiveness inspections and occurrence of trigger points and resulting action will be added to the standard Fish Facility Weekly Report in its own section and summary table labeled, "Table 2. LMO Tailrace Counts of Foraging Piscivorous Birds", from April 1 through June 30.

8. LITTLE GOOSE DAM

8.1. Monitoring. Little Goose will monitor and collect daily data on gulls, cormorants and terns from April 1 – October 31. Bird monitoring will occur 2 to 3 times per day in two zones; the forebay and tailrace. There will be two bird activities monitored; foraging and non-foraging.

8.2. Action Plan. Little Goose will perform bird hazing, which includes at least 8 hours per day, 7 days per week of contracted services from April 2 to June 23. Gulls, cormorants and terns will be hazed as needed during the juvenile fish passage season. Hazing will be performed using scare products. These include consumer fireworks, scare cannons, bird bangers and bird screamers.

8.2.1. Passive deterrents will be used. These include; needle strips, an overhead bird wire array, visual scare devices and a hydrocannon located at the juvenile fish bypass outfall. The wire array is composed of 12 wires across the turbine discharge area.

8.2.2. Limited lethal take may occur at the discretion of qualified APHIS Wildlife Services personnel.

8.3. Incident Response. If gulls and/or tern numbers reach an average of 100 per day or cormorants reach an average of 50 per day during the April 1 to August 31 period the project will commence into action one or more of the following toolbox control measures, in any combination, to best achieve reduced bird predation to an acceptable level.

- **a.** Deploy additional remotely activated propane canon(s);
- **b.** Increase hazing with pyrotechnics and other bird scare devices;
- **c.** Initiate limited lethal take by Wildlife Services personnel if not already started.

8.4. Reporting. Bird management data will be recorded into computer spreadsheets, assimilated and reported weekly and annually. A brief statement assessing the effectiveness of the avian deterrent program for that week will be included in the weekly report, with an overall summary provided in the annual report.

9. LOWER GRANITE DAM

9.1. Monitoring. Monitoring work at Lower Granite Dam will be done by COE biological technicians and by control agents of the USDA conducting bird hazing work at the dam. The agencies will conduct independent counts. USDA will usually be counting birds once daily in all zones, in conjunction with their normal hazing activities. Their work will be limited to April 1-June 30 each year. Biological technicians working at the Lower Granite separator will conduct counts twice daily (morning, evening) from approximately April 1 until separator operations end in early to mid-December. Binoculars will be utilized to make the counts and the normal count area will be from the base of the dam downstream to a buoy approximately 1/2 mile below the dam. The tailrace area of the dam has been divided into zones and the technicians will count the birds in each zone and record foraging or non-foraging behavior. Bird count data will be limited to gulls (California and ring-billed), cormorants and Caspian terns. American white pelicans will be recorded on an incidental basis in attempt to monitor their increasing abundance.

9.2. Action Plan. Base actions will be include the array of methods in long-time use by theUSDA/APHIS and will also include limited lethal control when the other methods prove ineffective. Passive avian deterrent structures include the overhead array of 26 wires spanning the tailrace downstream to the end of the navigation lock wall and across the river to the pole located just upstream of the visitor center overlook. Nonlethal control measures will include 15 mm pyrotechnics and Dominator rocket pyrotechnics. Agents will haze birds on both side of the river and will work as far as two miles below the dam. Limited lethal control of gulls and cormorants will be at the discretion of the agents working on site. Lethal take will be conducted with a shotgun in accordance with the USFWS-issued permit. Powerhouse operators and persons conducting tours will be notified before any lethal take activities take place. No lethal take will be allowed when schools or other tour groups are on site. Hazing activities will take place 8 hours per day from April 1 through April 20 and from June 2 through June 30. Hazing will take place 16 hours per day from April 21 through June 1 when the maximum numbers of juvenile salmonids are normally passing the dam.

9.3. Incident Response. A trigger for additional control measures is listed below. The trigger level is presently set at an order of magnitude above the average gull counts for the previous five-year period. It might be wise to consider lowering this number somewhat but it appears gulls are being effectively controlled at Lower Granite at the present time using the available techniques. The addition of limited lethal take in 2014 should help keep the numbers at reasonable numbers. In the event the numbers do significantly increase over time, possible control measures would include: remotely activated propane canons, biotech hazing with pyrotechnics (in addition to USDA/APHIS), playing remotely activated gull distress sounds and emergency call-out of off-duty JFF personnel to assist with hazing activities.

9.3.1. Avian Predation Trigger Level and Proposed Toolbox Control Measures. Gull numbers were obtained from daily counts off the Lower Granite JFF separator platform. At the present time, terns are not very abundant at Lower Granite and the project does not have count data. Cormorants are certainly present but much more difficult to count (and haze) than gulls. At this time, I recommend that a trigger level be calculated and utilized for gulls (both species combined) only. Below are the average gull numbers for each of five years running from April 1 through June 30 each year (APHIS hazing was being conducted):

Year	Gulls/Day (April 1 – June 30)
2013	9.36
2012	6.03
2011	6.43
2010	14.09
2009	11.5
2009-2013 Average	9.48 (st dev 3.05)

9.3.2. If gull numbers reach an average of 95 per day during the April 1 to June 30 time period (10x the 5-year average), the following project toolbox measures would be utilized in combination with APHIS (or other contractor) hazing activities. In order to achieve the best control it is likely a combination of measures would need to be utilized.

- **a.** Remotely-activated propane cannon(s);
- **b.** Biological Technician hazing with pyrotechnics;

- **c.** Emergency call of off-duty separator technicians for hazing;
- **d.** Play audible gull distress sounds (*Bird Chase "Super Sonic" Player, Bird-B-Gone Catalog PN #1B50-PCOM*);
- **e.** Others to consider in combination with above: visual deterrent devices (e.g., raptor effigies, scare-eye balloons, etc.).

9.4. Reporting. Reporting of bird numbers will consist of a table of average daily bird counts that will be included in each weekly ESA report, along with a brief statement assessing the effectiveness of the avian deterrent program for that week. In addition, a section on bird predation control work will be included in the annual "Adult and Juvenile Fish Monitoring Report".