2023 Fish Passage Plan

Lower Columbia & Lower Snake River Hydropower Projects
March 1, 2023 – February 28, 2024

U.S. Army Corps of Engineers Northwestern Division
Columbia Basin Water Management, Reservoir Control
CENWD-PDW-R

NOTE*: The Fish Passage Plan is a "living document" and may be updated throughout the year as coordinated with FPOM. Changes made after March 1 are NOT included in printed copies. For the most current version, please reference the online FPP at: https://pweb.crohms.org/tmt/documents/fpp/2023*

2023 Fish Passage Plan

Chapter 1 – Overview

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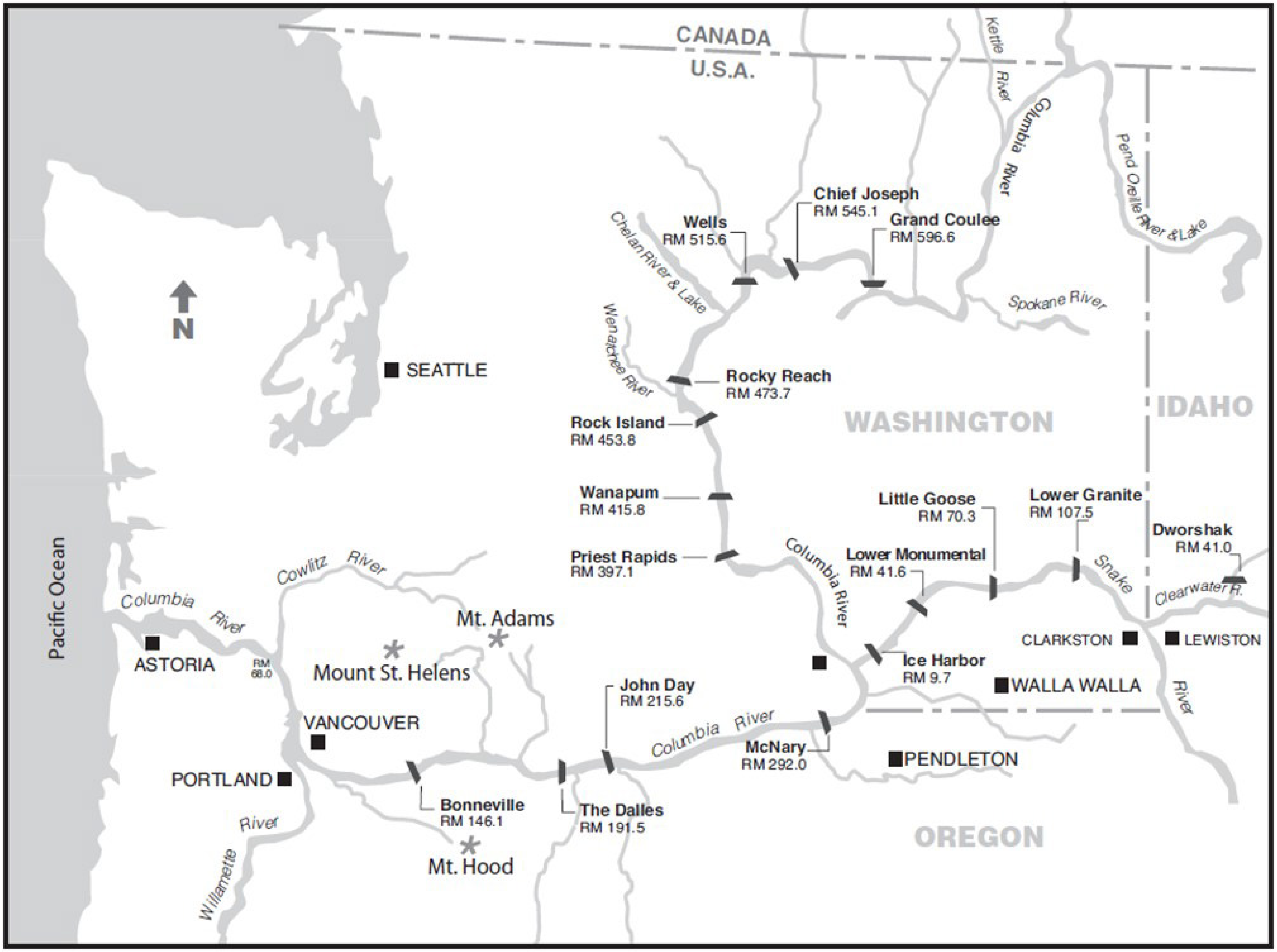

Figure OVE-1. Map of 11 of the 14 Federal hydropower projects in the Columbia River System (CRS), not including Hungry Horse, Albeni Falls, and Libby, and the 4 Mid-Columbia PUD projects.

Table OVE-1. Project Information and Operating Criteria for CRS 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 CRS 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 as 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** in the region; however, this acronym is already assigned to another NWD project, so the official Corps NWD acronym is **LWG**.

1. FISH PASSAGE PLAN (FPP) OVERVIEW

1.1. Introduction

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) coordination team. [1]

The FPP describes year-round operations and maintenance (O&M) actions scheduled to occur each year from March 1 through the end of February to provide fish passage and protection at the eight Corps hydropower 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 Columbia River (**Appendix H**) and at Dworshak Dam on the North Fork Clearwater River (**Appendix I**). Other Corps documents and agreements related to fish passage at these projects are consistent with the FPP.

The FPP is revised as necessary to incorporate changes due to new or modified facilities and operational procedures. Revisions will be coordinated with the region as described below in **section 2.3**, 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, agreements, and plans. When revising the FPP, the Corps also considers the Northwest Power and Conservation Council's Columbia River Basin Fish & Wildlife Program practicable.

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]

The Fish Passage Plan is developed as part of the ongoing O&M strategy to improve fish survival in the Columbia River System (CRS),[3] in accordance with all current and applicable ESA Section 7 Biological Opinions. Actions in the FPP shall comply with all other regulatory requirements (e.g., NEPA, CWA) and regional agreements that are in effect at the time (e.g., Fish Accords[4], Agreement for short-term operations of the CRS[5]).

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[1] FPP website: pweb.crohms.org/tmt/documents/fpp/

[2] Biological Opinions, decision documents, and other related documents are available online at: www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp.aspx

[3] In past ESA consultations, the Action Agencies used the term *Federal Columbia River Power System* (FCRPS). The FCRPS in its entirety includes 31 multi-purpose dam and reservoir projects operated by the Corps and Reclamation, and a transmission system operated by BPA. The *Columbia River System* (CRS) is a subset of 14 of the FCRPS projects that are operated as a coordinated water management system and the subject of current consultations.

[4] Fish Accords: www.salmonrecovery.gov/Partners/FishAccords.aspx

[5] Term Sheet Stay Agreement (see PDF pages 6-8), as extended through August 31, 2023: https://pweb.crohms.org/tmt/JointMotion_TermSheet_CourtOrder_and_Extension_AUG2022.pdf

1.3. Fish Facilities Inspection & Reporting

An illustration of a typical fish passage system is in **Figure OVE-2**. Inspection and reporting criteria for fish passage facilities at Corps projects are defined in the FPP project-specific **Chapters 2–9**. The Corps provides weekly inspection reports to NOAA Fisheries Hydropower Program in Portland, OR, 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 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 reports hourly individual spillbay and turbine unit operations at mainstem projects.

1.4. Deviations from FPP Criteria

The phrase "*when practicable*" is used in the FPP to describe 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 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.

River operational emergencies may occur that require projects to temporarily deviate from the FPP. These operations will be coordinated with fish agencies and tribes and conducted in a manner to avoid or minimize fish impacts to the extent practicable. Normally, coordination occurs prior to an action; however, if an emergency requires immediate attention, coordination will be completed as soon as practicable afterwards, as described in **section 2**.

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),[6] 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**).

1.5. Spill for Juvenile Fish Passage

Planned 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), which is included in the FPP as **Appendix E**. Spill operations to improve juvenile fish passage are developed in accordance with the current NOAA Fisheries Biological Opinion. During spring and summer spill for fish passage, spill at each project will be distributed across the spillway as

[6] Water Management Plan website: pweb.crohms.org/tmt/documents/wmp/

defined in patterns in the project-specific **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.

1.6. Total Dissolved Gas (TDG) Monitoring

The Federal *Clean Water Act* (CWA) 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. 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. 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**).

The most current information on State water quality standards is included in the Corps' annual *TDG Management Plan* (Appendix 4 of the WMP), which also provides definitions of spill types (e.g., fish passage spill, lack of load spill), the process for coordinating and implementing the Spill Priority List to manage systemwide 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.

1.7. Juvenile Fish Transportation Plan

Juvenile salmonids 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*, 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 transportation plan, including deviations, will be coordinated through TMT and NOAA Fisheries.

1.8. System Load Shaping

To avoid or minimize impacts of hydropower operations on fish, BPA coordinated the *System Load Shaping Guidelines*, included in the FPP as **Appendix C**. The Guidelines define how BPA requests load so that the Corps can operate turbine units at fish passage projects within ±1% of peak turbine efficiency (1% range) in-season, or as otherwise coordinated through FPOM and/or TMT to enhance fish passage (e.g., Bonneville Dam PH1 BOP and PH2 mid-range operations).

Excursions outside of the 1% range are tracked and reported as described in **Appendix C.** The intent of reporting excursions is to provide a means for quality assurance for project operations.

For reporting of excursions not covered by **Appendix C**, 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 current CRS BiOp. If unforeseen circumstances arise that preclude BPA or the Corps from notifying TMT prior to a variation from required operating criteria and those circumstances are not covered by **Appendix C**, those variations will be reported to TMT as soon as practicable.

1.9. Lamprey Passage

The Fish Accords[4] were originally signed in May 2008 and include actions to protect Pacific lamprey and improve juvenile and adult lamprey passage through the CRS. 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 project-specific **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.

1.10. Chief Joseph & Dworshak Turbine Dewatering Protocols

The Corps has coordinated and adopted fish protection procedures during turbine dewatering for maintenance at Chief Joseph Dam (**Appendix H**) and Dworshak Dam (**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 these Appendices provide fish-protection measures to avoid or minimize impacts on ESA-listed salmonids during turbine dewaterings at these projects.

2. IMPLEMENTATION & COORDINATION

2.1. Implementation

Implementation of the FPP requires information exchange and coordination between the Corps, NOAA Fisheries, BPA, other Federal and State fish agencies, and Tribes. 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 (see **FPOM Coordination section 2.3**). Corps District and RCC biologists attend monthly FPOM meetings dealing with project-specific issues to consider recommendations from affected interests; provide updates on construction, O&M, research, and other topics; develop criteria for the annual FPP; and coordinate fish passage issues that may require deviation from FPP criteria. For Corps operations that have system-wide effects, such as water management, spill, and unit availability, the Corps RCC coordinates through TMT (see **TMT Coordination section 2.4**).

2.2. Agency Responsibilities

2.2.1. 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. Collaborate with fish agencies and tribes to 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.

2.2.2. 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 recommended order for the spill priority list and any 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).

2.2.3. Bonneville Power Administration

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

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

iii. Utilize available flexibility of the FCRPS 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 CRS 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 the ±1% range per **Appendix C**.

2.2.4. 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.

2.3. FPOM Coordination [7]

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, regional Tribes, and other interested parties (see current list in **section 2.3.3**).

The annual FPP goes into effect each year starting March 1 and is effective year-round, though revisions may be approved through FPOM at any time. Proposed revisions are presented in an *FPP Change Form* with a description and justification for the change that is submitted to the relevant District Operations biologist for consideration by the Corps. 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 incorporated into the current year's online FPP. The Corps will provide FPP changes to TMT as necessary for use as part of the overall river operation plan. Special operational requirements will also be included in the annual *Water Management Plan*.

2.3.1. FPOM Memorandum of Coordination (MOC)

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

For O&M activities within the District's Operations Division, Project personnel will compile relevant information into a *Memorandum of Coordination* (MOC; see template at the end of this Chapter) that includes a summary of the activity, location, date and time, analyses of potential impacts to ESA-listed species, and potential alternative actions, then 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. For planned O&M, the MOC should be provided to FPOM for review at least two weeks in advance. For unplanned, non-emergency O&M (e.g., equipment failure), the MOC should be provided to FPOM at least three workdays in advance. Emergency O&M may be performed immediately, and a *Memo for the Record* (MFR) submitted to FPOM as soon as possible, either before or after the activity (see **section 2.3.2**).

[7] FPOM website: http://pweb.crohms.org/tmt/documents/FPOM/2010/

For each MOC, the analysis of potential impacts will include the following information (links to data are included in the MOC template):

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.").

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 to the project(s).

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).

If implementation requires assistance from Project staff, temporary equipment installation, 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.

2.3.2. FPOM 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.

2.3.3. FPOM Representatives & Participants (**Co-Chairs*)

FPOM membership is comprised of federal, state, and tribal representatives, as established in the FPOM Guidelines.[7] As of March 2022, the list of FPOM members and participants is as follows:

- Corps Walla Walla District – Operations: Chris Peery*, Scott St. John
- Corps Walla Walla District – Planning, Programs, & Project Mgmt: Steve Juhnke
- Corps Portland District – Operations: Tammy Mackey*
- Corps Portland District – Planning, Programs, & Project Mgmt: Brad Eppard
- Corps Seattle District: Katherine Cousins, Fred Goetz
- Corps Northwestern Division, Reservoir Control Center: Doug Baus, Lisa Wright
- Bonneville Power Administration: Scott Bettin, Ben Hausmann, Christine Peterson, Leah Sullivan
- Bureau of Reclamation: Jarod Blades
- NOAA Fisheries: Trevor Conder, Blane Bellerud, Kelsey Swieca
- US Fish & Wildlife Service: David Swank, Erin Britton Kuttel
- Confederated Tribes of the Umatilla: Tom Lorz (CRITFC)
- Colville Confederated Tribes: Kirk Truscott
- Nez Perce Tribe: Jay Hesse
- Confederated Tribes of Warm Springs: Jennifer Graham
- Yakama Nation: Tom Iverson
- Oregon Dept. of Fish & Wildlife: Erick Van Dyke
- Washington Dept. of Fish & Wildlife: Charles Morrill
- Idaho Dept. of Fish & Game: Jonathan Ebel

2.4. TMT Coordination [8]

Actions that may impact fish system-wide are coordinated and documented through TMT. Actions that may impact fish at a specific project that result from actual operations, implementation of FOP/BiOp actions, incidental take, BiOp terms and conditions, or research will be coordinated through the process outlined in **section 2.5**. TMT Guidelines are posted as an Appendix to the annual *Water Management Plan*.

The Corps RCC hosts TMT meetings throughout the year to consider recommendations for river operations and to implement the FOP, BiOps, and other recommendations from fish interests. As part of this process, TMT may evaluate research data, current conditions and forecasts, and advice on whether existing operations are consistent with current study results. TMT meeting agendas are posted online, and meetings are open to the public. Action Agency representatives provide the latest weather and runoff forecasts, and information on fish, hydrology, water

[8] TMT website: http://pweb.crohms.org/tmt/

quality, and power generation to assist in planning operations for fish passage. The Corps evaluates fish operation recommendations to determine impacts on overall system operations.

2.5. Day-to-Day Coordination

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 includes operation of turbine units outside of the 1% range, Snake River zero nighttime generation, reservoir operation at minimum operating pool (MOP) or some other specific elevation, and special operations for implementation of approved research projects in **Appendix A**. When reservoirs are not being operated to provide special protection for fish passage, projects may be operated within the full normal operating range.

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 an emergency. All other special operations will be evaluated for fish impacts and effects on other project O&M requirements and coordinated 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).

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, 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.

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.

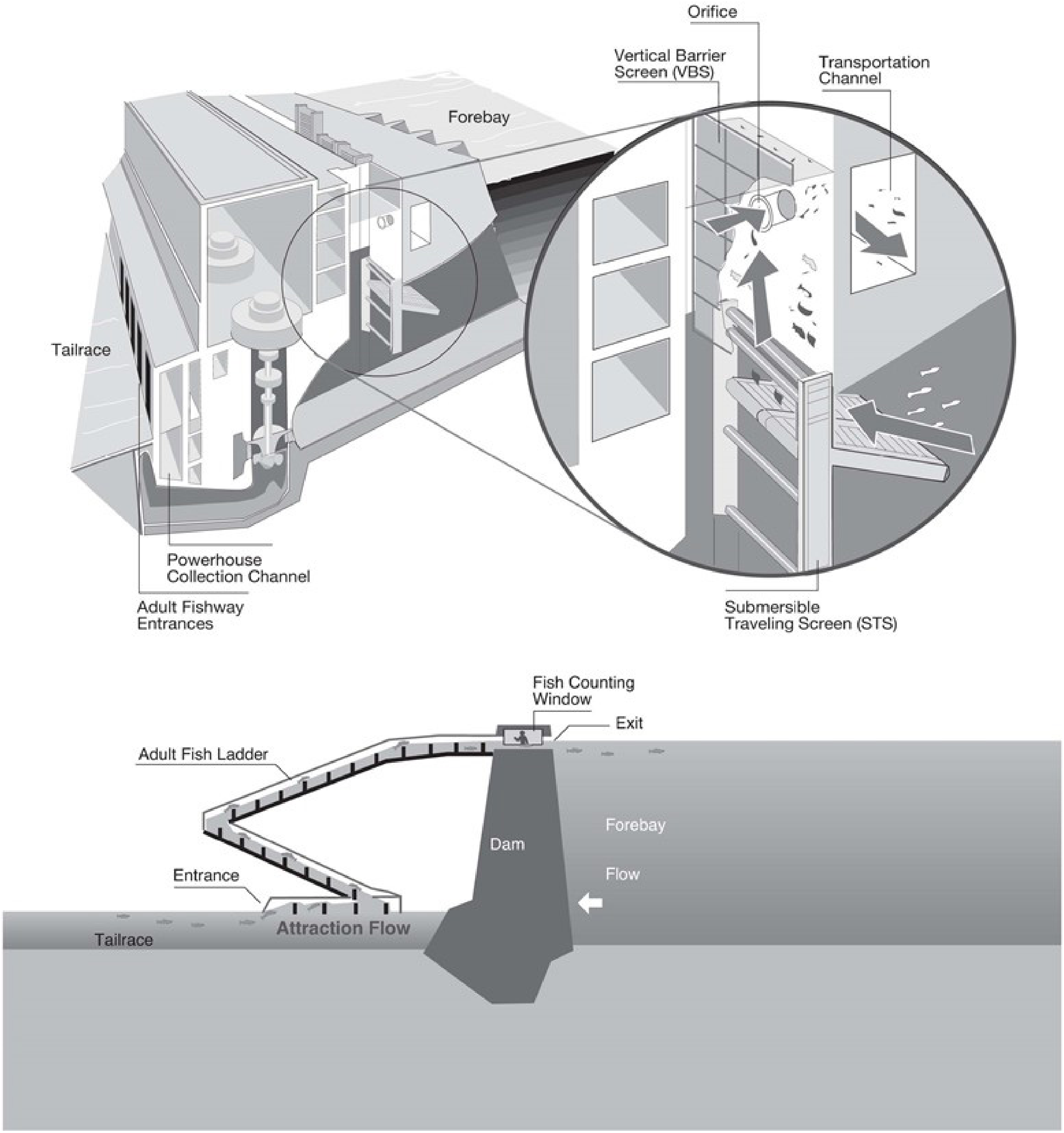


Figure OVE-2. Example Design of Fish Passage Structures at CRS Corps Hydropower Projects.

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

2023 Fish Passage Plan

Chapter 2 – Bonneville Dam

Table of Contents

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

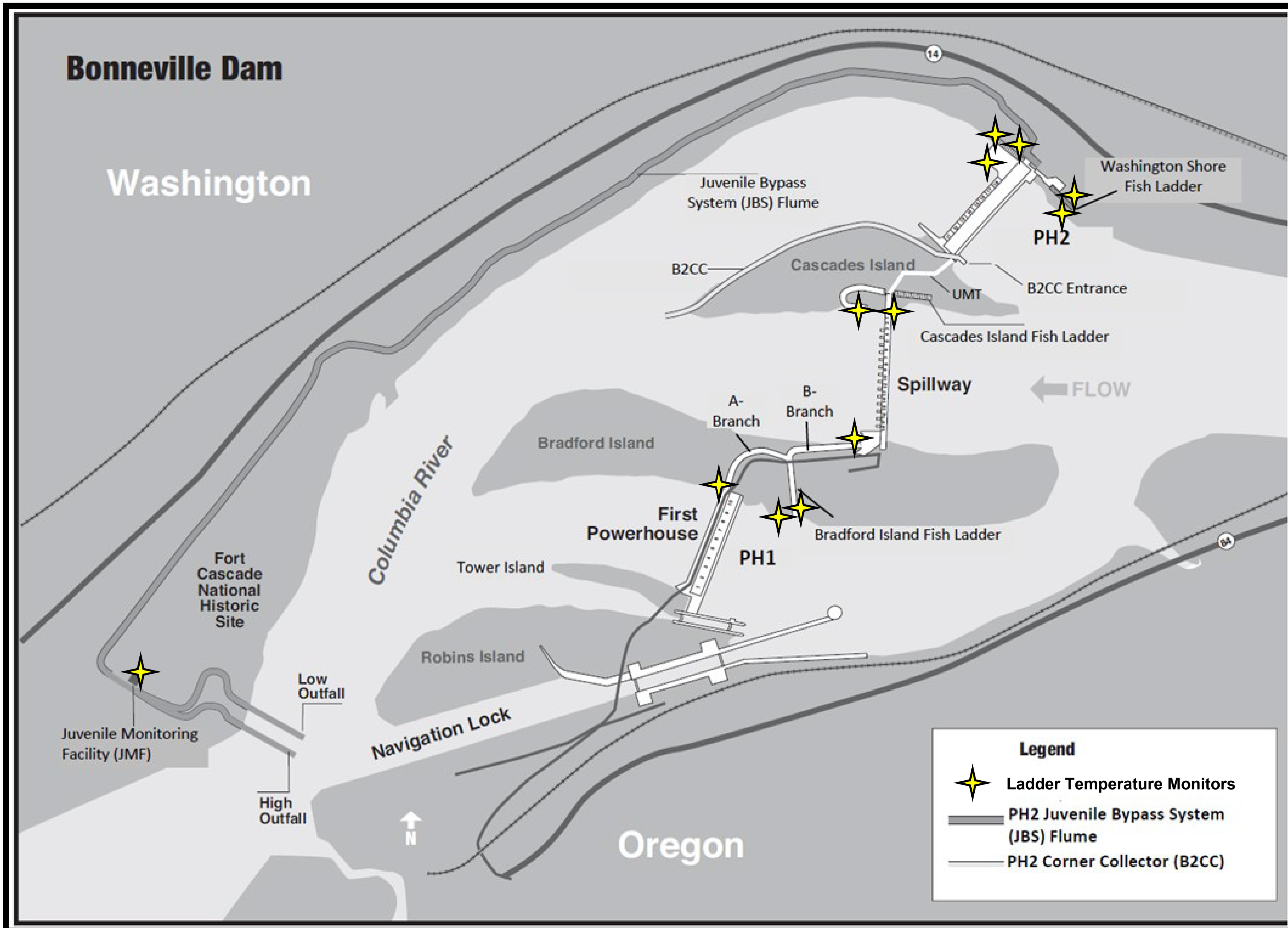


Figure BON-1. Bonneville Dam Overview, including Powerhouse 1 (PH1), Powerhouse 2 (PH2), Spillway, Adult Fish Ladders, PH2 Juvenile Bypass System (JBS), Corner Collector (B2CC), Juvenile Monitoring Facility (JMF) and JBS Outfall.

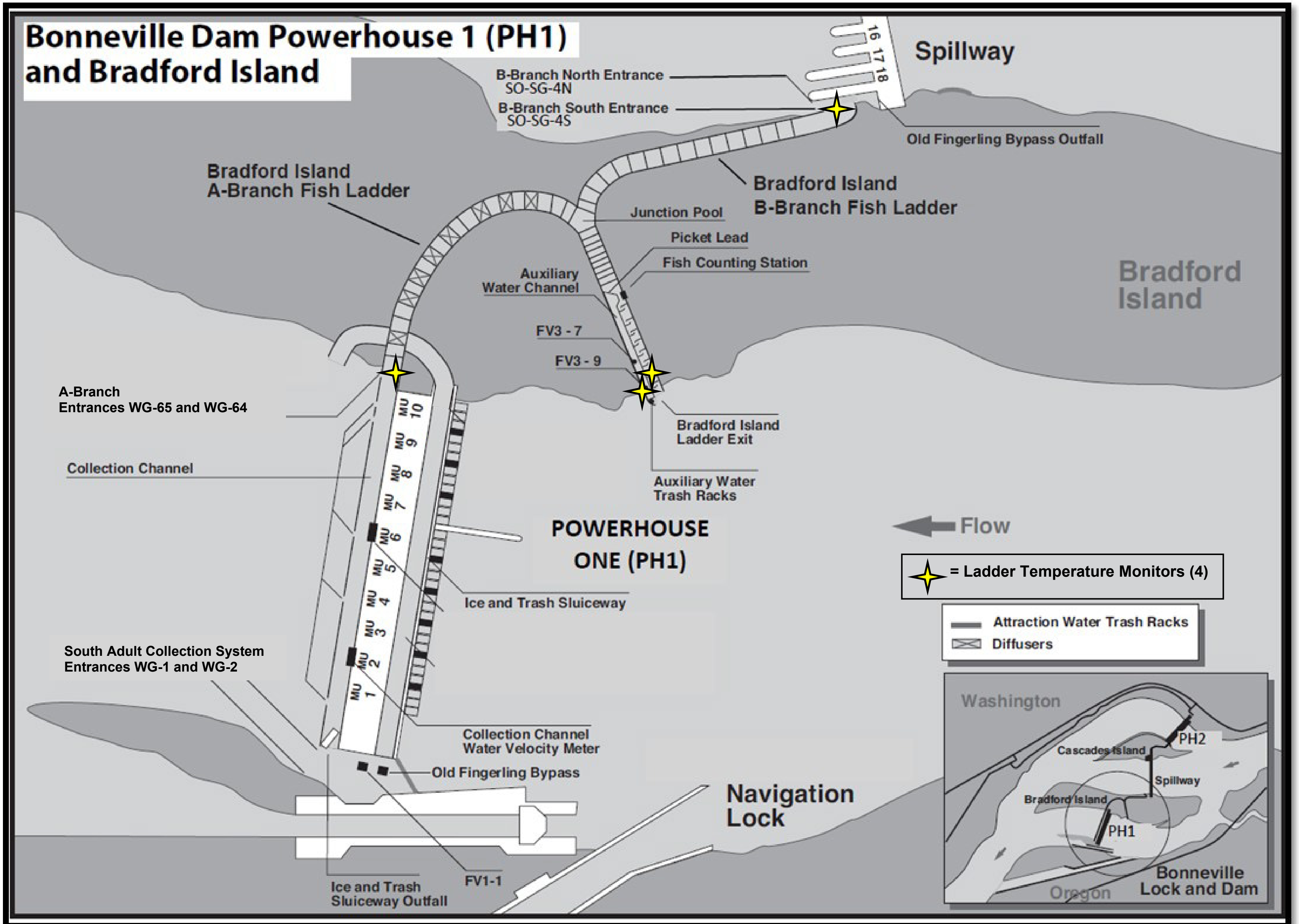


Figure BON-2. Bonneville Dam Powerhouse 1 (PH1) and Bradford Island Adult Fish Ladder A-Branch and B-Branch.

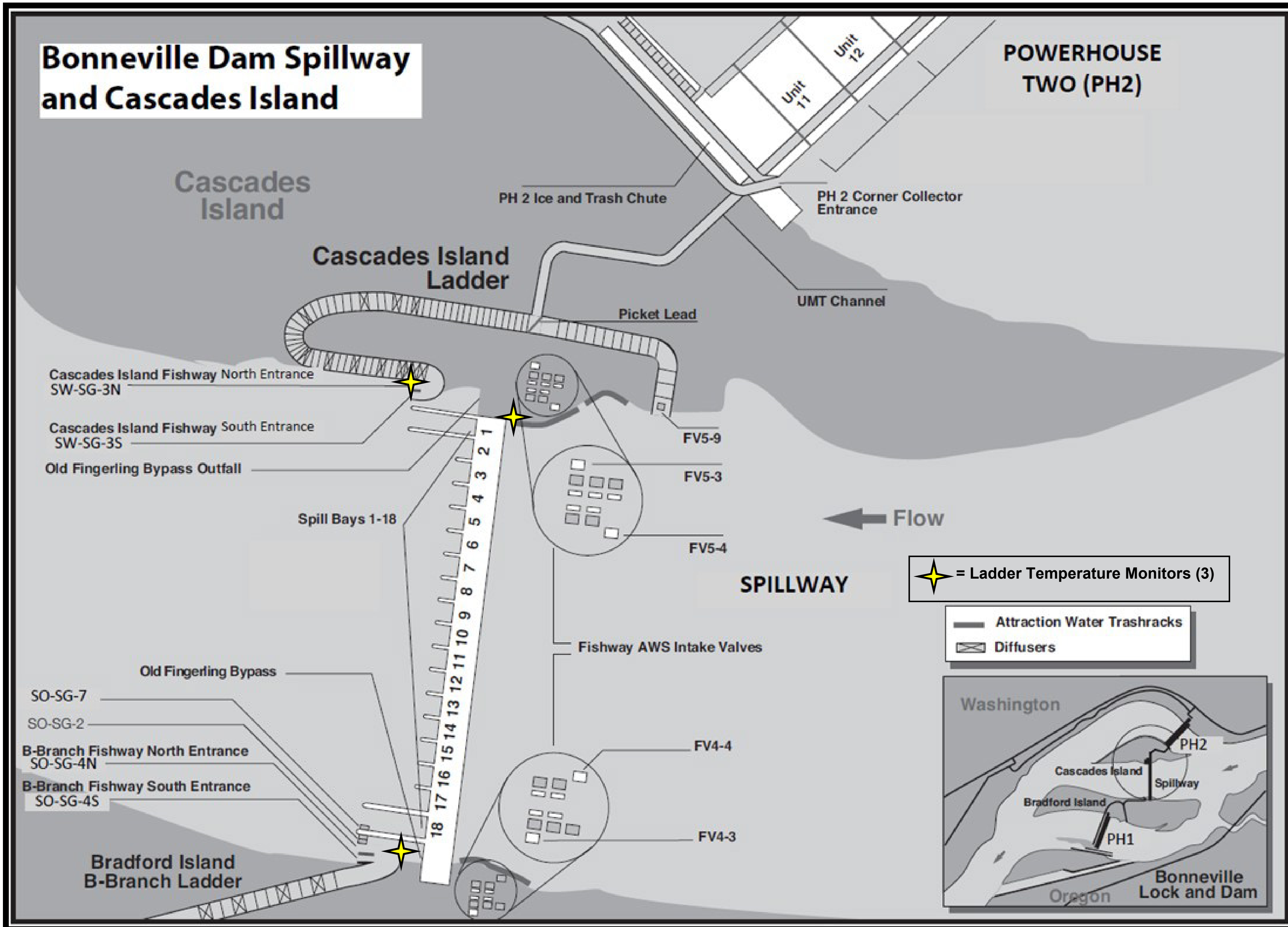


Figure BON-3. Bonneville Dam Spillway, Cascades Island Fish Ladder and Upstream Migrant Transportation (UMT) Channel.

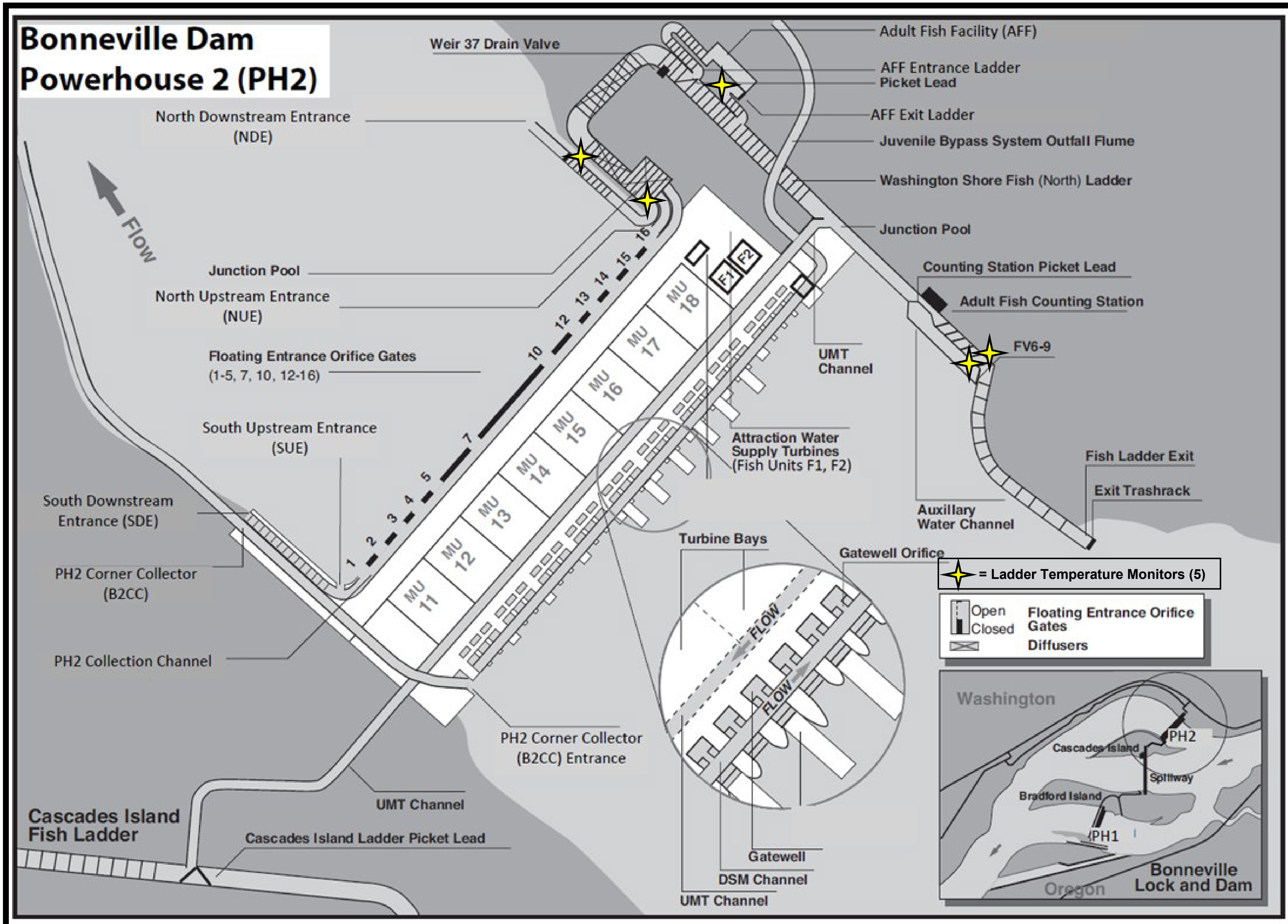


Figure BON-4. Bonneville Dam Powerhouse 2 (PH2) and Washington Shore (WS) North Fish Ladder.

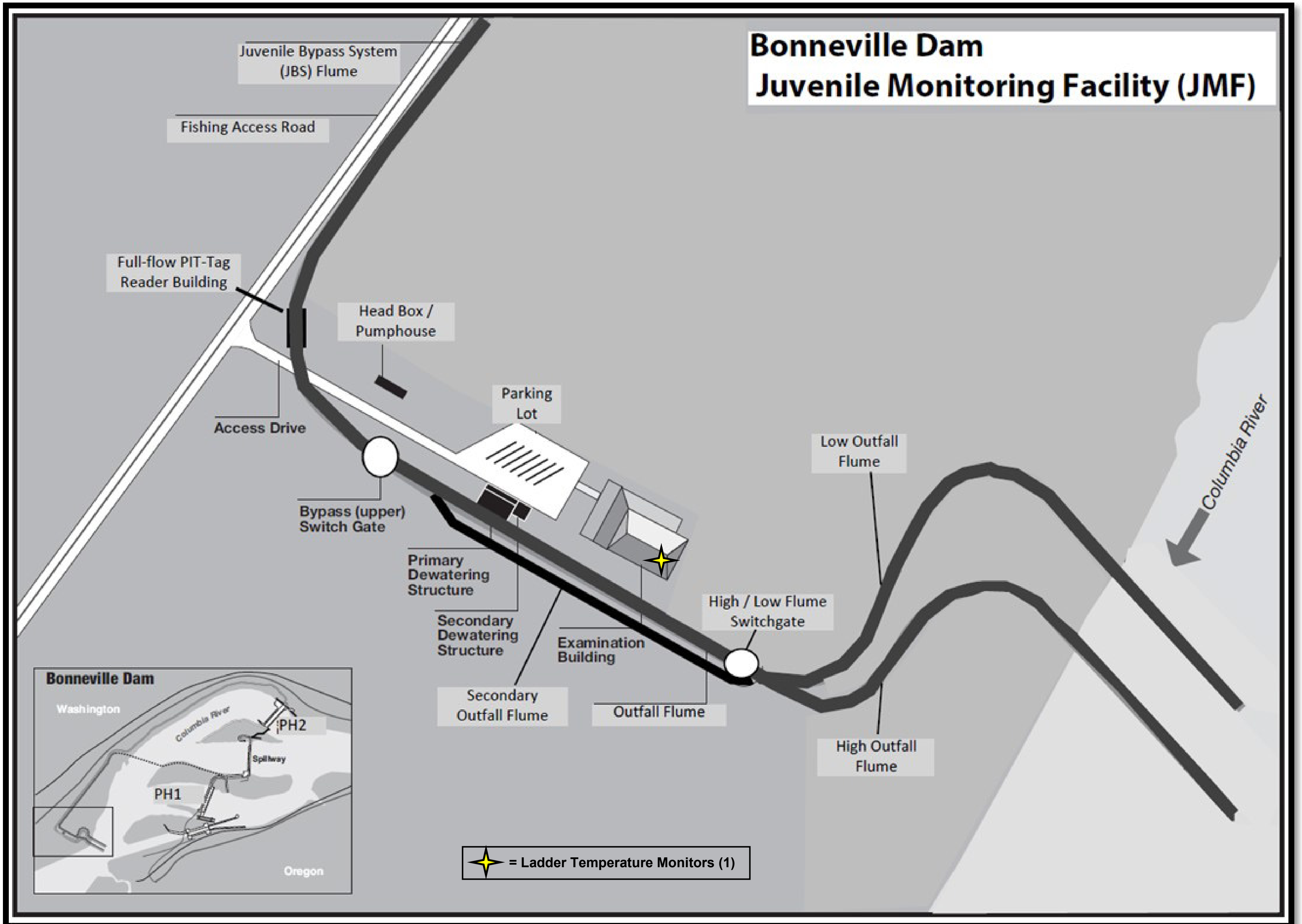
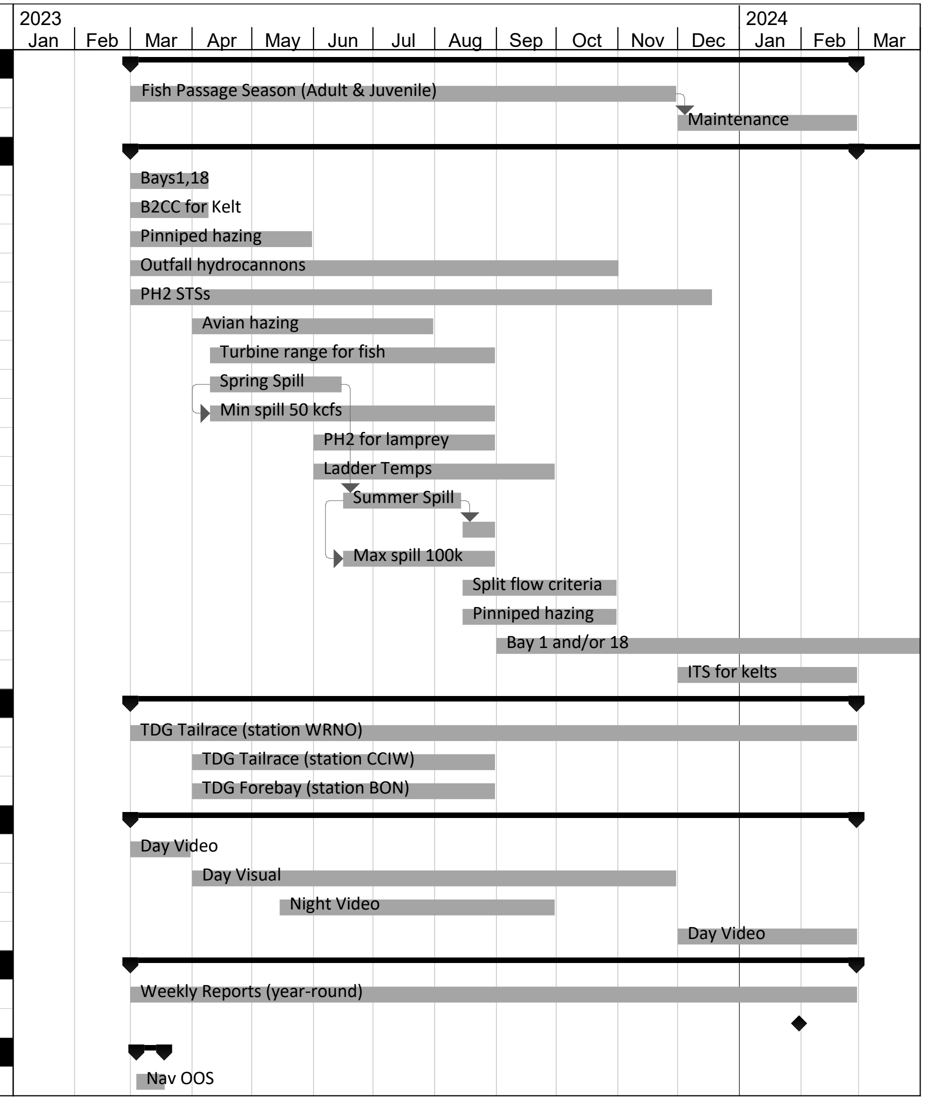


Figure BON-5. Bonneville Dam Juvenile (Smolt) Monitoring Facility (JMF) and Outfall Flumes.

Table BON-1. Bonneville Dam Schedule of Operations and Actions Defined in the 2023 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES (ADULT & JUVENILE)	**Wed 3/1/23**	**Thu 2/29/24**	
Fish Passage Season (Adult & Juvenile)	Wed 3/1/23	Thu 11/30/23	2.3, 2.4
Winter Maintenance Period	Fri 12/1/23	Thu 2/29/24	2.3, 2.4
PROJECT OPERATIONS FOR FISH PASSAGE	**Wed 3/1/23**	**Thu 2/29/24**	
Spillbays 1,18 for adult attraction	Wed 3/1/23	Sun 4/9/23	2.2.4.4
B2CC Operation for Kelt	Wed 3/1/23	Sun 4/9/23	2.3.2.5.v
Pinniped hazing	Wed 3/1/23	Wed 5/31/23	App L 3.5
Operate outfall hydrocannons	Wed 3/1/23	Wed 11/1/23	2.3.2.6
PH2 STS operation	Wed 3/1/23	Mon 12/18/23	2.3.2.5.a
Avian hazing	Sat 4/1/23	Mon 7/31/23	App L 3.2
Turbine operating range for fish passage	Mon 4/10/23	Thu 8/31/23	4.2.1
Spring Spill	Mon 4/10/23	Thu 6/15/23	App E (FOP)
Min spill 50 kcfs for juvenile egress	Mon 4/10/23	Thu 8/31/23	2.2.1
Reduced nighttime PH2 FU output for lamprey	Thu 6/1/23	Thu 8/31/23	2.4.2.13.vi
Ladder Temperature Monitoring	Thu 6/1/23	Sat 9/30/23	2.4.2.11
Summer Spill	Fri 6/16/23	Mon 8/14/23	App E (FOP)
Late Summer Spill	Tue 8/15/23	Thu 8/31/23	App E (FOP)
Day spill <=100 kcfs when PH1 operating	Fri 6/16/23	Thu 8/31/23	2.2.4.3
Split flow criteria	Tue 8/15/23	Tue 10/31/23	2.1.5
Pinniped Hazing	Tue 8/15/23	Tue 10/31/23	App L 3.5
Spillbays 1 and/or 18 for adult attraction	Fri 9/1/23	Tue 4/9/24	2.2.4.4
PH1 ITS gates for kelt passage	Fri 12/1/23	Thu 2/29/24	2.4.1.12
TDG MONITORING	**Wed 3/1/23**	**Thu 2/29/24**	
TDG Monitoring - Tailrace (WRNO)	Wed 3/1/23	Thu 2/29/24	2.2.3
TDG Monitoring - Tailrace (CCIW)	Sat 4/1/23	Thu 8/31/23	2.2.3
TDG Monitoring - Forebay (BON)	Sat 4/1/23	Thu 8/31/23	2.2.3
ADULT FISH COUNTING	**Wed 3/1/23**	**Thu 2/29/24**	
Day Video 0400-2000 PST	Wed 3/1/23	Fri 3/31/23	1.2.2
Day Visual 0500-2100 PDT	Sat 4/1/23	Thu 11/30/23	1.2.2
Night Video 2100-0500 PDT	Mon 5/15/23	Sat 9/30/23	1.2.2
Day Video 0400-2000 PST	Fri 12/1/23	Thu 2/29/24	1.2.2
REPORTS	**Wed 3/1/23**	**Thu 2/29/24**	
Weekly Reports (year-round)	Wed 3/1/23	Thu 2/29/24	2.5.2
Annual Report due NLT 31-Jan	Wed 1/31/24	Wed 1/31/24	2.5.2
SPECIAL OPS & STUDIES (APPENDIX A)	**Sat 3/4/23**	**Sat 3/18/23**	
Navigation Lock Outage	Sat 3/4/23	Sat 3/18/23	App A 1.4



1. FISH PASSAGE INFORMATION

Fish passage facilities at Bonneville Lock & Dam are shown in **Figures 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 Facilities and Migration Timing

1.1.1. Juvenile Fish Facilities. Juvenile fish passage routes at Bonneville Dam Powerhouse 1 (PH1) and Powerhouse 2 (PH2) include:

i. PH1 ice and trash sluiceway (ITS).

ii. PH1 minimum gap runner (MGR) turbines.

iii. PH2 juvenile bypass system (JBS), which consists 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
- excess water elimination facility
- one 48" fish transport pipe that 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).

iv. Two smaller PH2 turbines (Fish Units) supply auxiliary water to the adult fishway and have a fine trashrack with 0.75" clear opening but do not have STSs or streamlined trashracks.

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

1.1.2. Juvenile Fish Migration. The juvenile migration season is March 1–November 30. 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. The most recent 10 years of juvenile salmonid passage timing is summarized 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. To minimize impacts on downstream migrants, maintenance of juvenile fish facilities is scheduled between December 16 and the end of February and will be coordinated to avoid or minimize potential impacts on juvenile migrants that may be present during the work.

Table BON-2. Bonneville Dam Juvenile Salmonid Passage Timing for the 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**)			
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
2018	14-Apr	4-May	17-May	33	7-Jun	8-Jul	22-Jul	45
2019	15-Apr	7-May	23-May	38	6-Jun	22-Jun	14-Jul	38
2020	20-Apr	7-May	21-May	31	8-Jun	4-Jul	27-Jul	49
2021	19-Apr	8-May	23-May	34	15-Jun	4-Jul	13-Jul	28
2022	23-Apr	15-May	27-May	34	23-Jun	10-Jul	20-Jul	27
10-Yr MEDIAN	**20-Apr**	**9-May**	**23-May**	**34**	**15-Jun***	**29-Jun***	**19-Jul***	**35***
10-Yr MIN	**14-Apr**	**2-May**	**13-May**	**24**	**6-Jun***	**22-Jun***	**14-Jul***	**30***
10-Yr MAX	**28-Apr**	**18-May**	**6-Jun**	**44**	**21-Jun***	**9-Jul***	**15-Aug***	**70***
	Unclipped Steelhead				Clipped Steelhead			
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
2018	22-Apr	9-May	29-May	37	21-Apr	2-May	29-May	38
2019	23-Apr	8-May	29-May	36	22-Apr	4-May	19-May	27
2020	29-Apr	11-May	28-May	29	30-Apr	8-May	20-May	20
2021	30-Apr	15-May	3-Jun	34	28-Apr	6-May	20-May	22
2022	10-May	23-May	4-Jun	25	9-May	17-May	26-May	17
10-Yr MEDIAN	**25-Apr**	**13-May**	**30-May**	**36**	**29-Apr**	**12-May**	**28-May**	**30**
10-Yr MIN	**17-Apr**	**5-May**	**22-May**	**26**	**21-Apr**	**2-May**	**19-May**	**19**
10-Yr MAX	**5-May**	**27-May**	**9-Jun**	**45**	**8-May**	**30-May**	**12-Jun**	**41**
	Coho				Sockeye (Wild & Hatchery)			
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
2018	16-Apr	6-May	24-May	38	7-May	14-May	23-May	16
2019	19-Apr	10-May	2-Jun	44	5-May	22-May	1-Jun	27
2020	27-Apr	7-May	30-May	33	14-May	23-May	31-May	17
2021	30-Apr	8-May	30-May	30	9-May	19-May	29-May	20
2022	30-Apr	15-May	2-Jun	33	18-May	26-May	6-Jun	19
10-Yr MEDIAN	**25-Apr**	**13-May**	**30-May**	**36**	**13-May**	**22-May**	**1-Jun**	**20**
10-Yr MIN	**8-Apr**	**28-Apr**	**19-May**	**20**	**22-Apr**	**11-May**	**20-May**	**13**
10-Yr MAX	**15-May**	**24-May**	**9-Jun**	**47**	**3-Jun**	**10-Jun**	**4-Jun**	**34**

* Subyearling Chinook **MEDIAN, MIN, MAX** based on 1998-2006 data only. Data from 2007-present excluded due to potential bias from missed sample days during high water temperature sampling protocols (**Appendix K**).

** Subyearling Chinook only includes upriver brights to exclude influence by Spring Creek NFH Tules.

1.2. Adult Fish Passage Facilities and Migration Timing

1.2.1. Adult Fish Facilities. Bonneville Dam has two main fishway segments described below. Annual maintenance is scheduled during the winter maintenance period, December 1 through end of February, to minimize impacts on upstream migrants and to minimize fallback. The PH1 ice & trash sluiceway (ITS) is also used for adult passage year-round (**section 2.4.1**).

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 Bradford Island fishway has a counting station and auxiliary water supplies for attraction flow.

ii. Washington Shore (Figures 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. Washington Shore and Cascades Island fishways have counting stations. Washington Shore 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. Upstream migrants are present throughout the year and adult facilities are operated year-round. Counts of adult salmon, steelhead, bull trout, lamprey, and shad typically occur year-round (**Table BON-3**) and data are posted online.[1] Other species (sturgeon, grass carp, Atlantic salmon, etc.) are recorded as comments and reported in the *Annual Fish Passage Report*. The earliest and latest dates of peak adult passage based on yearly counts through the most recent passage year are in **Table BON-4**. Time-of-day (diel) distributions of adult salmonid activity at Bonneville Dam fishways are in **Figure BON-6**.

Table BON-3. Bonneville Dam Adult Fish Count Schedule March 2022 - February 2023.

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

*PST = Pacific Standard Time; PDT = Pacific Daylight Time, in effect during daylight saving time 3/13/22–11/6/22.

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	Feb 29	Mar 28
Coho	Jul 15 – Nov 15	Aug 29	Oct 11
Lamprey	Mar 15 – Nov 15	Jun 20	Jul 27

[1] Daily Adult Counts: www.fpc.org/currentdaily/HistFishTwo_7day-ytd_Adults.htm

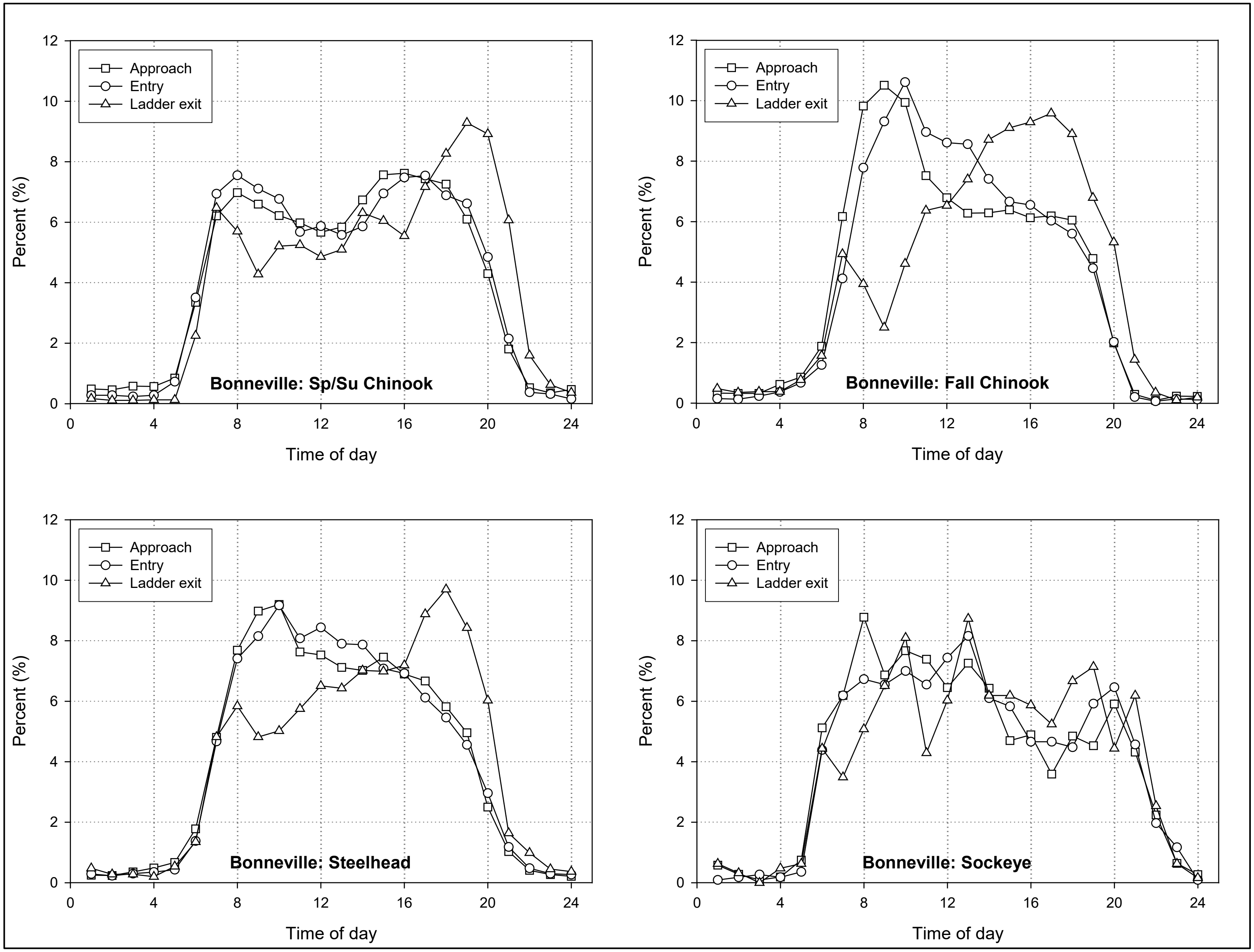


Figure BON-6. Diel Distribution of Adult Salmonids at Bonneville Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATION

2.1. General

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

2.1.2. Special operations related to research planned for this year are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

2.1.3. 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.

2.1.4. 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.

2.1.5. Split Flows. Unit priority order and operating ranges during split flows are in **section 4.1**.

> **2.1.5.1.a.** Before August 31, if adult and jack salmonid counts equal or exceed 30,000 fish/day, Project Fisheries will initiate coordination with FPOM to discuss options for splitting flow between powerhouses to balance attraction flow and adult passage among the project's fishways.
>
> **2.1.5.1.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/day.

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 in **Table BON-16**. 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. During spill that occurs September 1–April 9 (outside of juvenile fish spill season), the B2CC will be operated if available to provide a surface passage route.

2.2.3. 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 Management Plan* and the current *Dissolved Gas Monitoring Plan of Action*.[2] Starting March 1, TDG at Cascades Island will be reported every 4 hours, as well as the spill rate and total project outflow.

2.2.4. Day/Night Spill.

2.2.4.1. Hours for "Day" and "Night" spill are defined in **Table BON-5**.

2.2.4.2. 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. Transition to Day spill will begin after the Night period is over. 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.

2.2.4.3. 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.

2.2.4.4. From September 1 through April 9, during daytime hours defined in **Table BON-5**, spill will occur from Bays 1 and 18 each open one stop (6") 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 spillbay(s) adjacent to an operating ladder entrance.

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[2] TDG Management Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/
TDG Monitoring Plan of Action: www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality/

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

Date Range	Day Start Hour	Day End Hour	Night Start Hour [a]	Night End Hour
Jan 1 – Jan 19	0700	1730	1730	0700
Jan 20 – Feb 14	0630	1800	1800	0630
Feb 15 – Mar 1	0600	1830	1830	0600
Mar 2 – Start DST [b]	0600	1930	1930	0600
Start DST [b] – Apr 2	0700	2030	2030	0700
Apr 3 – Apr 20	0600	2130	2130	0600
Apr 21 – May 16	0600	2200	2200	0600
May 17 – May 31	0530	2230	2230	0530
Jun 1 – Jun 30	0530	2230	2230	0530
Jul 1 – Jul 31	0530	2300	2300	0530
Aug 1 – Aug 15	0600	2245	2245	0600
Aug 16 – Aug 31	0600	2130	2130	0600
Sep 1 – Sep 16	0630	2100	2100	0630
Sep 17 – Oct 4	0700	2030	2030	0700
Oct 5 – Oct 19	0730	2000	2000	0730
Oct 20 – Oct 29	0730	1930	1930	0730
Oct 30 – End DST [b]	0730	1800	1800	0730
End DST [b] – Dec 31	0630	1700	1700	0630

a. Transition to Night spill begins 15-20 minutes *before* the Night Start Hour.
b. DST = Daylight Saving Time, in effect from the second Sunday in March through the first Sunday in November.

2.3. Operating Criteria - Juvenile Fish Facilities

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

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

2.3.1.2. Ensure avian abatement measures are in place by March 1 or as soon as weather permits. From September through March, there will be no avian abatement measures other than avian lines. Repair and/or reinstall damaged or removed avian lines as soon as possible. Install and maintain new avian lines in locations determined to have significant avian predation. For more information, see the *Predation Monitoring & Deterrence Action Plans* for Bonneville Dam in **Appendix L** (Table 2 and section 3).

2.3.1.3. Operate the PH1 ice and trash sluiceway (ITS) per criteria in **section 2.4.1**.

2.3.1.4. Powerhouse Two (PH2).

i. Operate STSs until the third week of December to prevent adult salmonids from falling back through turbines. STSs may begin being removed on the Monday of the third week of December. Operate unscreened units on a last-on, first-off basis.

ii. Inspect each STS and operate on trial run (dogged off at deck level).

iii. Install STSs in each intake of operational units by the end of February.

iv. Video or manually inspect VBSs for damage, holes, debris, protrusions, and proper seating. Clean and repair all VBSs in operable units as necessary to maintain functionality.

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

vi. Inspect all gatewell orifices, orifice lighting, and flushing systems. Clean and/or repair as necessary so orifices and associated systems are fully functional.

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

viii. Inspect DSM channel, conduit outfall walls, and floor. Correct deficiencies.

ix. Once per year, visually inspect the outfall flume pipe (from exit of DSM to outfall) and associated switch gates (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.

x. Operate the PH2 corner collector (B2CC) during periods of spill to provide a surface passage route, per **section 2.2.2**.

2.3.1.5. Spillway.

i. Inspect spill gates and control systems and repair where necessary. Ensure the spillway can achieve FPP spill patterns in **Table BON-16** on the first day of the juvenile fish passage season, unless otherwise coordinated.

ii. 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.

iii. Spill guidance during the winter maintenance period is defined in **section 2.2**.

2.3.2. <u>Juvenile Facilities - Juvenile Fish Passage Season (March 1 – November 30).</u>

2.3.2.1. Measure main unit gatewell drawdown at least 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 common in many gatewells from sources such as lubricated lifting beams, etc. Remove any unusual accumulations of oil (e.g., oil slick) in gate slots within 24 hours. Determine appropriate procedures to remove fish during this situation in coordination with FPOM. Promptly deal with oil accumulations, regardless of unit operating status.

2.3.2.3. Implement avian and pinniped abatement measures as defined in the *Predation Monitoring & Deterrence Action Plans* for Bonneville Dam in **Appendix L**.

2.3.2.4. Set PH1 ITS chain gates 1A and 1B at 70' msl. If Unit 1 chain gates are OOS, set chain gates 2A and 2B at 70' msl. Operate PH1 ITS gates 3B, 6C, and 10B according to **Table BON-6**.

Table BON-6. Bonneville Dam Powerhouse One (PH1) Ice & Trash Sluiceway (ITS) Chain Gates 3B, 6C, and 10B Elevation (ft).

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

2.3.2.5. Powerhouse Two (PH2).

2.3.2.5.a. Install juvenile fish protection devices (STS, etc.) prior to the juvenile passage season. Operate screens (STS, VBS) until the Monday of the third week of December to prevent adult salmonids from falling back through turbine units.

2.3.2.5.b. Do not operate turbines without a full complement of operating STSs, except when in compliance with other coordinated fish measures.

2.3.2.5.c. If an STS or VBS is damaged, plugged, or fails, follow procedures in **section 3 – Fish Facilities Maintenance**.

2.3.2.5.d. Operate STSs at 60° angle from vertical.

2.3.2.5.e. Monitor and record each STS watt and/or amp gauge at least once per day.

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

2.3.2.5.g. If VBSs are manually inspected, shut off the unit and dip gatewells prior to pulling the VBS. It is not necessary to dip gatewells of units that have been off for at least 48 hours.

2.3.2.5.h. Do not schedule STS inspections when it may cause excessive TDG due to increased forced spill.

2.3.2.5.i. Inspect VBSs immediately prior to peaks in juvenile fish migration, 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 if there are any indications of STS or VBS malfunction or failure (e.g., deteriorating fish condition) or during periods of increased debris in the bypass system.

2.3.2.5.k. Measure main unit gatewell drawdown a minimum of once per week, or more frequently during times of overwhelming debris per **section 2.3.2.5.q**.

2.3.2.5.l. Remove debris from forebay and trash racks as required to maintain gatewell drawdown at or below 1.5’, or as indicated by fish condition (e.g., higher than expected descaling), or as determined by the Project Biologist.

2.3.2.5.m. In units being raked, run STSs continuously and close gatewell orifices.

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

2.3.2.5.o. Clean VBSs when drawdowns reach 1.1’ on any day (including weekends) and when drawdowns reach 0.9’ on Thursdays. If VBS drawdown equals or exceeds 1.5’ in 12 hours, shut down the unit.

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

2.3.2.5.q. In the event of overwhelming debris (as defined below), monitor gatewell drawdown daily and follow the procedures below:

i. Clean VBSs by installing the spare VBS in the back slot, raising the main VBS and spraying it off with a fire hose, then reinstalling the main VBS and pulling the spare (reverse order). If the TIE crane is out of service, use the Gantry Crane to pull the main VBS and do not install the spare VBS in the back slot.

ii. If the VBS drawdown criteria of < 1.1' CANNOT be maintained during the day due to debris, do not install the spare VBS in the back slot and do not dip the gatewells.

iii. If the VBS drawdown criteria of < 1.5' over 12 hours CANNOT be maintained due to debris even after performing the above operations, then do not pull STSs out until the screen re-installation criteria below have been met.

iv. Once screens have been removed, only operate these units if necessary to maintain TDG levels below gas cap limits.

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

2.3.2.5.r. Gatewell Cleaning.

i. 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 surface at least 50% clear of debris, clean at least once daily.

ii. Do not operate turbines with a gatewell fully covered with debris except to comply with other coordinated fish measures and then only last-on/first-off.

iii. Close gatewell orifices during the cleaning operations.

iv. After cleaning a gatewell, inspect and, if necessary, clean the orifice in that gatewell, and then check gatewell drawdown.

v. Coordinate gatewell cleaning with JMF personnel operating the downstream juvenile sampling facilities.

vi. A slight oily sheen is common in many gatewells. Remove any unusual accumulation of oil in gate slots within 24 hours. When this is not possible, close the gatewell orifice and shut down the turbine unit until cleaning is accomplished. Determine appropriate procedures to remove fish during this situation in coordination with FPOM. Promptly deal with oil accumulations regardless of unit operating status.

2.3.2.5.s. Gatewell Orifice Systems.

i. Ensure all gatewell orifice systems are operational.

ii. Orifices automatically flush 3 times/day, one orifice every 10 minutes. Manually flush orifices with less than a clear flow jet observed during inspection and any orifices that are known to have recurring plugging or other problems.

iii. Observe orifice jets through the light tubes during the inspection. Replace and clean light tubes and orifice tube lenses as necessary so that visual observations of orifice jets are possible during fishway inspections.

iv. Replace non-operational orifice lights within 24 hours. Ensure orifice lights remain on 24 hours/day. DSM gallery lights should be off except when there are personnel in the gallery.

2.3.2.5.t. DSM2 Channel Screen Cleaners.

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

ii. In the event the air system is unable to maintain desired water elevation in the dewatering area, increase the cleaning cycle duration as necessary.

iii. If the system is still unable to accommodate debris loads, activate the mechanical brush system 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.

iv. Once water elevations can be maintained, return the mechanical system to standby. The airburst system will be the primary screen cleaner.

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

vi. Run mechanical screen cleaners once a week to exercise the equipment.

2.3.2.5.u. DSM2 Channel Elevation.

i. 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.

ii. Maintain the channel elevation between 64.2’–64.4’ as measured at the staff gauge in front of the ERG.

iii. If the channel elevation exceeds the range of 64.2'–64.4', open the regulating orifices one at a time from south to north (starting at Unit 11) until proper channel elevation is achieved.

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

i. March 1–8: Open the B2CC daily from 0600–1000 hours. Open within 30 minutes of the start time and shift the closure time as necessary to maintain the 4-hour duration.

ii. March 9–25: Open the B2CC daily from 0600–1000 and from 1600–2000. Open within 30 minutes of the start time and shift the closure time as necessary to maintain the 4-hour duration.

iii. March 26 – August 31: Beginning at 0600 on March 26, operate the B2CC continuously (24 hours/day) through August 31. Close the B2CC within one hour of the end of summer spill on August 31.

iv. September 1–April 9: During spill that occurs outside of juvenile fish spill season, open the B2CC if available to provide a surface passage route.

2.3.2.6. Juvenile Monitoring Facility (JMF).

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

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

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

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

v. Operate the outfall avian hydrocannons from March 1 through November 1. During fish passage season, operate the hydrocannons 24 hours/day.

vi. For detailed monitoring facility guidance, see *Protocols for Juvenile Monitoring Facility Operations at Bonneville Dam in* **Appendix J**.

2.4. Operating Criteria - Adult Fish Facilities

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

2.4.1.1. Operate the adult fish passage facilities according to fish passage season standards in **section 2.4.2**.

2.4.1.2. Systems may be dewatered or operated out of criteria for repair and maintenance. Minimize outage periods to the extent practicable.

2.4.1.3. Only one ladder servicing the powerhouses and the associated powerhouse collection system (including the 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 spillway ladders will always be in full operation unless otherwise coordinated.

2.4.1.5. Operate spillbays 1 and/or 18 for adult attraction per **section 2.2.4**.

2.4.1.6. Adjust fish counting station 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) year-round.

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

2.4.1.9. Unless specially coordinated, all ladders will be dewatered. 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 ladder exits and clear of debris.

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

2.4.1.12. Except when closed to facilitate maintenance activities, operate the PH1 ITS gates 1A, 1B, 3B, 6C, and 10B from December 1 through the end of February for steelhead kelt passage. Set chain gate 1A and 1B at 70’ msl. Operate gates 3B, 6C, and 10B according to **Table BON-6**. From December 15 through end of February, the Project may close the ITS end gate 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 the fishway is out of service for winter maintenance), dredge AWS intakes to maintain the following elevations:

i. PH2 Fish Unit intake: -22’ to -24’ msl

ii. BI exit, FV3-7, FV3-9: +63’ msl

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

2.4.2.1. Maintain staff gauges and water level indicators in readable condition at all water levels encountered during fish passage season, including the 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.

2.4.2.2. Check stillwells used in lieu of staff gauges for calibration once/week.

2.4.2.3. Measure water depths at the Bradford Island A- and B-branch staff gauges, at 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’ outside of 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).

2.4.2.4. Maintain head on all entrances in the range of 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 criteria.

2.4.2.5. Maximum head on PH1 attraction water intakes and trash racks at all ladder exits is 0.5’. Maximum head on all picket leads is 4". Remove debris as necessary.

2.4.2.6. Cascades Island entrances are labeled “SW-SG” (Washington Sluice Gate) and Bradford Island entrances are “SO-SG” (Oregon Sluice Gate). Downstream entrances SW-SG-3 and SO-SG-4, adjacent to shorelines, consist of pairs of North (N) and South (S) gates.

i. Close side entrances SW-SG-5 and SO-SG-7.

ii. Operate downstream entrances SW-SG-1 and SO-SG-2 as continuously open, free-flowing vertical slots.

iii. At Cascades Island, close -3N and -3S at all tailwater elevations.

iv. At Bradford Island B-Branch, when tailwater exceeds 17’, close -4N and -4S. When tailwater is between 9’ and 17’, open sluice gate -4N. When tailwater is below 9’, open both sluice gates -4N and -4S.

2.4.2.7. Maintain water velocity 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 tailwater. Measure water velocities once per week during fishway inspections to verify channels are operating between 1.5 and 4 fps. If the velocity reading is out of criteria, weekly readings will increase to three times a week until proper conditions are met.

2.4.2.8. Operate Sea Lion Exclusion Devices (SLEDs) at all adult fishway entrances and all floating orifice gates (FOGs). All SLEDs may be left in year-round.

2.4.2.9. When spilling exclusively for adult attraction, open spillbays 1 and/or 18 one stop (6”) during day hours only if adjacent to operating fishway entrances, per **section 2.2.4.4**.

2.4.2.10. Fish Counting.

i. Maintain all equipment in good condition. Clean the counting window and backboard as needed to maintain good visibility.

ii. Crowder ranges at BON are:

- Washington Shore = 22.8” – 38.4”
- Cascades Island (currently out of service) = approx max opening 36”
- Bradford Island = 20.4” – 36.0”

iii. During visual counting and/or video recording (see current schedule in **Table BON-3**), maintain count station crowders in operating position. The crowder may remain in operating position during the counters’ hourly 10-minute break period.

iv. When not counting, or if counting is temporarily discontinued due to unscheduled events, open the crowder to full count slot width.

v. During counting, open the crowder as far as possible to allow accurate counting, no less than 18". This will usually occur during high turbidity conditions to maintain count accuracy. If passage is impaired by this condition, widen the count slot until proper passage conditions are achieved, even though count accuracy may be compromised to some degree. Project biologists, FFU, and the fish count supervisor shall coordinate to achieve optimum count slot passage and/or count accuracy conditions.

vi. Ensure the fish passage slot lights remain on overnight. 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.

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

2.4.2.11. Fishway Temperature Monitoring.

2.4.2.11.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**.

2.4.2.11.b. From June 1 through September 30, measure water temperature at adult fishway entrances and exits and submit data to the Fish Passage Center (FPC) weekly for posting online.[3] Ensure the location of the monitors meets the following criteria:

i. Within 10 meters of all shore-oriented entrances and exits.

ii. Entrance monitor within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers, if possible, to allow for sufficient mixing with surface water.

iii. Exit monitor 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, verify that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.4.2.12. Powerhouse One (PH1).

i. Weir Gates. Operate PH1 weir gates per requirements in **Table BON-7.** Operate the four weir gates in two pairs (1 & 65, 2 & 64), one gate pair at a time. During transition, close the former active pair and position the new active pair according to tailwater:

- Tailwater > 23' msl = operate gates 1 and 65 as the active pair.
- Tailwater < 26' msl = operate gates 2 and 64 as the active pair.
- Tailwater between 23' and 26' = active pair depends on whether tailwater is rising or falling with a "dead band" of 1.5'.

ii. Fish Valve FV1-1.

- **Emergency Closure.** If collection channel/tailwater differential is greater than 2.5', or if the pressure differential between the auxiliary water supply conduit and collection channel becomes excessive, as determined by operators, close FV1-1.
- **Differential.** Low: collection channel/tailwater differential < 1'. High: collection channel/tailwater differential > 2'.

[3] FPC ladder temperature website: www.fpc.org/smolt/smolt_queries/Q_ladderwatertempgraphv2.php

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

iv. Bradford Island. Open A-branch diffuser gates according to patterns in **Table BON-8** and B-branch diffuser gates according to **Table BON-9**.

v. Cascades Island. Diffuser operating ranges are defined in **Table BON-10**.

vi. PH1 Collection Channel Diffusers. Operate diffuser valves according to patterns in **Table BON-11.**

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

Table BON-7. 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	2.0
64	8.0 – 8.4	1 – 2	2.0
65	8.0 – 8.4	1 – 2	8.5

Table BON-8. 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-9. 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	10.5–28.0	FG3-32	> 26
				FG3-33	> 27

Table BON-10. 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-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).

i. During day spill (**Table BON-5**), operate all north (NUE, NDE) and south (SUE, SDE) entrances.

ii. At tailwater elevations ≤ 14’, operate weir crests at elevation 1’ (fully lowered). At tailwater elevations > 14’, operate weir crest at ≥ 13’ below tailwater.

iii. Operate all twelve active PH2 floating gate fishway entrances.

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

v. 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**).

vi. 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 between 2200 and 0400 hours.

2.5. <u>Fish Facilities Monitoring & Reporting</u>

2.5.1. Monitoring.

2.5.1.1. During fish passage season, inspect fish passage facilities at least three times per day, seven days a week, to ensure operation according to established criteria. Daily inspections will include at least one by Project Fisheries, one by Project Operators, and one modified (PLC check).

2.5.1.2. During the winter maintenance period, inspect fish passage facilities at least once per day, seven days a week, with at least three inspections per week performed by Project Fisheries.

2.5.1.3. Perform inspections more frequently in accordance with criteria in this document.

2.5.1.4. Report results of all inspections and the readiness of the facilities for operation to FPOM at the meeting immediately prior to the fish passage season.

2.5.1.5. Continue to implement the zebra mussel monitoring program. 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 project facilities.

2.5.2. Reporting.

2.5.2.1. Weekly Reports. Project biologists shall prepare weekly reports throughout the year summarizing project and fish facility operations for each week (Sunday through Saturday), along with an evaluation of resulting fish passage conditions. The reports will be e-mailed to CENWP-OD, CENWD-PDW-R (RCC), and other interested parties as soon as possible the following week. The weekly reports shall include:

i. Out-of-criteria situations and subsequent corrective actions.

ii. Equipment malfunctions, breakdowns, or damage along with a summary of resulting repairs.

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. Unusual activities at the project that may affect fish passage.

2.5.2.2. In-Season. Any adverse or negative impact to fish or fishways shall be reported in a *Memorandum for the Record* (MFR) prepared by Project biologists and sent to FPOM by the next working day, pursuant to the coordination process and template in **FPP Chapter 1 – Overview** (section 2.3.2).

2.5.2.3. Annual Report. Project biologists shall prepare an annual report by January 31 each year, summarizing fish facility operations for the previous year's winter maintenance period and fish passage season, December 1 through November 30. The annual report will also include all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the actions. The annual report will be provided to CENWP-OD in time for distribution to FPOM members at the February meeting.

3. FISH FACILITIES MAINTENANCE

3.1. Fish Facilities Routine Maintenance

3.1.1. Routine maintenance of fish facilities will be conducted when fish passage has been documented to be at its lowest during the regular scheduled workday, to the extent practicable, to minimize fish impacts. Maintenance that occurs during juvenile or adult passage season that may affect fish passage will be included in the weekly reports, per **section 2.5.2**. If maintenance requires operating outside of FPP criteria, the work will be coordinated with FPOM per the procedures defined in **FPP Chapter 1–Overview** (section 2.3).

3.1.2. Staff gauges and other water level sensors will be installed, cleaned, and repaired as needed.

3.1.3. Submersible Traveling Screens (STS).

i. The STS system will receive preventive maintenance or repair at all times of the year, including the winter maintenance period.

ii. 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.

iii. 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.

3.1.4. Juvenile Bypass Systems (JBS).

i. The JBS will receive preventive maintenance throughout the year.

ii. During the juvenile fish passage season, maintenance will normally be above-water work, such as maintenance of automatic systems, air lines, electrical systems, and monitoring equipment.

iii. During the winter maintenance period, systems may be dewatered downstream of the gatewell orifices, then visually inspected in all accessible areas for damaged equipment and in areas that may cause problems to juvenile fish. Any problem areas identified will 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.

iv. Trash racks will be raked just prior to the juvenile fish passage season and whenever trash accumulations are suspected because of increased head > 1.5’ across the trash racks 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.

3.1.5. Turbines and Spillbays.

i. Routine maintenance and repair of turbines and spillbays is a regular and recurring process that requires extended outages, as defined in **Turbine Maintenance section 4.3** and **Dewatering Plans section 5**. If maintenance requires operating outside of FPP criteria, work will be coordinated with FPOM.

ii. Certain turbine and spillbay flows are secondarily used to attract adult fish to fishway entrances, to keep predator fish away from juvenile release sites, and/or to move juveniles downstream of the project. Maintenance schedules for these turbines and spillbays will reflect equal weighting given to fish, power, and water management and coordinated with the appropriate fish and resource agencies through FPOM. During fish passage season, Units F1, F2, 1, 3, 11, and 18 will not be taken out of service, when practicable.

iii. From June 21–September 15, except during split flow operations, PH2 units will not be taken out of service to the extent practicable in order to minimize PH1 operation.

iv. 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.

3.1.6. Adult Fish Collection Systems.

i. Preventive maintenance and repairs occur throughout the year. During the adult fish passage season, this maintenance will not involve any operations that would cause failure to comply with fishway criteria except as specially coordinated or as needed for semi-annual maintenance.

ii. Inspection of those parts of the adult collection channel systems that require dewatering (e.g., diffusion gratings, leads, and entrance gates) will be scheduled once per year during the winter maintenance period while the system is dewatered, with one additional inspection during fish passage season, unless a channel must be dewatered for fishway modifications or to correct problems.

iii. An underwater video system or diver may be used for underwater inspections. This scheduled inspection and any associated maintenance will occur during the winter maintenance period and once during fish passage season unless specially coordinated. A Project Biologist will attend all dewatering activities potentially involving fish, as well as inspections, to provide fish-related input.

iv. Bonneville fishway 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, trash racks will be raked during the time of day when fish passage is least affected.

v. 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 confirm they are in place, either by dewatering the fish passageway and physically inspecting the diffuser gratings, or by other methods.

vi. Diffuser gratings may come loose during fish passage season. 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 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 ASAP 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 will be made as quickly as possible unless coordinated differently.

vii. Diffuser pits will be cleaned of debris by using a rolling operation. Diffusers are opened one-at-a-time for a period of ~5 minutes, 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 concurrent with ROV inspections to minimize impacts on fish passage.

3.1.7. Adult Fish Ladders & Counting Stations.

i. Also see *Adult Fish Trapping Protocols* in **Appendix G**. Adult ladders will be dewatered once each year during winter maintenance. During this time, 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 counting station equipment, 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.

ii. Trash racks at the ladder exits will be raked when criteria are approached or exceeded. When practicable, trash racks will be raked during the time of day when fish passage is least affected, usually late morning.

iii. 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.

3.2. Fish Facilities Non-Routine Maintenance.

3.2.1. Non-routine or unscheduled fish facility maintenance that will have a significant impact on adult or juvenile fish passage or operation of fish facilities (e.g., repair of fish screens, diffuser gratings, etc.) shall be coordinated through FPOM and RCC on a case-by-case basis by Project and CENWP-OD biologists, per the coordination process described in **FPP Chapter 1–Overview** (section 2.3). The CENWP-OD biologists will be notified as soon as possible after it becomes apparent that non-routine maintenance 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.

3.2.2. Non-routine maintenance that affects fish passage will be included in the weekly reports.

3.2.3. 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 spill pattern to follow until repairs are completed. This interim operation shall be coordinated with FPOM through the district biologist who will provide additional guidance to the project.

3.2.4. Juvenile Bypass System (JBS).

i. If an STS or VBS is damaged, plugged, malfunctioning, or inoperative in an operating unit, the unit will be regarded as an unscreened unit and taken out of service, per **section 2.3.2.5**. The screen will be repaired or replaced before returning the unit to service. If screens are pulled and replaced, the underwater video inspection camera will be deployed to check the screens for proper seating.

ii. The JBS is controlled automatically (PLC). When an automatic system fails, it can usually be operated manually so that the facility continues to operate according to criteria while the automatic system is repaired.

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

iv. Orifices allow fish out of the gatewells into the bypass channel. If an orifice valve system becomes inoperative, it will be repaired expeditiously. Orifices that become plugged with debris will be pneumatically flushed.

v. All STS gatewells will be inspected daily and cleaned before they become 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 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 comply 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. Gatewell drawdown will be checked and trashracks cleaned if necessary.

vi. 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 completed or until the end of fish passage season. Any decision on whether to shut the 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 PH2. Repairs will receive high priority.

3.2.5. Adult Fishway Auxiliary Water Systems. Most fishway auxiliary water systems are operated automatically. If the automatic system fails, project personnel will manually operate the system to maintain criteria and increase surveillance of the system to ensure criteria are being met until the automatic system is repaired. In the event of AWS failure, FPOM will be used in an advisory capacity to assist the project as needed.

i. Spillway. Two separate fishway auxiliary valves add water to each spillway ladder (Cascades Island and B-branch). If one of these valves or any other part of the system malfunctions, the functioning parts of the system will be adjusted to compensate. If repairs cannot be made in 24 hours, the sluice gate entrance will be closed (if open) to divert the reduced available water to the entrance slots. If a head of 1’ is still not achieved, stop logs will be added to the entrance slots until the desired head or a weir depth of no less than 6’ below tailwater is reached. At this point, the gate positions will be maintained until the system is repaired.

ii. 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 established limits.

iii. Powerhouse Two (PH2).

- 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* defined in **Table BON-12**, or until a fishway head of 1’ is achieved.
- If one of the fish turbines fails or is taken out of service, emergency operating criteria for turbines, floating orifices, diffuser gates, and main gates defined in **Table BON-12** will 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.
- From September 1 through March 31, if both fish turbines fail and cannot be repaired within 8 hours, coordination with FPOM will occur to develop operational guidelines that may include modified powerhouse priority.
- 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

3.2.6. Adult Fish Ladders & Counting Stations.

i. In most cases, if fishway entrance failures occur, project personnel will manually operate the entrance and increase surveillance of the system to ensure that criteria are being met until repairs are made. If the entrance cannot be manually operated, the gate will be maintained in an operational position to the extent possible. If not possible, the entrance will be repaired expediently and returned to manual or automatic control at the earliest possible date.

ii. Picket leads 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 to replace damaged leads so they can be 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 to dewater the fishway and repair any problems will be made in coordination with FPOM.

iii. Diffuser gratings may come loose during fish passage season. Daily inspections of fish 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 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 FPOM. 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. 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 available unit in the priority order will be operated. Unit priority order may be coordinated differently for fish research, construction, or project maintenance.

4.1.2. When splitting flows (**section 2.1.5**), 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.

4.1.3. 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, 9, 4, 5, 8, 7, 2
PH2 Fish Ladder out of service	**PH1**: 1, 10, 3, 6, 9, 4, 5, 8, 7, 2, **Then PH2**: 11, 18, 12, 17, 13, 14, 15, 16
Split Flows (see **section 2.1.5**)	**PH1**: 1, 10 (or top two available PH1 priority units), **Then PH2**: 11, 18, 12, 17, 13, 14, 15, 16, **Then PH1:** 3, 6, 9, 4, 5, 8, 7, 2
PH1 Unit Priority	1, 10, 3, 6, 9, 4, 5, 8, 7, 2
PH2 Unit Priority	11, 18, 12, 17, 13, 14, 15, 16

4.2. Turbine Unit Operating Range

Lower and upper limits of PH1 and PH2 turbine operating ranges are in **Table BON-15**. Turbine units will be operated within these ranges according to *BPA's Load Shaping Guidelines* (**Appendix C**) and as described below.

4.2.1. In-Season: April 10–August 31 (Spring/Summer Spill for Juvenile Fish Passage).

4.2.1.1. PH1: Units 1-10 will be operated between the 1% lower limit and the Best Operating Point (BOP), except under limited conditions and durations when PH1 units may be operated above BOP for the use of reserves or for TDG management during high flows (refer to **Appendix C** for more information). All required fish passage spill operations will be met prior to operating PH1 units above BOP.

4.2.1.2. PH2: Units 11-18 will be operated within restricted operating ranges as follows:

4.2.1.2.a. From April 10 through June 15 (spring spill), as a soft constraint, PH2 units should not be operated below the 1% mid-range (< 13 kcfs) to minimize turbulence for turbine-passed fish.

4.2.1.2.b. From April 1 through July 31, PH2 units will be operated within the 1% mid-range (13–15 kcfs) to minimize turbulence for bypassed fish until gatewell structural modifications are completed. *RCC will issue a teletype with any in-season modifications as construction and testing is completed.*

During this time, excess flow above project capacity (PH2 in mid-range + PH1 at BOP + FOP spill + corner collector, ladders, etc.) will be passed in the following sequential order with increasing flow, or as otherwise determined by Project Fisheries based on observed conditions. This sequence of operations is also summarized in **Table BON-14**:

i. April 1–9 Pre-Spring Spill and June 16 – July 31 Summer Spill:

1. Increase PH2 units up to the 1% upper limit.
2. Then, increase spill.

ii. April 10 – June 15 Spring Spill w/ Juvenile Trigger: when juvenile spring Chinook collection counts[4] exceed adult spring Chinook total passage counts[5] (excluding jacks) for at least three consecutive days, Project Fisheries will notify the control room to pass additional flow as follows:

1. Maintain PH2 units within the mid-range and increase spill up to a maximum of 150 kcfs to avoid causing erosion in the spillway stilling basin.

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[4] **Juvenile Spring Chinook –** reported as "*Collection Count*" in the SMP Smolt Data (query current year, "*BO2*", "*Combined Chinook Yearling*"): fpc.org/smolt/smolt_queries/Q_smoltpassageindexquery.php

[5] **Adult Spring Chinook –** reported as "*Spring Chinook Adult*" at Bonneville Dam: fpc.org/currentdaily/HistFishTwo_7day-ytd_Adults.htm

2. Then, increase PH2 units above the mid-range to the 1% upper limit prioritizing B2FGE modified units first (11, 18, 15, …) then the remaining unmodified units in order from south to north. Include 1% operation summary in the Weekly Report.
3. Then, increase spill above 150 kcfs, up to 180 kcfs. *PH2 UNITS MAY ONLY BE OPERATED ABOVE THE MID-RANGE WHEN SPILL IS BETWEEN 150 KCFS AND 180 KCFS.*
4. Then, increase spill above 180 kcfs and resume operating PH2 units within the mid-range.

iii. April 10 – June 15 Spring Spill w/ Adult Trigger: when adult spring Chinook total passage counts[5] (excluding jacks) exceed juvenile spring Chinook collection counts[4] for two consecutive days, Project Fisheries will notify the control room to pass additional flow as follows:

1. Increase PH2 units up to the 1% upper limit in order from north to south (Unit 18 to Unit 11).
2. Then, increase spill.

Table BON-14. Sequential Steps to Pass Increasing Flow per Temporary PH2 Operating Range Guidelines in section 4.2.1.2.b.

April 1 – 9 **Pre-FOP Spill**	1. PH2 in mid-range + PH1 up to BOP. 2. Then, increase PH2 > mid-range up to 1% upper limit. 3. Then, spill (start with B2CC if not already open).
April 10 – June 15 **FOP Spring Spill**	**JUVENILE TRIGGER** 1. FOP Spring Spill + PH2 in mid-range + PH1 up to BOP. 2. Then, increase spill above FOP up to 150 kcfs. 3. Then, increase PH2 above mid-range up to 1% upper limit (B2FGE modified units first, then unmodified units south to north). 4. Then, increase spill up to 180 kcfs. 5. Then, increase spill above 180 kcfs and resume PH2 in mid-range. **ADULT TRIGGER** 1. FOP Spring Spill + PH2 in mid-range + PH1 up to BOP. 2. Then, increase PH2 up to 1% upper limit (north to south). 3. Then, increase spill above FOP.
June 16 – July 31 **FOP Summer Spill**	1. FOP Summer Spill + PH2 in mid-range + PH1 up to BOP. 2. Then, increase PH2 up to 1% upper limit. 3. Then, increase spill above FOP.
August 1 – 31* **FOP Summer Spill**	1. FOP Summer Spill + PH2 in full 1% (*see footnote) + PH1 up to BOP. 2. Then, increase spill above FOP.

*Starting August 1, PH2 units may be operated within the full 1% range for flexibility during low flow. PH2 units will typically be within the mid-range but may be adjusted through the full 1% range as necessary to avoid dead-band issues during low flow. PH2 operations above the mid-range will be infrequent, consistent with previous years.

4.2.1.3. If in-season operation outside the 1% range or above BOP at PH1 is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. In-season 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 5.5**), 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 to flush fish from the unit.

iii. Operate a turbine unit solely to provide station service (< 1%).

iv. Comply with other coordinated fish measures.

4.2.2. Off-Season: September 1–April 9. 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.

4.3. Turbine Unit Maintenance

4.3.1. Turbine unit maintenance schedules will be reviewed by Project and District biologists for fish impacts. If maintenance requires operating outside of FPP criteria, the work will be coordinated with FPOM per the procedures defined in **FPP Chapter 1–Overview**.

4.3.2. 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, 10, 11, and 18 will be scheduled for any necessary extended outages between December 1 and April 30. In addition, Unit 10 maintenance outages may be scheduled from July 15 through August 31 when Powerhouse 1 units are not operating. 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. When PH1 is operating, Units 1 and 10 provide important attraction flow for adult fish and helps pass juvenile fish downstream. Therefore, long-term outages of Unit 1 and 10 will be avoided during the juvenile passage season until after adult fall Chinook and coho migration ends in late October.

4.3.3. Operational Testing. Operational testing may deviate from priority units and may require water that would otherwise be used for spill if 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. During testing, units may be operated outside of the 1% range for up to 20 minutes. Unit operations below the 1% range will be minimized to the extent practicable.

i. 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.

ii. 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.

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

4.3.5. In the event of long-term powerhouse outages, affected units 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 the 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.

4.3.6. Head gates[6] 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] Head gates may also be referred to as "operating" gates at some projects. The terms are interchangeable.

Table BON-15. Bonneville Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Efficiency (1% Range), Operating Limit, and PH1 Best Operating Point (BOP). [a, b]

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	19.2	7,463	23.1	8,964	27.3	10,527	26.4	10,473
36	19.9	7,476	23.9	8,994	28.3	10,564	28.0	10,816
37	20.5	7,485	24.8	9,050	29.2	10,598	29.6	11,174
38	21.1	7,486	25.7	9,111	30.2	10,627	31.3	11,532
39	21.7	7,487	26.6	9,180	31.2	10,654	33.0	11,927
40	22.3	7,495	27.5	9,241	32.1	10,677	34.8	12,350
41	22.9	7,510	28.4	9,293	33.2	10,759	36.7	12,732
42	23.6	7,530	29.3	9,331	34.3	10,837	38.6	13,047
43	24.3	7,552	30.1	9,362	35.4	10,910	40.4	13,331
44	25.0	7,573	31.1	9,411	36.5	10,979	42.2	13,616
45	25.7	7,588	32.1	9,489	37.6	11,045	44.0	13,910
46	26.3	7,597	33.2	9,599	38.8	11,109	45.7	14,213
47	26.9	7,604	34.4	9,729	39.9	11,170	47.4	14,519
48	27.5	7,609	35.6	9,864	41.0	11,227	47.9	14,288
49	28.1	7,615	36.8	9,981	42.1	11,282	48.1	13,901
50	28.7	7,623	37.9	10,063	43.2	11,333	48.5	13,608
51	29.4	7,632	38.9	10,109	44.2	11,356	48.9	13,331
52	30.0	7,641	39.8	10,131	45.2	11,378	49.2	13,048
53	30.6	7,648	40.6	10,141	46.2	11,398	49.6	12,778
54	31.3	7,657	41.5	10,156	47.2	11,418	50.0	12,565
55	31.9	7,668	42.3	10,180	48.2	11,465	50.3	12,381
56	32.5	7,679	43.2	10,212	49.2	11,478	50.6	12,202
57	33.1	7,690	44.2	10,249	50.3	11,518	51.0	12,031
58	33.8	7,701	45.2	10,293	51.4	11,557	51.1	11,831
59	34.4	7,714	46.2	10,344	52.4	11,594	51.1	11,600
60	35.1	7,726	47.2	10,400	53.5	11,630	51.2	11,384
61	35.7	7,737	48.3	10,461	54.3	11,610	51.4	11,215
62	36.3	7,747	49.3	10,526	55.1	11,591	51.6	11,053
63	36.9	7,756	50.4	10,590	56.0	11,572	51.7	10,876
64	37.6	7,768	51.5	10,654	56.6	11,519	51.6	10,655
65	38.2	7,783	52.6	10,713	56.8	11,388	51.4	10,438
66	38.8	7,780	53.4	10,712	57.1	11,265	51.0	10,172
67	39.4	7,775	54.2	10,703	57.3	11,124	51.0	10,026
68	39.9	7,769	54.9	10,690	57.6	11,021	51.1	9,881
69	40.4	7,765	55.6	10,679	57.8	10,896	50.8	9,673
70	41.0	7,766	56.3	10,651	58.0	10,736	50.3	9,439

Project	PH2 Units 11–18 With STS						PH2 Units 11–18 No STS					
Head	1% Lower Limit		1% Upper Limit		Operating Limit [b]		1% Lower Limit		1% Upper Limit		Operating Limit [b]	
(ft)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
35	30.8	12,470	38.0	15,397	41.0	16,921	31.2	12,500	38.5	15,402	44.4	18,465
36	31.7	12,462	39.9	15,671	42.5	16,972	32.3	12,524	40.3	15,630	46.5	18,741
37	32.7	12,456	41.8	15,939	44.3	17,131	33.3	12,542	42.2	15,875	48.6	19,000
38	33.6	12,419	43.8	16,212	46.3	17,347	34.3	12,534	44.1	16,122	50.7	19,257
39	34.4	12,359	45.8	16,472	48.2	17,543	35.3	12,516	46.1	16,350	52.9	19,512
40	35.1	12,271	47.8	16,728	50.2	17,744	36.2	12,469	48.1	16,591	55.1	19,765
41	35.8	12,169	49.9	16,973	52.3	17,947	37.0	12,401	50.2	16,824	57.4	20,000
42	36.4	12,050	51.9	17,216	54.3	18,152	37.7	12,307	52.3	17,057	59.6	20,222
43	37.0	11,932	54.0	17,447	56.4	18,353	38.4	12,192	54.4	17,289	61.9	20,433
44	37.6	11,829	56.1	17,657	58.5	18,544	39.0	12,069	56.6	17,519	64.1	20,646
45	38.2	11,741	58.1	17,839	60.7	18,730	39.6	11,950	58.8	17,743	66.4	20,844
46	39.0	11,673	60.0	17,982	62.8	18,914	40.2	11,843	61.0	17,962	68.7	21,039
47	39.8	11,624	61.8	18,064	64.9	19,091	40.9	11,753	63.2	18,171	71.0	21,229
48	40.6	11,593	63.3	18,072	67.1	19,257	41.6	11,680	65.4	18,360	73.2	21,399
49	41.5	11,571	64.7	18,031	69.2	19,422	42.4	11,625	67.4	18,508	75.5	21,563
50	42.4	11,557	65.9	17,941	70.4	19,289	43.2	11,594	69.2	18,569	76.5	21,172
51	43.3	11,545	67.0	17,852	71.6	19,173	44.1	11,580	70.8	18,566	76.5	20,528
52	44.2	11,540	68.3	17,814	72.7	19,079	45.1	11,577	72.1	18,519	76.5	19,918
53	45.1	11,540	69.6	17,803	73.9	19,001	46.0	11,574	73.3	18,445	76.5	19,384
54	46.0	11,532	71.0	17,800	75.1	18,912	46.9	11,567	74.4	18,353	76.5	18,925
55	46.9	11,517	72.5	17,808	76.3	18,830	47.8	11,553	75.5	18,243	76.5	18,515
56	47.7	11,501	74.0	17,832	76.5	18,489	48.7	11,539	76.5	18,139	76.5	18,133
57	48.6	11,491	75.6	17,882	76.5	18,117	49.6	11,530	77.6	18,067	76.5	17,771
58	49.4	11,490	77.3	17,968	76.5	17,766	50.5	11,529	79.1	18,064	76.5	17,426
59	50.3	11,500	79.2	18,093	76.5	17,435	51.4	11,542	80.7	18,127	76.5	17,097
60	51.2	11,521	81.1	18,241	76.5	17,122	52.4	11,568	82.6	18,237	76.5	16,786
61	52.1	11,535	81.9	18,121	76.5	16,843	53.3	11,580	83.6	18,160	76.5	16,504
62	53.0	11,548	82.6	18,008	76.5	16,577	54.2	11,587	84.6	18,102	76.5	16,234
63	53.8	11,561	83.3	17,888	76.5	16,322	55.0	11,592	85.7	18,055	76.5	15,978
64	54.7	11,570	84.0	17,773	76.5	16,078	55.9	11,601	86.9	18,027	76.5	15,735
65	55.5	11,576	84.6	17,662	76.5	15,844	56.8	11,608	88.1	18,022	76.5	15,502
66	56.3	11,579	85.3	17,562	76.5	15,620	57.6	11,612	89.4	18,038	76.5	15,279
67	57.0	11,574	86.0	17,469	76.5	15,407	58.4	11,613	90.9	18,080	76.5	15,066
68	57.7	11,562	86.7	17,375	76.5	15,203	59.1	11,609	92.5	18,152	76.5	14,862
69	58.3	11,537	87.3	17,285	76.5	15,008	59.9	11,598	94.2	18,247	76.5	14,665
70	58.8	11,505	88.0	17,205	76.5	14,818	60.6	11,586	96.0	18,361	76.5	14,476

a. Values provided by HDC (May 2022), except PH1 BOP from Turbine Survival Program (TSP) modeling and analysis (Jan 2013). Flow (cfs) is a calculated value based on turbine efficiency, project head, and power output (MW).

b. "*Operating Limit*" (added Feb 2018) is the maximum safe operating point based on cavitation or generator limit. BON PH2 units have a generator limit that restricts turbine output at higher heads. Values shaded in gray indicate the Operating Limit is below the modeled 1% Upper Limit.

5. DEWATERING PLANS

5.1. General

5.1.1. *Guidelines for Dewatering and Fish Handling Plans* (**Appendix F**) and project *Dewatering Plans*[7] 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.

5.1.2. 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.

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

5.1.4. 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.

5.1.5. 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.

5.2. Dewatering – Juvenile Bypass Systems (JBS)

5.2.1. See *Guidelines for Dewatering and Fish Handling* (**Appendix F**) and *Dewatering Plans*[7].

5.3. Dewatering – Adult Fish Ladder

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

5.3.2. All fishway auxiliary water supplies will be discontinued 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.

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

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[7] Project dewatering plans are available on the FPOM website: pweb.crohms.org/tmt/documents/FPOM/2010/

5.3.4. 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.

5.3.5. 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.

5.3.6. Dewatering for non-routine maintenance will occur according to the same criteria defined above. When possible, fishway auxiliary water will be continued and the ladder will be operated at orifice flow as long as possible (preferably 3-24 hours) prior to dewatering.

5.4. Dewatering – Powerhouse Fish Collection System

5.4.1. During the pumping or draining operation to dewater a portion or the entire collection channel, the water level will not be allowed to drop 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. Project Fisheries will directly assist fish rescue operations, provide technical guidance, ensure fish safety, and ensure rescue equipment/personnel are available if needed.

5.5. Dewatering – Turbine Units

5.5.1. 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.

5.5.2. 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.

5.5.3. 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.

5.5.4. 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.

5.5.5. 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.

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

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

5.5.8. 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.

5.6. Dewatering – Navigation Lock

5.6.1. 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. 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.

6. FOREBAY DEBRIS REMOVAL

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. Debris is removed by operating the PH1 ITS, B2CC, or passing it through the spillway with a special spill gate operation. Special spill operations that don't follow the normal spill schedule or rate limits will be coordinated prior to implementation. Normally the project will contact CENWP-OD at least two workdays before the special operation is required. Using information provided by the project, CENWP-OD will coordinate with FPOM and RCC, as necessary. Once the coordination is complete, RCC will issue a teletype to the project with the details.

7. RESPONSE TO HAZARDOUS MATERIALS SPILLS

Bonneville Project's guidance for responding to hazardous substance spills is contained in its *Emergency Spill Response Plan*. 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. 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):
Andrew Derugin (Supervisor), Jeanette Flemmer, Rebecca Cates, Tucker Gossett, Tammy Mackey (Operations Chief).

Table BON-16. [*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	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**
5	8	8.5	9	11	13	15	17	19	18	17	15	13	11	9	8.5	8	5	**210**	**392.1**

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	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**
5	8	8.5	11	14	16	19	22	25	25	22	19	16	14	11	8.5	8	5	**257**	**467.5**

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	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**
5	8	11	13	16	20	23	25	26	26	25	23	20	16	13	11	8	5	**294**	**527.9**
5	8	11	13	16	20	23	26	26	26	25	23	20	16	13	11	8	5	**295**	**529.8**
5	8	11	13	16	20	23	26	26	26	26	23	20	16	13	11	8	5	**296**	**531.6**
6	8	11	13	16	20	23	26	26	26	26	23	20	16	13	11	8	5	**297**	**533.5**
6	8	11	13	16	20	23	26	26	26	26	23	20	16	13	11	8	6	**298**	**535.4**
6	9	11	13	16	20	23	26	26	26	26	23	20	16	13	11	8	6	**299**	**537.1**
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**
6	9	12	14	16	20	23	26	26	26	26	23	20	16	14	12	9	6	**304**	**545.1**

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	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**
7	10	13	14	17	21	24	26	26	26	26	24	21	17	14	12	10	7	**315**	**563.4**
7	10	13	14	17	21	24	26	26	26	26	24	21	17	14	13	10	7	**316**	**565.0**
7	10	13	15	17	21	24	26	26	26	26	24	21	17	14	13	10	7	**317**	**566.5**
7	10	13	15	17	21	24	26	26	26	26	24	21	17	15	13	10	7	**318**	**568.1**
7	10	13	15	18	21	24	26	26	26	26	24	21	17	15	13	10	7	**319**	**569.6**
7	10	13	15	18	21	24	26	26	26	26	24	21	18	15	13	10	7	**320**	**571.2**
8	10	13	15	18	21	24	26	26	26	26	24	21	18	15	13	10	7	**321**	**572.9**
8	10	13	15	18	21	24	26	26	26	26	24	21	18	15	13	10	8	**322**	**574.7**
8	11	13	15	18	21	24	26	26	26	26	24	21	18	15	13	10	8	**323**	**576.3**
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**
8	11	14	16	18	21	24	26	26	26	26	24	21	18	15	14	11	8	**327**	**582.6**
8	11	14	16	18	21	24	26	26	26	26	24	21	18	16	14	11	8	**328**	**584.1**
8	11	14	16	19	21	24	26	26	26	26	24	21	18	16	14	11	8	**329**	**585.7**
8	11	14	16	19	21	24	26	26	26	26	24	21	19	16	14	11	8	**330**	**587.3**
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**
8	12	15	16	19	22	25	26	26	26	26	25	22	19	16	14	12	8	**337**	**598.9**
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**
8	12	15	17	19	22	25	26	26	26	26	25	22	19	17	15	12	8	**340**	**603.5**
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**

2023 Fish Passage Plan

Chapter 3 – The Dalles Dam

Table of Contents

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

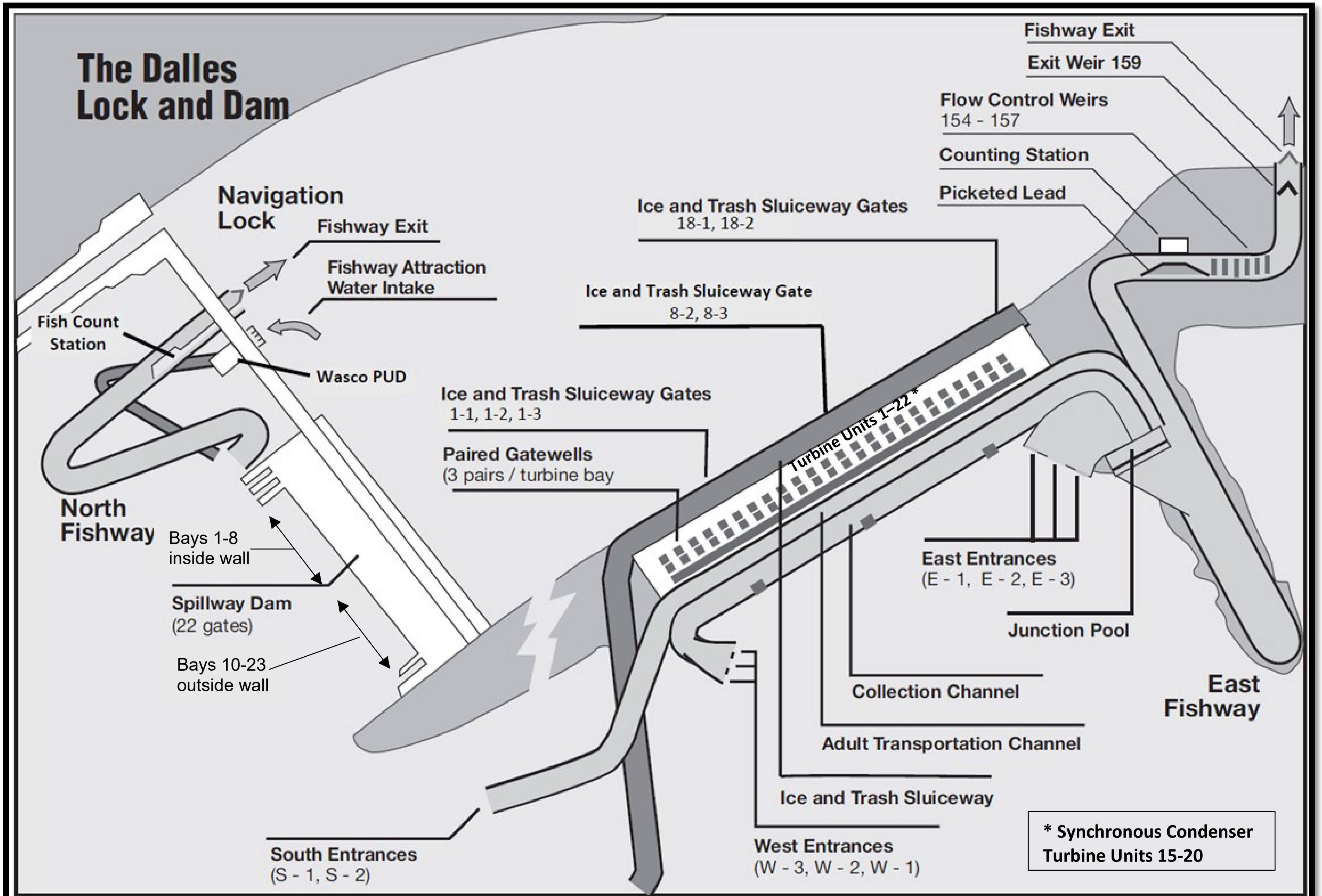


Figure TDA-1. The Dalles Dam General Site Plan.

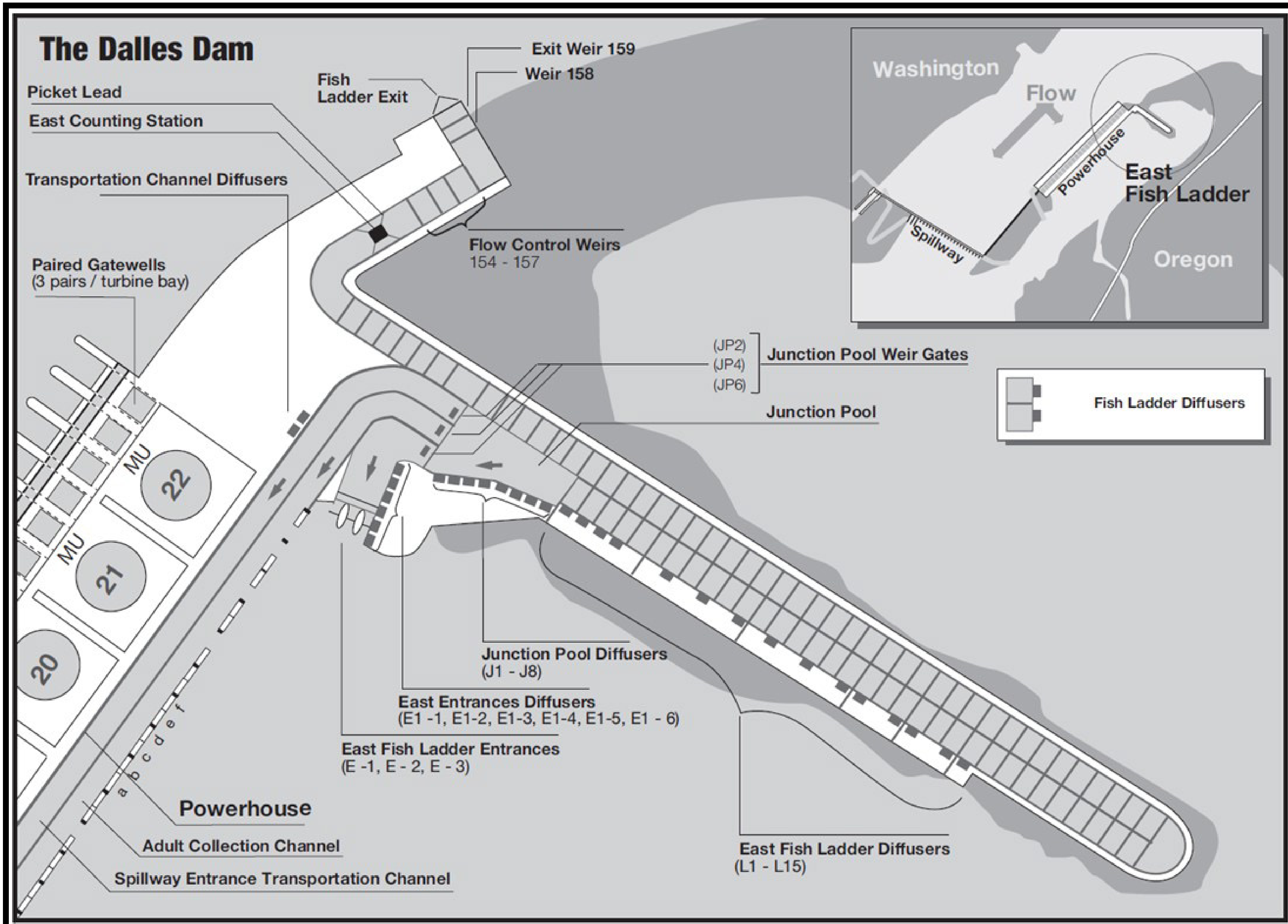


Figure TDA-2. The Dalles Dam East Fish Ladder.

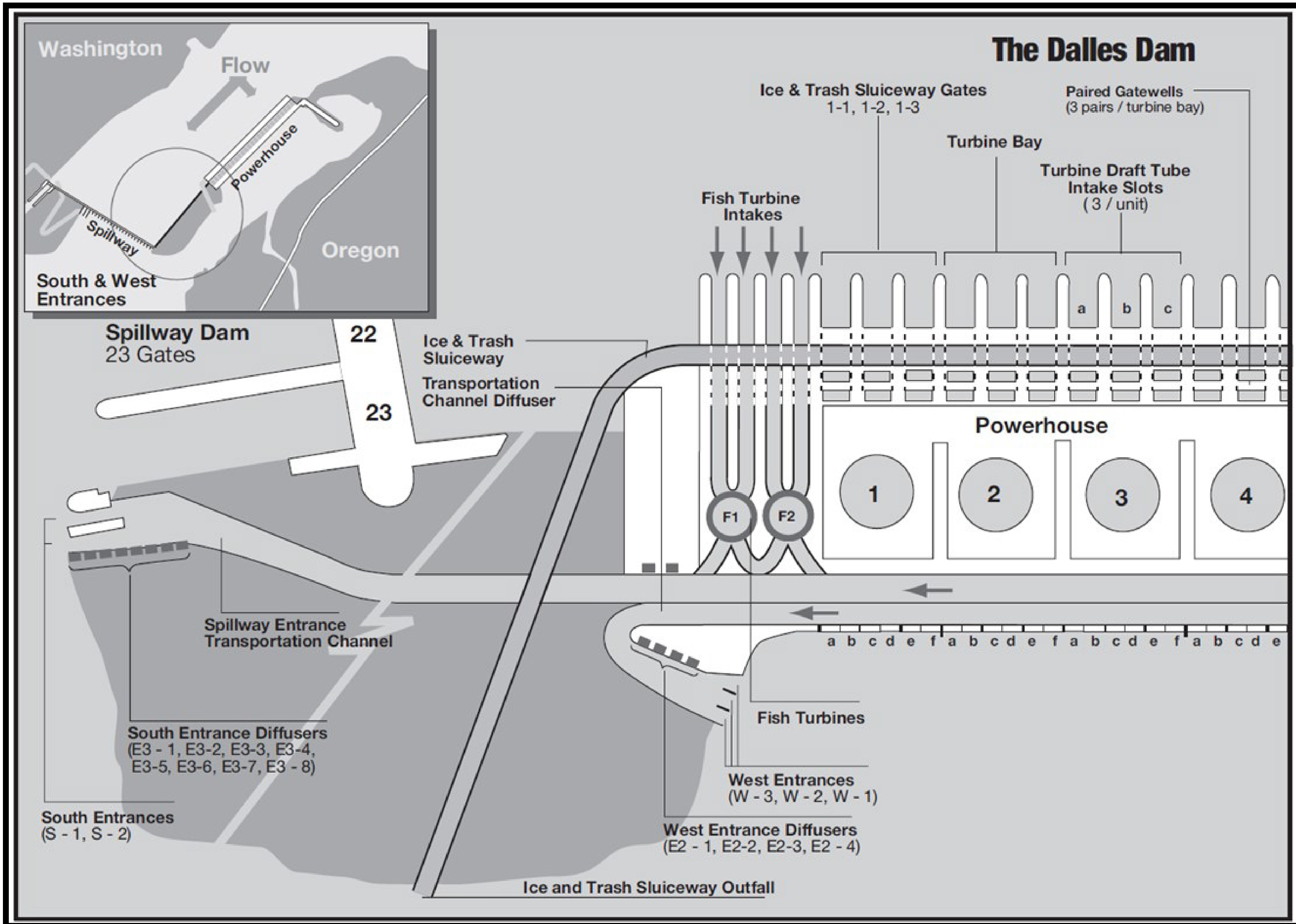


Figure TDA-3. The Dalles Dam South and West Fish Ladder Entrances.

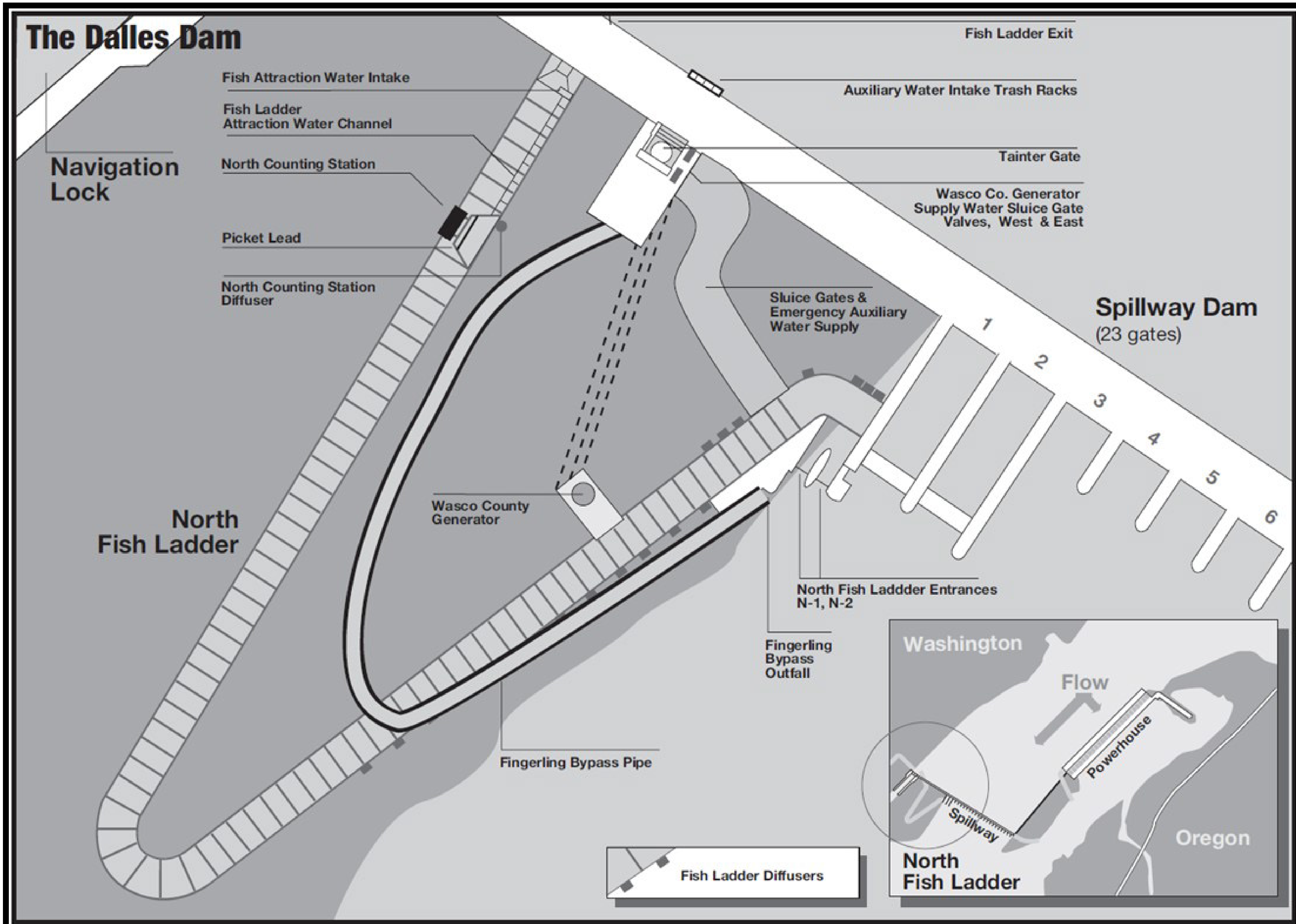
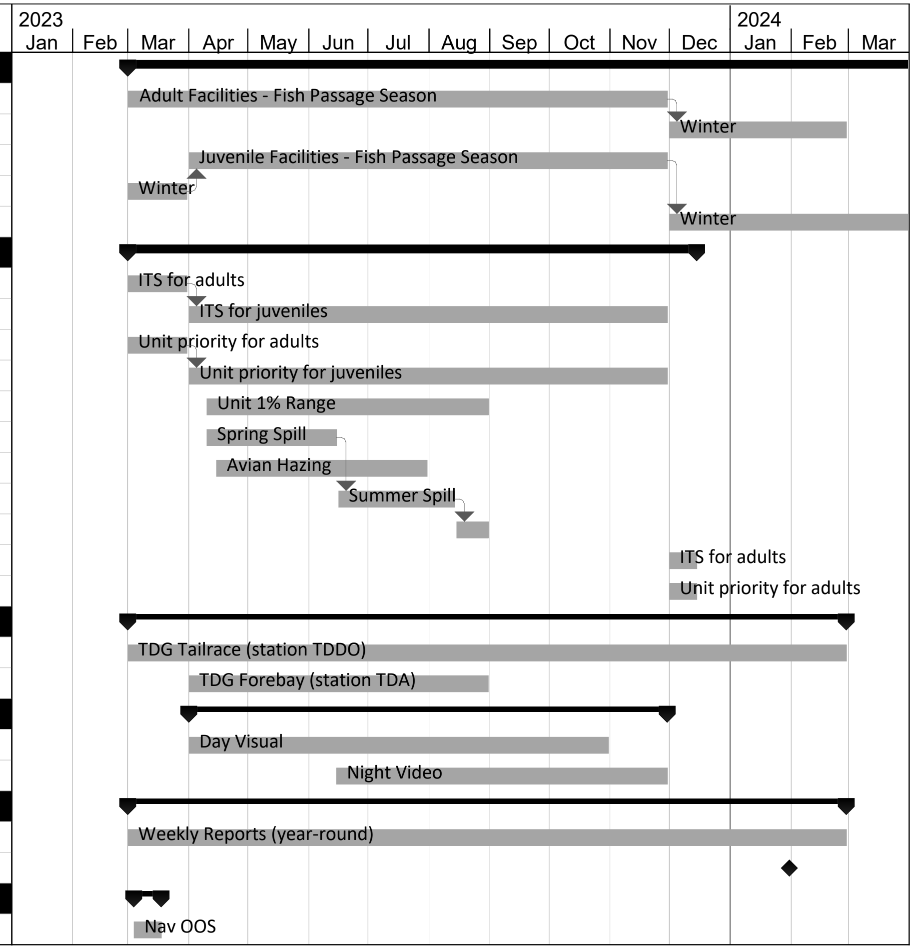


Figure TDA-4. The Dalles Dam North Fish Ladder and Spillway.

Table TDA-1. The Dalles Dam Schedule of Operations and Actions Defined in the 2023 Fish Passage Plan.

Task Name	Start	Finish	FPP Section
FISH PASSAGE FACILITIES	**Wed 3/1/23**	**Sun 3/31/24**	
Adult Facilities - Fish Passage Season	Wed 3/1/23	Thu 11/30/23	2.4.2
Adult Facilities - Winter Maintenance	Fri 12/1/23	Thu 2/29/24	2.4.1
Juvenile Facilities - Fish Passage Season	Sat 4/1/23	Thu 11/30/23	2.3.2
Juvenile Facilities - Winter Maintenance	Wed 3/1/23	Fri 3/31/23	2.3.1
	Fri 12/1/23	Sun 3/31/24	
PROJECT OPERATIONS FOR FISH PASSAGE	**Wed 3/1/23**	**Fri 12/15/23**	
ITS for adult fallbacks, kelt	Wed 3/1/23	Fri 3/31/23	2.4.2.9
ITS for juvenile passage	Sat 4/1/23	Thu 11/30/23	2.3.2.5
Turbine unit priority order for adults	Wed 3/1/23	Fri 3/31/23	4.1
Turbine unit priority order for juveniles	Sat 4/1/23	Thu 11/30/23	4.1
Turbine unit 1% operating range	Mon 4/10/23	Thu 8/31/23	4.2
Spring Spill	Mon 4/10/23	Thu 6/15/23	App E (FOP)
Avian Hazing	Sat 4/15/23	Mon 7/31/23	App L 4.2
Summer Spill	Fri 6/16/23	Mon 8/14/23	App E (FOP)
Late Summer Spill	Tue 8/15/23	Thu 8/31/23	App E (FOP)
ITS for kelts, adult fallbacks	Fri 12/1/23	Fri 12/15/23	2.4.1.7
Turbine unit priority order for adults	Fri 12/1/23	Fri 12/15/23	4.1
TDG MONITORING	**Wed 3/1/23**	**Thu 2/29/24**	
TDG Monitoring - Tailrace (year-round)	Wed 3/1/23	Thu 2/29/24	2.2.2
TDG Monitoring - Forebay	Sat 4/1/23	Thu 8/31/23	2.2.2
ADULT FISH COUNTING	**Sat 4/1/23**	**Thu 11/30/23**	
Day Visual 0500-2100 PDT	Sat 4/1/23	Tue 10/31/23	Table TDA-2
Night Video 2100-0500 PDT	Thu 6/15/23	Thu 11/30/23	Table TDA-2
REPORTS	**Wed 3/1/23**	**Thu 2/29/24**	
Weekly Reports (year-round)	Wed 3/1/23	Thu 2/29/24	2.5.2
Annual Report due NLT Jan 31	Wed 1/31/24	Wed 1/31/24	2.5.2
SPECIAL OPS & STUDIES (APPENDIX A)	**Sat 3/4/23**	**Sat 3/18/23**	
Navigation Lock Outage	Sat 3/4/23	Sat 3/18/23	App A 1.4



1. FISH PASSAGE INFORMATION

Fish passage facilities at The Dalles Lock & Dam are shown in **Figures TDA-1** through **TDA-4** and described below. The annual schedule of project operations, maintenance, and other actions described in the Fish Passage Plan (FPP) and Appendices is included in **Table TDA-1**.

1.1. Juvenile Fish Facilities and Migration Timing

1.1.1. Juvenile Fish Facilities. Turbine units at The Dalles Dam are not screened. Juvenile fish passage routes at The Dalles Dam consist of the spillway, the Ice & Trash Sluiceway (ITS), and one 6” orifice in each turbine unit gatewell. The sluiceway is a rectangular channel that extends along the forebay side of the 22-unit powerhouse that provides a surface passage route for fish. When any of the sluiceway gates (located in the forebay side of the sluiceway) are opened, water and fish are skimmed from the forebay into the sluiceway and released in the tailrace downstream of the project.

1.1.2. Juvenile Fish Migration Timing. 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 John Day Dam (see **FPP Chapter 4 - John Day Dam, Table JDA-2**) – juvenile fish arrival at The Dalles Dam is approximately one day later than at John Day. 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 Facilities and Migration Timing

1.2.1. Adult Fish Facilities.

1.2.1.1. Adult fish passage facilities at The Dalles Dam consist 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. The east fishway auxiliary water is provided by two fish turbine units providing 4.7–5.0 kcfs. A backup auxiliary water supply, unscreened for juveniles, can provide 1.5 kcfs if needed. The backup system can be used in conjunction with a single fish unit. Annual maintenance of adult fish facilities is scheduled during the winter maintenance period (December through February) to minimize impacts on upstream migrants. One ladder is dewatered at a time unless otherwise coordinated through FPOM.

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.

1.2.2. Adult Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult passage facilities are operated year-round. Counting of adult salmon, steelhead, bull trout, lamprey, and shad occurs during the dates defined for the current year in **Table TDA-2**, and daily counts are posted online.[1] The presence of other species (i.e., sturgeon, grass carp, Atlantic salmon, etc.) are recorded as comments and reported 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 passage in **Table TDA-3**.

1.2.2.3. Time-of-day (diel) distributions of adult salmonid activity at The Dalles Dam fishway entrances and exits are shown in **Figure TDA-5**.

Table TDA-2. The Dalles Dam Adult Fish Count Schedule March 2022 – February 2023.

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

*PST = Pacific Standard Time; PDT = Pacific Daylight Time, in effect during daylight saving time 3/13/22–11/6/22.

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	Jun 29	Aug 1

[1] Daily adult salmon counts: https://www.fpc.org/currentdaily/HistFishTwo_7day-ytd_Adults.htm

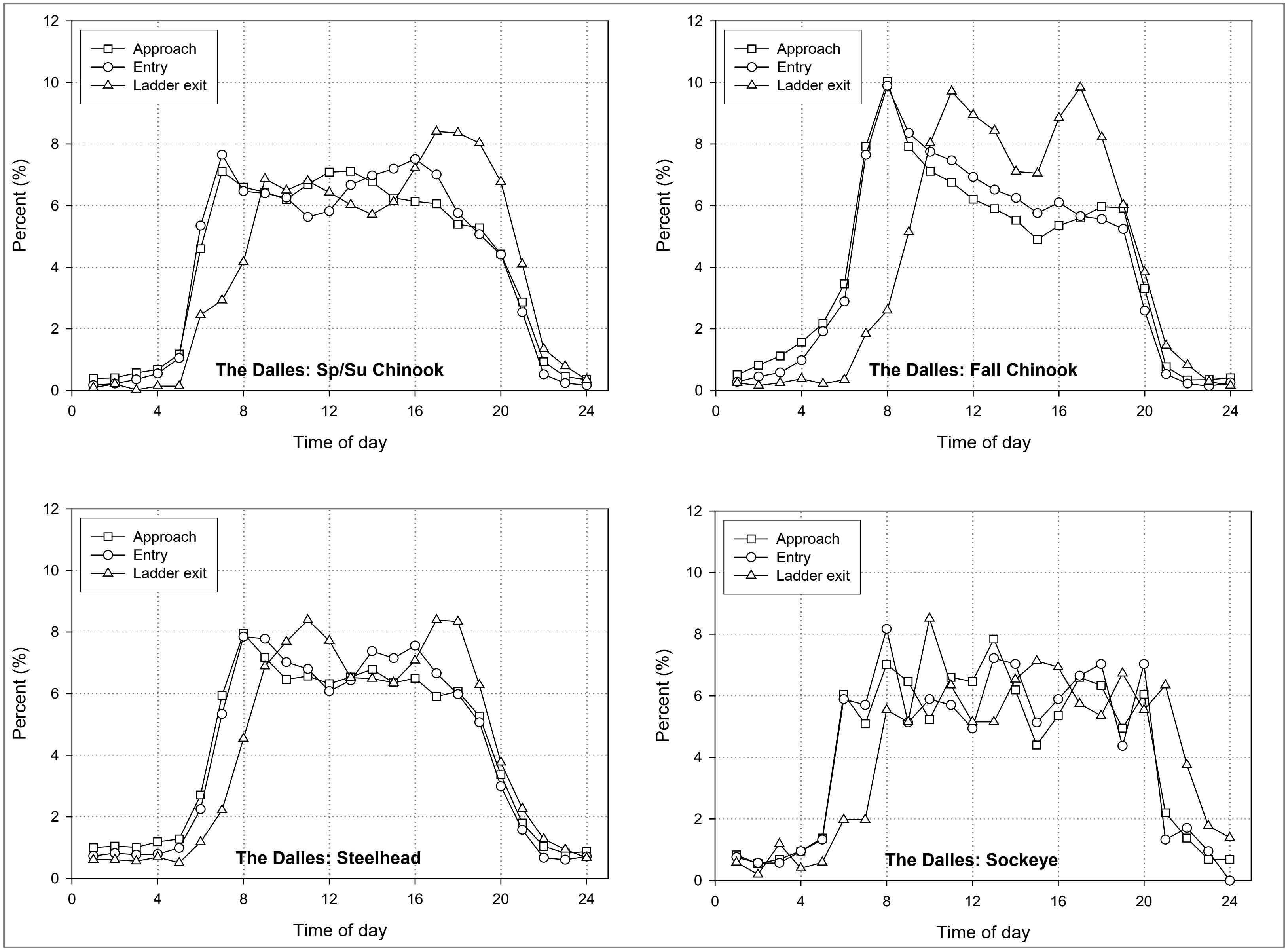


Figure TDA-5. Diel Distribution of Adult Salmonids at The Dalles Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

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 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 Management Plan* and the current *Dissolved Gas Monitoring Plan of Action*.[2]

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.

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[2] TDG Management Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/
TDG Monitoring Plan of Action: www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality/

2.3. Operating Criteria - Juvenile Fish Facilities

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

2.3.1.1. Use an ROV to inspect trashracks and main unit intakes. Remove debris from forebay, trashracks, gatewell slots, and gatewell orifices so that these areas are free of debris on the first day of juvenile passage season, 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 repair spill gates and control systems as needed so that the spillway can achieve FPP spill patterns April 10 through August 31, except for coordinated changes. No more than two functioning bays within the spillwall may be out at one time in case of spill.

2.3.1.4. Discontinue operation of the ice & trash sluiceway (ITS) from December 16 through the end of February, 24 hours/day, except during periods of spill when the sluiceway will be operated if available, per **section 2.2.3**. Close the endgate and open sluice gates 1-1 and 18-3 to allow fish egress from the ITS when equalized with the forebay. Inspect and correct any epoxy or concrete deficiencies on the ITS walls and floors, where accessible.

2.3.1.5. Ensure avian abatement measures are in place by April 1, in accordance with *Predation Monitoring & Deterrence Action Plans* in **Appendix L** (Table 2 and section 4).

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

2.3.2.1. Inspect all gatewells daily.

2.3.2.2. Measure gatewell drawdown at least once per week and more frequently as needed during high debris periods (three times per week or more). Clean trashracks when drawdown in gatewell slots exceeds 1.5', or as flow conditions dictate.

2.3.2.3. Between June 1 and June 15, determine if there is debris buildup on the trashracks by inspecting three units across the powerhouse that have the most prior operation and will not interfere with sluiceway operation. Rake trashracks as needed (all trashracks can be raked using the Hammerhead crane).

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. From April 1 through November 30, operate the ITS 24 hours/day per **Table TDA-4** for juvenile fish passage**.** Open gates 1-1, 1-2, 1-3 over operating Main Unit (MU)-1; open gates 8-1, 8-3 over operating MU-8; and open gate 18-2 over operating MU-18. If any these MUs are out of service for more than 10 hours, operate the next available MU and associated gates adjacent to the unit (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).

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	**2.4.2.9 (Mar)** **2.4.1.6 (Dec)**
April 1–November 30	OPEN End gate OPEN Sluice gates 1-1, 1-2, 1-3 / 8-1, 8-3 / 18-2	Juvenile passage	**2.3.2.6**
*December 16–end of February	CLOSE End gate OPEN Sluice gates 1-1 / 18-3	No passage. Allows egress when equalized w/ forebay	**2.3.1.4, 2.4.1.7.ii**

*Dec 16–end of Feb, discontinue ITS operation except during periods of spill when the ITS will be operated if available, per **section 2.2.3**.

2.3.2.6. When units are being dewatered, leave ITS endgate open and close sluice gates to expose gatewell orifices, then install orifice blocker. After orifice-sealing devices are installed, sluice gates should be returned to the open position. All 6” orifices will be closed as units are dewatered. Installation time should be approximately 5 hours.

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. Spill for fish passage will be distributed across the spillbays as defined in the spill pattern table at the end of this chapter (**Table TDA-7**).

2.3.2.9. Operate in accordance with the *Predation Monitoring and Deterrence Action Plans* for The Dalles Dam in **Appendix L** (Table 2 and section 4).

2.4. Operating Criteria - Adult Fish Facilities

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

2.4.1.1. Only one of the two adult fish facilities may be out of service at any one time during the winter maintenance period unless coordinated through FPOM. The operating facility shall be operated in accordance with fish passage season criteria in **section 2.4.2** unless specially coordinated. Outage periods will be minimized to the extent practicable.

2.4.1.2. Dewatering of areas below tailwater can be done every other year as determined by maintenance needs. All diffuser gratings and weirs will be inspected by ROV if not dewatered.

2.4.1.3. 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.

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

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

2.4.1.6. Inspect count station equipment and ensure operational. Prior to watering up ladders, reinstall picket leads at counting stations and ensure they are properly seated with a 1" gap (not to exceed 1.25") along the bottom for lamprey passage.

2.4.1.7. Ice & Trash Sluiceway (ITS).

i. From December 1 through December 15, operate the ITS 24 hours/day per **Table TDA-4** for adult fallback and steelhead kelt passage. 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).

ii. From December 16 through the end of February (except during periods of spill when the ITS will be operated if available, per **section 2.2.3**), discontinue ITS operation 24 hours/day. Close the endgate and open sluice gates 1-1 and 18-3 to allow fish egress from the ITS when equalized with the forebay.

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

2.4.2.1. Maintain staff gauges and water level indicators in readable condition at all water levels encountered during the fish passage season and check accuracy weekly. When necessary, clean and/or recalibrate instruments ASAP.

2.4.2.2. Maintain water depth over fish ladder weirs at 1.0’ ±0.1’. During adult shad passage season when more than 5,000 shad/day are counted at Bonneville Dam, increase depth to 1.3’ ±0.1’, except as defined below.

2.4.2.3. Maintain main entrance weir depths at 8’ or greater below tailwater. RCC will regulate to maintain a minimum tailwater of 70’ msl to remain in the entrance weir criteria operating range.

2.4.2.4. Maintain head on all entrances in the range of 1’–2’ (1.5’ optimum). When unable to achieve head criteria, refer to **section 3.2.2**.

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

2.4.2.6. Measure fishway channel water velocities once per week during adult passage season as part of the fishway inspection program. If operating the AWS backup system, check velocities 3 times per week. A portable flow meter will be used in accessible locations of the fishway channels that are supplemented by auxiliary water and results provided in the weekly fishway status report. Maintain water velocity in the range of 1.5–4.0 feet per second (fps), 2 fps optimum, for the full length of the powerhouse collection channel and the lower ends of fish ladders that are below tailwater.

2.4.2.7. Fishway Temperature Monitoring.

2.4.2.7.a. Measure water temperatures in the count station of each adult fishway and record 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.

2.4.2.7.b. From June 1 through September 30, measure water temperature at adult fishway entrances and exits and submit data to the Fish Passage Center (FPC) weekly for posting online.[3] Ensure the location of the monitors meets the following criteria:

i. Within 10 meters of all shore-oriented entrances and exits.

ii. Entrance monitor within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers, if possible, to allow for sufficient mixing with surface water.

iii. Exit monitor 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, verify that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.4.2.8. Adult Fish Counting.

i. Maintain count station crowders and picket leads in operating position while visual counting, video recording, and when the PIT-tag antenna operation is being conducted. The current fish counting schedule is in **Table TDA-2**.

ii. Crowder ranges are: TDA-East = 20–34”, TDA-North = 18–38”

iii. When not counting, or if counting is temporarily discontinued due to unscheduled events, open the crowder to full count slot width. The crowder may remain in operating position during the counter’s hourly 10-minute break.

iv. During counting, open the crowder as far as possible to allow accurate counting, at least 18”. Do not close to less than 18”. This will usually occur during high turbidity conditions to allow count accuracy criteria to be achieved. 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. Project biologists, FFU, and the fish count supervisor shall coordinate to achieve optimum count slot passage and/or count accuracy conditions.

[3] FPC ladder temperature data: www.fpc.org/smolt/smolt_queries/Q_ladderwatertempgraphv2.php

2.4.2.9. Ice & Trash Sluiceway (ITS). From March 1–31, operate the ITS 24 hours/day for adult fallback and steelhead kelt passage, per **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.

i. 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’.

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

iii. Telescoping weir #158 will always track 1.0’ ±0.1’ below weir #159 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. West Powerhouse 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 will remain operational as backup to W1 and W2.

2.4.2.13. East Powerhouse Entrance. Operate entrance weirs E2 and E3 to maintain a gate crest of 8’ or greater below tailwater, currently operated at 13’ below tailwater. E1 will be closed at 81' msl but will remain operational. At lower tailwater elevations, E1 may be operated manually at any depth to provide criteria entrance differential. Operate east ladder junction pool weirs at the following minimum depths in relation to east entrance tailwater surface elevation: JP6 > 7’

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

2.4.2.15. Ladder Crowding. Beginning September 1 (after spill for juvenile fish passage has ended), assess ladder crowding daily during peak seasonal passage periods and operate according to the following criteria:

i. If the East Fishway daily counts of combined adult salmonids exceed 25,000 per day (or 20,000 if ladder temperatures are above 70°F), inspect the entire the East Fishway ladder twice each day by walking from the exit to the east entrance and make observations and picture recording at the pool between 157 and 158, the pool downstream of the count station, and the pool at the 180° bend in the ladder.

ii. If Project Biologists determine there is a fish crowding emergency, or if the East Fishway daily count of combined adult salmonids exceeds 35,000 per day (or 30,000 if ladder temperatures are above 70°F), 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, as follows: 15 kcfs total spill, with Bay 1 open four stops (6 kcfs) and Bays 7 and 8 each open three stops (4.5 kcfs per bay). Continue this operation and daily coordination with FPOM as long as adult counts are greater than or equal to project passage (both ladders) when the operation started, or unless otherwise coordinated with FPOM.

iii. If inspectors see crowding that is not an emergency but is a concern, consult with FPOM to evaluate the situation. If the team determines crowding is severe enough, implement the spill operation as defined above.

2.5. Fish Facilities Monitoring & Reporting

2.5.1. Monitoring.

2.5.1.1. During fish passage season, inspect fish passage facilities at least twice per day, seven days a week, to ensure operations are in accordance with established criteria. A third inspection will be made using the data logging system. Check entrance conditions daily for the previous 24 hours for entrance criteria.

2.5.1.2. During the winter maintenance period, inspect fish passage facilities once a day, seven days per week.

2.5.1.3. More frequent inspections of some facility components will occur per criteria in this document. Additional fishway inspections may be performed by FFU and fish agencies.

2.5.1.4. Report results of all inspections and the readiness of the facilities for operation to FPOM at the meeting immediately prior to the fish passage season.

2.5.1.5. Continue to implement the zebra mussel monitoring program. This includes veliger sampling with plankton net collection, colonization sample units, and dewatering inspections. Samples will be provided to PSU for analysis. 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 project facilities.

2.5.2. Reporting.

2.5.2.1. Weekly Reports. Project biologists shall prepare weekly reports throughout the year summarizing project and fish facility operations for each week (Sunday through Saturday), along with an evaluation of resulting fish passage conditions. The reports will be e-mailed to CENWP-OD, CENWD-PDW-R (RCC), and other interested parties as soon as possible the following week. The weekly reports shall include:

i. Out-of-criteria situations and subsequent corrective actions.

ii. Maintenance or equipment malfunctions, breakdowns, or damage, with a summary of resulting repairs.

iii. Adult fishway control calibrations.

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

v. Unusual activities at the project that may have affected fish passage.

2.5.2.2. In-Season. Any adverse or negative impact to fish or fishways shall be reported in a *Memorandum for the Record* (MFR) prepared by Project biologists and sent to FPOM by the next working day, pursuant to the coordination process and template in **FPP Chapter 1 – Overview** (section 2.3.2).

2.5.2.3. Annual Report. Project biologists shall prepare an annual report by January 31 each year, summarizing fish facility operations for the previous year's winter maintenance period and fish passage season, December 1 through November 30. The annual report also will include all actions taken to discourage avian predation at the project, with an overview of the effectiveness. The annual report will be provided to CENWP-OD in time for distribution to FPOM members at the February meeting.

3. FISH FACILITIES MAINTENANCE

3.1. Fish Facilities Routine Maintenance

3.1.1. Routine maintenance of fish facilities will be conducted when fish passage has been documented to be at its lowest, to the extent practicable, to minimize fish impacts. Maintenance that occurs during juvenile or adult passage season that may affect fish passage will be included in the weekly reports. If maintenance requires operating outside of FPP criteria, the work will be coordinated with FPOM per the procedures defined in **FPP Chapter 1–Overview** (section 2.3).

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

3.1.3. Ice & Trash Sluiceway (ITS). The ITS will receive preventive maintenance throughout the year. During juvenile passage season (April 1–Nov 30), work will normally be above water, such as maintenance of automatic systems, air lines, electrical systems, and monitoring equipment. All accessible areas are visually inspected for damaged equipment and potential problems to juvenile fish. Problems will be repaired and modifications to the channel and general maintenance completed.

3.1.4. Fishway Auxiliary Water Systems (AWS). Fishway auxiliary water is provided by discharge from hydroelectric turbine systems and/or AWS backup system. Preventive maintenance and routine repair occur throughout the year. Trashracks for the AWS intakes will be raked when drawdown exceeds criteria. When practicable, trashracks will be raked during the time of day when fish passage is least affected.

3.1.5. Turbines & Spillbays. Routine maintenance of turbines and spillbays is a regular and recurring process that requires extended outages, as defined in **section 4.3** and **section 5**. Maintenance that requires operating outside of FPP criteria will be coordinated with FPOM. Certain turbine and spillbay discharges are also used to attract adult fish to fishway entrances, thus maintenance schedules for these turbines and spillbays will reflect equal weight given to fish, power, and water management, and coordinated with appropriate agencies. No other fish-related restrictions regarding maintenance will be placed on any units at this project, except to coordinate research activities. The lowest priority units for scheduling maintenance during fish passage season are F1, F2, 1, 2, 3, 4, 8, and 18 (during ITS operation). Trash racks are raked if necessary, as determined by ROV inspection just prior to juvenile passage season (before April 1), between June 1 and June 15, and whenever debris accumulation is suspected because of increased head across the trash racks.

3.1.6. Adult Collection Systems. Preventive maintenance and repairs occur throughout the year. During the adult fish passage season, maintenance will not involve any operations that will cause a failure to comply with fishway criteria unless specially coordinated. Inspection of 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 when the system is dewatered. An inspection during the first week of August with the system watered-up will also be conducted. A diver or underwater video system may be used for underwater inspections. The Project biologist or alternate Corps fish personnel will attend all dewatering activities and inspections potentially involving fish to provide fish input.

3.1.7. Adult Ladders and Count Stations. Adult ladders are 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. 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 count station equipment, and other potential problems. Problems identified during passage season that do not affect fish passage, as well as those identified when dewatered, are repaired. Trashracks at the ladder exits and north AWS intake are raked when criteria are exceeded. Trashracks are raked between 1100 and one hour before sunset. Fish count station windows are cleaned as necessary and when practicable.

3.2. Fish Facilities Non-Routine Maintenance

3.2.1. Non-routine or unscheduled fish facility maintenance that may impact fish passage or operation of fish facilities (e.g., repair of diffuser gratings, etc.) shall be coordinated through FPOM on a case-by-case basis by Project and CENWP-OD biologists, per the coordination process described in **FPP Chapter 1–Overview**. CENWP-OD biologists will be notified as soon as possible of any required non-routine maintenance or repairs. 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. Non-routine maintenance that affects fish passage will be included in the weekly reports.

3.2.2. Sluiceway. If a sluiceway chain gate fails, an adjacent gate can be operated until repairs are made. Failed gate hoists will be promptly repaired. The gate will be removed when there are problems with the seal that cannot be promptly repaired. Damage to the epoxy-lined section of the sluiceway will be repaired. The sluiceway may be closed temporarily to install a gatewell orifice plug in preparation for turbine dewatering.

3.2.1. Spillway. If a spill gate becomes inoperable, the operators will make necessary changes to provide spill and then immediately notify the Project Operations supervisor and the Project biologist to determine the best spill 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.

3.2.2. Fishway Auxiliary Water Systems. Most fishway auxiliary water systems operate automatically. If the automatic system fails, Project personnel will manually operate the system as described below and increase surveillance to ensure criteria are being met until the system is repaired. In the event of AWS failure, the project will coordinate with FPOM to determine the best operating procedure.

i. If one of the two fishway auxiliary water turbines fails or malfunctions for any duration, follow the sequential steps below until an entrance head of 1' is reached:

- Increase discharge of remaining operating fish unit to maximum capacity.
- Open AWS backup water supply.

ii. If both fishway auxiliary water turbines fail or malfunction, regardless of fish passage season, operate the adult passage facility as follows:

- Open AWS backup water supply.
- Raise the south entrance weirs to elevation 81' msl (closed position).
- Close west entrance.
- Close entrance weir E1 and keep E2 and E3 at 8' depth.
- Operate closest available main unit to the east entrance for attraction flow.

iii. If both fishway auxiliary water turbines and the AWS fail or malfunction, regardless of fish passage season, operate the adult passage facility as follows:

- Raise the south entrance weirs to elevation 81' msl (closed position).
- Close west entrance.
- Close entrance weir E1 and E2 and keep E3 at 6' depth.
- Evaluate modifying spill operations at the north shore ladder to enhance adult passage.

iv. If the North Wasco County power unit auxiliary water system fails, start the backup auxiliary water system and operate to maintain north ladder entrance criteria. Schedule unit outages October 1–March 15. If the backup system fails, N1 will remain open with a weir depth of 6' below the tailwater surface.

3.2.3. Powerhouse & Spillway Adult 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 repaired. If this becomes necessary, Project personnel will increase surveillance on the system to ensure criteria are being met. If the failure will not allow the entrance to be manually operated, the gate will be maintained in an operational position to the extent possible. If not possible, the entrance will be repaired expediently and returned to manual or automatic control at the earliest possible date.

3.2.4. Adult Ladders and Count Stations. Fish ladder structures include picket leads, count stations, fishway exits, and overflow weirs with orifices. Picket leads with excessive spacing (greater than 1"), erosion of concrete around 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 to dewater the fishway and repair any problem will be made in coordination with FPOM.

3.2.5. Diffuser Gratings. Diffuser chambers for adding auxiliary water to ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during winter maintenance to confirm they are in place, either by dewatering to physically inspect the gratings, using underwater video cameras and divers, or other methods. 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, the associated diffuser valve will be closed ASAP. Immediate action must be taken to correct the situation and minimize impacts on fish. If possible, a video inspection should occur as soon as possible to determine the extent of the problem. If gratings are found to be missing or moved, creating openings into the diffuser chambers, a repair method shall be developed and coordinated with FPOM. Repairs will be made as quickly as possible unless otherwise coordinated.

4. TURBINE UNIT OPERATION & MAINTENANCE

4.1. Turbine Unit Priority Order

4.1.1. 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). 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
March 1–31	1 and 18 †
April 1 – November 30 (Juvenile Fish Passage Season)	**1, 8, 18***
If additional units needed, operate one unit from each block moving west to east. Repeat as needed.	Block 2-4, Block 5-7, Block 9-12, Block 13-16, Block 17-22
December 1–15	1 and 18†
December 16 – end of February	Any Order

† Mar 1-31 and Dec 1-15 priority order for adult fallbacks and kelt passage = Units 1 & 18 with two open sluice gates/unit (per **Table TDA-4**).

***Apr–Nov priority order for juvenile fish passage = Units under open sluice gates 1, 8, 18 (per **Table TDA-4**).

4.2. Turbine Unit Operating Range

4.2.1. Turbine unit flow and power output at the lower and upper limits of the ±1% peak efficiency range, and at the operating limit, are defined in **Table TDA-6.** Turbine units will be operated within these ranges according to *BPA's Load Shaping Guidelines* (**Appendix C**), as summarized below.

4.2.2. In-Season: April 10–August 31 (Spring/Summer Spill for Juvenile Fish Passage). Turbine units will be operated within ±1% of peak turbine efficiency (1% range), except under limited conditions and durations when turbines may be operated above the 1% range for the use of reserves or for TDG management during high flows (refer to **Appendix C** for more information). All required fish passage spill operations will be met prior to operating turbines above the 1% range.

At The Dalles Dam, if in-season operation outside the 1% range is necessary, units will be operated in the following priority order: 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, the intent is to minimize fish impacts during turbine passage. In-season operation outside the 1% range shall be recorded by Project personnel to provide to BPA on a weekly basis according to the *Guidelines* (**Appendix C**). 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 5.5**), 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 to flush fish from the unit.

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

iv. Comply with other coordinated fish measures.

4.2.3. Off-Season: September 1–April 9. 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.

4.3. Turbine Unit Maintenance

4.3.1. Turbine maintenance schedules will be reviewed by Project and District biologists for fish impacts. If maintenance requires operating outside of FPP criteria, work will be coordinated with FPOM per procedures defined in **FPP Chapter 1–Overview**.

4.3.2. If the draft tube is to be dewatered (see **section 5.5**), the unit will be operated at full load above the 1% range (or at speed no load below the 1% range if not possible to load) for a minimum of 15 minutes prior to installing tail logs to flush fish from the unit.

4.3.3. Operational Testing. Some types of turbine maintenance require testing turbine operation throughout its full range before and after maintenance. 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 project is operating at minimum generation requirements. 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.

i. 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.

ii. 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 returning to operational status.

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

4.3.5. Wicket gate opening for functional testing on a watered-up unit will not exceed 15 minutes total open time.

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 [b]		1% Lower Limit		1% Upper Limit		Operating Limit [b]	
(feet)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
55	33.2	8,369	47.9	12,080	57.0	14,815	36.0	9,020	57.7	14,462	64.4	16,297
56	33.9	8,391	48.9	12,106	58.7	14,955	36.3	8,927	59.6	14,646	66.4	16,494
57	34.7	8,410	50.0	12,134	60.4	15,094	36.7	8,848	61.8	14,909	68.5	16,681
58	35.4	8,415	51.1	12,168	62.1	15,243	37.0	8,763	63.9	15,136	70.5	16,879
59	36.0	8,411	52.3	12,208	63.8	15,384	37.5	8,716	65.2	15,148	72.6	17,092
60	36.7	8,406	53.5	12,251	65.5	15,526	38.2	8,695	66.3	15,099	74.5	17,308
61	37.4	8,408	54.6	12,299	67.2	15,687	38.9	8,699	67.1	14,998	76.6	17,561
62	38.1	8,414	55.9	12,370	68.9	15,865	39.6	8,699	67.7	14,864	78.7	17,790
63	38.8	8,423	57.3	12,459	70.6	16,057	40.4	8,706	68.1	14,655	80.8	18,059
64	39.5	8,434	58.7	12,542	72.3	16,248	41.3	8,725	68.1	14,383	82.9	18,397
65	40.2	8,449	59.9	12,586	73.9	16,433	42.1	8,735	68.4	14,205	85.1	18,829
66	41.0	8,466	60.9	12,584	75.6	16,586	42.9	8,748	69.3	14,155	87.1	19,153
67	41.8	8,487	61.8	12,553	77.2	16,727	43.6	8,764	70.7	14,193	89.3	19,488
68	42.6	8,508	62.6	12,511	78.9	16,879	44.4	8,774	72.2	14,278	91.4	19,711
69	43.4	8,527	63.4	12,466	80.8	17,135	45.1	8,778	73.8	14,364	93.7	19,999
70	44.1	8,543	64.1	12,415	82.2	17,178	45.8	8,785	75.2	14,426	95.7	20,159
71	44.9	8,554	64.8	12,354	83.1	17,019	46.5	8,794	76.6	14,466	97.1	20,046
72	45.6	8,561	65.4	12,282	84.0	16,861	47.3	8,798	77.8	14,495	98.6	20,025
73	46.3	8,566	66.0	12,214	85.0	16,720	47.9	8,800	79.1	14,519	99.9	19,988
74	47.0	8,568	66.7	12,164	85.9	16,593	48.6	8,804	80.4	14,543	101.3	19,926
75	47.6	8,566	67.6	12,157	86.9	16,498	49.4	8,813	81.6	14,571	102.5	19,778
76	48.2	8,556	68.8	12,206	87.9	16,416	50.1	8,825	83.0	14,614	103.8	19,622
77	48.8	8,542	70.2	12,284	89.0	16,343	50.9	8,840	84.5	14,676	104.1	19,023
78	49.4	8,531	71.6	12,361	89.9	16,247	51.7	8,855	86.0	14,737	104.1	18,495
79	50.1	8,530	72.9	12,417	90.8	16,142	52.5	8,874	87.3	14,770	104.1	18,139
80	50.8	8,540	74.0	12,449	91.6	16,014	53.3	8,893	88.5	14,771	104.1	17,841
81	51.4	8,526	75.5	12,530	92.3	15,841	54.1	8,914	89.4	14,742	104.1	17,570
82	51.9	8,512	77.0	12,613	92.8	15,656	54.9	8,936	90.2	14,692	104.1	17,310
83	52.5	8,497	78.5	12,698	93.2	15,469	55.7	8,958	91.0	14,632	103.1	16,887
84	53.1	8,485	79.9	12,771	93.7	15,299	56.5	8,977	91.7	14,562	102.8	16,583
85	53.7	8,471	81.2	12,817	94.1	15,139	57.3	8,993	92.3	14,488	102.6	16,333 [b]
86	54.2	8,454	82.4	12,850	94.4	14,971	57.9	8,977	93.4	14,493	102.6	16,097
87	54.7	8,428	83.6	12,883	94.4	14,754	58.4	8,953	94.4	14,471	102.5	15,870
88	55.1	8,398	84.8	12,917	94.4	14,543	58.9	8,925	95.3	14,437	102.4	15,631
89	55.6	8,371	86.1	12,962	94.4	14,346	59.4	8,901	96.1	14,395	102.0	15,362
90	56.0	8,347	87.4	13,015	94.4	14,159	59.9	8,882	96.8	14,342	101.3	15,064
91	56.5	8,328	88.8	13,073	94.4	13,980	60.5	8,871	97.3	14,267	100.4	14,734
92	57.0	8,311	90.1	13,126	94.4	13,807	61.1	8,865	97.8	14,175	99.0	14,364
93	57.6	8,295	91.4	13,176	94.4	13,641	61.7	8,857	98.2	14,091	97.4	13,966
94	58.1	8,281	92.7	13,222	94.4	13,481	62.3	8,839	98.9	14,032	95.9	13,585
95	58.6	8,269	93.9	13,255	94.4	13,326	62.7	8,814	99.6	13,993	94.6	13,247

a. Values provided by HDC (May 2022). Flow (cfs) is a calculated value based on turbine efficiency, project head, and power output (MW).

b. "*Operating Limit*" is the maximum safe operating point based on cavitation or generator limit (added Feb 2018). TDA units 15-22 have a generator limit that restricts turbine output at higher heads. Values shaded in gray indicate the Operating Limit is below the modeled 1% Upper Limit.

5. DEWATERING PLANS

5.1. General

5.1.1. *Guidelines for Dewatering and Fish Handling* (**Appendix F**) and project *Dewatering Plans*[4] 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.

5.1.2. 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.

5.2. Dewatering – Juvenile Bypass System [*not applicable for TDA*]

5.3. Dewatering – Adult Fish Ladder

5.3.1. Prior to dewatering, 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. For non-routine or unscheduled maintenance, discontinue fishway auxiliary water and operate the ladder at reduced flow as long as possible (prefer 3-24 hours).

5.3.2. A Project biologist will ensure availability of fish rescue equipment and adequate numbers of personnel necessary to move fish out of the dewatered ladder.

5.3.3. 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.

5.3.4. The Project biologist or alternate Corps fish personnel will oversee fish rescue when the ladders are dewatered. Juvenile fish will be transported and released in the tailrace and adults released in the forebay (except identifiable steelhead kelts should be released into the tailrace).

5.3.5. 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.

[4] Project Dewatering Plans: pweb.crohms.org/tmt/documents/FPOM/2010/

5.4. Dewatering – Powerhouse Collection System

5.4.1. 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 onsite during pumping operations to ensure fish are not stranded or a water level sensor that de-activates the dewatering process will be used.

5.4.2. The Project biologist will ensure that rescue equipment is available if needed.

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

5.5. Dewatering – Turbine Units

5.5.1. Gatewells need not be dipped as is required at other projects due to the lack of VBSs at The Dalles Dam. Immediately before draining, operate the unit at speed no load briefly to flush fish out of the draft tube. If the turbine unit draft tube is dewatered, operate unit with full load for a minimum of 15 minutes prior to immediately installing tail logs. If not possible to load, operate at speed no load for a minimum of 15 minutes. Install the 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.

5.5.2. 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 as determined by the Project Biologist.

5.5.3. 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, ensure that rescue equipment is available if needed, and directly participate in fish salvage.

5.6. Dewatering – Navigation Lock

5.6.1. 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. 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 and transported via bag or tank to be released in the river.

6. FOREBAY DEBRIS REMOVAL

Debris at projects can impact fish passage conditions by plugging or blocking trashracks, gatewell orifices, dewatering screens, separators, or facility piping, resulting in fish injuries, impingement, and descaling. 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 as some projects do not have forebay debris removal capability. In this case, the only viable alternative is to spill to pass the debris. Special spill operations that don't follow the normal spill schedule or volume limits will be coordinated prior to implementation. Normally, the project will contact CENWP-OD at least two workdays prior to the day the special operation is required. CENWP-OD will then coordinate with FPOM and RCC, as necessary. Once the coordination is complete, RCC will issue a teletype detailing the special operations.

7. RESPONSE TO HAZARDOUS MATERIALS SPILLS

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

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 (contact info available in the Control Room):

- Bob Cordie (Supervisor); Jeff Randall; James Day; 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

PROJECT OUTFLOW			SPILL			TDA 40% Spill Patterns Vertical Gate Opening (ft) per Spillbay [a, b]																							Total Open	Note
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)	
175.5	171.1	178.4	70.2	39.4%	41.0%	6	6	6	6	6	6	6	6																48	c
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

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
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
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	

PROJECT OUTFLOW			SPILL			TDA 40% Spill Patterns Vertical Gate Opening (ft) per Spillbay [a, b]																							Total Open	Note
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)	
617.6			**347.6**	**56.3%**		15	16	18	18	18	18	18	18				16		16	16		16			16	12	12		**243**	
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**	

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
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**	
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. Spillbay 9 cannot be used due to failure of the trunnion pin in 2009.

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

2023 Fish Passage Plan

Chapter 4 – John Day Dam

Table of Contents

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

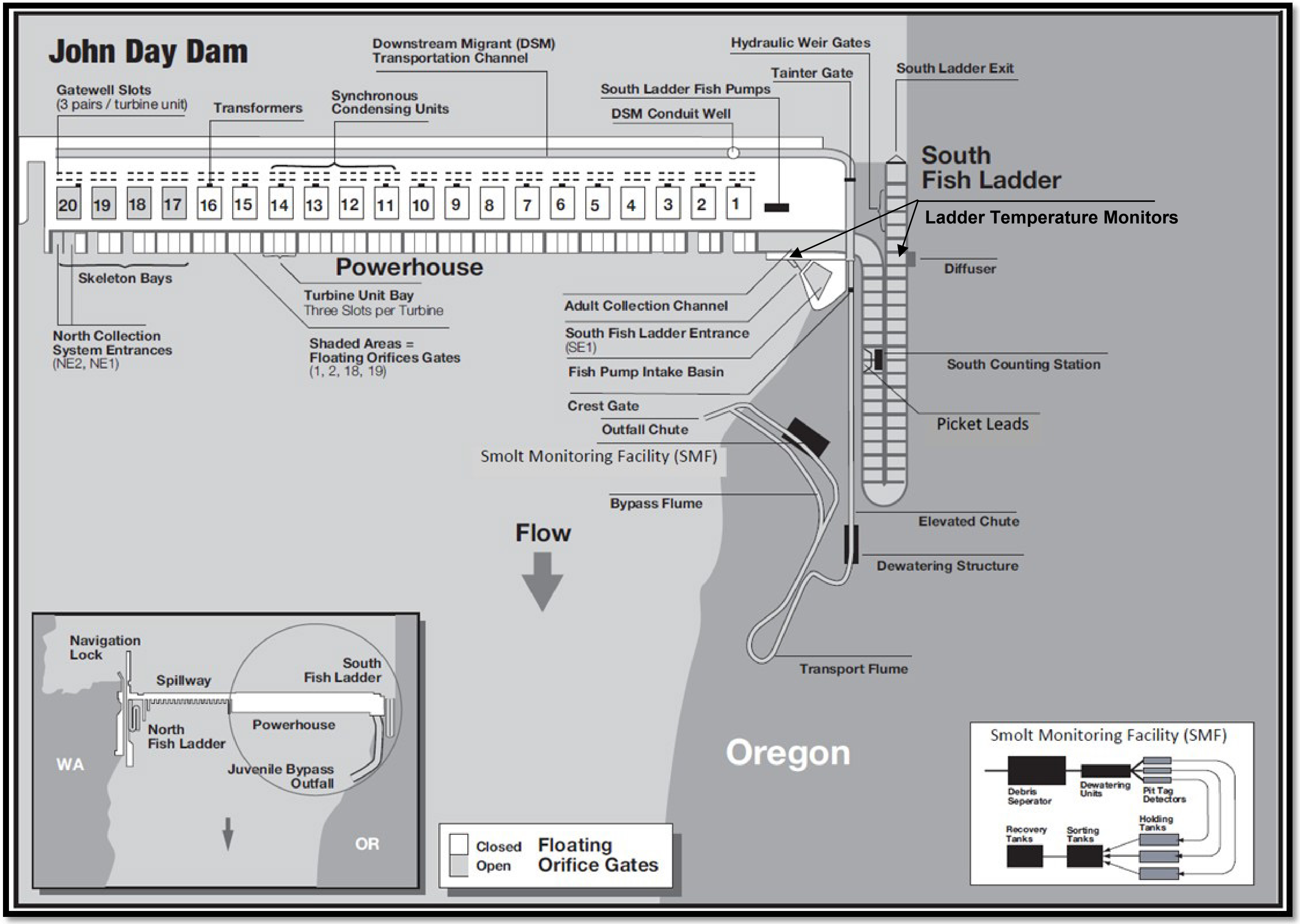


Figure JDA-1. John Day Dam South Fish Ladder, Powerhouse Collection System, and Juvenile Bypass System.

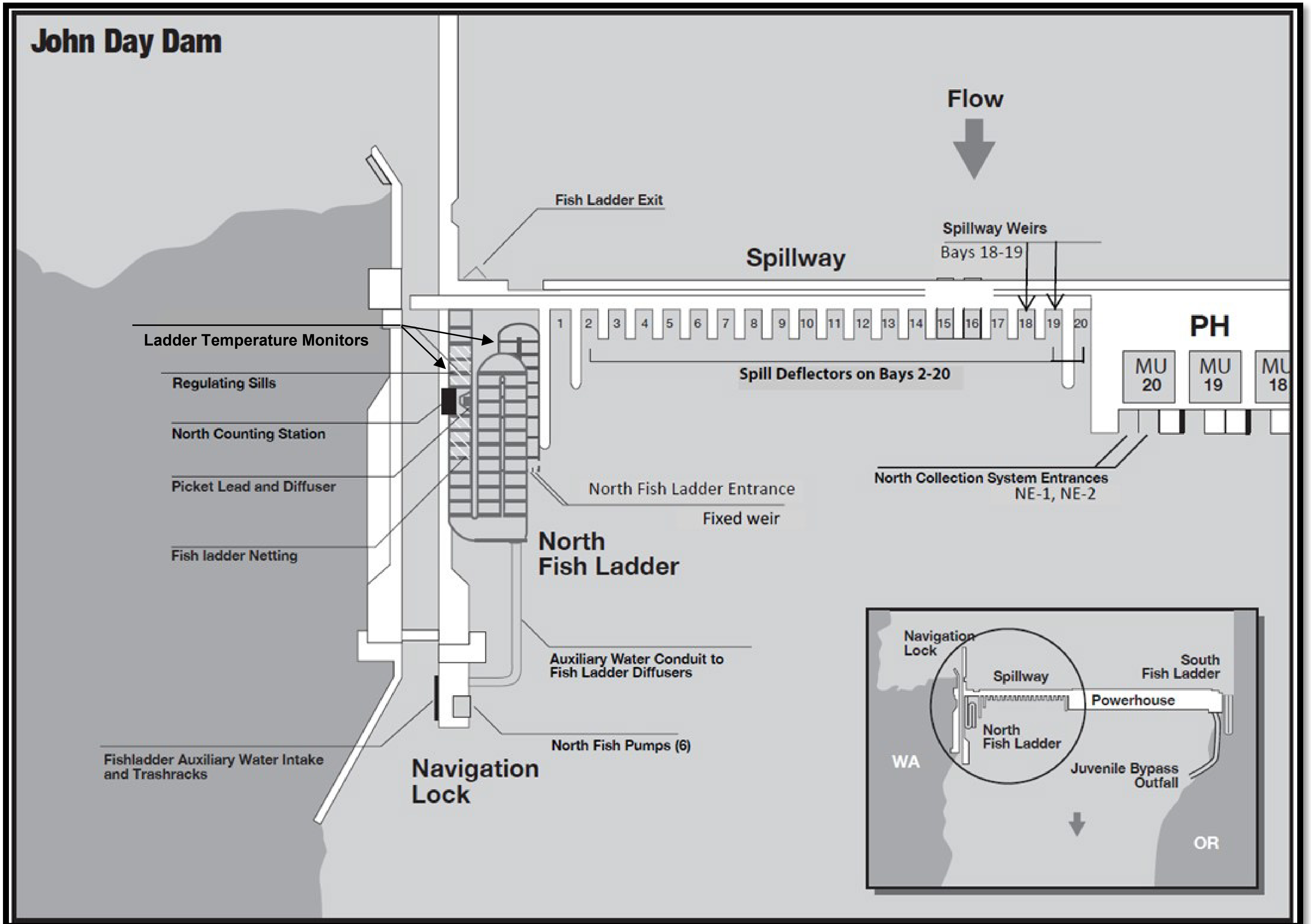
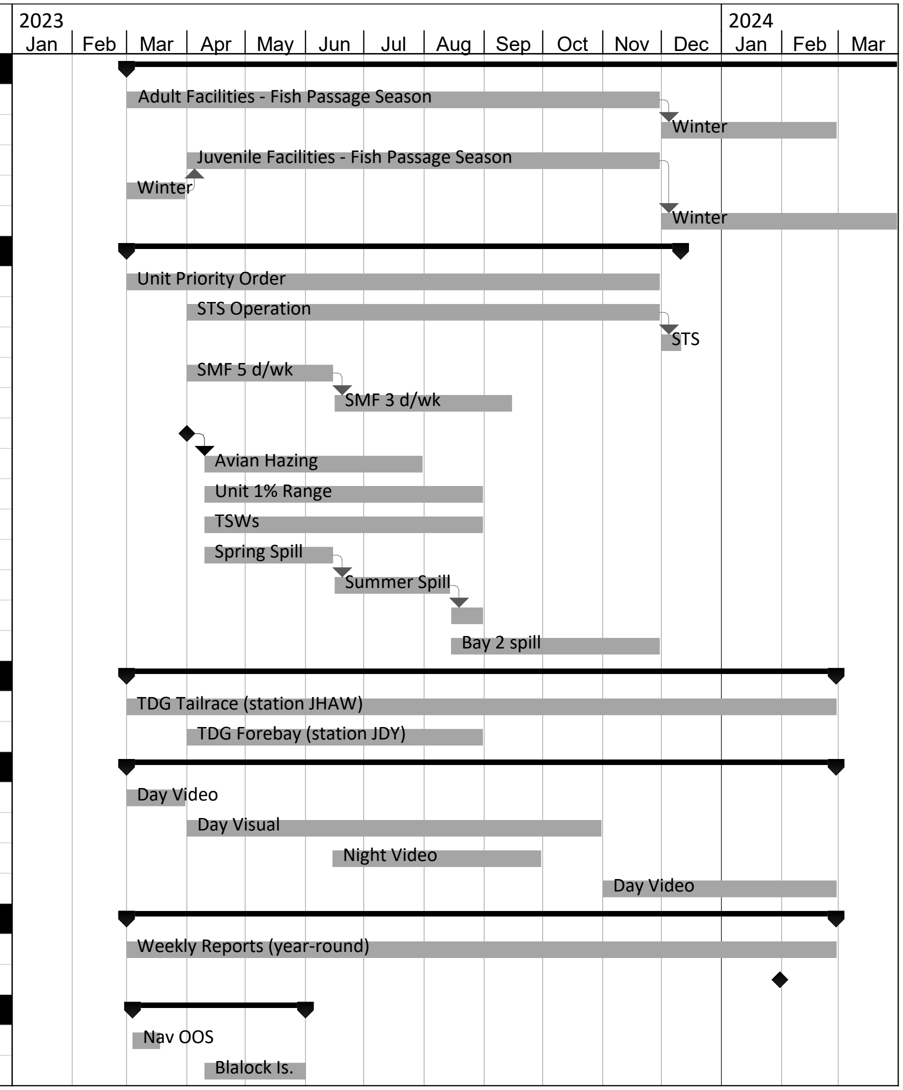


Figure JDA-2. John Day Dam Spillway and North Fish Ladder.

Table JDA-1. John Day Dam Schedule of Operations and Actions Defined in the 2023 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**Wed 3/1/23**	**Sun 3/31/24**	
Adult Facilities - Fish Passage Season	Wed 3/1/23	Thu 11/30/23	2.4.2
Adult Facilities - Winter Maintenance	Fri 12/1/23	Thu 2/29/24	2.4.1
Juvenile Facilities - Fish Passage Season	Sat 4/1/23	Thu 11/30/23	2.3.2
Juvenile Facilities - Winter Maintenance	Wed 3/1/23	Fri 3/31/23	2.3.1
	Fri 12/1/23	Sun 3/31/24	
PROJECT OPERATIONS FOR FISH PASSAGE	**Wed 3/1/23**	**Mon 12/11/23**	
Turbine unit priority order	Wed 3/1/23	Thu 11/30/23	4.1
STS Operation for Juveniles	Sat 4/1/23	Thu 11/30/23	2.3.2.1
STS Operation for Adult Fallbacks	Fri 12/1/23	Mon 12/11/23	2.3.1.1
Smolt Condition Monitoring 5 days/week	Sat 4/1/23	Thu 6/15/23	2.3.2.3
Smolt Condition Monitoring 3 days/week	Fri 6/16/23	Fri 9/15/23	2.3.2.3
Avian Wires installed NLT April 1	Sat 4/1/23	Sat 4/1/23	2.3.1.13
Avian Hazing	Mon 4/10/23	Mon 7/31/23	App L 5.2
Turbine unit 1% operating range	Mon 4/10/23	Thu 8/31/23	4.2
TSW Operation	Mon 4/10/23	Thu 8/31/23	2.3.2.16
Spring Spill	Mon 4/10/23	Thu 6/15/23	App E (FOP)
Summer Spill	Fri 6/16/23	Mon 8/14/23	App E (FOP)
Late Summer Spill	Tue 8/15/23	Thu 8/31/23	App E (FOP)
Spillbay 2 for adult attraction	Tue 8/15/23	Thu 11/30/23	2.2.3
TDG MONITORING	**Wed 3/1/23**	**Thu 2/29/24**	
TDG Monitoring - Tailrace (year-round)	Wed 3/1/23	Thu 2/29/24	2.2.2
TDG Monitoring - Forebay	Sat 4/1/23	Thu 8/31/23	2.2.2
ADULT FISH COUNTING	**Wed 3/1/23**	**Thu 2/29/24**	
Day Video 0400-2000 PST	Wed 3/1/23	Fri 3/31/23	Table JDA-3
Day Visual 0500-2100 PDT	Sat 4/1/23	Tue 10/31/23	Table JDA-3
Night Video 2100-0500 PDT	Thu 6/15/23	Sat 9/30/23	Table JDA-3
Day Video 0400-2000 PST	Wed 11/1/23	Thu 2/29/24	Table JDA-3
REPORTS	**Wed 3/1/23**	**Thu 2/29/24**	
Weekly Reports (year-round)	Wed 3/1/23	Thu 2/29/24	2.5.2
Annual Report due NLT Jan 31	Wed 1/31/24	Wed 1/31/24	2.5.2
SPECIAL OPERATIONS	**Sat 3/4/23**	**Thu 6/1/23**	
Navigation Lock Outage	Sat 3/4/23	Sat 3/18/23	App A 1.4
Blalock Island Operation	Mon 4/10/23	Thu 6/1/23	App A 4.1.1



1. FISH PASSAGE INFORMATION

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

1.1. Juvenile Fish Facilities and Migration Timing

1.1.1. Juvenile Facilities. The Juvenile Bypass System (JBS) at John Day Dam was completed in 1987 and the Smolt Monitoring Facility (SMF) was completed in 1998. 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.

Each of the project's 16 turbine units include one vertical barrier screen (VBS), one submersible traveling screen (STS), and three 14"-diameter orifices (one per gatewell).

During SMF juvenile fish sampling, flow with collected fish from the SMF is sent over the crest gate and down an elevated chute to the dewatering structure that reduces 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 tailrace (bypass mode). The differential between the forebay and bypass conduit is controlled by the tainter gate.

1.1.2. Juvenile Migration Timing & Counting. Juvenile salmonid passage timing at John Day has been determined by gatewell and SMF sampling (**Table JDA-2**). 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. Bull trout, lamprey, juvenile sturgeon, and non-listed fish are recorded as by-catch in the SMF report.

Results to-date of ongoing research show significant daytime passage during daytime operations. 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[1] 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.

[1] Data are for powerhouse passage only. 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			
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	13-Jun	29-Jun	7-Jul	25
2017	24-Apr	8-May	18-May	25	9-Jun	1-Jul	15-Jul	37
2018 (March 1 start)	20-Apr	8-May	20-May	31	4-Jun	29-Jun	19-Jul	46
2019 (March 1 start)	19-Apr	7-May	23-May	35	8-Jun	30-Jun	16-Jul	39
2020	26-Apr	12-May	24-May	29	7-Jun	27-Jun	22-Jul	46
2021	3-May	15-May	2-Jun	31	10-Jun	28-Jun	4-Jul	25
2022	10-May	19-May	2-Jun	24	7-Jun	27-Jun	25-Jul	49
MEDIAN (1998-2015) *	**28-Apr**	**14-May**	**29-May**	**32**	**16-Jun****	**29-Jun****	**28-Jul****	**43****
MIN (1998-2015) *	**20-Apr**	**6-May**	**22-May**	**24**	**6-Jun****	**27-Jun****	**20-Jul****	**31****
MAX (1998-2015) *	**6-May**	**27-May**	**20-Jun**	**46**	**27-Jun****	**30-Jul****	**22-Aug****	**59****
	Unclipped Steelhead				Clipped Steelhead			
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
2018 (March 1 start)	22-Apr	8-May	30-May	39	20-Apr	2-May	22-May	33
2019 (March 1 start)	21-Apr	27-Apr	21-May	31	19-Apr	25-Apr	11-May	23
2020	4-May	25-May	30-May	27	2-May	12-May	28-May	27
2021	3-May	19-May	4-Jun	33	29-Apr	9-May	31-May	33
2022	17-May	30-May	8-Jun	23	10-May	18-May	7-Jun	29
MEDIAN (1998-2015) *	**26-Apr**	**13-May**	**29-May**	**34**	**29-Apr**	**14-May**	**29-May**	**31**
MIN (1998-2015) *	**16-Apr**	**1-May**	**19-May**	**24**	**15-Apr**	**2-May**	**15-May**	**21**
MAX (1998-2015) *	**6-May**	**28-May**	**8-Jun**	**51**	**7-May**	**29-May**	**10-Jun**	**44**
	Coho				Sockeye (Wild & Hatchery)			
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
2018 (March 1 start)	6-May	20-May	2-Jun	28	6-May	12-May	26-May	21
2019 (March 1 start)	27-Apr	17-May	6-Jun	41	5-May	19-May	31-May	27
2020	26-Apr	4-May	30-May	35	10-May	20-May	30-May	21
2021	5-May	17-May	4-Jun	31	9-May	23-May	2-Jun	25
2022	10-May	23-May	9-Jun	31	18-May	24-May	3-Jun	17
MEDIAN (1998-2015) *	**8-May**	**22-May**	**5-Jun**	**30**	**10-May**	**21-May**	**2-Jun**	**24**
MIN (1998-2015) *	**23-Apr**	**13-May**	**31-May**	**24**	**30-Apr**	**11-May**	**25-May**	**16**
MAX (1998-2015) *	**17-May**	**3-Jun**	**14-Aug**	**90**	**1-Jun**	**14-Jun**	**27-Jun**	**41**

* **MEDIAN, MIN, MAX** for spring migrants based on 1998-2015 data only. Data from 2016-present excluded due to potential bias from every-other-day sampling and March sampling in 2018 and 2019.

** Subyearling Chinook based on 1998-2005 data only. Data from 2006-present excluded due to potential bias from missed sample days during high water temperature sampling protocols (per **Appendix K**).

1.2. Adult Fish Facilities and Migration Timing.

1.2.1. Adult Fish Passage 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 passage facilities are operated year-round. Counting of adult salmon, steelhead, bull trout, and lamprey occurs during the dates defined for the current year in **Table JDA-3** and daily counts are posted online.[2] The presence of other species (e.g., sturgeon) are recorded as comments and reported 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**.

1.2.2.3. 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 in 2021.

Count Period	Counting Method and Hours*
March 1 – 31	Video 0400–2000 hours (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	Video 0400–2000 hours (PST)

*PST = Pacific Standard Time; PDT = Pacific Daylight Time, in effect during daylight saving time 3/13/22–11/6/22.

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

[2] Daily adult salmon counts: https://www.fpc.org/currentdaily/HistFishTwo_7day-ytd_Adults.htm

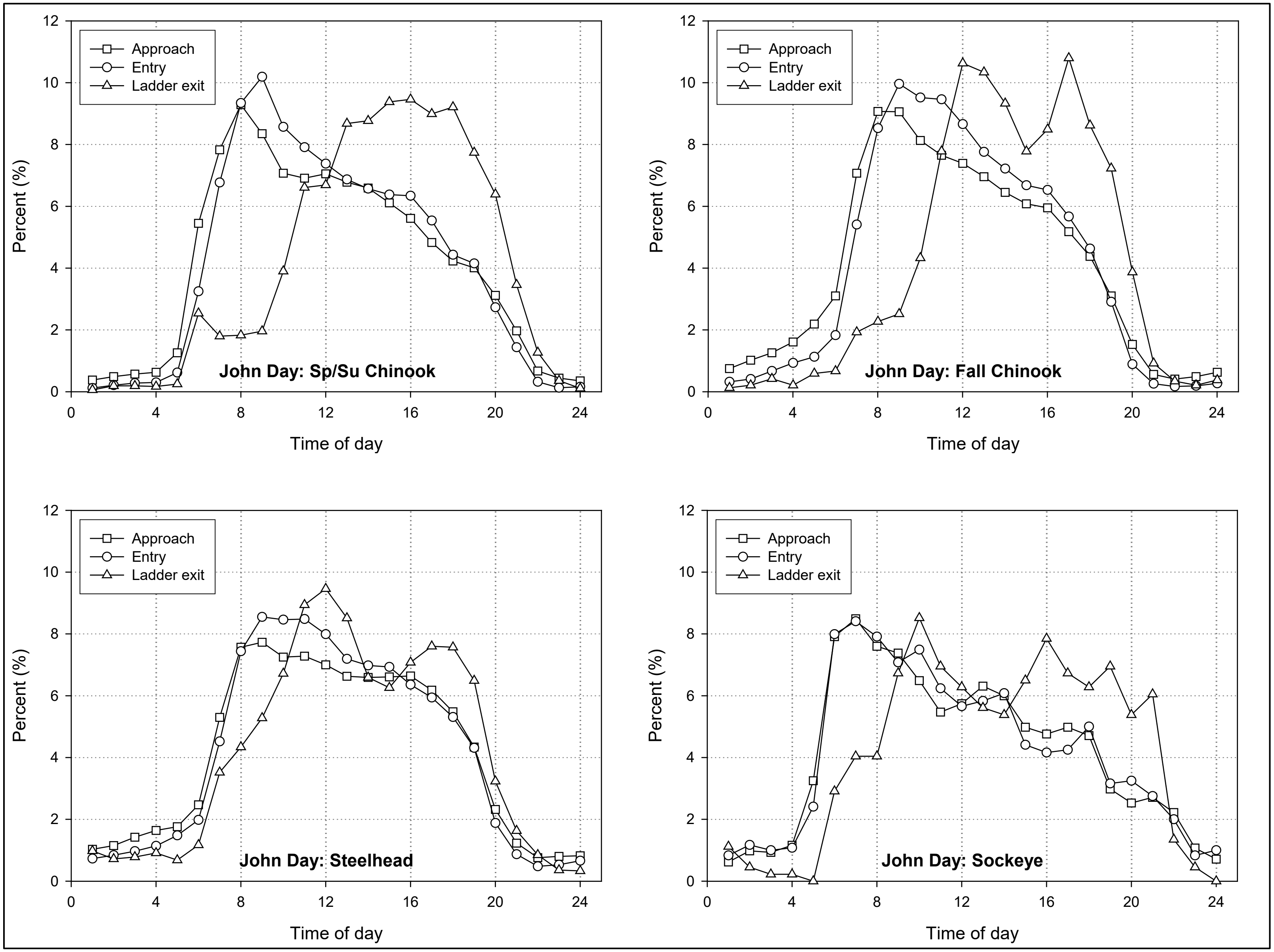


Figure JDA-3. Diel Distribution of Adult Salmonids at John Day Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*) – report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

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 15 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 Management Plan* and the current *Dissolved Gas Monitoring Plan of Action*.[3]

2.2.3. From August 15 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**.

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[3] TDG Management Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/
TDG Monitoring Plan of Action: www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality/

Table JDA-5. Daytime Spill Hours for Adult Attraction at John Day Dam, Aug 15–Nov 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 – Start DST [a]	0600	1930
Start DST [a] – Apr 2	0700	2030
April 3–20	0600	2130
April 21 – May 16	0600	2200
May 17 – June 30	0530	2230
July 1–31	0530	2300
August 1–15	0600	2245
August 16–31	0600	2130
September 1–16	0630	2100
September 17 – October 4	0700	2030
October 5–19	0730	2000
October 20–29	0730	1930
October 30 – End DST [a]	0730	1800
End DST [a] – December 31	0630	1700

a. DST = Daylight Saving Time, in effect from the second Sunday in March through the first Sunday in November.

2.3. Operating Criteria - Juvenile Fish Facilities

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

2.3.1.1. From December 1 until Monday of the third week in December, submersible traveling screens (STS) will remain in place and the juvenile bypass system (JBS) channel will operate for adult fallbacks, thereby shortening some aspects of the winter maintenance period. During this period, priority units will be screened to the extent practicable (barring operational failure). STSs will only be removed from non-priority units when necessary to begin maintenance. STSs may be removed starting on Monday of the third week in December.

2.3.1.2. All units are available to meet power demands.

2.3.1.3. Remove debris from the forebay, all trash racks, and gatewell slots so these areas are debris-free by April 1.

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

2.3.1.5. Inspect and operate each STS. Install STSs in each intake slot of all operational units by April 1, unless otherwise coordinated with the fish agencies and tribes.

2.3.1.6. 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.

2.3.1.7. 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.

2.3.1.8. Dewater the downstream migrant (DSM) channel only when required for inspection, maintenance, or structural modifications (see **section 5**). Minimize the outage duration to the extent practicable.

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

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

2.3.1.11. 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.

2.3.1.12. At the SMF, ensure all following items are fully operational:

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

ii. All valves and auxiliary water systems.

iii. Flushing water valves and their perforated plates.

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

v. Fish/debris separator, including perforated plates and adult passage chamber.

vi. PIT-tag detectors.

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

2.3.1.13. Avian abatement measures shall be in place by April 1 or as soon as weather permits. For more information, see the *Predation Monitoring & Deterrence Action Plans* for John Day Dam in **Appendix L** (Table 2 and section 5).

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

2.3.2.1. STSs and VBSs.

i. Operate STSs from April 1 through November 30 for juvenile fish passage, and from December 1 until Monday of the third week in December for adult fallbacks. Do not operate units without a full complement of rotating STSs except to comply with other coordinated fish measures.

ii. 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.

iii. Operate Unit 2 when Unit 1 is out of service for STS inspection.

iv. Monitor each STS amp and/or watt meter readings at least once per shift.

v. If an STS or VBS is damaged, plugged, or non-operational, follow procedures in **section 3**.

vi. Include inspection reports in weekly fishway reports and provide to FPOM.

2.3.2.2. Gatewells and Orifices.

i. Open all gatewell orifices whenever STSs are deployed. If an orifice cannot be opened for any reason, the corresponding unit must be taken out of service within 1 hour until repairs are made.

ii. Inspect all STS gatewells daily.

iii. 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 surface at least 50% clear, clean gatewells at least once daily. Do not operate turbines that have a gatewell fully covered with debris except to comply with other coordinated fish measures, and then only on a "last-on/first-off" basis. During cleaning, close the powerhouse gatewell orifices. After gatewell de-barking, cycle the orifice in that gatewell. Check gatewell drawdown.

iv. When using a dip basket for gatewell cleaning, coordinate with SMF staff.

v. Monitor and record juvenile mortality numbers in all gatewells as potential indicators of gatewell environment problems. Include mortality estimates in the weekly status reports.

vi. Measure gatewell drawdown across the trashrack at least once per week. Remove debris from forebay and trashracks as required to maintain gatewell drawdown < 1.5'. If VBS drawdown reaches 1.2', inspect the screen and prepare to clean as necessary.

vii. Close and open each orifice three times daily, or more frequently as determined by the Project Biologist if necessary due to debris accumulation in gatewells.

viii. If a unit goes out of service, keep orifices open in the associated gatewells unless that gatewell is dewatered.

ix. Inspect orifice lights daily to ensure they are operating. Replace all burned out orifice lights within 24 hours.

x. From April 1 through August 1, rake Units 1–5 monthly and Units 6–10 *or* 11–16 every other month. After August 1, rake units as determined necessary by ROV inspection or as needed to maintain gatewell drawdown in criteria. Perform additional raking whenever trash accumulations are suspected because of increased differential ≥ 1.5' across the trash racks, or as determined by the Project Biologist in response to increased juvenile fish descaling at the dam, deteriorating fish condition at the SMF, or increased tumbleweeds in the forebay.

xi. During raking, close the gatewell orifices of the unit being raked.

xii. If debris loads are obvious in the forebay, rake trash in front of the affected unit(s) weekly until the debris is removed. Debris accumulations in the forebay of 300 feet or more in any direction from the face of the dam will be removed within 48 hours. Continue debris removal efforts until the debris is cleared.

xiii. 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.

xiv. Maintain the water level in the bypass conduit between 4.0' and 5.0' as measured at Unit 16.

2.3.2.3. Smolt Monitoring Facility (SMF).

i. From April 1 through September 15, Project fish personnel will monitor the SMF 10 hours/day, 5 days/week, to ensure proper functioning and to respond quickly in the event of an emergency.

ii. From April 1 through June 15, condition sampling will occur 5 days per week (Monday through Friday) for 6–8 hours with a target of 100 fish of the predominant species.

iii. From June 16 through September 15, condition sampling will occur 3 days per week (Monday, Wednesday, Friday) for 6-8 hours with a target of 100 fish of the predominant species.

iv. On-site staff will perform a walking inspection of the entire SMF system every two hours to ensure safe fish 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). When the SMF is in bypass mode, Project Fisheries staff will continue to perform daily inspections of the JBS to ensure the system is operating within criteria. Staff will pay particular attention to the following to ensure proper function of sampling system:

- Dewatering facilities, including screens, free of holes or gaps, and the screen cleaner brush system.
- All valves and auxiliary water systems.
- Flushing water valves and perforated plates.
- All gates, including crest, tainter, switch, and rotating gates.
- Fish/debris separator, including perforated plates and adult passage chamber.
- PIT-tag detectors.
- All sampling building systems, including holding tanks, valves, and conduits.
- During low to normal debris loads, the Primary Dewatering Screen (PDS) sweepers will be cycled twice per shift (six times per day). If higher debris loads, the frequency of screen sweeper cycling will be increased as determined by the Project Fisheries inspection.
- The fish/debris separator will be visually inspected every 30 minutes to prevent injury and/or mortality to fish. During high debris periods (likely during spring runoff), additional personnel may be required to keep the separator free of any obstructions to fish passage. The Project Biologist will decide to assign a person to remove debris from the separator for as long as necessary to ensure the safety of passing fish.

- When water temperatures are ≥ 70°F, all fish handling to remove adult fish from the PDS area will be coordinated through FPOM. The condition sampling will be reduced to two days per week (Monday and Thursday) until water temperatures drop below 69.5°F.

2.3.2.4. Temporary Spillway Weirs (TSWs).

i. John Day Dam has two temporary, or top, spillway weirs (TSWs) in spillbays 18 and 19 that provide surface passage routes for fish.

ii. Opening and closing the TSWs requires a crew and gantry crane and must be done during daylight hours as weather allows.

iii. When open, each TSW spills approximately 9.7 kcfs. Spill patterns with and without TSWs are in **Tables JDA-8** and **JDA-9**, respectively.

iv. Both TSWs will be installed as early as possible on the first day of spring spill.

v. During high flow, TSW removal is recommended before river flow exceeds 685 kcfs.

vi. Both TSWs will be closed on the last normal workday of summer spill (no later than August 31), as late in the day as possible. Spill for juvenile fish passage will be maintained through midnight on August 31 using the "No TSWs" patterns.

2.3.2.5. Avian Predation Management. Operate in accordance with the *Predation Monitoring and Deterrence Action Plans* for John Day Dam in **Appendix L** (Table 2 and section 5). Avian monitoring at John Day Dam will occur daily during the adult and juvenile fish passage season and hazing will occur daily from April 10 through July 31.

2.4. Operating Criteria - Adult Fish Facilities

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

2.4.1.1. Operate according to criteria for adult fish passage season in **section 2.4.2** below, 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.

2.4.1.2. 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 should 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 the top of the north fish ladders to address the fish jumping problem in this area.

2.4.1.7. Maximum head on attraction water intakes and trash racks at all ladder exits is 0.5'. Remove debris when significant amounts accumulate.

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

2.4.2.1. Maintain staff gauges and water level indicators in readable condition at all water levels encountered during the fish passage season and check calibration weekly. When necessary, clean and/or recalibrate instruments as soon as practicable.

2.4.2.2. Maintain water depth over fish ladder weirs at 1.0’ ±0.1’. When the adult shad count at Bonneville Dam exceeds 5,000/day, increase water depth to 1.3’ ±0.1’.

2.4.2.3. Maintain main entrance weir depths at 8’ or greater below tailwater. Maintain tailwater elevation above 158’ msl to stay within criteria operating range for entrance weirs.

2.4.2.4. Maintain head on all entrances in the range of 1’–2’ (1.5’ optimum). When unable to achieve head criteria, refer to **section 3.2**.

2.4.2.5. Open floating orifice gates 1, 2, 18 and 19, and operate fish pumps to maintain fishway criteria. The system can be maintained using two fish pumps and leaving the 3rd as a backup. The entrance gate should be submerged 8’ deep or greater to be in criteria.

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

2.4.2.7. Measure fishway channel water velocities at least three times per week (daily preferred) during adult fish passage season as part of the fishway inspection program. Velocities will be measured through all fishway channels that are supplemented by auxiliary water and results reported in the project weekly fishway status report. Maintain water velocity in the range of 1.5–4.0 feet per second (fps), 2 fps optimum, in all channels and the lower ends of fish ladders that are below the tailwater.

2.4.2.8. North Fishway. 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. Provide adult attraction flow from August 15 through November 30 by spilling from Bay 2 open one stop (1.5 kcfs) during daylight hours defined in **Table JDA-5**.

2.4.2.9. South Fishway. Operate entrance weirs SE-1, NE-1, and NE-2 to maintain proper depths (>8') and entrance differentials (>1'-2').

2.4.2.10. Powerhouse. Operate entrances NE-1 and NE-2. Operate four powerhouse floating orifices, 1, 2, 18, and 19, and open associated auxiliary water diffusers (see also **section 2.4.2.5**). From 0400–2000 hours, operate Unit 1 near 100 MW (±10) to provide best entrance conditions. If additional load is required by BPA, Unit 1 may be operated above 100 MW, but it should be the last unit brought up to full load when demand increases and the first unit to reduce when demand decreases (see **Appendix C - Load Shaping Guidelines**).

2.4.2.11. Fishway Temperature Monitoring.

2.4.2.11.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 through FPOM prior to any action to verify protocols that will be followed.

2.4.2.11.b. From April 1 through October 31, measure water temperature at adult fishway entrances and exits and submit data to the Fish Passage Center (FPC) weekly for posting online.[4] Ensure the location of the monitors meets the following criteria:

i. Within 10 meters of all shore-oriented entrances and exits.

ii. Entrance monitor within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers, if possible, to allow for sufficient mixing with surface water.

iii. Exit monitor within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

[4] FPC ladder temperature data website: www.fpc.org/smolt/smolt_queries/Q_ladderwatertempgraphv2.php

iv. If an existing temperature monitoring location is proposed to be used for either the exit or entrance, verify that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.4.2.12. Adult Fish Counting.

i. The current adult fish counting schedule is in **Table JDA-3**.

ii. Crowder ranges are: JDA-North = 18"–28"; JDA-South = 18"–30"

iii. When not counting, or if counting is temporarily discontinued due to unscheduled events, open the crowder to full count slot width. The crowder may remain in operating position during the counter's hourly 10-minute break.

iv. During counting, open the crowder as far as possible to allow accurate counting, at least 18". Do not close to less than 18" inches while counting. This will usually occur during high turbidity conditions to maintain count accuracy. If passage is impaired by narrow count slot conditions, open the count slot until proper passage conditions are achieved, despite reduced count accuracy. Project biologists, FFU, and the fish count supervisor shall coordinate to achieve optimum count slot passage and/or count accuracy conditions.

2.5. Fish Facilities Monitoring & Reporting

2.5.1. Monitoring.

2.5.1.1. During fish passage season, inspect fish passage facilities at least twice per day, seven days a week to ensure operation according to established criteria.

2.5.1.2. During the winter maintenance period, inspect fish facilities once a day, seven days a week. More frequent inspections of some facility components will occur per FPP criteria.

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

2.5.1.4. Report results of all inspections and the readiness of the facilities for operation to FPOM at the meeting immediately prior to the fish passage season.

2.5.1.5. Continue to implement the zebra mussel monitoring program. 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 project facilities.

2.5.2. Reporting.

2.5.2.1. Weekly Reports. Project biologists shall prepare weekly reports throughout the year summarizing project and fish facility operations for each week (Sunday through Saturday), along with an evaluation of resulting fish passage conditions. The reports will be e-mailed to

CENWP-OD, CENWD-PDW-R (RCC), and other interested parties as soon as possible the following week. The weekly reports shall include:

i. Out-of-criteria situations and subsequent corrective actions.

ii. Equipment malfunctions, breakdowns, or damage, with a summary of resulting repairs.

iii. Adult fishway control calibrations.

iv. STS and VBS inspections.

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

vi. Unusual activities at the project that may affect fish passage.

2.5.2.2. In-Season. Any adverse or negative impact to fish or fishways shall be reported in a *Memorandum for the Record* (MFR) prepared by Project biologists and sent to FPOM by the next working day, pursuant to the coordination process and template in **FPP Chapter 1 – Overview**.

2.5.2.3. Annual Report. Project biologists shall prepare an annual report by January 31 each year, summarizing fish facility operations for the previous year's winter maintenance period and fish passage season, December 1 through November 30. The annual report will also include all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the actions. The annual report will be provided to CENWP-OD in time for distribution to FPOM members at the February meeting.

3. FISH FACILITIES MAINTENANCE

3.1. Fish Facilities Routine Maintenance

3.1.1. Routine maintenance of fish facilities will be conducted when fish passage has been documented to be at its lowest, to the extent practicable, to minimize fish impacts. Maintenance that occurs during juvenile or adult passage season that may affect fish passage will be included in the weekly reports, per **section 2.5.2**. If maintenance requires operating outside of FPP criteria, the work will be coordinated with FPOM per the procedures defined in **FPP Chapter 1– Overview** (section 2.3).

3.1.2. 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 through December 15, a turbine unit cannot operate without a full complement of functioning STSs.

3.1.3. 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.

3.1.4. Turbines & Spillbays. Routine maintenance and repair of project turbines and spillbays is a regular and recurring process that requires extended outages (see **Turbine Maintenance section 4.3** and **Dewatering Plans section 5**). If maintenance requires operating outside of FPP criteria, the work will be coordinated with FPOM. Certain turbine and spillbay discharges are secondarily used to attract adult fish to fishway entrances, to keep predator fish from accumulating near juvenile release sites, and to move juveniles downstream away from the project. The maintenance schedules for these turbines and spillbays will reflect equal weight given to fish, power, and water management and will be coordinated with the appropriate fish agencies. Units 1, 2, and 5 should not be scheduled for maintenance during fish passage season.

3.1.5. 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.

3.1.6. Adult Fish Collection Systems. Preventive maintenance and repairs occur throughout the year as needed. During the adult fish passage season, this maintenance will not result in failing to achieve fishway criteria unless coordinated with 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 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**).

3.1.7. Adult Ladders and Count Stations. Adult fish ladders are 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 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 repaired. Rake trash racks at ladder exits when criteria are exceeded. When practicable, rake trash racks during the time of day when fish passage would be least impacted. Clean fish count station windows, light panels, and crowder panels as needed to achieve accurate counts and, when practicable, during the time of day when fish passage is least impacted. Inspect north netting on ladders daily to prevent fish leaping and maintain as necessary. Include inspection summaries in the weekly report.

3.2. Fish Facilities Non-Routine Maintenance

3.2.1. Non-routine or unscheduled fish facility maintenance that may impact fish passage or operation of fish facilities (e.g., repair of diffuser gratings, etc.) shall be coordinated through FPOM on a case-by-case basis by Project and CENWP-OD biologists, per the coordination process described in **FPP Chapter 1–Overview** (section 2.3). The CENWP-OD biologists will be notified as soon as possible after it becomes apparent that non-routine maintenance 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.

3.2.2. Non-routine maintenance that affects fish passage will be included in the weekly reports.

3.2.2. Juvenile Bypass System (JBS).

3.2.2.1. The JBS is automatically controlled. If the automatic system fails, operate manually until automation is repaired.

3.2.2.2. If the orifices become plugged with debris, do not operate the turbine until it has been cleaned.

3.2.2.3. If an STS or VBS is found to be damaged or malfunctioning 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.

3.2.2.4. 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, minimize power generation to the extent practicable. If this operating mode is expected to last longer than four days, sequentially shut down all units required for generation, salvage fish from gatewells, remove STSs, and restart the unit. Close the orifice gates during this process.

3.2.3. Turbines and Spillbays.

3.2.3.1. Whenever Unit 1 is not operating, operate Unit 2 for adult attraction.

3.2.3.2. Between September 1 and the end of November, spillbay 2 may be closed for up to one workday for maintenance activities. During the outage, operate spillbay 5 for adult attraction flow. Efforts should be made to minimize the outage as much as possible.

3.2.3.3. If a spill gate becomes inoperable, the operators will make the necessary changes to accommodate spill and then immediately notify the operations supervisor and Project Biologist to determine the best spill pattern 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.

3.2.4. Fishway Auxiliary Water Systems. The fishway auxiliary water systems are mostly automated. If the automatic system fails, manually operate the system to maintain the fish facility within criteria until 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. In the event of an AWS failure during adult passage season, coordinate with FPOM to determine the best operation.

3.2.4.1. South Ladder: Assuming all three auxiliary water turbines are being used to meet criteria, operate as follows in the event of a failure of one or more turbines:

3.2.4.1.a. If one turbine fails, increase the output of the two remaining turbines to meet adult fishway criteria.

3.2.4.1.b. If two turbines fail, operate the adult fish facility 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.

3.2.4.1.c. If all three turbine units fail, operate as follows until repairs can be made:

i. Open SE-1 with the weir crest 6' below the tailwater surface.

ii. Close NE1 and NE2.

iii. Place cross-channel bulkheads in powerhouse collection channel between Units 2 and 3.

iv. Close floating orifice gate in front of Unit 2, leaving the floating orifice gate in front of Unit 1 open.

3.2.4.2. North Ladder: The six AWS pumps installed in 2011 can achieve the optimal attraction criteria of 1.5' at all tailrace elevations. There is a built-in contingency as one of the six pumps is always spare and will be automatically started by PLC in case of another pump's failure.

3.2.5. 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 surveillance of the adult system to ensure criteria are being met. If the failure will not allow the entrance to be operated manually, the gate will be maintained in an operational position to the extent possible. 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.

3.2.6. Adult Ladders and Count Stations. Pickets with excessive spacing (>1"), erosion of concrete around the picket leads, or missing pickets may 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 to dewater the fishway for repairs will be made in coordination with FPOM.

3.2.7. 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 the associated diffuser and develop a method of repair as coordinated with FPOM. Repair as quickly as possible unless coordinated differently.

4. TURBINE UNIT OPERATION & MAINTENANCE

4.1. Turbine Unit Priority Order

4.1.1. Turbine 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	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	Any Order

*When a main unit is not available, the paired adjacent unit will be used to comply with requested priority.

4.2. Turbine Unit Operating Range

4.2.1. Turbine unit flow and power output at the lower and upper limits of the ±1% peak efficiency range, and at the operating limit, are defined in **Table JDA-7**, except units with locked runner blades (non-adjustable) are in **Table JDA-7-A**. Turbine units will be operated within these ranges according to *BPA's Load Shaping Guidelines* (**Appendix C**), as summarized below.

4.2.2. In-Season: April 10–August 31 (Spring/Summer Spill for Juvenile Fish Passage). Turbine units will be operated within ±1% of peak turbine efficiency (1% range), except under limited conditions and durations when turbines may be operated above the 1% range for the use of reserves or for TDG management during high flows (refer to **Appendix C** for more information). All required fish passage spill operations will be met prior to operating turbines above the 1% range.

At John Day Dam, if in-season operation outside the 1% range is necessary, units will be operated in order 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. In-season operation outside the 1% range shall be recorded by Project personnel and provided 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 5.5**), 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 to flush fish from the unit.

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

iv. Comply with other coordinated fish measures.

4.2.3. Off-Season: September 1–April 9. 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.

4.3. Turbine Unit Maintenance

4.3.1. Turbine unit maintenance schedules will be reviewed by Project and District biologists for fish impacts. If maintenance requires operating outside of FPP criteria, the work will be coordinated with FPOM per the procedures defined in **FPP Chapter 1–Overview**.

4.3.2. If the draft tube is to be dewatered (see **section 5.5**), the unit will be operated at full load above the 1% range (or at speed-no-load below the 1% range if not possible to load) for a minimum of 15 minutes prior to installing tail logs to flush fish from the unit.

4.3.3. Operational Testing. Some types of turbine maintenance require testing turbine operation throughout its full range before and after maintenance. 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 project is operating at minimum generation requirements. 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.

> **i.** Pre-Maintenance: 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 5.5.2**.
>
> **ii.** Post-Maintenance: After maintenance or repair, units may be operationally tested while in maintenance or forced outage status for up to a cumulative time of 30 minutes (within 1% range) before returning to operational status.

4.3.4. Wicket gate opening for functional testing of a watered-up unit will not exceed 15 minutes total open time.

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	JDA Units 1–16 With STS (see footnote b for exceptions)						JDA Units 1–16 No STS (see footnote b for exceptions)					
Head	1% Lower Limit		1% Upper Limit		Operating Limit [c]		1% Lower Limit		1% Upper Limit		Operating Limit [c]	
(feet)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
80	67.6	11,608	98.9	17,000	120.9	21,451	67.9	11,615	103.1	17,649	123.9	21,880
81	68.3	11,573	102.2	17,333	123.2	21,563	68.7	11,595	106.3	17,950	126.4	22,036
82	68.9	11,530	105.6	17,667	125.6	21,702	69.4	11,567	109.7	18,275	129.0	22,218
83	69.5	11,479	109.1	18,017	128.1	21,845	70.2	11,539	113.1	18,589	131.6	22,402
84	70.1	11,430	112.5	18,336	130.8	22,013	70.9	11,506	116.4	18,888	134.0	22,550
85	70.7	11,381	115.6	18,597	133.2	22,131	71.7	11,477	119.5	19,144	136.5	22,746
86	71.3	11,332	118.5	18,817	135.1	22,131	72.4	11,445	122.5	19,367	138.5	22,792
87	71.9	11,283	121.0	18,986	136.4	22,009	73.1	11,414	125.3	19,577	139.8	22,674
88	72.5	11,231	123.6	19,148	137.7	21,876	73.8	11,383	128.1	19,760	141.2	22,589
89	73.1	11,186	125.7	19,237	139.1	21,766	74.5	11,353	130.7	19,919	142.5	22,446
90	73.6	11,136	127.8	19,337	140.6	21,679	75.2	11,327	133.0	20,030	143.6	22,176
91	74.2	11,091	129.7	19,389	141.8	21,536	75.9	11,297	135.3	20,129	144.8	21,985
92	74.8	11,042	131.6	19,442	142.9	21,372	76.6	11,269	137.2	20,174	146.1	21,864
93	75.3	10,992	133.6	19,512	143.9	21,231	77.4	11,241	138.9	20,187	147.1	21,727
94	75.8	10,945	135.6	19,567	145.0	21,107	78.1	11,213	140.5	20,176	148.0	21,556
95	76.4	10,903	137.6	19,627	145.9	20,968	78.8	11,191	141.8	20,132	148.8	21,369
96	77.1	10,867	139.7	19,701	146.7	20,819	79.7	11,176	142.7	20,026	149.6	21,182
97	77.7	10,837	141.9	19,782	147.5	20,683	80.5	11,165	143.5	19,909	150.4	21,017
98	78.5	10,812	144.1	19,858	148.3	20,541	81.4	11,158	144.6	19,820	151.0	20,855
99	79.1	10,785	146.5	19,967	149.1	20,378	82.3	11,153	145.8	19,758	151.6	20,699
100	79.8	10,757	149.1	20,087	149.7	20,194	83.2	11,146	147.4	19,759	152.3	20,551
101	80.5	10,732	151.4	20,180	150.4	20,017	84.0	11,139	149.3	19,792	153.0	20,401
102	81.2	10,709	153.7	20,270	151.0	19,852	84.9	11,135	151.1	19,817	153.6	20,245
103	81.9	10,682	156.2	20,377	151.7	19,691	85.8	11,133	153.1	19,858	154.2	20,059
104	83.0	10,717	155.7	20,104	152.3	19,593	86.6	11,119	155.3	19,940	154.7	19,819
105	84.0	10,741	155.5	19,877	152.9	19,489	87.3	11,095	158.2	20,098	155.2	19,575
106	85.0	10,752	155.8	19,714	153.5	19,374	88.2	11,095	158.8	19,985	155.6	19,438
107	85.9	10,769	155.9	19,537	154.0	19,258	89.0	11,087	159.6	19,886	156.1	19,299
108	86.8	10,780	156.1	19,374	154.5	19,145	89.8	11,079	160.2	19,776	156.5	19,168
109	87.8	10,794	156.1	19,193	155.0	19,038	90.6	11,072	161.1	19,693	157.0	19,045
110	88.7	10,809	156.1	19,030	155.5	18,935	91.4	11,068	162.0	19,629	157.4	18,936

a. Values provided by HDC (May 2022). Flow (cfs) is a calculated value based on turbine efficiency, project head, and power output (MW).

b. Units 3, 8, 9, 10, 11, 13, and 14 have locked runner blades and are restricted to an operating range of approximately 17-19 kcfs, as defined below in **Table JDA-7-A**. *Unit 4 is OOS for rehab and will be a fully adjustable Kaplan when it returns to service (estimated RTS 2024).*

c. "Operating Limit" (added Feb 2018) is the maximum safe operating point based on cavitation or generator limit. JDA units have a generator limit that restricts turbine output at higher heads. Values shaded in gray indicate the Operating Limit is below the 1% Upper Limit.

Table JDA-7-A. Operating Range Values for John Day Turbine Units 3, 8, 9, 10, 11, 13, and 14 with Locked Runner Blades (Non-Adjustable). [a]

Project Head (feet)	Unit 3 w/ Blades Hydraulically Locked at 29.1° (Dec 2020)								Unit 8 w/ Blades Welded at 29.4° (March 2017)							
	With STS				No STS				With STS				No STS			
	Lower Limit		Upper Limit		Lower Limit		Upper Limit		Lower Limit		Upper Limit		Lower Limit		Upper Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
80	103.5	18,039	107.7	18,769	103.5	17,961	107.7	18,688	106.3	18,435	110.9	19,239	106.3	18,435	110.9	19,239
81	104.8	18,010	109.0	18,728	104.8	17,932	109.0	18,653	107.7	18,413	112.2	19,186	107.7	18,417	112.2	19,190
82	106.1	17,979	110.2	18,685	106.1	17,906	110.3	18,609	109.1	18,392	113.5	19,133	109.1	18,400	113.5	19,141
83	107.4	17,949	111.5	18,648	107.5	17,881	111.6	18,568	110.5	18,371	114.8	19,086	110.5	18,383	114.8	19,098
84	108.6	17,919	112.9	18,616	108.8	17,855	113.0	18,539	111.9	18,350	116.1	19,042	112.0	18,367	116.2	19,058
85	109.9	17,891	114.2	18,589	110.1	17,830	114.3	18,513	113.3	18,328	117.5	19,005	113.4	18,348	117.6	19,025
86	111.7	17,933	115.9	18,615	111.9	17,872	116.0	18,541	115.0	18,355	119.2	19,025	115.1	18,380	119.3	19,048
87	113.4	17,969	117.6	18,643	113.6	17,914	117.8	18,572	116.7	18,381	120.9	19,041	116.9	18,410	121.0	19,068
88	115.1	18,005	119.4	18,676	115.3	17,949	119.5	18,601	118.3	18,404	122.5	19,055	118.6	18,437	122.7	19,086
89	116.8	18,037	121.1	18,704	117.0	17,985	121.3	18,636	120.0	18,427	124.2	19,067	120.3	18,464	124.4	19,102
90	118.5	18,070	122.8	18,736	118.8	18,021	123.0	18,665	121.7	18,448	125.9	19,078	122.0	18,489	126.1	19,117
91	119.8	18,058	124.3	18,743	120.1	18,012	124.5	18,674	122.9	18,411	127.1	19,040	123.2	18,457	127.4	19,083
92	121.1	18,043	125.8	18,750	121.5	18,002	126.1	18,684	124.2	18,375	128.4	19,004	124.5	18,425	128.7	19,051
93	122.4	18,029	127.3	18,755	122.8	17,989	127.6	18,694	125.4	18,341	129.7	18,970	125.8	18,394	130.1	19,020
94	123.7	18,013	128.8	18,762	124.1	17,976	129.1	18,701	126.7	18,306	131.0	18,938	127.0	18,363	131.4	18,993
95	124.9	17,994	130.3	18,770	125.4	17,962	130.6	18,710	127.9	18,271	132.4	18,909	128.3	18,332	132.8	18,968
96	126.5	18,018	131.9	18,782	127.0	17,988	132.3	18,725	129.6	18,294	134.0	18,919	130.0	18,359	134.4	18,982
97	128.1	18,041	133.5	18,797	128.7	18,013	133.9	18,741	131.2	18,317	135.6	18,926	131.7	18,386	136.1	18,993
98	129.8	18,064	135.1	18,813	130.3	18,037	135.6	18,761	132.9	18,337	137.3	18,940	133.4	18,410	137.8	19,010
99	131.4	18,085	136.8	18,837	132.0	18,061	137.3	18,786	134.6	18,359	139.0	18,954	135.2	18,437	139.5	19,028
100	133.0	18,107	138.6	18,868	133.6	18,085	139.0	18,819	136.2	18,376	140.7	18,975	136.8	18,458	141.3	19,053
101	134.6	18,134	140.2	18,890	135.3	18,115	140.7	18,843	137.8	18,395	142.4	18,998	138.4	18,473	142.9	19,072
102	136.2	18,159	141.9	18,915	136.9	18,143	142.4	18,869	139.4	18,411	144.1	19,024	140.0	18,485	144.6	19,095
103	137.9	18,187	143.6	18,938	138.6	18,172	144.1	18,894	141.0	18,427	145.8	19,052	141.6	18,497	146.3	19,119
104	139.5	18,209	145.3	18,967	140.2	18,195	145.9	18,925	142.6	18,443	147.6	19,081	143.1	18,509	148.0	19,143
105	141.1	18,230	147.0	18,997	141.9	18,218	147.6	18,957	144.2	18,456	149.3	19,111	144.7	18,518	149.8	19,170
106	142.3	18,217	148.6	19,030	143.1	18,203	149.2	18,986	145.5	18,447	151.0	19,147	145.9	18,505	151.4	19,202
107	143.4	18,197	150.3	19,064	144.2	18,182	150.8	19,015	146.7	18,434	152.7	19,187	147.2	18,487	153.1	19,238
108	144.5	18,171	151.9	19,097	145.3	18,154	152.5	19,046	147.9	18,415	154.5	19,229	148.3	18,464	154.9	19,276
109	145.5	18,137	153.5	19,132	146.3	18,119	154.1	19,077	149.1	18,393	155.3	19,149	149.5	18,438	155.3	19,149
110	146.5	18,096	155.2	19,168	147.3	18,077	155.7	19,109	150.2	18,365	155.3	18,978	150.6	18,406	155.3	18,978

Project Head (feet)	Unit 9 w/ Blades Welded at 29.0° (Sep 2015)								Unit 10 w/ Blades Welded at 29.1° (Dec 2020)							
	With STS				No STS				With STS				No STS			
	Lower Limit		Upper Limit		Lower Limit		Upper Limit		Lower Limit		Upper Limit		Lower Limit		Upper Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
80	106.0	18,388	110.6	19,182	106.0	18,388	110.6	19,182	104.1	18,013	108.4	18,747	104.1	18,013	108.4	18,747
81	107.3	18,354	111.9	19,126	107.4	18,358	111.9	19,130	105.4	17,984	109.6	18,696	105.4	17,988	109.6	18,699
82	108.7	18,322	113.1	19,070	108.7	18,330	113.2	19,078	106.7	17,954	110.8	18,642	106.8	17,963	110.9	18,647
83	110.0	18,291	114.4	19,018	110.1	18,302	114.5	19,030	108.0	17,924	112.1	18,596	108.1	17,936	112.1	18,603
84	111.4	18,260	115.7	18,970	111.5	18,275	115.8	18,986	109.4	17,895	113.4	18,555	109.5	17,911	113.5	18,565
85	112.7	18,226	117.0	18,930	112.8	18,246	117.2	18,950	110.7	17,868	114.7	18,517	110.8	17,888	114.8	18,530
86	114.3	18,245	118.7	18,949	114.5	18,269	118.9	18,973	112.4	17,905	116.4	18,534	112.6	17,930	116.5	18,549
87	115.9	18,262	120.4	18,964	116.1	18,290	120.6	18,992	114.1	17,940	118.0	18,550	114.3	17,968	118.1	18,569
88	117.5	18,275	122.1	18,977	117.7	18,307	122.3	19,009	115.8	17,971	119.7	18,568	116.0	18,004	119.8	18,588
89	119.1	18,287	123.7	18,985	119.4	18,323	123.9	19,021	117.5	18,002	121.4	18,587	117.8	18,038	121.5	18,610
90	120.8	18,302	125.3	18,985	121.0	18,342	125.6	19,025	119.2	18,030	123.0	18,605	119.5	18,071	123.2	18,631
91	121.9	18,258	126.6	18,948	122.2	18,301	126.9	18,993	120.6	18,013	124.4	18,595	120.8	18,058	124.6	18,624
92	123.1	18,215	127.8	18,912	123.4	18,262	128.2	18,960	121.9	17,995	125.9	18,586	122.2	18,044	126.1	18,617
93	124.3	18,172	129.1	18,877	124.6	18,223	129.5	18,929	123.1	17,976	127.3	18,576	123.5	18,028	127.5	18,610
94	125.5	18,129	130.4	18,843	125.8	18,184	130.8	18,900	124.4	17,956	128.7	18,567	124.8	18,013	128.9	18,604
95	126.6	18,086	131.7	18,811	127.0	18,145	132.1	18,872	125.7	17,935	130.1	18,560	126.1	17,996	130.4	18,599
96	128.2	18,099	133.3	18,817	128.6	18,161	133.7	18,881	127.3	17,957	131.6	18,564	127.8	18,021	131.9	18,605
97	129.8	18,112	134.9	18,819	130.3	18,178	135.3	18,888	129.0	17,977	133.2	18,569	129.4	18,045	133.5	18,614
98	131.4	18,122	136.5	18,828	131.9	18,193	137.0	18,901	130.6	17,998	134.8	18,579	131.1	18,070	135.1	18,625
99	132.9	18,133	138.1	18,839	133.5	18,208	138.7	18,916	132.2	18,017	136.4	18,593	132.8	18,093	136.8	18,642
100	134.5	18,141	139.8	18,856	135.1	18,220	140.4	18,936	133.8	18,036	138.1	18,614	134.4	18,117	138.5	18,666
101	136.2	18,169	141.5	18,882	136.7	18,243	142.1	18,959	135.5	18,060	139.7	18,626	136.1	18,144	140.1	18,681
102	137.8	18,194	143.2	18,911	138.3	18,264	143.8	18,984	137.1	18,084	141.3	18,638	137.8	18,173	141.7	18,696
103	139.5	18,219	145.0	18,941	140.0	18,286	145.5	19,010	138.7	18,105	142.9	18,654	139.4	18,198	143.4	18,714
104	141.1	18,243	146.7	18,973	141.6	18,306	147.2	19,038	140.3	18,125	144.6	18,670	141.1	18,222	145.0	18,733
105	142.7	18,265	148.5	19,006	143.2	18,324	149.0	19,067	141.9	18,142	146.2	18,691	142.7	18,243	146.7	18,756
106	144.1	18,266	150.2	19,046	144.5	18,321	150.7	19,103	143.2	18,132	147.9	18,728	143.9	18,229	148.4	18,791
107	145.4	18,262	152.0	19,090	145.8	18,313	152.4	19,143	144.4	18,116	149.6	18,767	145.1	18,209	150.1	18,828
108	146.7	18,253	153.7	19,135	147.0	18,300	154.1	19,184	145.5	18,093	151.3	18,807	146.2	18,182	151.7	18,865
109	147.9	18,240	155.3	19,147	148.2	18,283	155.3	19,147	146.6	18,065	153.0	18,847	147.3	18,150	153.4	18,903
110	149.1	18,221	155.3	18,975	149.4	18,260	155.3	18,975	147.7	18,030	154.7	18,890	148.3	18,111	155.1	18,943

Project Head (feet)	Unit 11 w/ Blades Welded at 29.9° (April 2012)								Unit 13 w/ Blades Pinned at 29.5° (Jun 2023) and Unit 14 w/ Blades Welded at 29.6° (Aug 2019)							
	With STS				No STS				With STS				No STS			
	Lower Limit		Upper Limit		Lower Limit		Upper Limit		Lower Limit		Upper Limit		Lower Limit		Upper Limit	
	MW	MW	MW	MW	MW	MW	MW	MW	MW	cfs	MW	cfs	MW	cfs	MW	cfs
80	106.0	18,379	110.5	19,171	106.0	18,379	110.5	19,171	104.8	18,154	109.2	18,914	104.8	18,154	109.2	18,914
81	107.4	18,360	111.9	19,130	107.4	18,364	111.9	19,134	106.2	18,130	110.5	18,870	106.2	18,133	110.5	18,873
82	108.8	18,343	113.2	19,087	108.9	18,350	113.3	19,095	107.6	18,108	111.8	18,824	107.6	18,114	111.8	18,830
83	110.2	18,326	114.6	19,048	110.3	18,338	114.7	19,060	108.9	18,088	113.1	18,778	109.0	18,097	113.2	18,787
84	111.7	18,310	116.0	19,013	111.8	18,325	116.1	19,030	110.3	18,066	114.4	18,741	110.4	18,078	114.5	18,753
85	113.1	18,291	117.4	18,986	113.2	18,311	117.5	19,007	111.7	18,045	115.8	18,711	111.8	18,060	115.9	18,726
86	114.8	18,326	119.2	19,019	115.0	18,349	119.3	19,044	113.4	18,082	117.5	18,738	113.5	18,100	117.7	18,757
87	116.6	18,358	120.9	19,048	116.7	18,385	121.1	19,077	115.2	18,118	119.3	18,764	115.3	18,139	119.4	18,785
88	118.3	18,386	122.7	19,074	118.5	18,417	122.9	19,107	116.9	18,151	121.0	18,788	117.0	18,175	121.2	18,812
89	120.0	18,413	124.4	19,096	120.2	18,448	124.7	19,133	118.6	18,184	122.7	18,805	118.8	18,211	122.9	18,833
90	121.7	18,444	126.1	19,110	122.0	18,482	126.4	19,151	120.4	18,216	124.4	18,825	120.6	18,246	124.6	18,855
91	123.0	18,414	127.5	19,087	123.3	18,457	127.8	19,132	121.7	18,196	125.8	18,813	121.9	18,229	126.0	18,846
92	124.3	18,386	128.9	19,064	124.6	18,433	129.2	19,114	123.0	18,177	127.2	18,801	123.2	18,213	127.5	18,838
93	125.6	18,358	130.3	19,043	125.9	18,408	130.6	19,097	124.3	18,157	128.7	18,791	124.6	18,195	128.9	18,830
94	126.9	18,330	131.6	19,024	127.2	18,384	132.0	19,081	125.6	18,136	130.1	18,780	125.9	18,178	130.4	18,823
95	128.1	18,302	133.0	19,005	128.5	18,360	133.5	19,067	126.9	18,115	131.5	18,771	127.2	18,160	131.8	18,816
96	129.8	18,330	134.7	19,024	130.3	18,391	135.2	19,090	128.6	18,141	133.1	18,783	128.9	18,189	133.5	18,831
97	131.6	18,358	136.4	19,040	132.0	18,424	136.9	19,110	130.3	18,167	134.8	18,796	130.6	18,217	135.1	18,847
98	133.3	18,384	138.2	19,063	133.8	18,453	138.7	19,137	131.9	18,192	136.4	18,813	132.3	18,246	136.8	18,867
99	135.0	18,410	139.9	19,087	135.5	18,483	140.5	19,166	133.6	18,215	138.2	18,835	134.0	18,272	138.6	18,893
100	136.7	18,433	141.8	19,117	137.3	18,511	142.4	19,200	135.3	18,240	139.9	18,861	135.7	18,300	140.4	18,922
101	138.2	18,446	143.4	19,130	138.8	18,519	144.0	19,209	137.0	18,266	141.6	18,881	137.4	18,329	142.1	18,945
102	139.8	18,456	145.0	19,147	140.3	18,526	145.6	19,221	138.6	18,294	143.2	18,899	139.1	18,361	143.7	18,966
103	141.4	18,467	146.7	19,163	141.9	18,533	147.2	19,233	140.3	18,319	144.9	18,921	140.8	18,389	145.4	18,991
104	142.9	18,476	148.4	19,181	143.4	18,538	148.9	19,247	142.0	18,342	146.6	18,945	142.5	18,414	147.2	19,019
105	144.4	18,482	150.0	19,201	144.9	18,540	150.5	19,263	143.6	18,364	148.3	18,969	144.2	18,440	148.9	19,046
106	145.7	18,469	151.7	19,228	146.1	18,523	152.1	19,286	144.8	18,349	150.0	19,002	145.4	18,421	150.6	19,076
107	146.9	18,449	153.3	19,258	147.3	18,500	153.8	19,312	146.0	18,330	151.6	19,034	146.6	18,399	152.2	19,104
108	148.0	18,425	155.0	19,290	148.4	18,471	155.3	19,322	147.2	18,305	153.3	19,068	147.7	18,371	153.9	19,136
109	149.2	18,397	155.3	19,146	149.5	18,439	155.3	19,146	148.3	18,273	155.0	19,104	148.8	18,336	155.3	19,135
110	150.2	18,362	155.3	18,975	150.6	18,401	155.3	18,975	149.3	18,236	155.3	18,963	149.8	18,296	155.3	18,963

a. Units 3, 8, 9, 10, 11, 13, and 14 have runner blades that are locked at a fixed angle (non-adjustable) and are restricted to a smaller operating range until the unit is repaired. Values updated by HDC in May 2022 and June 2023 (Unit 13).

5. DEWATERING PLANS

5.1. General

5.1.1. *Guidelines for Dewatering and Fish Handling* (**Appendix F**) and project *Dewatering Plans*[5] 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.

5.1.2. 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. 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. The fish agencies and tribes will be encouraged to participate in all ladder dewaterings.

5.2. Dewatering – Adult Fish Ladders

5.2.1. Prior to dewatering, when possible, operate ladders to be dewatered at orifice flow, with the AWS off, for at least 24 hours but not more than 108 hours. For non-routine or unscheduled maintenance, discontinue auxiliary water and operate ladder at reduced flow as long as possible for up to 72 hours prior to dewatering and follow guidance in **section 5.4**.

5.2.2. Project personnel will install head gates[6] to shut down ladder flow. Where possible, a flushing flow of 1”–2” will be maintained in the ladder until fish are rescued.

5.2.3. A Project biologist will ensure availability of fish rescue equipment and adequate numbers of personnel necessary to move fish out of the dewatered ladder. 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. Juvenile fish will be transported and released in the tailrace and adults released in the forebay (except identifiable steelhead kelts should be released into the tailrace).

5.2.4. 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.

[5] Dewatering Plans: pweb.crohms.org/tmt/documents/FPOM/2010/

[6] Head gates may also be referred to as “operating” gates at some projects. The terms are interchangeable.

5.3. Dewatering – Powerhouse Fish Collection System

5.3.1. 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.

5.4. Dewatering – Juvenile Bypass System (JBS)

5.4.1. When draining the juvenile bypass channel, it is typical to flush the channel with only Unit 16 bypass orifices open. Unit 16 gatewells will be dipped in advance to minimize the number of fish contained in this flushing water during fish passage season.

5.5. Dewatering – Turbine Units

5.5.1. 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. Dipping is not required during winter maintenance, December 16–March 31, when fish screens have been removed. 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.

5.5.2. 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.

5.5.3. 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.

5.5.4. 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. The Project Biologist will ensure that all necessary rescue equipment is available.

5.6. Dewatering – Navigation Lock

5.6.1. 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. 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.

6. FOREBAY DEBRIS REMOVAL

Debris at projects can impact fish passage conditions by plugging or blocking 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. 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.

7. RESPONSE TO HAZARDOUS MATERIALS SPILLS

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. 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.

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 (contact info available in the Control Room): Scott Fielding, Eric Grosvenor; Michael Lotspeich; Tammy Mackey.

Table JDA-8. [*page 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 Stops (#)	Spill [a] (kcfs)
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 [c]	19 [c]	20 [b]		
																	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**

[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	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**
	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**

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	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**
	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**

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	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**
	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**

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	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**
	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**

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	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**
	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**

JDA Spill Patterns with TSWs in Bays 18, 19 - # Gate Stops per Spillbay																				Total Stops (#)	Spill [a] (kcfs)
1 [b]	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18** [c]	**19** [c]	**20** [b]		
	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**
	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**

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	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**
	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**

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	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**
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**

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	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**
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**

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	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**
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. [*page 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 Stops (#)	Spill [a] (kcfs)
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
	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		10	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		20	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		30	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		40	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

[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	3	3	3	3	3	3	2	2	2	2	2	CLOSE	CLOSE		**50**	**80.0**
	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**

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	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**
	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**

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	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**
	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**

JDA Spill Patterns with No TSWs - # Gate Stops per Spillbay																				Total Stops (#)	Spill [a] (kcfs)
1 [b]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
	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**
	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**

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)**
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**
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**
11	11	17	17	17	16	16	16	16	16	16	16	16	16	17	16	11	CLOSE	CLOSE		**261**	**417.6**
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**
11	11	17	17	17	17	16	17	16	17	16	17	16	16	17	16	11	CLOSE	CLOSE		**265**	**424.0**
11	11	17	17	17	17	16	17	16	17	16	17	16	16	17	17	11	CLOSE	CLOSE		**266**	**425.6**
11	11	17	17	17	17	17	17	16	17	16	17	16	16	17	17	11	CLOSE	CLOSE		**267**	**427.2**
11	11	17	17	17	17	17	17	16	17	16	17	16	17	17	17	11	CLOSE	CLOSE		**268**	**428.8**
11	11	17	17	17	17	17	17	17	17	16	17	16	17	17	17	11	CLOSE	CLOSE		**269**	**430.4**
11	11	17	17	17	17	17	17	17	17	17	17	16	17	17	17	11	CLOSE	CLOSE		**270**	**432.0**
11	11	17	17	17	17	17	17	17	17	17	17	17	17	17	17	11	CLOSE	CLOSE		**271**	**433.6**
11	11	18	17	17	17	17	17	17	17	17	17	17	17	17	17	11	CLOSE	CLOSE		**272**	**435.2**
11	11	18	18	17	17	17	17	17	17	17	17	17	17	17	17	11	CLOSE	CLOSE		**273**	**436.8**
11	11	18	18	17	17	17	17	17	17	17	17	17	17	18	17	11	CLOSE	CLOSE		**274**	**438.4**
11	11	18	18	18	17	17	17	17	17	17	17	17	17	18	17	11	CLOSE	CLOSE		**275**	**440.0**
11	11	18	18	18	17	17	18	17	17	17	17	17	17	18	17	11	CLOSE	CLOSE		**276**	**441.6**
11	11	18	18	18	17	17	18	17	18	17	17	17	17	18	17	11	CLOSE	CLOSE		**277**	**443.2**
11	11	18	18	18	17	17	18	17	18	17	18	17	17	18	17	11	CLOSE	CLOSE		**278**	**444.8**
11	11	18	18	18	18	17	18	17	18	17	18	17	17	18	17	11	CLOSE	CLOSE		**279**	**446.4**
11	11	18	18	18	18	17	18	17	18	17	18	17	17	18	18	11	CLOSE	CLOSE		**280**	**448.0**
11	11	18	18	18	18	18	18	17	18	17	18	17	17	18	18	11	CLOSE	CLOSE		**281**	**449.6**
11	11	18	18	18	18	18	18	17	18	17	18	17	18	18	18	11	CLOSE	CLOSE		**282**	**451.2**
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**
11	11	18	18	18	18	18	18	18	18	18	18	18	18	18	18	11	CLOSE	CLOSE		**285**	**456.0**
11	11	19	18	18	18	18	18	18	18	18	18	18	18	18	18	11	CLOSE	CLOSE		**286**	**457.6**
11	11	19	19	18	18	18	18	18	18	18	18	18	18	18	18	11	CLOSE	CLOSE		**287**	**459.2**
11	11	19	19	18	18	18	18	18	18	18	18	18	18	19	18	11	CLOSE	CLOSE		**288**	**460.8**
11	11	19	19	19	18	18	18	18	18	18	18	18	18	19	18	11	CLOSE	CLOSE		**289**	**462.4**
11	11	19	19	19	18	18	19	18	18	18	18	18	18	19	18	11	CLOSE	CLOSE		**290**	**464.0**
11	11	19	19	19	18	18	19	18	19	18	18	18	18	19	18	11	CLOSE	CLOSE		**291**	**465.6**
11	11	19	19	19	18	18	19	18	19	18	19	18	18	19	18	11	CLOSE	CLOSE		**292**	**467.2**
11	11	19	19	19	19	18	19	18	19	18	19	18	18	19	18	11	CLOSE	CLOSE		**293**	**468.8**
11	11	19	19	19	19	18	19	18	19	18	19	18	18	19	19	11	CLOSE	CLOSE		**294**	**470.4**

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	19	19	19	19	19	19	18	19	18	19	18	18	19	19	11	CLOSE	CLOSE		**295**	**472.0**
11	11	19	19	19	19	19	19	18	19	18	19	18	19	19	19	11	CLOSE	CLOSE		**296**	**473.6**
11	11	19	19	19	19	19	19	19	19	18	19	18	19	19	19	11	CLOSE	CLOSE		**297**	**475.2**
11	11	19	19	19	19	19	19	19	19	19	19	18	19	19	19	11	CLOSE	CLOSE		**298**	**476.8**
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**
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**
11	11	21	21	20	20	20	20	20	20	20	20	20	20	20	20	11	CLOSE	CLOSE		**315**	**504.0**
11	11	21	21	20	20	20	20	20	20	20	20	20	20	21	20	11	CLOSE	CLOSE		**316**	**505.6**
11	11	21	21	21	20	20	20	20	20	20	20	20	20	21	20	11	CLOSE	CLOSE		**317**	**507.2**
11	11	21	21	21	20	20	21	20	20	20	20	20	20	21	20	11	CLOSE	CLOSE		**318**	**508.8**
11	11	21	21	21	20	20	21	20	21	20	20	20	20	21	20	11	CLOSE	CLOSE		**319**	**510.4**
11	11	21	21	21	20	20	21	20	21	20	21	20	20	21	20	11	CLOSE	CLOSE		**320**	**512.0**
11	11	21	21	21	21	20	21	20	21	20	21	20	20	21	20	11	CLOSE	CLOSE		**321**	**513.6**
11	11	21	21	21	21	20	21	20	21	20	21	20	20	21	21	11	CLOSE	CLOSE		**322**	**515.2**
11	11	21	21	21	21	21	21	20	21	20	21	20	20	21	21	11	CLOSE	CLOSE		**323**	**516.8**
11	11	21	21	21	21	21	21	20	21	20	21	20	21	21	21	11	CLOSE	CLOSE		**324**	**518.4**
11	11	21	21	21	21	21	21	21	21	20	21	20	21	21	21	11	CLOSE	CLOSE		**325**	**520.0**
11	11	21	21	21	21	21	21	21	21	21	21	20	21	21	21	11	CLOSE	CLOSE		**326**	**521.6**
11	11	21	21	21	21	21	21	21	21	21	21	21	21	21	21	11	CLOSE	CLOSE		**327**	**523.2**
11	11	22	21	21	21	21	21	21	21	21	21	21	21	21	21	11	CLOSE	CLOSE		**328**	**524.8**
11	11	22	22	21	21	21	21	21	21	21	21	21	21	21	21	11	CLOSE	CLOSE		**329**	**526.4**
11	11	22	22	21	21	21	21	21	21	21	21	21	21	22	21	11	CLOSE	CLOSE		**330**	**528.0**
11	11	22	22	22	21	21	21	21	21	21	21	21	21	22	21	11	CLOSE	CLOSE		**331**	**529.6**
11	11	22	22	22	21	21	22	21	21	21	21	21	21	22	21	11	CLOSE	CLOSE		**332**	**531.2**
11	11	22	22	22	21	21	22	21	22	21	21	21	21	22	21	11	CLOSE	CLOSE		**333**	**532.8**
11	11	22	22	22	21	21	22	21	22	21	22	21	21	22	21	11	CLOSE	CLOSE		**334**	**534.4**
11	11	22	22	22	22	21	22	21	22	21	22	21	21	22	21	11	CLOSE	CLOSE		**335**	**536.0**
11	11	22	22	22	22	21	22	21	22	21	22	21	21	22	22	11	CLOSE	CLOSE		**336**	**537.6**
11	11	22	22	22	22	22	22	21	22	21	22	21	21	22	22	11	CLOSE	CLOSE		**337**	**539.2**
11	11	22	22	22	22	22	22	21	22	21	22	21	22	22	22	11	CLOSE	CLOSE		**338**	**540.8**
11	11	22	22	22	22	22	22	22	22	21	22	21	22	22	22	11	CLOSE	CLOSE		**339**	**542.4**
11	11	22	22	22	22	22	22	22	22	22	22	21	22	22	22	11	CLOSE	CLOSE		**340**	**544.0**
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**

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	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**
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**
11	11	24	24	24	24	24	24	23	24	23	24	23	24	24	24	11	CLOSE	CLOSE		**366**	**585.6**
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**

2023 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’/hour
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 for McNary Dam is available on the Corps Walla Walla District website at: www.nww.usace.army.mil/Locations/District-Locks-and-Dams/McNary-Lock-and-Dam/

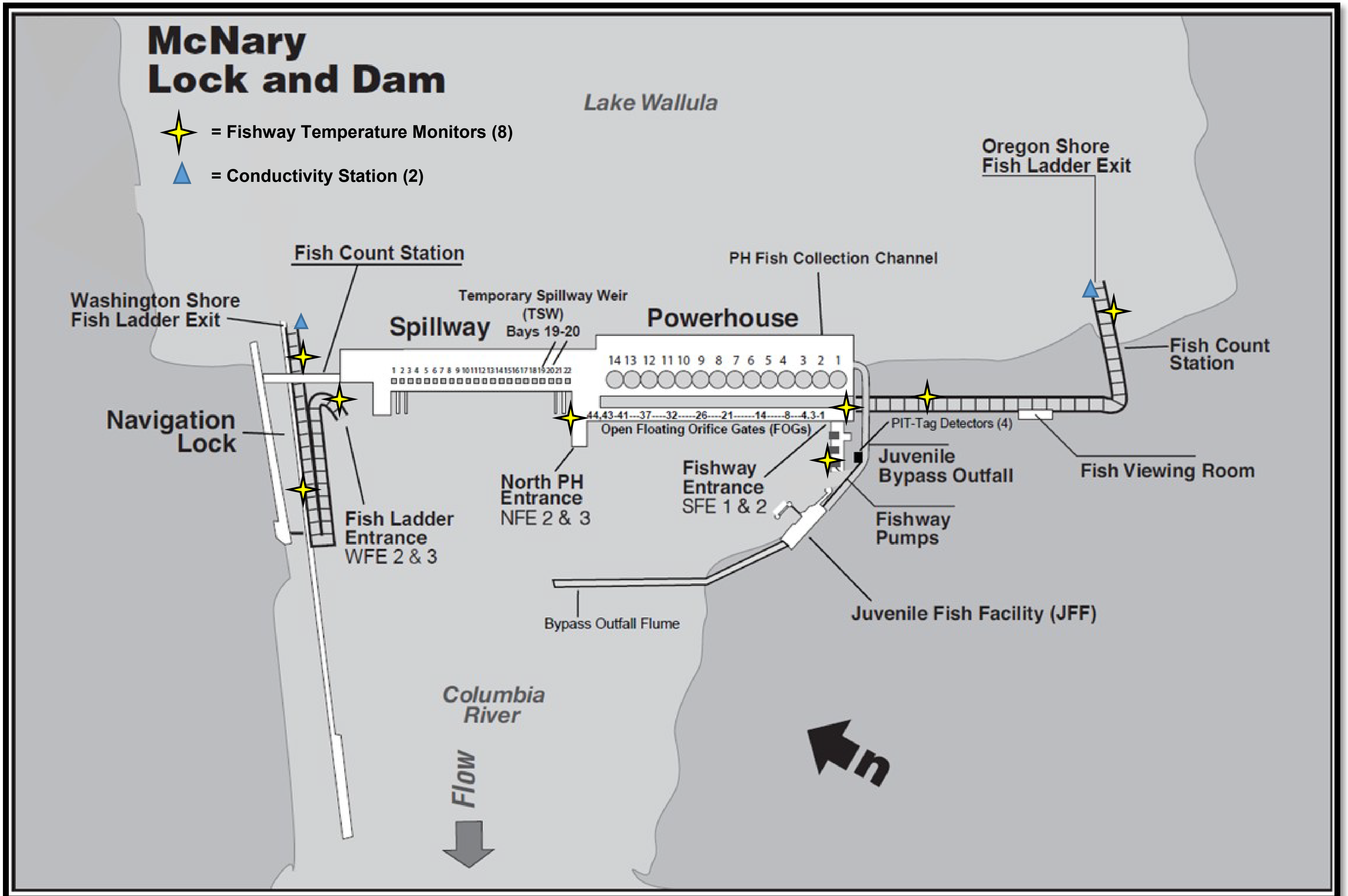
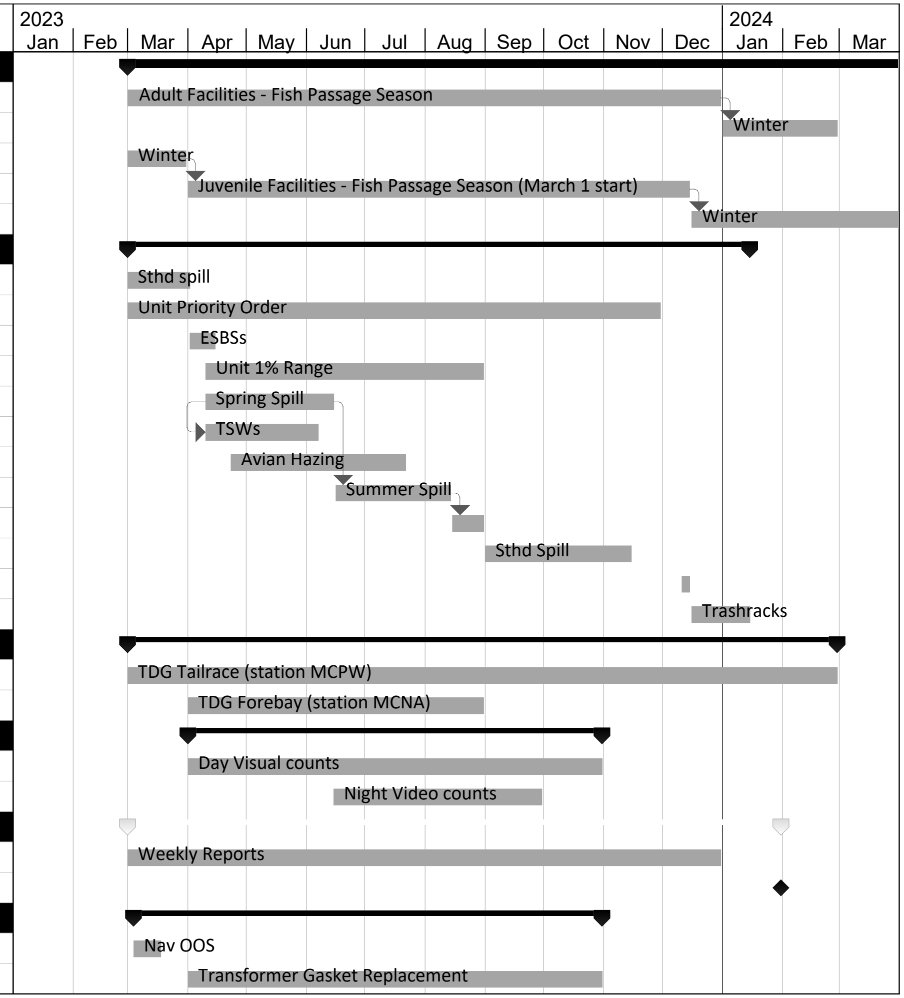


Figure MCN-1. McNary Lock & Dam General Site Plan.

Table MCN-1. McNary Dam Schedule of Operations and Actions Defined in the 2023 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**Wed 3/1/23**	**Sun 3/31/24**	
Adult Facilities - Fish Passage Season	Wed 3/1/23	Sun 12/31/23	2.4.2
Adult Facilities - Winter Maintenance	Mon 1/1/24	Thu 2/29/24	2.4.1
Juvenile Facilities - Winter Maintenance	Wed 3/1/23	Fri 3/31/23	2.3.1
Juvenile Facilities - Fish Passage Season	Sat 4/1/23	Fri 12/15/23	2.3.2
Juvenile Facilities - Winter Maintenance	Sat 12/16/23	Sun 3/31/24	2.3.1
PROJECT OPERATIONS FOR FISH PASSAGE	**Wed 3/1/23**	**Mon 1/15/24**	
TSW Spill for Adult Steelhead	Wed 3/1/23	Sun 4/2/23	2.2.2
Turbine unit priority order	Wed 3/1/23	Thu 11/30/23	4.1
ESBSs installed	Sun 4/2/23	Sat 4/15/23	2.3.2.2.
Turbine unit 1% operating range	Mon 4/10/23	Thu 8/31/23	4.3
Spring Spill	Mon 4/10/23	Thu 6/15/23	App E (FOP)
Both TSWs in operation	Mon 4/10/23	Wed 6/7/23	2.3.2.6
Avian hazing	Sun 4/23/23	Sat 7/22/23	App L 6.3
Summer Spill	Fri 6/16/23	Mon 8/14/23	App E (FOP)
Late Summer Spill	Tue 8/15/23	Thu 8/31/23	App E (FOP)
TSW Spill for Adult Steelhead	Fri 9/1/23	Wed 11/15/23	2.2.2
Remove ESBSs	Mon 12/11/23	Fri 12/15/23	2.3.1.3
Inspect/rake trashracks	Sat 12/16/23	Mon 1/15/24	2.3.1.1.
TDG MONITORING	**Wed 3/1/23**	**Thu 2/29/24**	
TDG Monitoring - Tailrace (year-round)	Wed 3/1/23	Thu 2/29/24	2.2
TDG Monitoring - Forebay	Sat 4/1/23	Thu 8/31/23	2.2
ADULT FISH COUNTING	**Sat 4/1/23**	**Tue 10/31/23**	
Day Visual 0500-2100 PDT	Sat 4/1/23	Tue 10/31/23	Table MCN-3
Night Video 2100-0500 PDT	Thu 6/15/23	Sat 9/30/23	Table MCN-3
REPORTS	**Wed 3/1/23**	**Wed 1/31/24**	
Weekly Reports	Wed 3/1/23	Sun 12/31/23	2.5.2
Annual Report due NLT Jan 31	Wed 1/31/24	Wed 1/31/24	2.5.2
SPECIAL OPS & STUDIES (Appendix A)	**Sat 3/4/23**	**Tue 10/31/23**	
Navigation Lock annual outage	Sat 3/4/23	Sat 3/18/23	App A 1.4
Transformer Gasket Replacement	Sat 4/1/23	Tue 10/31/23	App A 5.1.4



1. FISH PASSAGE INFORMATION

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

1.1. Juvenile Fish Facilities and Migration Timing

1.1.1. Juvenile Facilities. Maintenance of juvenile fish facilities that may impact fish or facility operations should be conducted during the winter maintenance period. Juvenile fish passage structures and facilities at McNary Dam consist of:

i. Extended-length submersible bar screens (ESBSs) with flow vanes.

ii. Vertical barrier screens (VBSs).

iii. Gatewell orifices.

iv. Concrete collection channel with emergency bypass outlets.

v. Primary and secondary dewatering structures.

vi. Pipeline/corrugated metal flume for routing juvenile fish to the sampling facilities or bypassing them back to the river.

vii. Full-flow PIT tag detection and deflection system.

viii. Separator to separate adults from juvenile fish, and juvenile fish by size.

ix. Covered raceways and tanks for holding sampled fish.

x. Sampling facilities, office, and sampling building with fish marking facilities.

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%	# Days	10%	50%	90%	# Days
	Yearling Chinook (wild & hatchery)				Subyearling Chinook (wild & hatchery)			
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	46
2018	27-Apr	7-May	17-May	20	21-May	26-Jun	18-Jul	58
2019	19-Apr	9-May	21-May	32	4-Jun	22-Jun	14-Jul	40
2020*	21-Apr	7-May	21-May	30	2-Jun	18-Jun	12-Jul	40
2021	25-Apr	13-May	23-May	28	12-Jun	24-Jun	4-Jul	22
2022*	11-Apr	11-May	27-May	46	12-Jun	22-Jun	24-Jul	42
10-Yr MEDIAN	**24-Apr**	**8-May**	**20-May**	**27**	**10-Jun**	**26-Jun**	**16-Jul**	**38**
10-Yr MIN	**11-Apr**	**3-May**	**13-May**	**20**	**21-May**	**18-Jun**	**2-Jul**	**22**
10-Yr MAX	**1-May**	**13-May**	**29-May**	**46**	**22-Jun**	**4-Jul**	**26-Jul**	**58**
	Unclipped Steelhead				Clipped Steelhead			
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
2018	19-Apr	5-May	27-May	38	19-Apr	1-May	13-May	24
2019	14-Apr	27-Apr	23-May	39	11-Apr	19-Apr	9-May	28
2020*	11-Apr	9-May	25-May	44	21-Apr	3-May	21-May	30
2021	21-Apr	9-May	29-May	38	21-Apr	29-Apr	19-May	28
2022*	17-Apr	19-May	6-Jun	50	7-Apr	5-May	21-May	44
10-Yr MEDIAN	**20-Apr**	**8-May**	**27-May**	**38**	**21-Apr**	**2-May**	**17-May**	**26**
10-Yr MIN	**11-Apr**	**27-Apr**	**19-May**	**26**	**7-Apr**	**19-Apr**	**9-May**	**20**
10-Yr MAX	**1-May**	**19-May**	**6-Jun**	**50**	**27-Apr**	**9-May**	**27-May**	**44**
	Coho (wild & hatchery)				Sockeye (wild & hatchery)			
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
2018	29-Apr	11-May	27-May	28	5-May	11-May	17-May	12
2019	19-Apr	19-May	29-May	40	29-Apr	19-May	6-Jun	38
2020*	21-Apr	11-May	31-May	40	5-May	17-May	27-May	22
2021	29-Apr	19-May	2-Jun	34	1-May	15-May	27-May	26
2022*	27-Apr	25-May	4-Jun	38	7-May	21-May	10-Jun	34
10-Yr MEDIAN	**29-Apr**	**19-May**	**1-Jun**	**33**	**30-Apr**	**16-May**	**26-May**	**27**
10-Yr MIN	**19-Apr**	**11-May**	**25-May**	**26**	**27-Apr**	**11-May**	**17-May**	**12**
10-Yr MAX	**5-May**	**25-May**	**8-Jun**	**40**	**7-May**	**21-May**	**10-Jun**	**38**

*Passage dates in 2020 and 2022 include early start of McNary sampling on March 1^{st}.

1.2. Adult Fish Facilities and Migration Timing.

1.2.1. Adult Fish Passage Facilities. McNary Dam adult 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 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, bull trout, shad, and lamprey are counted per the schedule in **Table MCN-3** and daily counts are posted online.[1] The presence of other species (e.g., sturgeon, grass carp, Atlantic salmon, etc.) are recorded as comments and reported 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**.

[1] Daily adult salmon counts: https://www.fpc.org/currentdaily/HistFishTwo_7day-ytd_Adults.htm

1.2.2.3. 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 for 2023.

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 3/13/22–11/6/22.

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 6	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 18

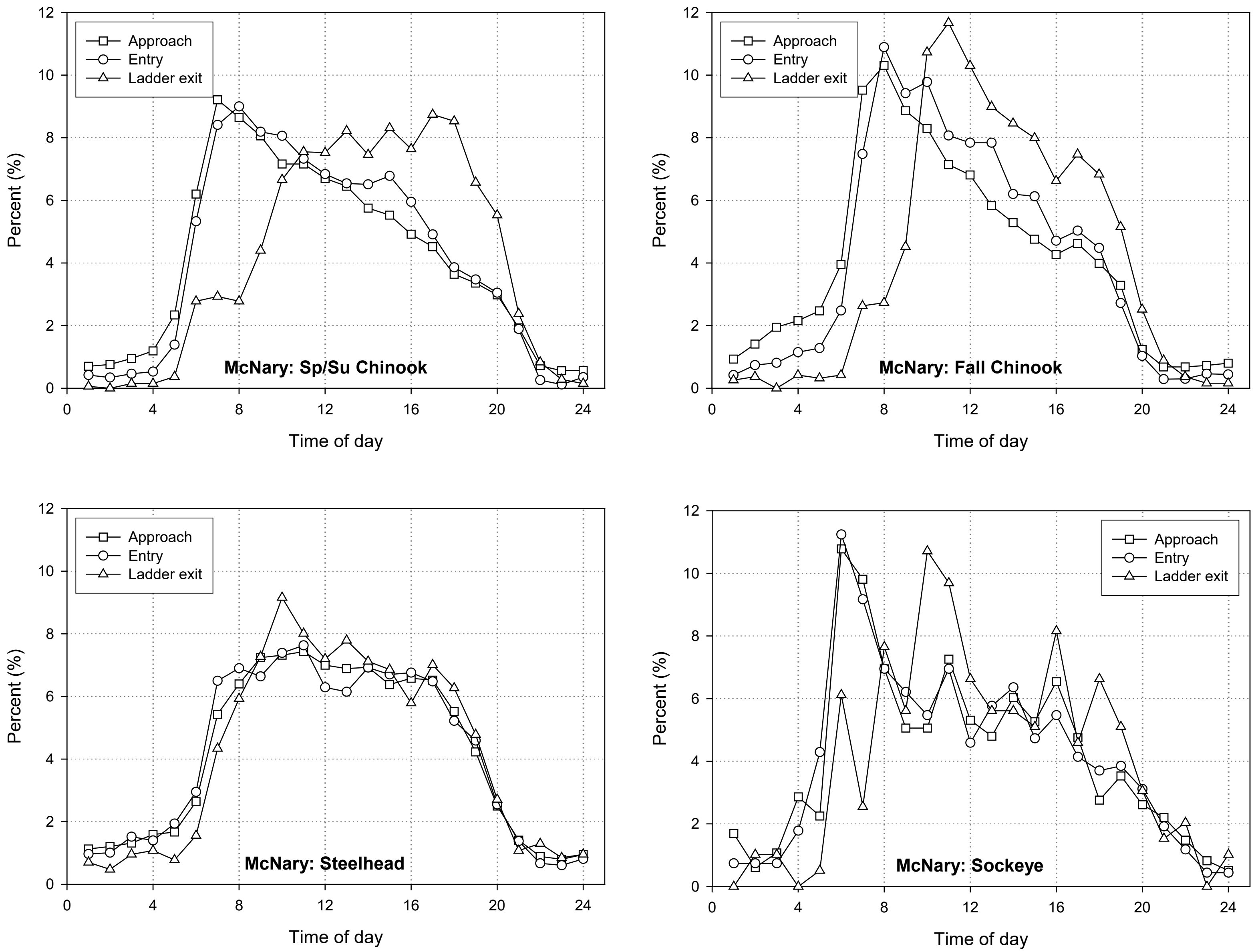


Figure MCN-2. Diel Distribution of Adult Salmonids at McNary Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

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 feet of any fishway entrance or exit, within 50 feet 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 deemed an emergency (coordination guidance in **FPP Chapter 1 - Overview**). On a monthly basis, as appropriate, the Project biologist will provide a summary of 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**.

2.2.2. Spill at McNary Dam will be distributed in spill patterns defined in **Tables MCN-7 through MCN-10**, except as noted below in s**ection 2.2.1.1**.

2.2.2.1. Interim Spillway Hoist Operation / Minimization of Unsafe Operating Practices.

As an interim operation until overloaded hoists are repaired or replaced so they are no longer in an overloaded condition, McNary spillway hoists will be separated into two control groups: **Manual** (dogged off and manually adjusted) and **Auto**. Currently, of the 22 spillbays at McNary Dam, three are Manual (Bays 2, 6, and 16) and two serve TSW1 and TSW2 until they are removed, typically in early June. This provides a total of 17 spillbays with functioning hoists until early June, then 19 spillbays for the remaining of the spill season that can be rotated through Manual and Auto mode assignments, as described below. During spring and summer spill, April 10–August 31, four or five (during June) of these spillbays will be operated in Auto-adjusted mode each month according to the rotation schedule below. The change will occur during the first full week of the month. Hoists will initially be set to the average openings identified in the applicable interim spill patterns in **Table MCN-11**. Gate operation categories are as follows:

i. <u>Manual Gates</u> – Manual gates will be set at the mid-point of the 50 kcfs spill block associated with the current flow level and manually dogged and will not be adjusted for 30 days or until there is a delta of 50 kcfs (+/- 25 kcfs) of current settings. All Manual gates will be raised or lowered with a safety observer stationed at the spillway deck, in the event of sustained flow increases more than the difference of designated spill limits, when one or more of the following occur:

A. Present for more than 72 hours.

B. All Auto Gate openings exceed an increase of 2+ "stops" per Auto Gate beyond normal flow settings of Spillway Gate stops identified in Spill Pattern Table settings and if flows are expected to increase for 72 hours or more.

C. Expected flows are at peak delta and are predicted to rise beyond a max spill delta of 30 kcfs.

ii. <u>Auto Gates</u> – Auto gates will be set at the pattern associated with the current spill and flow rate in **Table MCN-11** and will be left in auto-response mode for approximately 30 days before being rotated to the next spillway gate assignment. See gate rotation schedule below:

Rotation schedule for gates in Manual (Dogged) and Auto[a] adjustment modes:

			Crane 7				No Hoist										Crane 6			TSW	TSW		
Mode	First week of:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Macro/Dogged	April																			Open	Open		
Micro/Auto	May																			Open	Open		
	June																			Open	Open		
	July																						
	Aug																						

[a] Auto mode bays will be adjusted through their operational range as required. Desired spill volumes will be achieved by adjusting a single automatic bay one stop at a time. Automatic bays will operate within one stop of each other.

2.2.3. Spill for Adult Steelhead Overshoots. Surface spill will be implemented at McNary and the four lower Snake River dams as a means of providing non-powerhouse downstream passage for adult steelhead that overshoot natal tributaries prior to spawning or that strive to repeat a subsequent reproduction cycle (iteroparity). This operation is pursuant to non-discretionary terms and conditions in the 2020 NOAA Fisheries Columbia River System (CRS) Biological Opinion[2], which calls for surface spill via the spillway weir at each of the five projects **March 1–30 and October 1–November 15, three times each week on non-consecutive days for four hours in the morning** (generally between 05:00 and 11:00). This operation is also considered in the 2020 USFWS CRS Biological Opinion[3] as a means of providing safe and effective downstream passage for adult steelhead and other fish.

i. In 2023, spring surface spill will continue through the start of spring spill for juvenile fish on April 10, and fall surface spill will begin on September 1, to comply with the Agreement for short-term operations of the Columbia River

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[2] NOAA CRS BiOp, section 2.17.4.G, "*Reduce Take of Overshoot Adult Steelhead*": https://www.fisheries.noaa.gov/webdam/download/109136871

[3] USFWS CRS BiOp, section 5.7.4, "*Off-season Surface Spill for Downstream Passage of Adult Steelhead*": https://ecos.fws.gov/tails/pub/document/17101031

System.[4] As such, in 2023, surface spill for adult steelhead will occur at McNary Dam **March 1–April 9 and September 1–November 15, three times each week on non-consecutive days for four hours in the morning**.

ii. McNary surface spill will occur via the TSW in spillbay 20. To start TSW spill on September 1, the project will need up to 3 workdays to remove the standard spill gate section from spillbay 20 and reinstall the TSW. Spill will be maintained at the FOP summer spill level of 20 kcfs and shifted to available spillbays through August 31.

2.2.4. 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.

2.2.5. Total dissolved gas (TDG) is monitored at McNary Dam during the periods defined in **Table MCN-1**, pursuant to the Corps' annual *TDG Management Plan* and the current *Dissolved Gas Monitoring Plan of Action*.[5]

2.3. Operating Criteria – Juvenile Fish Facilities

2.3.1. Juvenile Fish Facilities - Winter Maintenance Period (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, ensuring 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. Remove ESBSs beginning on the Monday of the third week in December. After ESBSs are removed, inspect for juvenile salmonid mortalities and all other incidental fish mortalities. Inspect ESBSs within a week after removal, or as soon

[4] Stay Agreement: pweb.crohms.org/tmt/JointMotion_TermSheet_CourtOrder_and_Extensions_2023_0831.pdf

[5] TDG Management Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/
TDG Monitoring Plan of Action: www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality/

as practical. Count all mortalities (or make best estimate) for each ESBS and report to CENWW-OD-T.

ii. Complete maintenance 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 ensure 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 with an underwater video camera.

2.3.1.4. Collection Channel.

i. Maintain orifice lights in operational condition.

ii. Maintain orifices clean and valves operating correctly.

iii. Ensure the orifice air backflush system works correctly.

iv. Maintain the netting over handrails and orifice chutes in good condition.

v. Maintain the plastic covers over orifice chutes in good condition and clean so orifice flow is visible.

2.3.1.5. Dewatering Structure and Flume.

i. Maintain the inclined and side dewatering screens clean and in good condition with no gaps between screen panels, no damaged panels, and no missing silicone.

ii. Maintain the cleaning brush systems operating correctly.

iii. Maintain all valves in good condition and operating correctly.

iv. Maintain stilling well water level sensing device operating correctly.

v. Maintain 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. Maintain the flume switch gate in operational condition.

ii. Ensure the flume, perforated plate, and bar screen edges are smooth with no rough edges.

iii. Maintain the wet separator and fish distribution system operating as designed.

iv. Maintain brushes on all crowders in good condition or new.

v. Maintain crowders operating properly.

vi. Maintain all valves, slide gates, and switch gates operating correctly.

vii. Ensure raceway and tank retainer screens are set in place with no holes or sharp wires protruding.

viii. Maintain all sampling equipment operating correctly.

ix. 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. Record all maintenance and inspections.

2.3.1.8. Inspect bird wires, water cannon, and other predation 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. For information on avian management at McNary Dam, see the *Predation Monitoring and Deterrence Action Plans* in **Appendix L** (Table 2 and section 6).

2.3.2. Juvenile Fish Facilities – Fish Passage Season (April 1 – December 15).

Operate April 1– November 30 for juvenile fish bypass and sampling, and December 1–15 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, clean at least once daily. If flows through an orifice or fish conditions give indications that an orifice may be partially obstructed with debris, close and backflush the orifice to remove the obstruction. If the obstruction cannot be removed, close the orifice and operate the alternate orifice for that gatewell slot. If both orifices become obstructed or plugged with debris, do not operate the turbine unit until the gatewell and orifices are clear 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, immediately close the gatewell orifices and shut down the turbine unit within one hour until the material has been removed and any problems corrected. The 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. Take action as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow the fish to exit the gatewell. Do not close orifices 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. Installation of the remaining ESBSs may begin as early as April 2 starting at the lowest priority units (least likely to operate) and must be completed by no later than April 15.

ii. Operate ESBSs with flow vanes attached.

iii. Operate ESBSs with debris cleaners in automatic mode. Set cleaning frequency to 60 minutes. Increase or decrease frequency if needed to maintain clean screens.

iv. Inspect ESBSs weekly by underwater video in at least three operating turbine units. Spot-check VBSs at the same time.

v. Conduct additional ESBS inspections if fish condition warrants it.

vi. 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-operational or damaged ESBS or VBS.* Units with ESBSs in place and closed orifices shall not operate for more than 10 hours, and preferably less than 3 hours. Minimize orifice closure by efficiently planning and implementing repairs (e.g., have equipment, materials, and personnel ready before closing orifices).

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 and the VBSs cannot be cleaned within 8 hours, operate the respective turbine unit at a reduced generation loading 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.

x. At the end of the season, make formal determination as to adequacy of bar screen panels and debris cleaner brushes and replace components as necessary.

2.3.2.3. Collection Channel.

i. Maintain 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, see **section 3.2.2.4** to determine if the unit must be shut down and if fish must be dipped from the gatewell(s).

ii. Maintain 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 or after December 16) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly if needed for access.

iii. Replace all burned out orifice lights within 24 hours of notification. Orifice lights shall remain lighted 24 hours/day.

iv. Maintain orifice jets hitting no closer than 3’ from back wall and collection channel full.

v. Operate orifice valves 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, inspect and cycle orifices 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 gatewell, the respective turbine unit generation may be reduced to the lower end of the 1% efficiency range to minimize orifice plugging problems.

vii. Maintain netting along handrails in good condition (no holes or gaps).

viii. Maintain plastic covers over orifice chutes in good condition.

2.3.2.4. Dewatering Structure.

i. Ensure no gaps between panels or missing silicone in side and inclined screens.

ii. Maintain the trash sweeps operating correctly. 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 debris loads present. Frequency of operation may vary from once every 15 minutes to once every 2 or more hours. This frequency should coincide with the ESBS cycle time.

iii. If problems occur with the automated cleaning system, operate cleaners at least once per shift unless otherwise determined by the Project biologist.

iv. The dewatering structure may be dewatered twice during the season, during low fish passage periods in June and September, and for inspection and cleaning of the dewatering screens. Before dewatering occurs, the Project biologist must notify CENWW-OD-T who will coordinate the proposed action with NOAA Fisheries and other FPOM participants.

v. Turn off lights at the dewatering structure 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. Maintain all silicone sealer in good condition.

ii. Maintain the crowder screen brushes in good operating condition.

iii. Ensure 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. To prevent debris plugging in the spring, release ice blocks through each 10” bypass line, 1-3 times per day, as warranted by woody debris loads. Pass additional ice blocks down the pipelines during high debris periods as needed to keep the pipes debris free. Continue releasing ice blocks through the pipes 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. Temporary Spillway Weirs (TSW).

i. McNary Dam has two temporary, or top, spillway weirs (TSWs) in spillbays 19 and 20 that provide surface routes for fish passage.

ii. The spill rate through each TSW is approximately 9.6 kcfs (19.2 kcfs total).

iii. Spring spill for juvenile fish passage will begin with both TSWs open per spill patterns in **Table MCN-7,** or the relevant Manual/Auto spill patterns in **Table MCN-11** (see **section 2.2.1.1**).

iv. The TSWs can be opened and closed from the control room (unless they are attached to a crane, then a crane operator is required).

v. The process to remove the TSWs and re-install standard spill gate sections may take up to 5 workdays, as described below.

vi. Both TSWs will be in service April 10 through June 7, then closed and removed starting on June 8 or the next workday (unless coordinated differently via FPOM). The process to remove the TSWs and install standard spill gate sections may take up to 5 workdays, depending on weather conditions and crane status. During this time, spill will be maintained at the FOP target level and distributed in patterns in **Table MCN-10**. To ensure worker safety, all bays being worked in and adjacent bays will be closed, including bays where gate sections are stored. Therefore, daily from about 0630–1700 hours, Bays 14–21 will be closed so gate sections can be retrieved and installed safely in Bays 19 and 20. During this time, spill will be averaged across Bays 1–13 and 22. At 1700 hours, Bays 14–18 and 21 will be re-opened.

vii. After both TSWs are removed and standard spill gate sections are installed, Bays 19 and 20 will be operated as conventional (deep) spillbays for the remainder of juvenile fish passage spill season per patterns with no TSWs in **Table MCN-9**, or the Manual/Auto patterns w/ NO TSWs in **Table MCN-11**.

2.3.2.7. Emergency Bypass.

i. Freezing Conditions. Between November 1 and December 15, if the National Weather Service forecast for Umatilla, OR[6] is a daily high temperature below 32°F or a daily low temperature below 20°F, the McNary Fisheries staff may place the JFF channel in emergency bypass mode until the beginning of the winter maintenance period when the channel is fully dewatered.

ii. Late Season Mechanical Failure. After November 30, if a mechanical failure forces the JFF juvenile channel into emergency bypass mode, the McNary

[6] NWS weather forecast for Umatilla, OR: https://forecast.weather.gov/MapClick.php?lat=45.917680000000075&lon=-119.34202999999997

Fisheries staff may leave the juvenile channel in emergency bypass mode until the beginning of winter maintenance when the channel is fully dewatered.

iii. If the project installs a proposed “X” or “Y” valve in the south trash sluiceway that eliminates the need for emergency bypass, the fisheries staff may shut down 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.

2.3.2.8. Inspect all facilities according to the fish facilities monitoring plan. Report findings per **section 2.5**.

2.3.2.9. Avian Predation Management. Operate in accordance with the *Predation Monitoring and Deterrence Action Plans* for McNary Dam in **Appendix L** (Table 2 and section 6). Monitor bird wires and other avian deterrent devices to ensure good condition and replace any broken wires or devices as soon as possible. Implement harassment program to deter avian predation in areas actively used by birds and not covered by bird wires or other devices. 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.

2.4. <u>Operating Criteria - Adult Fish Facilities</u>

2.4.1. <u>Adult Fish Facilities - Winter Maintenance Period (January 1 – end of February).</u>

2.4.1.1. 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. 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.

2.4.1.2. Minimize outage periods 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.

2.4.1.3. Inspect all staff gauges and water level indicators. Repair and/or clean where necessary. Calibrate all water level measuring devices as necessary for proper operations.

2.4.1.4. Inspect fish ladder exits for debris and clean as necessary.

2.4.1.5. Maintain all trashracks and picketed leads clean and installed correctly.

2.4.1.6. Inspect all spill gates and ensure they are operable.

2.4.1.7. Maintain fish pumps ready for operation.

2.4.1.8. Maintain adult PIT-tag system as required. Coordinate with PSMFC.

2.4.2. <u>Adult Fish Facilities – Adult Fish Passage Season (March 1 – December 31).</u>

2.4.2.1. Maintain all staff gauges in readable condition at all water levels encountered during the fish passage season. Repair or clean as necessary.

2.4.2.2. Maintain water depth over fishway ladder weirs in the range of 1.0’–1.3’.

2.4.2.3. Maintain head on all fishway entrances in the range of 1’–2’.

2.4.2.4. North Shore Entrances (WFE 2 & 3). Operate two downstream gates. Maintain weir depth at 8’ or greater below tailwater.

2.4.2.5. North Powerhouse Entrances (NFE 2 & 3). Operate two downstream gates. Maintain weir depth at 8’ or greater below tailwater.

2.4.2.6. South Shore Entrances (SFE 1 & 2). Operate two downstream gates. Maintain weir depth at 8’ or greater below tailwater.

2.4.2.7. Channel Velocity.

i. Maintain water velocities in the adult collection channel in the range of 1.5–4.0 feet per second (fps), which is the optimum velocity for returning adult salmon and steelhead to migrate upstream though the fishway. Complete velocity readings three times per week and include in required fishway inspections and in weekly and annual reports.

ii. Measure surface water velocities in the open access area near the south shore 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 water velocity at this location represents the slowest velocity conditions throughout the length of the channel.

2.4.2.8. Operate twelve FOGs: 1, 3, 4, 8, 14, 21, 26, 32, 37, 41, 43, and 44

2.4.2.9. Correctly install trashracks and picketed leads. Maximum head on ladder exits and picketed leads is 0.5’. Normal head differential on clean leads is 0.3’.

2.4.2.10. 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).

2.4.2.11. Counting Windows.

i. Maintain all equipment in good condition. Clean the counting window and backboard as needed to maintain good visibility.

ii. Crowder ranges at MCN are:

- Washington Shore = 19 $^{3}/_{16}$" (not adjustable)
- Oregon Shore downstream = 13 $^{1}/_{8}$" – 17 $^{5}/_{8}$"
- Oregon Shore upstream = 13 $^{1}/_{2}$" – 17 $^{1}/_{8}$"

iii. When not counting, open crowder to full count slot width and remove picketed leads.

iv. During counting, open crowder as far as possible to allow accurate counting, no less than 18" to the extent possible. This will usually occur during high turbidity conditions to achieve count accuracy criteria.

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 according to the fish facilities monitoring program.

iii. Inspect picketed leads during all inspections to ensure they are clean and in the correct position (all the way down).

iv. 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, measure water temperature at adult fishway entrances and exits and submit data to the Fish Passage Center (FPC) weekly for posting online.[7] Ensure the location of the monitors meets the following criteria:

i. Within 10 meters of all shore-oriented entrances and exits.

ii. Entrance monitor within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers, if possible, to allow for sufficient mixing with surface water.

iii. Exit monitor within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

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[7] FPC ladder temperature data: www.fpc.org/smolt/smolt_queries/Q_ladderwatertempgraphv2.php

iv. If an existing temperature monitoring location is proposed to be used for either the exit or entrance, verify that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.5. Fish Facilities Monitoring & Reporting

2.5.1. Monitoring.

2.5.1.1. Project biologists shall inspect fish passage facilities at the frequencies described above in the juvenile and adult fish facilities operating criteria, **sections 2.3 and 2.4**.

2.5.1.2. Project biologists will inspect project facilities for the presence of zebra and Quagga mussels once per month and during dewaterings, and will provide a monthly inspection report to CENWW-OD-T.

2.5.2. Reporting.

2.5.2.1. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31 summarizing project and fish facility operations for each week (Friday through Thursday), along with an evaluation of resulting fish passage conditions. The reports will be e-mailed CENWW-OD-T by noon the following Monday. The weekly reports will include:

i. Out-of-criteria situations and subsequent corrective actions taken.

ii. Equipment malfunctions, breakdowns, or damage, with a summary of resulting repairs.

iii. Adult fishway control calibrations.

iv. ESBS and VBS inspections.

v. Unusual activities that at the project that may have affected fish passage.

2.5.2.2. In-Season. Any adverse or negative impact to fish or fishways shall be reported in a *Memorandum for the Record* (MFR) prepared by Project biologists and sent to FPOM by the next working day, pursuant to the coordination process and template in **FPP Chapter 1 – Overview** (section 2.3.2).

2.5.2.3. Annual Reports. Project biologists shall prepare a draft annual report by February 10 and a final report by March 15 summarizing fish facility operations 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 actions.

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*[8] 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 that 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 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 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.
- **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.

[8] Project Dewatering Plans: pweb.crohms.org/tmt/documents/FPOM/2010/

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, gatewell orifices closed, 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 and orifices reopened. 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 knowingly damaged VBS.

3.2.2.4. Gatewell Orifices. Each gatewell has two orifices with air operated valves to allow fish to exit the gatewell. Under normal operation, one orifice per gatewell (normally the south orifice) is operated. If an air-valve that operates the orifice fails or the 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 air-valves that operate the orifices fail and the orifice cannot be fully operated, or must be kept closed, the turbine unit will normally be taken out of service until repairs can be made. At the discretion of the Project Biologist, both orifices in a gatewell may be closed for up to 5 hours in an operating turbine unit with ESBSs in place, but orifice closure times may need to be less depending on fish numbers and condition. Reduce turbine unit loading to the lower end of the 1% efficiency range if deemed necessary by the Project Biologist. If both orifices remain closed after 5 hours, the turbine unit will be taken out of service. During any orifice closure, gatewells shall be monitored hourly (unit is operating) or at least every 2 hours (unit is not operating) by project personnel for signs of fish problems or mortality. If repairs are to take longer than 48 hours and both orifices in a gatewell need to remain closed, juvenile fish will be dipped from the gatewell with a gatewell dip basket in accordance with the project dewatering and fish-handling plan. 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 prior to the 48 hours in accordance with the project dewatering and fish-handling plan.

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 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 juvenile fish for research and sampling purposes, enumerate fish through the sampling system, or bypass some 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 always provide some fish passage at the project. 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), 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 2 pumps are expected to be out of service 6 days or longer, then the middle 8 of 12 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, NFE3 and the middle eight of twelve open floating orifices (4, 8, 14, 21, 26, 32, 37, 41) will be closed, and SFE1 and SFE2 operated 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 SFE2 will be closed.

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 UNIT OPERATIONS & 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 operations 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 needed, as coordinated by the Project Biologist.

4.2. Warm Water Turbine Operations

4.2.1. 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 temperature in the McNary JFF sample tank > 68°F.

ii. Water temperature elsewhere at the Project (e.g., gatewells) that is 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 per **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, 14). If possible, Unit 1 shall be operated for attraction flow to the two Oregon shore ladder entrances. Project Fisheries will coordinate with CENWW to modify the sequence as necessary to provide equal or better levels of fish protection. Starting and stopping two or more units at a time should be avoided during warm water conditions, if possible, especially during the hours of 1000–2400. The Project and CENWW will coordinate these protocols 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 salmonids.

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. <u>Turbine Unit Operating Range</u>

4.3.1. Turbine unit flow and power output at the lower and upper limits of the ±1% peak efficiency range, and at the operating limit, are defined in **Table MCN-6**, except Unit 6 with locked blades is in **Table MCN-6-A**. Turbine units will be operated within these ranges according to *BPA's Load Shaping Guidelines* (**Appendix C**), as summarized below.

4.3.2. In-Season: April 10–August 31 (Spring/Summer Spill for Juvenile Fish Passage). Turbine units will be operated within ±1% of peak turbine efficiency (1% range), except under limited conditions and durations when turbines may be operated above the 1% range for the use of reserves or for TDG management during high flows (refer to **Appendix C** for more information). All required fish passage spill operations will be met prior to operating turbines above the 1% range. If in-season operation outside the 1% range is necessary, Project personnel shall record the information and 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 4.4.7**), 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 to flush fish from the unit.

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

iv. Comply with other coordinated fish measures.

4.3.3. Off-Season: September 1–April 9. 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, b]

Project	MCN Units 1–14 With ESBS						MCN Units 1–14 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. Values provided by HDC (Mar 1999; updated Jan 2005). Flow (cfs) calculated based on turbine efficiency, project head, and power output (MW). “Operating Limit” is the maximum safe operating point based on cavitation or generator limit (added Feb 2018).

b. Units 5 and 6 have hydraulically locked blades and restricted operating ranges defined below in **Table MCN-6-A**.

Table MCN-6-A. Temporary Operating Range for McNary Units 5 and 6 with Locked Blades.

Project	MCN Unit 5 (Blades Locked at 22.0°) – With ESBS						MCN Unit 5 (Blades Locked at 22.0°) – No ESBS					
Head	Lower Limit		Peak Efficiency		Upper Limit		Lower Limit		Peak Efficiency		Upper Limit	
(feet)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
62	44.9	10,245	46.7	10,585	48.6	11,084	45.8	10,236	47.6	10,570	49.5	11,059
63	45.7	10,239	47.6	10,610	49.7	11,143	46.6	10,230	48.5	10,595	50.6	11,117
64	46.4	10,232	48.5	10,633	50.8	11,198	47.3	10,224	49.4	10,618	51.7	11,173
65	47.2	10,226	49.4	10,656	51.9	11,252	48.1	10,217	50.3	10,641	52.8	11,227
66	48.0	10,228	50.3	10,654	52.8	11,247	48.9	10,220	51.2	10,640	53.7	11,222
67	48.8	10,229	51.1	10,652	53.6	11,240	49.7	10,222	52.1	10,638	54.6	11,216
68	49.6	10,230	52.0	10,650	54.5	11,234	50.6	10,223	52.9	10,636	55.5	11,210
69	50.5	10,230	52.8	10,647	55.4	11,227	51.4	10,224	53.8	10,633	56.4	11,204
70	51.3	10,230	53.7	10,643	56.2	11,220	52.3	10,224	54.7	10,630	57.2	11,197
71	52.3	10,275	54.7	10,673	57.2	11,233	53.3	10,269	55.7	10,660	58.2	11,210
72	53.4	10,319	55.7	10,701	58.2	11,245	54.4	10,313	56.7	10,689	59.2	11,223
73	54.4	10,360	56.7	10,728	59.1	11,256	55.5	10,355	57.7	10,716	60.2	11,234
74	55.5	10,400	57.7	10,754	60.1	11,266	56.5	10,395	58.8	10,742	61.2	11,245
75	56.5	10,438	58.7	10,778	61.0	11,276	57.6	10,433	59.8	10,767	62.1	11,255
76	57.4	10,459	59.7	10,810	62.1	11,320	58.5	10,454	60.8	10,799	63.2	11,299
77	58.3	10,479	60.7	10,841	63.2	11,363	59.4	10,475	61.8	10,830	64.4	11,342
78	59.2	10,499	61.6	10,871	64.3	11,405	60.3	10,494	62.8	10,860	65.5	11,384
79	60.1	10,518	62.6	10,900	65.4	11,446	61.3	10,513	63.8	10,889	66.6	11,425
80	61.0	10,536	63.6	10,928	66.5	11,485	62.2	10,531	64.8	10,917	67.7	11,464
81	61.9	10,558	64.5	10,944	67.4	11,495	63.1	10,553	65.7	10,933	68.6	11,474
82	62.8	10,579	65.4	10,960	68.3	11,504	64.0	10,575	66.6	10,949	69.5	11,483
83	63.7	10,600	66.3	10,975	69.2	11,513	64.9	10,596	67.6	10,964	70.4	11,492
84	64.6	10,620	67.2	10,990	70.1	11,522	65.9	10,616	68.5	10,979	71.3	11,501
85	65.5	10,640	68.1	11,004	71.0	11,531	66.8	10,635	69.4	10,993	72.3	11,510
86	66.5	10,679	69.1	11,027	71.9	11,537	67.8	10,675	70.4	11,028	73.3	11,541
87	67.5	10,718	70.0	11,050	72.7	11,543	68.8	10,714	71.5	11,063	74.3	11,571
	MCN Unit 6 (Blades Locked at 22.5°) – With ESBS						MCN Unit 6 (Blades Locked at 22.5°) – No ESBS					
62	46.8	10,665	49.1	11,130	49.8	11,345	47.6	10,648	49.9	11,078	50.5	11,289
63	47.5	10,659	50.1	11,175	50.9	11,405	48.4	10,641	50.9	11,122	51.6	11,348
64	48.3	10,652	51.2	11,218	52.0	11,462	49.2	10,635	52.0	11,165	52.8	11,405
65	49.1	10,645	52.2	11,259	53.1	11,517	50.0	10,628	53.0	11,205	53.9	11,460
66	49.9	10,647	53.1	11,255	54.0	11,511	50.9	10,631	53.9	11,202	54.8	11,455
67	50.8	10,649	54.0	11,251	54.9	11,505	51.7	10,633	54.8	11,198	55.7	11,449
68	51.7	10,650	54.9	11,246	55.8	11,498	52.6	10,634	55.7	11,194	56.6	11,443
69	52.5	10,650	55.8	11,241	56.7	11,491	53.5	10,635	56.6	11,189	57.5	11,436
70	53.4	10,650	56.6	11,235	57.6	11,484	54.4	10,635	57.5	11,184	58.4	11,429
71	54.5	10,697	57.6	11,256	58.5	11,497	55.5	10,682	58.5	11,205	59.4	11,443
72	55.6	10,742	58.7	11,275	59.5	11,509	56.6	10,728	59.6	11,225	60.4	11,455
73	56.6	10,785	59.7	11,294	60.5	11,521	57.7	10,771	60.6	11,244	61.4	11,467
74	57.7	10,827	60.7	11,311	61.5	11,531	58.8	10,813	61.6	11,262	62.4	11,478

75	58.8	10,866	61.7	11,328	62.5	11,541	59.9	10,853	62.6	11,279	63.4	11,488
76	59.8	10,888	62.8	11,368	63.6	11,587	60.9	10,875	63.7	11,319	64.6	11,534
77	60.7	10,909	63.8	11,407	64.7	11,631	61.8	10,896	64.8	11,357	65.7	11,578
78	61.6	10,929	64.9	11,444	65.8	11,674	62.8	10,916	65.9	11,395	66.8	11,620
79	62.6	10,949	66.0	11,481	66.9	11,715	63.7	10,936	67.0	11,431	67.9	11,662
80	63.5	10,968	67.0	11,516	68.0	11,755	64.7	10,955	68.1	11,466	69.1	11,702
81	64.4	10,991	68.0	11,529	69.0	11,765	65.6	10,978	69.0	11,479	70.0	11,712
82	65.4	11,013	68.9	11,541	69.9	11,775	66.6	11,000	70.0	11,492	71.0	11,721
83	66.3	11,035	69.8	11,553	70.8	11,784	67.5	11,022	70.9	11,504	71.9	11,731
84	67.3	11,056	70.8	11,565	71.7	11,793	68.5	11,043	71.8	11,515	72.8	11,740
85	68.2	11,076	71.7	11,576	72.7	11,802	69.5	11,063	72.8	11,527	73.8	11,749
86	69.2	11,117	72.6	11,590	73.5	11,808	70.5	11,104	73.7	11,541	74.7	11,755
87	70.3	11,158	73.5	11,604	74.4	11,815	71.6	11,145	74.7	11,555	75.6	11,761

a. Units 5 and 6 have hydraulically locked (non-adjustable) runner blades to prevent oil leaks and are restricted to a smaller operating range until the blade seals are repaired. Values provided by HDC based on the abbreviated index test of Unit 5 (Aug 2021) and Unit 6 (Jan 2019).

4.4. Turbine Unit Maintenance

4.4.1. Turbine unit maintenance schedules will be reviewed annually by Project and District Operations biologists for fish impacts. If maintenance requires operating outside of FPP criteria, the work will be coordinated with FPOM per the procedures defined in **FPP Chapter 1– Overview** (section 2.3).

4.4.2. Priority unit maintenance will be scheduled for the winter maintenance period or when there are few fish passing the project, to the extent possible. Impacts to migrating adults should be minimized. When possible, units used for temperature operations should remain available.

4.4.3. Each unit requires annual maintenance that may take several days up 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.

4.4.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take over one year to accomplish.

4.4.5. Turbines, 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.

4.4.6. 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 project is operating at minimum generation requirements. 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.

4.4.6.1. 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 measurements and testing and to allow all fish to move through the unit.

4.4.6.2. 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.

4.4.7. 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 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.

4.4.8. Head Gates (also referred to as Operating Gates). Head gates will normally remain in standard operating position except as required for maintenance.

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. 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 encircle debris with a log boom and 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 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. McNary Dam Spill Patterns for Fish Passage with TSWs in Bays 19-20 and Bays 2, 6, and 16 Locked at 4 or 6 Stops.

Table MCN-7 Spill Patterns with TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22	(#)	(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	5	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
												1		2		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
										0		1		2	4	2	2	TSW	TSW	2	2	15	47.9
												2		2	4	2	2	TSW	TSW	2	2	16	49.8
										1		2		2	4	2	2	TSW	TSW	2	2	17	51.8
										2		2		2	4	2	2	TSW	TSW	2	2	18	53.7
								1		2		2		2	4	2	2	TSW	TSW	2	2	19	55.7
								2		2		2		2	4	2	2	TSW	TSW	2	2	20	57.6
		1						2		2		2		2	4	2	2	TSW	TSW	2	2	21	59.6
		2						2		2		2		2	4	2	2	TSW	TSW	2	2	22	61.5
		2		1				2		2		2		2	4	2	2	TSW	TSW	2	2	23	63.5
		2		2				2		2		2		2	4	2	2	TSW	TSW	2	2	24	65.4
		2		2		1		2		2		2		2	4	2	2	TSW	TSW	2	2	25	67.4
	4	0		2		0		2		2		2		2	4	2	2	TSW	TSW	2	2	26	68.7
	4			2		1		2		2		2		2	4	2	2	TSW	TSW	2	2	27	70.7
	4			2		2		2		2		2		2	4	2	2	TSW	TSW	2	2	28	72.6
	4	1		2		2		2		2		2		2	4	2	2	TSW	TSW	2	2	29	74.6
	4	2		2		2		2		2		2		2	4	2	2	TSW	TSW	2	2	30	76.5
1	4	2		2		2		2		2		2		2	4	2	2	TSW	TSW	2	2	31	78.5
2	4	2		2		2		2		2		2		2	4	2	2	TSW	TSW	2	2	32	80.4
2	4	2	1	2		2		2		2		2		2	4	2	2	TSW	TSW	2	2	33	82.4

Table MCN-7 Spill Patterns with TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22	(#)	(kcfs)
2	4	2	2	2		2		2		2		2		2	4	2	2	TSW	TSW	2	2	34	84.3
2	4	2	2	2		2	1	2		2		2		2	4	2	2	TSW	TSW	2	2	35	86.3
2	4	2	2	2		2	2	2		2		2		2	4	2	2	TSW	TSW	2	2	36	88.2
2	4	2	2	2		2	2	2		2	1	2		2	4	2	2	TSW	TSW	2	2	37	90.2
2	4	2	2	2		2	2	2		2	2	2		2	4	2	2	TSW	TSW	2	2	38	92.1
2	4	2	2	2		2	2	2	1	2	2	2		2	4	2	2	TSW	TSW	2	2	39	94.1
2	4	2	2	2		2	2	2	2	2	2	2		2	4	2	2	TSW	TSW	2	2	40	96.0
2	4	2	2	2		2	2	2	2	2	2	2	1	2	4	2	2	TSW	TSW	2	2	41	98.0
2	4	2	2	2		2	2	2	2	2	2	2	2	2	4	2	2	TSW	TSW	2	2	42	99.9
2	4	2	2	3		2	2	2	2	2	2	2	2	2	4	2	2	TSW	TSW	2	2	43	101.6
2	4	2	2	0	6	0	2	2	2	2	2	2	2	2	4	2	2	TSW	TSW	2	2	44	102.5
2	4	2	2		6	1	2	2	2	2	2	2	2	2	4	2	2	TSW	TSW	2	2	45	104.5
2	4	2	2		6	2	2	2	2	2	2	2	2	2	4	2	2	TSW	TSW	2	2	46	106.4
2	4	2	2	1	6	2	2	2	2	2	2	2	2	2	4	2	2	TSW	TSW	2	2	47	108.4
2	4	2	2	2	6	2	2	2	2	2	2	2	2	2	4	2	2	TSW	TSW	2	2	48	110.3
2	4	2	2	2	6	2	2	2	2	2	2	2	2	2	4	2	2	TSW	TSW	3	2	49	112.0
2	4	2	2	2	6	2	2	2	2	2	2	2	2	2	4	2	3	TSW	TSW	3	2	50	113.7
2	4	3	2	2	6	2	2	2	2	2	2	2	2	2	4	2	3	TSW	TSW	3	2	51	115.4
2	4	3	2	3	6	2	2	2	2	2	2	2	2	2	4	2	3	TSW	TSW	3	2	52	117.1
2	4	3	2	3	6	2	2	2	2	2	2	2	3	2	4	2	3	TSW	TSW	3	2	53	118.8
2	4	3	2	3	6	3	2	2	2	2	2	2	3	2	4	2	3	TSW	TSW	3	2	54	120.5
2	4	3	2	3	6	3	2	2	2	2	3	2	3	2	4	2	3	TSW	TSW	3	2	55	122.2
2	4	3	2	3	6	3	2	3	2	2	3	2	3	2	4	2	3	TSW	TSW	3	2	56	123.9
2	4	3	2	3	6	3	2	3	3	2	3	2	3	2	4	2	3	TSW	TSW	3	2	57	125.6
2	4	3	2	3	6	3	2	3	3	2	3	2	3	2	4	2	3	TSW	TSW	3	3	58	127.3
3	4	3	2	3	6	3	2	3	3	2	3	2	3	2	4	2	3	TSW	TSW	3	3	59	129.0
3	4	3	2	3	6	3	2	3	3	2	3	2	3	2	4	3	3	TSW	TSW	3	3	60	130.7
3	4	3	3	3	6	3	2	3	3	2	3	2	3	2	4	3	3	TSW	TSW	3	3	61	132.4
3	4	3	3	3	6	3	2	3	3	2	3	2	3	3	4	3	3	TSW	TSW	3	3	62	134.1
3	4	3	3	3	6	3	3	3	3	2	3	2	3	3	4	3	3	TSW	TSW	3	3	63	135.8
3	4	3	3	3	6	3	3	3	3	2	3	3	3	3	4	3	3	TSW	TSW	3	3	64	137.5
3	4	3	3	3	6	3	3	3	3	3	3	3	3	3	4	3	3	TSW	TSW	3	3	65	139.2
3	4	3	3	3	6	3	3	3	3	3	3	3	3	3	4	3	3	TSW	TSW	4	3	66	140.8
3	4	3	3	3	6	3	3	3	3	3	3	3	3	3	4	3	4	TSW	TSW	4	3	67	142.4
3	4	4	3	3	6	3	3	3	3	3	3	3	3	3	4	3	4	TSW	TSW	4	3	68	144.0

Table MCN-7 Spill Patterns with TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22	(#)	(kcfs)
3	4	4	3	4	6	3	3	3	3	3	3	3	3	3	4	3	4	TSW	TSW	4	3	**69**	**145.6**
3	4	4	3	4	6	3	3	3	3	3	3	3	4	3	4	3	4	TSW	TSW	4	3	**70**	**147.2**
3	4	4	3	4	6	4	3	3	3	3	3	3	4	3	4	3	4	TSW	TSW	4	3	**71**	**148.8**
3	4	4	3	4	6	4	3	3	3	3	4	3	4	3	4	3	4	TSW	TSW	4	3	**72**	**150.4**
3	4	4	3	4	6	4	3	4	3	3	4	3	4	3	4	3	4	TSW	TSW	4	3	**73**	**152.0**
3	4	4	3	4	6	4	3	4	4	3	4	3	4	3	4	3	4	TSW	TSW	4	3	**74**	**153.6**
3	4	4	3	4	6	4	3	4	4	3	4	3	4	3	4	3	4	TSW	TSW	4	4	**75**	**155.2**
4	4	4	3	4	6	4	3	4	4	3	4	3	4	3	4	3	4	TSW	TSW	4	4	**76**	**156.8**
4	4	4	3	4	6	4	3	4	4	3	4	3	4	3	4	4	4	TSW	TSW	4	4	**77**	**158.4**
4	4	4	4	4	6	4	3	4	4	3	4	3	4	3	4	4	4	TSW	TSW	4	4	**78**	**160.0**
4	4	4	4	4	6	4	3	4	4	3	4	3	4	4	4	4	4	TSW	TSW	4	4	**79**	**161.6**
4	4	4	4	4	6	4	4	4	4	3	4	3	4	4	4	4	4	TSW	TSW	4	4	**80**	**163.2**
4	4	4	4	4	6	4	4	4	4	3	4	4	4	4	4	4	4	TSW	TSW	4	4	**81**	**164.8**
4	4	4	4	4	6	4	4	4	4	4	4	4	4	4	4	4	4	TSW	TSW	4	4	**82**	**166.4**
4	4	4	4	4	6	4	4	4	4	4	4	4	4	4	4	4	4	TSW	TSW	5	4	**83**	**168.0**
4	4	4	4	4	6	4	4	4	4	4	4	4	4	4	4	4	5	TSW	TSW	5	4	**84**	**169.6**
4	4	5	4	4	6	4	4	4	4	4	4	4	4	4	4	4	5	TSW	TSW	5	4	**85**	**171.2**
4	4	5	4	5	6	4	4	4	4	4	4	4	4	4	4	4	5	TSW	TSW	5	4	**86**	**172.8**
4	4	5	4	5	6	4	4	4	4	4	4	4	5	4	4	4	5	TSW	TSW	5	4	**87**	**174.4**
4	4	5	4	5	6	5	4	4	4	4	4	4	5	4	4	4	5	TSW	TSW	5	4	**88**	**176.0**
4	4	5	4	5	6	5	4	4	4	4	5	4	5	4	4	4	5	TSW	TSW	5	4	**89**	**177.6**
4	4	5	4	5	6	5	4	5	4	4	5	4	5	4	4	4	5	TSW	TSW	5	4	**90**	**179.2**
4	4	5	4	5	6	5	4	5	5	4	5	4	5	4	4	4	5	TSW	TSW	5	4	**91**	**180.8**
4	4	5	4	5	6	5	4	5	5	4	5	4	5	4	4	4	5	TSW	TSW	5	5	**92**	**182.4**
5	4	5	4	5	6	5	4	5	5	4	5	4	5	4	4	4	5	TSW	TSW	5	5	**93**	**184.0**
5	4	5	4	5	6	5	4	5	5	4	5	4	5	4	4	5	5	TSW	TSW	5	5	**94**	**185.6**
5	4	5	5	5	6	5	4	5	5	4	5	4	5	4	4	5	5	TSW	TSW	5	5	**95**	**187.2**
5	4	5	5	5	6	5	4	5	5	4	5	4	5	5	4	5	5	TSW	TSW	5	5	**96**	**188.8**
5	4	5	5	5	6	5	5	5	5	4	5	4	5	5	4	5	5	TSW	TSW	5	5	**97**	**190.4**
5	4	5	5	5	6	5	5	5	5	4	5	5	5	5	4	5	5	TSW	TSW	5	5	**98**	**192.0**
5	4	5	5	5	6	5	5	5	5	5	5	5	5	5	4	5	5	TSW	TSW	5	5	**99**	**193.6**
5	4	5	5	5	6	5	5	5	5	5	5	5	5	5	4	5	5	TSW	TSW	6	5	**100**	**195.2**
5	4	5	5	5	6	5	5	5	5	5	5	5	5	5	4	5	6	TSW	TSW	6	5	**101**	**196.8**
5	4	6	5	5	6	5	5	5	5	5	5	5	5	5	4	5	6	TSW	TSW	6	5	**102**	**198.4**
5	4	5	5	5	6	5	5	5	5	5	5	5	5	5	6	5	6	TSW	TSW	6	5	**103**	**200.0**

Table MCN-7 Spill Patterns with TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22	(#)	(kcfs)
5	4	6	5	5	6	5	5	5	5	5	5	5	5	5	6	5	6	TSW	TSW	6	5	**104**	**201.6**
5	4	6	5	6	6	5	5	5	5	5	5	5	5	5	6	5	6	TSW	TSW	6	5	**105**	**203.2**
5	4	6	5	6	6	5	5	5	5	5	5	5	6	5	6	5	6	TSW	TSW	6	5	**106**	**204.8**
5	4	6	5	6	6	6	5	5	5	5	5	5	6	5	6	5	6	TSW	TSW	6	5	**107**	**206.4**
5	4	6	5	6	6	6	5	5	5	5	6	5	6	5	6	5	6	TSW	TSW	6	5	**108**	**208.0**
5	4	6	5	6	6	6	5	6	5	5	6	5	6	5	6	5	6	TSW	TSW	6	5	**109**	**209.6**
5	4	6	5	6	6	6	5	6	6	5	6	5	6	5	6	5	6	TSW	TSW	6	5	**110**	**211.2**
5	4	6	5	6	6	6	5	6	6	5	6	5	6	5	6	5	6	TSW	TSW	6	6	**111**	**212.8**
6	4	6	5	6	6	6	5	6	6	5	6	5	6	5	6	5	6	TSW	TSW	6	6	**112**	**214.4**
6	4	6	5	6	6	6	5	6	6	5	6	5	6	5	6	6	6	TSW	TSW	6	6	**113**	**216.0**
6	4	6	6	6	6	6	5	6	6	5	6	5	6	5	6	6	6	TSW	TSW	6	6	**114**	**217.6**
6	4	6	6	6	6	6	5	6	6	5	6	5	6	6	6	6	6	TSW	TSW	6	6	**115**	**219.2**
6	4	6	6	6	6	6	6	6	6	5	6	5	6	6	6	6	6	TSW	TSW	6	6	**116**	**220.8**
6	4	6	6	6	6	6	6	6	6	5	6	6	6	6	6	6	6	TSW	TSW	6	6	**117**	**222.4**
6	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	TSW	TSW	6	6	**118**	**224.0**
6	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	TSW	TSW	7	6	**119**	**225.6**
6	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	TSW	TSW	7	6	**120**	**227.2**
6	4	7	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	TSW	TSW	7	6	**121**	**228.8**
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	TSW	TSW	7	6	**122**	**230.4**
6	6	7	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	TSW	TSW	7	6	**123**	**232.0**
6	6	7	7	6	6	6	6	6	6	6	6	6	6	6	6	7	7	TSW	TSW	7	6	**125**	**235.2**
6	6	7	7	7	6	6	6	6	6	6	6	6	6	6	6	7	7	TSW	TSW	7	6	**126**	**236.8**
6	6	7	7	7	6	7	6	6	6	6	6	6	6	7	6	7	7	TSW	TSW	7	6	**128**	**240.0**
6	6	7	7	7	6	7	7	6	6	6	6	6	7	7	6	7	7	TSW	TSW	7	6	**130**	**243.2**
6	6	7	7	7	6	7	7	7	6	6	6	7	7	7	6	7	7	TSW	TSW	7	6	**132**	**246.4**
6	6	7	7	7	6	7	7	7	7	6	7	7	7	7	6	7	7	TSW	TSW	7	6	**134**	**249.6**
7	6	7	7	7	6	7	7	7	7	7	7	7	7	7	6	7	7	TSW	TSW	7	6	**136**	**252.8**
7	6	7	7	7	6	7	7	7	7	7	7	7	7	7	6	7	8	TSW	TSW	7	7	**138**	**256.1**
7	6	8	7	7	6	7	7	7	7	7	7	7	7	7	6	7	8	TSW	TSW	8	7	**140**	**259.5**
7	6	8	8	7	6	7	7	7	7	7	7	7	7	7	6	8	8	TSW	TSW	8	7	**142**	**262.9**
7	6	8	8	8	6	7	7	7	7	7	7	7	7	7	6	8	8	TSW	TSW	8	7	**143**	**264.6**
7	6	8	8	8	6	8	7	7	7	7	7	7	7	8	6	8	8	TSW	TSW	8	7	**145**	**268.0**
7	6	8	8	8	6	8	8	7	7	7	7	7	8	8	6	8	8	TSW	TSW	8	7	**147**	**271.4**
7	6	8	8	8	6	8	8	8	7	7	7	8	8	8	6	8	8	TSW	TSW	8	7	**149**	**274.8**
7	6	8	8	8	6	8	8	8	8	7	8	8	8	8	6	8	8	TSW	TSW	8	7	**151**	**278.2**

Table MCN-7 Spill Patterns with TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22	(#)	(kcfs)
8	6	8	8	8	6	8	8	8	8	8	8	8	8	8	6	8	8	TSW	TSW	8	7	**153**	**281.6**
8	6	8	8	8	6	8	8	8	8	8	8	8	8	8	6	8	9	TSW	TSW	8	8	**155**	**284.9**
8	6	9	8	8	6	8	8	8	8	8	8	8	8	8	6	8	9	TSW	TSW	9	8	**157**	**288.1**
8	6	9	9	8	6	8	8	8	8	8	8	8	8	8	6	9	9	TSW	TSW	9	8	**159**	**291.3**
8	6	9	9	9	6	8	8	8	8	8	8	8	8	8	6	9	9	TSW	TSW	9	8	**160**	**292.9**
8	6	9	9	9	6	9	8	8	8	8	8	8	8	9	6	9	9	TSW	TSW	9	8	**162**	**296.1**
8	6	9	9	9	6	9	9	8	8	8	8	8	9	9	6	9	9	TSW	TSW	9	8	**164**	**299.3**
8	6	9	9	9	6	9	9	9	8	8	8	9	9	9	6	9	9	TSW	TSW	9	8	**166**	**302.5**
8	6	9	9	9	6	9	9	9	9	8	9	9	9	9	6	9	9	TSW	TSW	9	8	**168**	**305.7**
9	6	9	9	9	6	9	9	9	9	9	9	9	9	9	6	9	9	TSW	TSW	9	8	**170**	**308.9**
9	6	9	9	9	6	9	9	9	9	9	9	9	9	9	6	9	10	TSW	TSW	9	9	**172**	**312.1**
9	6	10	9	9	6	9	9	9	9	9	9	9	9	9	6	9	10	TSW	TSW	10	9	**174**	**315.3**
9	6	10	10	9	6	9	9	9	9	9	9	9	9	9	6	10	10	TSW	TSW	10	9	**176**	**318.5**
9	6	10	10	10	6	9	9	9	9	9	9	9	9	9	6	10	10	TSW	TSW	10	9	**177**	**320.1**
9	6	10	10	10	6	10	9	9	9	9	9	9	9	10	6	10	10	TSW	TSW	10	9	**179**	**323.3**
9	6	10	10	10	6	10	10	9	9	9	9	9	10	10	6	10	10	TSW	TSW	10	9	**181**	**326.5**
9	6	10	10	10	6	10	10	10	9	9	9	10	10	10	6	10	10	TSW	TSW	10	9	**183**	**329.7**
9	6	10	10	10	6	10	10	10	10	9	10	10	10	10	6	10	10	TSW	TSW	10	9	**185**	**332.9**
10	6	10	10	10	6	10	10	10	10	10	10	10	10	10	6	10	10	TSW	TSW	10	9	**187**	**336.1**
10	6	10	10	10	6	10	10	10	10	10	10	10	10	10	6	10	11	TSW	TSW	10	10	**189**	**339.2**
10	6	11	10	10	6	10	10	10	10	10	10	10	10	10	6	10	11	TSW	TSW	11	10	**191**	**342.2**
10	6	11	11	10	6	10	10	10	10	10	10	10	10	10	6	11	11	TSW	TSW	11	10	**193**	**345.2**
10	6	11	11	11	6	10	10	10	10	10	10	10	10	10	6	11	11	TSW	TSW	11	10	**194**	**346.7**
10	6	11	11	11	6	11	10	10	10	10	10	10	10	11	6	11	11	TSW	TSW	11	10	**196**	**349.7**
10	6	11	11	11	6	11	11	10	10	10	10	10	11	11	6	11	11	TSW	TSW	11	10	**198**	**352.7**
10	6	11	11	11	6	11	11	11	10	10	10	11	11	11	6	11	11	TSW	TSW	11	10	**200**	**355.7**
10	6	11	11	11	6	11	11	11	11	10	11	11	11	11	6	11	11	TSW	TSW	11	10	**202**	**358.7**
11	6	11	11	11	6	11	11	11	11	11	11	11	11	11	6	11	11	TSW	TSW	11	10	**204**	**361.7**
11	6	11	11	11	6	11	11	11	11	11	11	11	11	11	6	11	12	TSW	TSW	11	11	**206**	**364.8**
11	6	12	11	11	6	11	11	11	11	11	11	11	11	11	6	11	12	TSW	TSW	12	11	**208**	**368.0**
11	6	12	12	11	6	11	11	11	11	11	11	11	11	11	6	12	12	TSW	TSW	12	11	**210**	**371.2**
11	6	12	12	12	6	11	11	11	11	11	11	11	11	11	6	12	12	TSW	TSW	12	11	**211**	**372.8**
11	6	12	12	12	6	12	11	11	11	11	11	11	11	12	6	12	12	TSW	TSW	12	11	**213**	**376.0**
11	6	12	12	12	6	12	12	11	11	11	11	11	12	12	6	12	12	TSW	TSW	12	11	**215**	**379.2**
11	6	12	12	12	6	12	12	12	11	11	11	12	12	12	6	12	12	TSW	TSW	12	11	**217**	**382.4**

Table MCN-7 Spill Patterns with TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [c]	20 [c]	21	22	(#)	(kcfs)
11	6	12	12	12	6	12	12	12	12	11	12	12	12	12	6	12	12	TSW	TSW	12	11	**219**	**385.6**
12	6	12	12	12	6	12	12	12	12	12	12	12	12	12	6	12	12	TSW	TSW	12	11	**221**	**388.8**
12	6	12	12	12	6	12	12	12	12	12	12	12	12	12	6	12	13	TSW	TSW	12	12	**223**	**392.0**
12	6	13	12	12	6	12	12	12	12	12	12	12	12	12	6	12	13	TSW	TSW	13	12	**225**	**395.2**
12	6	13	13	12	6	12	12	12	12	12	12	12	12	12	6	13	13	TSW	TSW	13	12	**227**	**398.4**
12	6	13	13	13	6	12	12	12	12	12	12	12	12	12	6	13	13	TSW	TSW	13	12	**228**	**400.0**
12	6	13	13	13	6	13	12	12	12	12	12	12	12	13	6	13	13	TSW	TSW	13	12	**230**	**403.2**
12	6	13	13	13	6	13	13	12	12	12	12	12	13	13	6	13	13	TSW	TSW	13	12	**232**	**406.4**
12	6	13	13	13	6	13	13	13	12	12	12	13	13	13	6	13	13	TSW	TSW	13	12	**234**	**409.6**
12	6	13	13	13	6	13	13	13	13	12	13	13	13	13	6	13	13	TSW	TSW	13	12	**236**	**412.8**
12	6	13	13	13	6	13	13	13	13	13	13	13	13	13	6	13	13	TSW	TSW	13	12	**237**	**414.4**
13	6	13	13	13	6	13	13	13	13	13	13	13	13	13	6	13	13	TSW	TSW	13	13	**239**	**417.6**

a. Spill (kcfs) is calculated as a function of the total number of gate tops + TSW spill at forebay elevation 339 ft.

b. Bays 19-20 with TSWs = fixed spill of approx 19.2 kcfs (9.6 kcfs/bay) at fb el 339'. The upper TSW gates will be raised 3-5 ft above the water surface to ensure free flow over the TSW crests.

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] (kcfs)
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]		
																		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. McNary Dam Spill Patterns with NO TSWs and Bays 2, 6, and 16 Locked at 4 or 6 Stops.

Table MCN-9 Spill Patterns with NO TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops.																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(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
		1		2			2		2		2		2	2			2	4	2			21	40.4
		2		2			2		2		2		2	2			2	4	2			22	42.3
		2		2			2		2		2		2	2			2	4	2	1		23	44.3
		2		2			2		2		2		2	2			2	4	2	2		24	46.2
		2		2			2		2		2		2	2			2	4	3	2		25	47.9
		2		2			2		2		2		2	2			2	4	4	2		26	49.5
1		2		2			2		2		2		2	2			2	4	4	2		27	51.5
2		2		2			2		2		2		2	2			2	4	4	2		28	53.4
3		2		2			2		2		2		2	2			2	4	4	2		29	55.1
0	4	2		2			2		2		2		2	2			2	4	4	2		30	56.7
	4	3		2			2		2		2		2	2			2	4	4	2		31	58.4
	4	4		2			2		2		2		2	2			2	4	4	2		32	60.0
	4	4		2		1	2		2		2		2	2			2	4	4	2		33	62.0
	4	4		2		2	2		2		2		2	2			2	4	4	2		34	63.9
	4	4		2		3	2		2		2		2	2			2	4	4	2		35	65.6
	4	4		2	4	0	2		2		2		2	2			2	4	4	2		36	67.2
	4	4		2	4		2		2		2		2	2		1	2	4	4	2		37	69.2

Table MCN-9 Spill Patterns with NO TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total Stops (#)	Spill [a] (kcfs)
	4	4		2	4		2		2		2		2	2		2	2	4	4	2		38	71.1
	4	4		2	4		2		2		2		2	2		3	2	4	4	2		39	72.8
	4	4		2	4		2		2		2		2	2	4	0	2	4	4	2		40	74.4
	4	4		2	4		2		2		2		2	2	4	1	2	4	4	2		41	76.4
	4	4		2	4		2		2		2		2	2	4	2	2	4	4	2		42	78.3
1	4	4		2	4		2		2		2		2	2	4	2	2	4	4	2		43	80.3
2	4	4		2	4		2		2		2		2	2	4	2	2	4	4	2		44	82.2
2	4	4	1	2	4		2		2		2		2	2	4	2	2	4	4	2		45	84.2
2	4	4	2	2	4		2		2		2		2	2	4	2	2	4	4	2		46	86.1
2	4	4	2	2	4	1	2		2		2		2	2	4	2	2	4	4	2		47	88.1
2	4	4	2	2	4	2	2		2		2		2	2	4	2	2	4	4	2		48	90.0
2	4	4	2	2	4	2	2	1	2		2		2	2	4	2	2	4	4	2		49	92.0
2	4	4	2	2	4	2	2	2	2		2		2	2	4	2	2	4	4	2		50	93.9
2	4	4	2	2	4	2	2	2	2	1	2		2	2	4	2	2	4	4	2		51	95.9
2	4	4	2	2	4	2	2	2	2	2	2		2	2	4	2	2	4	4	2		52	97.8
2	4	4	2	2	4	2	2	2	2	2	2	1	2	2	4	2	2	4	4	2		53	99.8
2	4	4	2	2	4	2	2	2	2	2	2	2	2	2	4	2	2	4	4	2		54	101.7
2	4	4	2	2	4	2	2	2	2	2	2	2	2	2	4	2	2	4	4	2	1	55	103.7
2	4	4	2	2	4	2	2	2	2	2	2	2	2	2	4	2	2	4	4	2	2	56	105.6
2	4	4	2	2	4	2	2	2	2	2	2	2	2	2	4	2	2	5	4	2	2	57	107.2
2	4	4	2	2	4	2	2	2	2	2	2	2	2	2	4	2	2	5	5	2	2	58	108.8
2	4	4	2	2	4	2	2	2	2	2	2	2	2	2	4	2	3	5	5	2	2	59	110.5
2	4	4	2	2	4	2	2	2	2	2	2	2	2	2	4	2	3	5	5	3	2	60	112.2
2	4	4	3	2	4	2	2	2	2	2	2	2	2	2	4	2	3	5	5	3	2	61	113.9
2	4	4	3	2	4	2	2	2	2	2	2	2	2	2	4	3	3	5	5	3	2	62	115.6
2	4	4	3	3	4	2	2	2	2	2	2	2	2	2	4	3	3	5	5	3	2	63	117.3
2	4	4	3	3	4	2	2	2	2	2	2	2	2	3	4	3	3	5	5	3	2	64	119.0
2	4	4	3	3	4	3	2	2	2	2	2	2	2	3	4	3	3	5	5	3	2	65	120.7
2	4	4	3	3	4	3	2	2	2	2	2	2	3	3	4	3	3	5	5	3	2	66	122.4
2	4	4	3	3	4	3	3	2	2	2	2	2	3	3	4	3	3	5	5	3	2	67	124.1
2	4	4	3	3	4	3	3	2	2	2	2	3	3	3	4	3	3	5	5	3	2	68	125.8
2	4	4	3	3	4	3	3	3	2	2	2	3	3	3	4	3	3	5	5	3	2	69	127.5
2	4	4	3	3	4	3	3	3	2	2	3	3	3	3	4	3	3	5	5	3	2	70	129.2
2	4	4	3	3	4	3	3	3	3	2	3	3	3	3	4	3	3	5	5	3	2	71	130.9
2	4	4	3	3	4	3	3	3	3	3	3	3	3	3	4	3	3	5	5	3	2	72	132.6
3	4	4	3	3	4	3	3	3	3	3	3	3	3	3	4	3	3	5	5	3	2	73	134.3

Table MCN-9 Spill Patterns with NO TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops.																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(kcfs)
3	4	4	3	3	4	3	3	3	3	3	3	3	3	3	4	3	3	5	5	3	3	**74**	**136.0**
3	4	5	3	3	4	3	3	3	3	3	3	3	3	3	4	3	3	5	5	3	3	**75**	**137.6**
3	4	5	3	3	4	3	3	3	3	3	3	3	3	3	4	3	3	6	5	3	3	**76**	**139.2**
3	4	5	3	3	4	3	3	3	3	3	3	3	3	3	4	3	3	6	6	3	3	**77**	**140.8**
3	4	5	3	3	4	3	3	3	3	3	3	3	3	3	4	3	4	6	6	3	3	**78**	**142.4**
3	4	5	3	3	4	3	3	3	3	3	3	3	3	3	4	3	4	6	6	4	3	**79**	**144.0**
3	4	5	4	3	4	3	3	3	3	3	3	3	3	3	4	3	4	6	6	4	3	**80**	**145.6**
3	4	5	4	3	4	3	3	3	3	3	3	3	3	3	4	4	4	6	6	4	3	**81**	**147.2**
3	4	5	4	4	4	3	3	3	3	3	3	3	3	3	4	4	4	6	6	4	3	**82**	**148.8**
3	4	5	4	4	4	3	3	3	3	3	3	3	3	4	4	4	4	6	6	4	3	**83**	**150.4**
3	4	5	4	4	4	4	3	3	3	3	3	3	3	4	4	4	4	6	6	4	3	**84**	**152.0**
3	4	5	4	4	4	4	3	3	3	3	3	3	4	4	4	4	4	6	6	4	3	**85**	**153.6**
3	4	5	4	4	4	4	4	3	3	3	3	3	4	4	4	4	4	6	6	4	3	**86**	**155.2**
3	4	5	4	4	4	4	4	3	3	3	3	4	4	4	4	4	4	6	6	4	3	**87**	**156.8**
3	4	5	4	4	4	4	4	4	3	3	3	4	4	4	4	4	4	6	6	4	3	**88**	**158.4**
3	4	5	4	4	4	4	4	4	3	3	4	4	4	4	4	4	4	6	6	4	3	**89**	**160.0**
3	4	5	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	6	6	4	3	**90**	**161.6**
3	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	4	3	**91**	**163.2**
4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	4	3	**92**	**164.8**
4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	4	4	**93**	**166.4**
4	4	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	4	4	**94**	**168.0**
4	4	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	7	6	4	4	**95**	**169.6**
4	4	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	7	7	4	4	**96**	**171.2**
4	4	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	7	7	4	4	**97**	**172.8**
4	4	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	7	7	5	4	**98**	**174.4**
4	4	6	5	4	4	4	4	4	4	4	4	4	4	4	4	4	5	7	7	5	4	**99**	**176.0**
4	4	6	5	4	4	4	4	4	4	4	4	4	4	4	4	5	5	7	7	5	4	**100**	**177.6**
4	4	6	5	5	4	4	4	4	4	4	4	4	4	4	4	5	5	7	7	5	4	**101**	**179.2**
4	4	6	5	5	4	4	4	4	4	4	4	4	4	5	4	5	5	7	7	5	4	**102**	**180.8**
4	4	6	5	5	4	5	4	4	4	4	4	4	4	5	4	5	5	7	7	5	4	**103**	**182.4**
4	4	6	5	5	4	5	4	4	4	4	4	4	5	5	4	5	5	7	7	5	4	**104**	**184.0**
4	4	6	5	5	4	5	5	4	4	4	4	4	5	5	4	5	5	7	7	5	4	**105**	**185.6**
4	4	6	5	5	4	5	5	4	4	4	4	5	5	5	4	5	5	7	7	5	4	**106**	**187.2**
4	4	6	5	5	4	5	5	5	4	4	4	5	5	5	4	5	5	7	7	5	4	**107**	**188.8**
4	4	6	5	5	4	5	5	5	4	4	5	5	5	5	4	5	5	7	7	5	4	**108**	**190.4**
4	4	6	5	5	4	5	5	5	5	4	5	5	5	5	4	5	5	7	7	5	4	**109**	**192.0**

Table MCN-9 Spill Patterns with NO TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops.																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(kcfs)
4	4	6	5	5	4	5	5	5	5	5	5	5	5	5	4	5	5	7	7	5	4	**110**	**193.6**
5	4	6	5	5	4	5	5	5	5	5	5	5	5	5	4	5	5	7	7	5	4	**111**	**195.2**
5	4	6	5	5	4	5	5	5	5	5	5	5	5	5	4	5	5	7	7	5	5	**112**	**196.8**
5	4	7	5	5	4	5	5	5	5	5	5	5	5	5	4	5	5	7	7	5	5	**113**	**198.4**
5	4	7	5	5	4	5	5	5	5	5	5	5	5	5	4	5	5	8	7	5	5	**114**	**200.1**
5	4	7	5	5	4	5	5	5	5	5	5	5	5	5	4	5	5	8	8	5	5	**115**	**201.8**
5	4	7	5	5	4	5	5	5	5	5	5	5	5	5	4	5	6	8	8	5	5	**116**	**203.4**
5	4	7	5	5	4	5	5	5	5	5	5	5	5	5	4	5	6	8	8	6	5	**117**	**205.0**
5	4	7	6	5	4	5	5	5	5	5	5	5	5	5	4	5	6	8	8	6	5	**118**	**206.6**
5	4	7	6	5	4	5	5	5	5	5	5	5	5	5	4	6	6	8	8	6	5	**119**	**208.2**
5	4	7	6	6	4	5	5	5	5	5	5	5	5	5	4	6	6	8	8	6	5	**120**	**209.8**
5	4	7	6	6	4	5	5	5	5	5	5	5	5	6	4	6	6	8	8	6	5	**121**	**211.4**
5	4	7	6	6	4	6	5	5	5	5	5	5	5	6	4	6	6	8	8	6	5	**122**	**213.0**
5	4	7	6	6	4	6	5	5	5	5	5	5	6	6	4	6	6	8	8	6	5	**123**	**214.6**
5	4	7	6	6	4	6	6	5	5	5	5	5	6	6	4	6	6	8	8	6	5	**124**	**216.2**
5	4	7	6	6	4	6	6	5	5	5	5	6	6	6	4	6	6	8	8	6	5	**125**	**217.8**
5	4	7	6	6	4	6	6	6	5	5	5	6	6	6	4	6	6	8	8	6	5	**126**	**219.4**
5	4	7	6	6	4	6	6	6	5	5	6	6	6	6	4	6	6	8	8	6	5	**127**	**221.0**
5	4	7	6	6	4	6	6	6	6	5	6	6	6	6	4	6	6	8	8	6	5	**128**	**222.6**
5	4	7	6	6	4	6	6	6	6	6	6	6	6	6	4	6	6	8	8	6	5	**129**	**224.2**
6	4	7	6	6	4	6	6	6	6	6	6	6	6	6	4	6	6	8	8	6	5	**130**	**225.8**
6	4	7	6	6	4	6	6	6	6	6	6	6	6	6	4	6	6	8	8	6	6	**131**	**227.4**
6	4	8	6	6	4	6	6	6	6	6	6	6	6	6	4	6	6	8	8	6	6	**132**	**229.1**
5	6	8	6	6	4	6	6	6	6	6	6	6	6	6	4	6	6	8	8	6	6	**133**	**230.7**
6	6	8	6	6	4	6	6	6	6	6	6	6	6	6	4	6	6	8	8	6	6	**134**	**232.3**
5	6	8	6	6	6	6	6	6	6	6	6	6	6	6	4	6	6	8	8	6	6	**135**	**233.9**
6	6	8	6	6	6	6	6	6	6	6	6	6	6	6	4	6	6	8	8	6	6	**136**	**235.5**
5	6	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	8	8	6	6	**137**	**237.1**
6	6	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	8	8	6	6	**138**	**238.7**
6	6	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	8	6	6	**139**	**240.3**
6	6	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	9	6	6	**140**	**241.9**
6	6	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	9	9	6	6	**141**	**243.5**
6	6	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	9	9	7	6	**142**	**245.1**
6	6	8	7	6	6	6	6	6	6	6	6	6	6	6	6	6	7	9	9	7	6	**143**	**246.7**
6	6	8	7	6	6	6	6	6	6	6	6	6	6	6	6	7	7	9	9	7	6	**144**	**248.3**
6	6	8	7	7	6	6	6	6	6	6	6	6	6	6	6	7	7	9	9	7	6	**145**	**249.9**

Table MCN-9 Spill Patterns with NO TSWs (# Gate Stops per Spillbay) - Bays 2, 6, and 16 locked at 4 or 6 stops.																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(kcfs)
6	6	8	7	7	6	6	6	6	6	6	6	6	6	7	6	7	7	9	9	7	6	**146**	**251.5**
6	6	8	7	7	6	7	6	6	6	6	6	6	6	7	6	7	7	9	9	7	6	**147**	**253.1**
6	6	8	7	7	6	7	6	6	6	6	6	6	7	7	6	7	7	9	9	7	6	**148**	**254.7**
6	6	8	7	7	6	7	7	6	6	6	6	6	7	7	6	7	7	9	9	7	6	**149**	**256.3**
6	6	8	7	7	6	7	7	6	6	6	6	7	7	7	6	7	7	9	9	7	6	**150**	**257.9**
6	6	8	7	7	6	7	7	7	6	6	6	7	7	7	6	7	7	9	9	7	6	**151**	**259.5**
6	6	8	7	7	6	7	7	7	6	6	7	7	7	7	6	7	7	9	9	7	6	**152**	**261.1**
6	6	8	7	7	6	7	7	7	7	6	7	7	7	7	6	7	7	9	9	7	6	**153**	**262.7**
6	6	8	7	7	6	7	7	7	7	7	7	7	7	7	6	7	7	9	9	7	6	**154**	**264.3**
7	6	8	7	7	6	7	7	7	7	7	7	7	7	7	6	7	7	9	9	7	6	**155**	**265.9**
7	6	8	7	7	6	7	7	7	7	7	7	7	7	7	6	7	7	9	9	7	7	**156**	**267.5**
7	6	9	7	7	6	7	7	7	7	7	7	7	7	7	6	7	7	9	9	7	7	**157**	**269.1**
7	6	9	7	7	6	7	7	7	7	7	7	7	7	7	6	7	7	10	9	7	7	**158**	**270.7**
7	6	9	7	7	6	7	7	7	7	7	7	7	7	7	6	7	7	10	10	7	7	**159**	**272.3**
7	6	9	7	7	6	7	7	7	7	7	7	7	7	7	6	7	8	10	10	7	7	**160**	**274.0**
7	6	9	7	7	6	7	7	7	7	7	7	7	7	7	6	7	8	10	10	8	7	**161**	**275.7**
7	6	9	8	7	6	7	7	7	7	7	7	7	7	7	6	7	8	10	10	8	7	**162**	**277.4**
7	6	9	8	7	6	7	7	7	7	7	7	7	7	7	6	8	8	10	10	8	7	**163**	**279.1**
7	6	9	8	8	6	7	7	7	7	7	7	7	7	7	6	8	8	10	10	8	7	**164**	**280.8**
7	6	9	8	8	6	7	7	7	7	7	7	7	7	8	6	8	8	10	10	8	7	**165**	**282.5**
7	6	9	8	8	6	8	7	7	7	7	7	7	7	8	6	8	8	10	10	8	7	**166**	**284.2**
7	6	9	8	8	6	8	7	7	7	7	7	7	8	8	6	8	8	10	10	8	7	**167**	**285.9**
7	6	9	8	8	6	8	8	7	7	7	7	7	8	8	6	8	8	10	10	8	7	**168**	**287.6**
7	6	9	8	8	6	8	8	7	7	7	7	8	8	8	6	8	8	10	10	8	7	**169**	**289.3**
7	6	9	8	8	6	8	8	8	7	7	7	8	8	8	6	8	8	10	10	8	7	**170**	**291.0**
7	6	9	8	8	6	8	8	8	7	7	8	8	8	8	6	8	8	10	10	8	7	**171**	**292.7**
7	6	9	8	8	6	8	8	8	8	7	8	8	8	8	6	8	8	10	10	8	7	**172**	**294.4**
7	6	9	8	8	6	8	8	8	8	8	8	8	8	8	6	8	8	10	10	8	7	**173**	**296.1**
8	6	9	8	8	6	8	8	8	8	8	8	8	8	8	6	8	8	10	10	8	7	**174**	**297.8**
8	6	9	8	8	6	8	8	8	8	8	8	8	8	8	6	8	8	10	10	8	8	**175**	**299.5**
8	6	10	8	8	6	8	8	8	8	8	8	8	8	8	6	8	8	10	10	8	8	**176**	**301.1**

a. Spill (kcfs) is calculated as a function of the total number of gate tops at forebay elevation 339 ft.

Table MCN-10. [*page 1 of 5*]. McNary Dam Spill Patterns during TSW Removal in Bays 19-20.

NOTE: The process to remove the TSWs and re-install standard spill gate sections in Bays 19-20 may take up to 5 days depending on weather conditions and crane status. During this time, Bays 19-20 will be closed all hours until standard spill gate sections are installed and the bays can be operated as conventional (deep) spillbays. For worker safety, all bays being worked in and adjacent bays must be closed, which includes bays where the gate sections are stored. Therefore, during the workday (approx. 0630-1700), bays 14-21 will be closed and FOP spill will be distributed across the remaining bays 1-13 and 22. See section 2.3.2.6 for more information.

Table MCN-10 Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(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

Table MCN-10 Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(kcfs)
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
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

Table MCN-10 Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(kcfs)
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**
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**

Table MCN-10 Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(kcfs)
7	7	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	CLOSE	CLOSE	CLOSE	CLOSE		112	192.8
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
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
9	9	9	9	8	8	8	8	8	8	8	8	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		145	247.3
9	9	9	9	9	8	8	8	8	8	8	8	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		146	248.9
9	9	9	9	9	8	8	8	8	8	8	9	9	9	9	9	9	CLOSE	CLOSE	CLOSE	CLOSE		147	250.5

Table MCN-10 Spill Patterns During TSW Removal (# Gate Stops per Spillbay)																						Total Stops	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(kcfs)
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
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

[a] Spill (kcfs) is calculated as a function of the total number of gate stops at forebay elevation 339 ft.

Table MCN-11. Interim Manual/Auto Spill Patterns for McNary Dam with Bays 2, 6, and 16 Dogged at Four or Six Stops. See section 2.2.2.1 for more information (added July 2022).

APRIL Manual/Auto Spill Patterns with TSWs (# Gate Stops per Spillbay) [c] Bays 2, 6, and 16 locked at 4 or 6 stops (manually adjusted)																						Total Stops	Total Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [b]	20 [b]	21	22	(#)	(kcfs)
2	4		2	2			2	1	2		2	2		2	4	2	2	TSW	TSW	2		31	78.5
2	4	3	2	2		3	2	1	2	3	2	2		2	4	2	2	TSW	TSW	2	3	43	100.9
2	4	6	2	2		6	2	1	2	6	2	2		2	4	2	2	TSW	TSW	2	6	55	120.1
3	4	0	3	3	6	0	3	3	3	0	3	3	3	3	4	3	4	TSW	TSW	4	0	55	120.0
3	4	3	3	3	6	3	3	3	3	3	3	3	3	3	4	3	4	TSW	TSW	4	3	67	142.4
3	4	6	3	3	6	6	3	3	3	6	3	3	3	3	4	3	4	TSW	TSW	4	6	79	161.6
4	4	2	4	5	6	2	4	5	5	1	5	4	5	4	4	4	5	TSW	TSW	5	2	80	162.5
4	4	5	4	5	6	5	4	5	5	4	5	4	5	4	4	4	5	TSW	TSW	5	5	92	182.4
4	4	8	4	5	6	8	4	5	5	7	5	4	5	4	4	4	5	TSW	TSW	5	8	104	201.9
6	4	3	6	6	6	3	6	6	6	2	6	6	6	6	6	6	6	TSW	TSW	6	3	105	203.1
6	4	6	6	6	6	6	6	6	6	5	6	6	6	6	6	6	6	TSW	TSW	6	6	117	222.4
6	4	9	6	6	6	9	6	6	6	8	6	6	6	6	6	6	6	TSW	TSW	6	9	129	242.0
7	6	5	8	7	6	4	7	7	7	4	7	7	7	7	6	8	8	TSW	TSW	8	4	130	243.6
7	6	8	8	7	6	7	7	7	7	7	7	7	7	7	6	8	8	TSW	TSW	8	7	142	262.9
7	6	11	8	7	6	10	7	7	7	10	7	7	7	7	6	8	8	TSW	TSW	8	10	154	282.3

MAY Manual/Auto Spill Patterns with TSWs (# Gate Stops per Spillbay) [c] Bays 2, 6, and 16 locked at 4 or 6 stops (manually adjusted)																						Total Stops	Total Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [b]	20 [b]	21	22	(#)	(kcfs)
2	4	2		2		3	2	1		2	2	1		2	4		2	TSW	TSW	2		31	78.5
2	4	2	3	2		3	2	1	3	2	2	1	3	2	4	3	2	TSW	TSW	2		43	100.7
2	4	2	6	2		3	2	1	6	2	2	1	6	2	4	6	2	TSW	TSW	2		55	120.1
3	4	3	0	3	6	3	3	3	0	3	3	3	0	3	4	0	4	TSW	TSW	4	3	55	120.0
3	4	3	3	3	6	3	3	3	3	3	3	3	3	3	4	3	4	TSW	TSW	4	3	67	142.4
3	4	3	6	3	6	3	3	3	6	3	3	3	6	3	4	6	4	TSW	TSW	4	3	79	161.6
4	4	5	1	5	6	5	4	5	2	4	5	4	2	4	4	1	5	TSW	TSW	5	5	80	162.5
4	4	5	4	5	6	5	4	5	5	4	5	4	5	4	4	4	5	TSW	TSW	5	5	92	182.4
4	4	5	7	5	6	5	4	5	8	4	5	4	8	4	4	7	5	TSW	TSW	5	5	104	201.9
6	4	6	3	6	6	6	6	6	3	5	6	6	3	6	6	3	6	TSW	TSW	6	6	105	203.1
6	4	6	6	6	6	6	6	6	6	5	6	6	6	6	6	6	6	TSW	TSW	6	6	117	222.4
6	4	6	9	6	6	6	6	6	9	5	6	6	9	6	6	9	6	TSW	TSW	6	6	129	242.0
7	6	8	5	7	6	7	7	7	4	7	7	7	4	7	6	5	8	TSW	TSW	8	7	130	243.6
7	6	8	8	7	6	7	7	7	7	7	7	7	7	7	6	8	8	TSW	TSW	8	7	142	262.9
7	6	8	11	7	6	7	7	7	10	7	7	7	10	7	6	11	8	TSW	TSW	8	7	154	282.3

JUNE Manual/Auto Patterns with TSWs (# Gate Stops per Spillbay) [c] Bays 2, 6, and 16 locked at 4 or 6 stops (manually adjusted)																						Total Stops	Total Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 [b]	20 [b]	21	22	(#)	(kcfs)
2	4	2	2			2	2		2	1		2		2	4	2		TSW	TSW	2	2	**31**	**78.5**
2	4	2	2	3		2	2	3	2	1	3	2		2	4	2	3	TSW	TSW	2	2	**43**	**100.7**
2	4	2	2	6		2	2	6	2	1	6	2		2	4	2	6	TSW	TSW	2	2	**55**	**120.1**
3	4	3	3	0	6	3	3	0	3	3	0	3	3	3	4	3	1	TSW	TSW	4	3	**55**	**120.0**
3	4	3	3	3	6	3	3	3	3	3	3	3	3	3	4	3	4	TSW	TSW	4	3	**67**	**142.4**
3	4	3	3	6	6	3	3	6	3	3	6	3	3	3	4	3	7	TSW	TSW	4	3	**79**	**161.6**
4	4	5	4	2	6	5	4	2	5	4	2	4	5	4	4	4	2	TSW	TSW	5	5	**80**	**162.5**
4	4	5	4	5	6	5	4	5	5	4	5	4	5	4	4	4	5	TSW	TSW	5	5	**92**	**182.4**
4	4	5	4	8	6	5	4	8	5	4	8	4	5	4	4	4	8	TSW	TSW	5	5	**104**	**201.9**
6	4	6	6	3	6	6	6	3	6	5	3	6	6	6	6	6	3	TSW	TSW	6	6	**105**	**203.1**
6	4	6	6	6	6	6	6	6	6	5	6	6	6	6	6	6	6	TSW	TSW	6	6	**117**	**222.4**
6	4	6	6	9	6	6	6	9	6	5	9	6	6	6	6	6	9	TSW	TSW	6	6	**129**	**242.0**
7	6	8	8	4	6	7	7	4	7	7	4	7	7	7	6	8	5	TSW	TSW	8	7	**130**	**243.6**
7	6	8	8	7	6	7	7	7	7	7	7	7	7	7	6	8	8	TSW	TSW	8	7	**142**	**262.9**
7	6	8	8	10	6	7	7	10	7	7	10	7	7	7	6	8	11	TSW	TSW	8	7	**154**	**282.3**

Manual/Auto Spill Patterns with NO TSWs (# Gate Stops per Spillbay) [c] Bays 2, 6, and 16 locked at 3 or 5 stops																						Total Stops	Total Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	(#)	(kcfs)
3	5		2		3	2		2		2	2		3	2	3	2		3		2		**36**	**68.0**
3	5	1	2		3	2	1	2		2	2	1	3	2	3	2		3	1	2		**40**	**76.0**
3	5	2	2		3	2	2	2		2	2	2	3	2	3	2		3	2	2		**44**	**83.6**
3	5	3	2		3	2	3	2		2	2	3	3	2	3	2		3	3	2		**48**	**90.4**
3	5	4	2		3	2	4	2		2	2	4	3	2	3	2		3	4	2		**52**	**96.8**
4	5	2	2	3	3	3	0	3	2	2	3	0	3	3	3	3	2	3	0	3	2	**54**	**101.0**
4	5	3	2	3	3	3	1	3	2	2	3	1	3	3	3	3	2	3	1	3	2	**58**	**108.7**
4	5	4	2	3	3	3	2	3	2	2	3	2	3	3	3	3	2	3	2	3	2	**62**	**116.0**
4	5	5	2	3	3	3	3	3	2	2	3	3	3	3	3	3	2	3	3	3	2	**66**	**122.7**
4	5	6	2	3	3	3	4	3	2	2	3	4	3	3	3	3	2	3	4	3	2	**70**	**129.1**
4	5	3	4	3	3	4	2	4	3	3	4	2	3	3	3	4	3	4	2	3	3	**72**	**132.5**
4	5	4	4	3	3	4	3	4	3	3	4	3	3	3	3	4	3	4	3	3	3	**76**	**139.2**
4	5	5	4	3	3	4	4	4	3	3	4	4	3	3	3	4	3	4	4	3	3	**80**	**145.6**
4	5	6	4	3	3	4	5	4	3	3	4	5	3	3	3	4	3	4	5	3	3	**84**	**152.0**
4	5	7	4	3	3	4	6	4	3	3	4	6	3	3	3	4	3	4	6	3	3	**88**	**158.4**

[a] Spill (kcfs) is calculated as a function of the total number of gate stops + TSW spill at forebay elevation 339 ft.

[b] Bays 19-20 with TSWs spill approximately 19.2 kcfs (9.6 kcfs/bay) at forebay elevation 339 ft. The upper TSW gates will be raised 3-5 ft above the water surface to ensure free flow over the TSW crests.

[c] Auto mode bays will be adjusted through their operational range as required. Desired spill volumes will be achieved by adjusting a single automatic bay one stop at a time. Automatic bays will operate within one stop of each other.

2023 Fish Passage Plan

Chapter 6 – Ice Harbor Dam

Table of Contents

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'/hour
Powerhouse Length (ft)	671'
Powerhouse Hydraulic Capacity (kcfs)	106 kcfs
Turbine Units (#)	6 (Unit 1 Smith Kaplan; Units 2-3 Voith 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 to **ICE**. However, that acronym is assigned to another NWD project, so the official Corps NWD acronym for Ice Harbor is **IHR**.

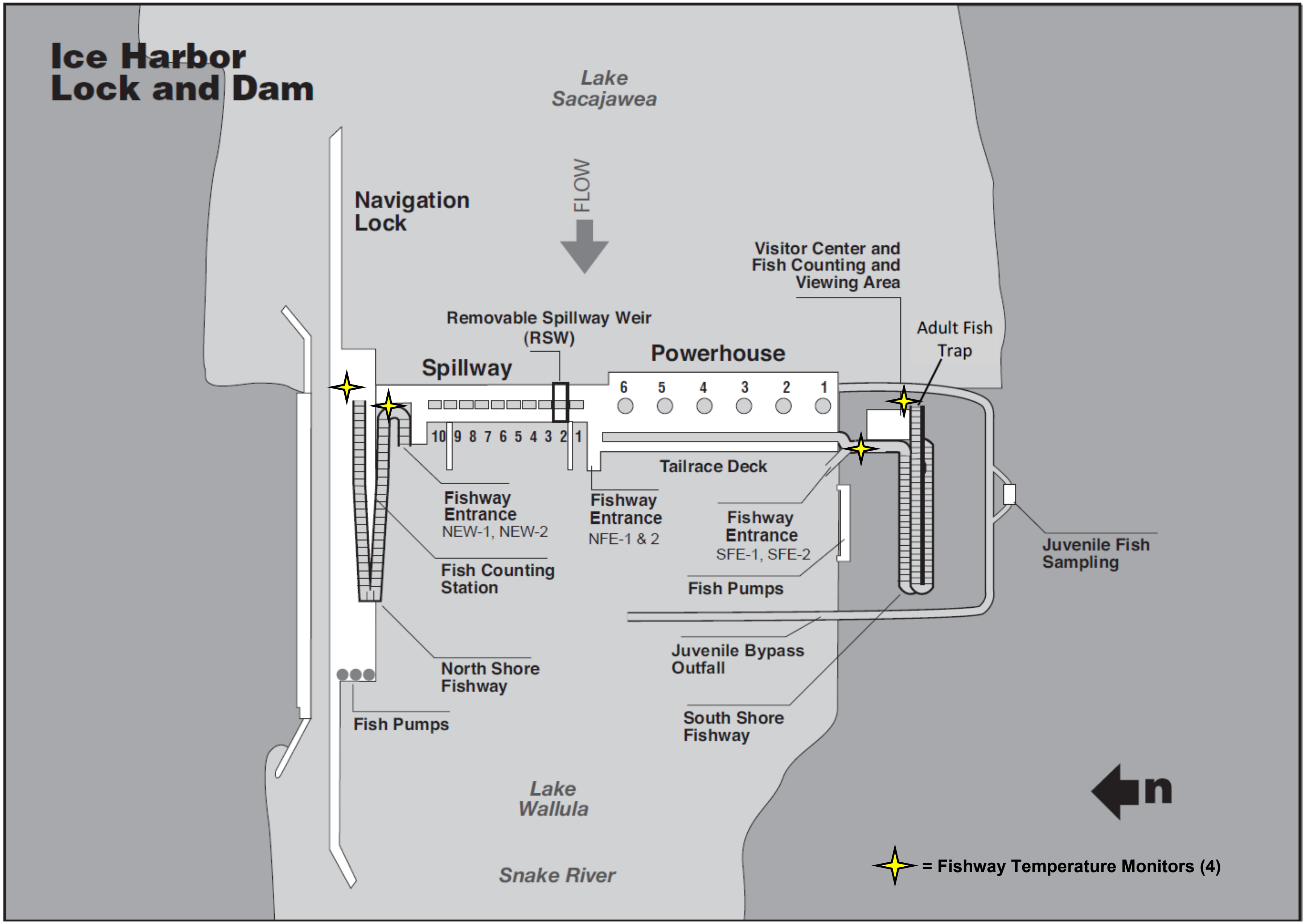
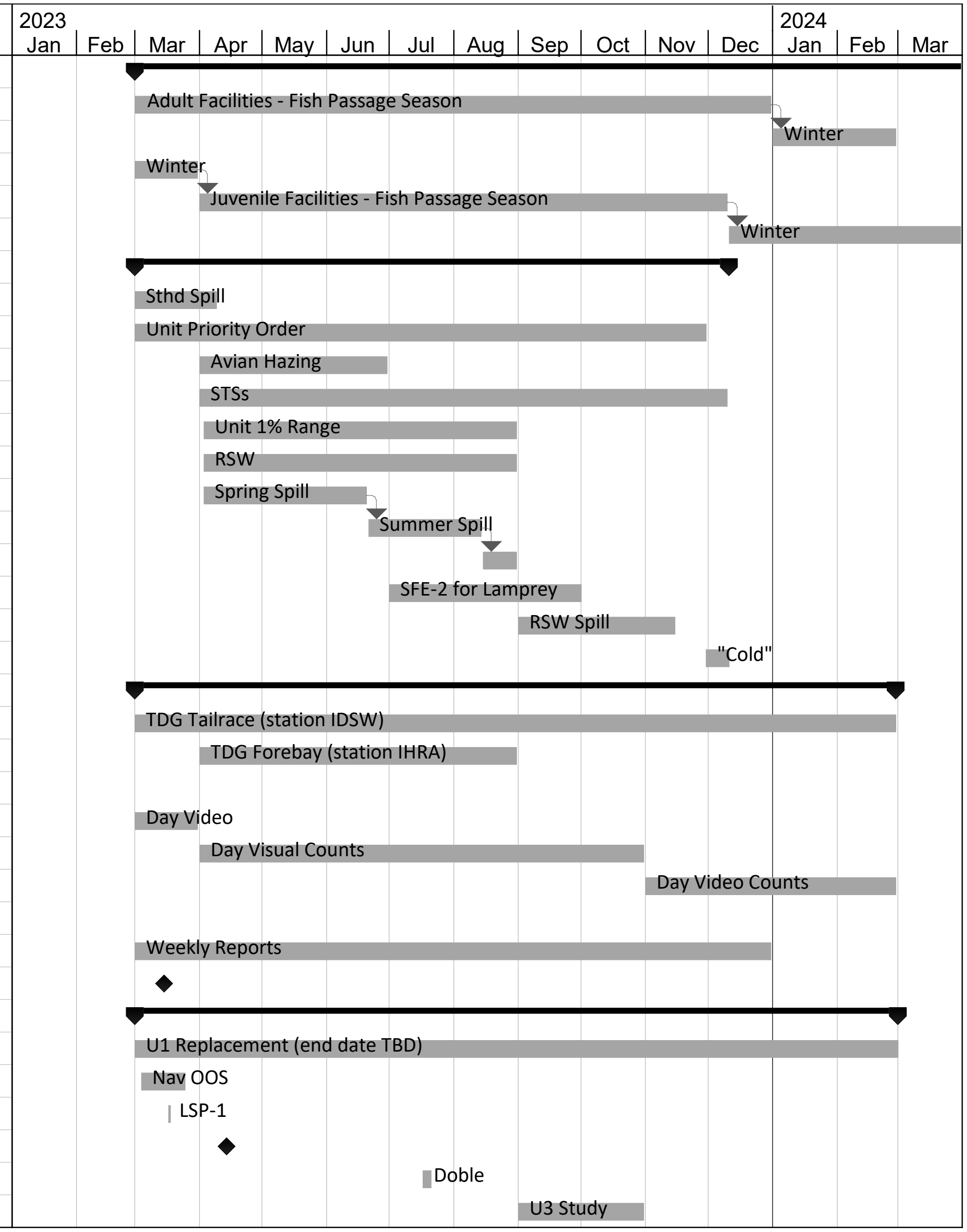


Figure IHR- 1. Ice Harbor Lock and Dam General Site Plan.

Table IHR-1. Ice Harbor Dam Schedule of Operations and Actions Defined in the 2023 Fish Passage Plan.

Task Name	Start	End
FISH PASSAGE FACILITIES	**Wed 3/1/23**	**Sun 3/31/24**
Adult Facilities - Fish Passage Season	Wed 3/1/23	Sun 12/31/23
Adult Facilities - Winter Maintenance	Mon 1/1/24	Thu 2/29/24
Juvenile Facilities - Winter Maintenance	Wed 3/1/23	Fri 3/31/23
Juvenile Facilities - Fish Passage Season	Sat 4/1/23	Sun 12/10/23
Juvenile Facilities - Winter Maintenance	Mon 12/11/23	Sun 3/31/24
PROJECT OPERATIONS FOR FISH PASSAGE	**Wed 3/1/23**	**Mon 12/11/23**
RSW Spill for Adult Steelhead	Wed 3/1/23	Sun 4/9/23
Turbine unit priority order	Wed 3/1/23	Thu 11/30/23
Avian hazing	Sat 4/1/23	Fri 6/30/23
STSs	Sat 4/1/23	Sun 12/10/23
Turbine unit 1% operating range	Mon 4/3/23	Thu 8/31/23
RSW in service (end date approx)	Mon 4/3/23	Thu 8/31/23
Spring Spill	Mon 4/3/23	Tue 6/20/23
Summer Spill	Wed 6/21/23	Mon 8/14/23
Late Summer Spill	Tue 8/15/23	Thu 8/31/23
Lamprey Entrance Structure Open at SFE-2	Sat 7/1/23	Sun 10/1/23
RSW Spill for Adult Steelhead	Fri 9/1/23	Wed 11/15/23
STS removal during cold weather	Thu 11/30/23	Mon 12/11/23
TDG MONITORING	**Wed 3/1/23**	**Thu 2/29/24**
TDG Monitoring - Tailrace (year-round)	Wed 3/1/23	Thu 2/29/24
TDG Monitoring - Forebay	Sat 4/1/23	Thu 8/31/23
ADULT FISH COUNTING	**Wed 3/1/23**	**Thu 2/29/24**
Day Video 0400-2000 PST	Wed 3/1/23	Fri 3/31/23
Day Visual 0500-2100 PDT	Sat 4/1/23	Tue 10/31/23
Day Video 0400-2000 PST	Wed 11/1/23	Thu 2/29/24
REPORTS	**Wed 3/1/23**	**Sun 12/31/23**
Weekly Reports	Wed 3/1/23	Sun 12/31/23
Annual Report due (for previous year)	Wed 3/15/23	Wed 3/15/23
SPECIAL OPS & STUDIES (Appendix A)	**Wed 3/1/23**	**Fri 3/1/24**
Unit 1 Replacement (thru 2025)	Wed 3/1/23	Fri 3/1/24
Navigation Lock annual outage	Sat 3/4/23	Sat 3/25/23
LSP-1 Switchgear Testing	Fri 3/17/23	Sat 3/18/23
Lines 1&2 Maintenance (U1-4 OOS)	Fri 4/14/23	Fri 4/14/23
Doble testing	Mon 7/17/23	Fri 7/21/23
U3 Direct Injury & Sensor Fish Study	Fri 9/1/23	Tue 10/31/23



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 Facilities and Migration Timing.

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 (see **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 Facilities and Migration Timing.

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 five 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, bull trout, shad, and lamprey are counted per the schedule in **Table IHR-2** and daily counts are posted online.[1] The presence of other species (i.e., sturgeon, grass carp, Atlantic salmon, etc.) are recorded as comments and reported 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 March 2022–February 2023.

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

*PST = Pacific Standard Time; PDT = Pacific Daylight Time, in effect during daylight saving time 3/13/22–11/6/22.

Table IHR-3. Ice Harbor Dam Adult Fish Peak Passage Timing. *

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 10	Sep 3

*Based on yearly counts from 1962 through the most recent count year.

[1] Daily adult salmon counts: https://www.fpc.org/currentdaily/HistFishTwo_7day-ytd_Adults.htm

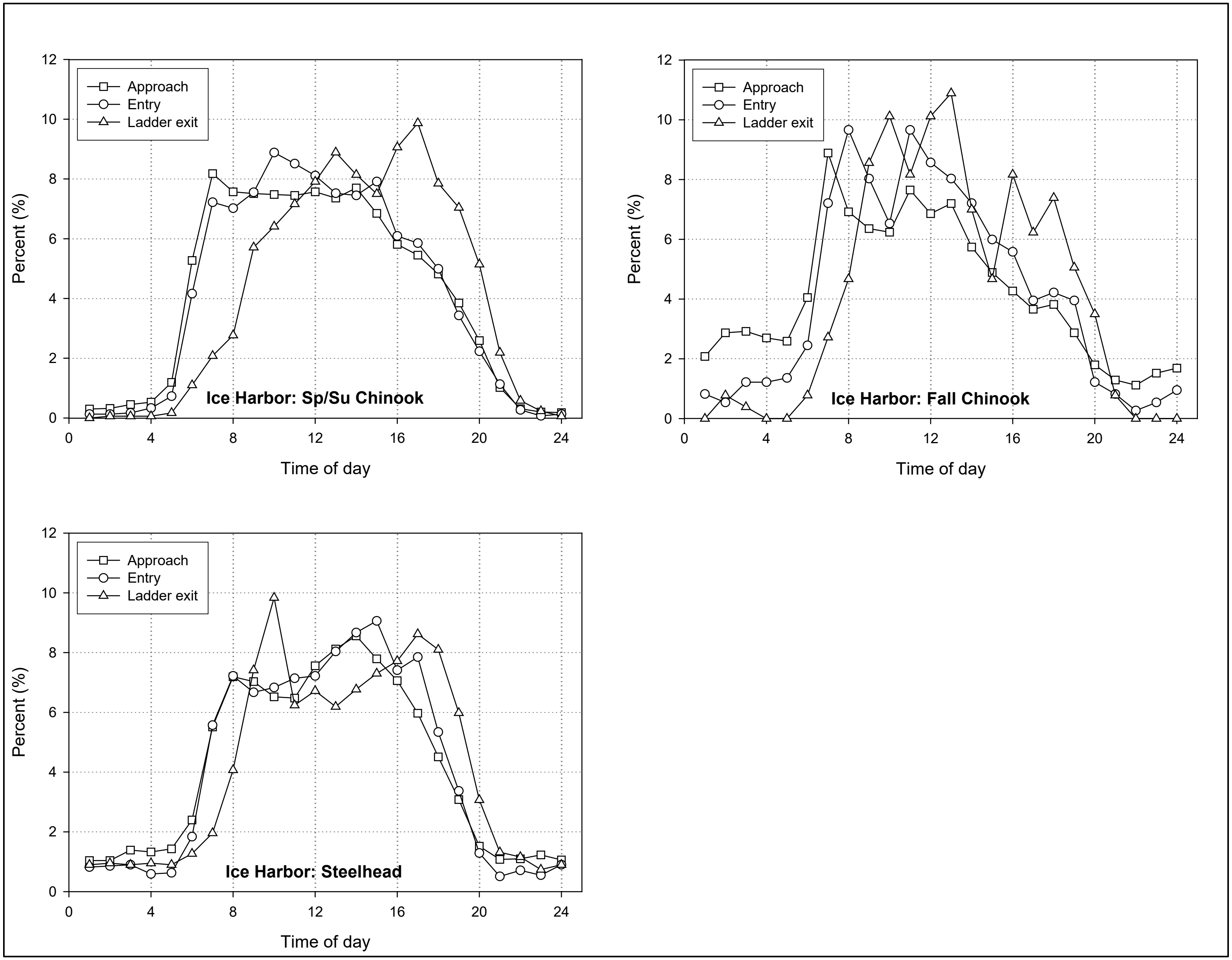


Figure IHR-2. Diel Distribution of Adult Salmonids at Ice Harbor Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

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. Spill for Adult Steelhead Overshoots. Surface spill will be implemented at McNary and the four lower Snake River dams as a means of providing non-powerhouse downstream passage for adult steelhead that overshoot natal tributaries prior to spawning or that strive to repeat a subsequent reproduction cycle (iteroparity). This operation is pursuant to non-discretionary terms and conditions in the 2020 NOAA Fisheries Columbia River System (CRS) Biological Opinion[2], which calls for surface spill via the spillway weir at each of the five projects **March 1–30 and October 1–November 15, three times each week on non-consecutive days for four hours in the morning** (generally between 05:00 and 11:00). This operation is also considered in the 2020 USFWS CRS Biological Opinion[3] as a means of providing safe and effective downstream passage for adult steelhead and other fish.

i. In 2023, spring surface spill will continue through the start of spring spill for juvenile fish on April 10, and fall surface spill will begin on September 1, to

[2] NOAA CRS BiOp, section 2.17.4.G, "*Reduce Take of Overshoot Adult Steelhead*": https://www.fisheries.noaa.gov/webdam/download/109136871

[3] USFWS CRS BiOp, section 5.7.4, "*Off-season Surface Spill for Downstream Passage of Adult Steelhead*": https://ecos.fws.gov/tails/pub/document/17101031

comply with the Agreement for short-term operations of the Columbia River System.[4] As such, in 2023, surface spill for adult steelhead will occur at the four Lower Snake River dams **March 1–April 2 and September 1–November 15, three times each week on non-consecutive days for four hours in the morning**.

2.2.3. 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.

2.2.4. Total dissolved gas (TDG) is monitored at Ice Harbor Dam during the periods defined in **Table IHR-1**, pursuant to the Corps' annual *TDG Management Plan* and current *Dissolved Gas Monitoring Plan of Action*.[5]

2.3. Operating Criteria – Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance Period (3rd week of December – 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. Removal of STSs may begin Monday of the third week of December.

ii. Complete maintenance on all screens.

iii. Inspect STSs prior to installation and operate one trial run (dogged off on deck) to ensure proper operation. 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. Maintain water-up valve capable of operating when needed.

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[4] Stay Agreement: pweb.crohms.org/tmt/JointMotion_TermSheet_CourtOrder_and_Extensions_2023_0831.pdf

[5] TDG Management Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/.
TDG Monitoring Plan of Action: www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality/

ii. Maintain orifice lights operational.

iii. Maintain orifices clean and valves operating correctly.

iv. Maintain orifice air backflush system working correctly.

v. Maintain netting along handrails in good condition.

vi. Maintain netting or covers over orifice chutes in good condition.

2.3.1.4. Dewatering Structure and Flume.

i. Maintain inclined screen in clean and good condition with no gaps between screen panels, damaged panels, or missing silicone.

ii. Maintain screen cleaning system (brush and air flush) operating correctly.

iii. Overflow weirs should be maintained, tested, and operating correctly.

iv. Maintain all valves operating correctly.

v. Maintain flume interior smooth with no rough edges.

vi. Maintain full-flow PIT-tag system as required. Coordinate with PSMFC.

2.3.1.5. Sampling Facilities.

i. Maintain flume dewatering structure in good operating condition with no holes or gaps between dewatering screen panels. Silicone sealer in good condition.

ii. Maintain flume drop gate in good operating condition.

iii. Maintain the wet separator and fish distribution system ready for operation as designed.

iv. Maintain all dewatering screens and seals in separator and flume in good condition with no holes or gaps between panels, or sharp edges.

v. Maintain all valves and switch gates in good operating condition.

vi. Maintain all sampling equipment in good operating condition.

vii. Maintain juvenile PIT-tag system as required. Coordinate with PSMFC.

2.3.1.6. Record all maintenance and inspections.

2.3.1.7. 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. For more information on avian management at Ice Harbor Dam, see the *Predation Monitoring and Deterrence Action Plans* Dam in **Appendix L** (Table 2 and section 7).

2.3.2. Juvenile Facilities – Fish Passage Season (April 1 – 3rd week of December).

Operate in accordance with the following criteria April 1–October 31 for juvenile fish passage, and November 1 until the third week of December 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, clean at least once daily. If flows through an orifice or fish conditions give indications that an orifice may be partially obstructed with debris, close and backflush the orifice to remove the obstruction. If the obstruction cannot be removed, close the orifice and operate the alternate orifice for that gatewell slot. If both orifices become obstructed or plugged with debris, do not operate the turbine unit 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, immediately close the gatewell orifices and shut down the turbine unit 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. Take action be as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow fish to exit the gatewell. Do not close orifices 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 the 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 the 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 unless the turbine unit has not been run since the last inspection. 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 for unscheduled maintenance of STSs in **section 3.2.2**. In no case should a turbine unit be operated with a missing, damaged, or a known non-operational STS or VBS.

vi. Between spring and summer, inspect at least two VBSs in two different turbine units that were operated frequently in the spring. If debris accumulation is noted, inspect other VBSs and clean as necessary.

vii. After October 1, up to half of the STSs may be removed for annual maintenance provided there is no operation of units without screens.

viii. Between Thanksgiving and the Monday of the 3rd week of December, if the National Weather Service forecast for Ice Harbor Dam[6] is below 20°F for 24 hours or longer, STSs may be removed. Prior to removing screens, request special permission from CENWW-OD-T, who will then inform NOAA Fisheries and FPOM.

ix. At the end of the season, make a formal determination as to the adequacy of STS screen mesh and replacement if necessary.

2.3.2.3. Collection Channel.

i. Ensure orifices are 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) range, 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 3.2.2.4** to determine if the unit must be shut down and if fish must be dipped from the gatewell(s).

ii. Ensure orifice lights are functioning and operating in open orifices 24 hrs/day. Replace all burned out orifice lights within 24 hours of notification. Orifice lights and area lights may be turned off the evening before the channel is dewatered at the end of the season (Monday of the 3rd week of December or later) to encourage

[6] NWS weather forecast for Ice Harbor Dam: forecast.weather.gov/MapClick.php?lat=46.2469&lon=-118.8807

fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

iii. Orifice jets hitting no closer than 3' from back wall, collection channel full.

iv. Orifice valves are either fully open or closed.

v. Backflush orifices at least once a day. During periods of high fish and debris passage, April 1–July 31, inspect and backflush orifices once per 8-hour shift, or more frequently as determined by the Project biologist to keep orifices clean.

vi. Ensure the water-up valve is capable of operating when needed.

vii. Maintain netting along handrails and netting or covers over orifice chutes in good condition with no holes or gaps.

2.3.2.4. Dewatering Structure.

i. Maintain 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. Ensure no gaps between screen panels in the inclined screen or holes in the screen panels.

v. Turn off lights at the dewatering structure at night, unless needed for personnel access, to encourage fish to move downstream volitionally.

2.3.2.5. Sampling Facilities.

i. Inspect all screens 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°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. Maintain crowder screen brushes 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. Removable Spillway Weir (RSW).

i. Ice Harbor Dam has one removable spillway weir (RSW) in spillbay 2 that, when open, provides a surface route for fish passage. The RSW can be opened and closed from the control room.

ii. The spill rate through the RSW is a function of the forebay elevation – as the pool elevation increases, more water is spilled over the RSW:

IHR Forebay Elevation (ft)	RSW Spill Rate (kcfs)
437	7.1
437.5	7.6
438	8.1
438.5	8.7
439	9.2
439.5	9.8
440	10.4

iii. The RSW will be in the raised position and operational during spill for juvenile passage (**Appendix E**) and spill for adult steelhead (**section 2.2.2**):

- Raise the spill gate to where it does not touch flow passing down the RSW.
- During high flows, if the Northwest River Forecast Center (NWRFC) inflow forecast for Ice Harbor[7] is above 200 kcfs, coordinate with RCC and CENWW-OD-T to initiate aggressive forebay debris removal to avoid impeding RSW operation. If inflow exceeds 260 kcfs, the upstream river gauge flow is increasing, and the NWRFC inflow forecast is above 300 kcfs, stow the RSW (complete rotation to the landing pad).
- During summer spill (June 21-August 31), when daily average total project outflow is less than 30 kcfs and the inflow forecast remains below 30 kcfs for at least three days on a declining hydrograph, close the RSW and spill according to patterns with no RSW in **Table IHR-6**. If daily average project

[7] NWRFC inflow forecast for Ice Harbor Dam: www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?IHDW1

outflow subsequently increases above 30 kcfs and the inflow forecast remains above 30 kcfs for at least three days, re-open the RSW. Continue to open and close the RSW according to these criteria throughout summer spill.

2.3.2.7. Inspect all facilities according to fish facilities monitoring plans. Record all maintenance and inspections.

2.3.2.8. Avian Predation Management. Operate in accordance with the *Predation Monitoring and Deterrence Action Plans* for Ice Harbor Dam in **Appendix L** (Table 2 and section 7). Monitor bird wires and other avian deterrent devices to ensure good condition and replace any broken wires or devices as soon as possible. Implement harassment program to deter avian predation in areas actively used by birds and not covered by bird wires or other devices. 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.

2.4. Operating Criteria - Adult Fish Facilities.

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

2.4.1.1. Inspect all staff gauges and water level indicators. Repair and/or clean where necessary. Calibrate all water level measuring devices as necessary for proper operations.

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. Inspect all spill gates and ensure they are operable.

2.4.1.5. Maintain fish pumps ready for operation.

2.4.1.6. Maintain adult PIT-tag system as required. Coordinate with PSMFC.

2.4.1.7. 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 Facilities – Adult Fish Passage Season (March 1–December 31).

Note: During extremely high flows when the 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. Maintain water depth over fishway ladder weirs in the range of 1.0’–1.3’.

2.4.2.2. Maintain head on all fishway entrances in the range of 1’–2’.

2.4.2.3. North Shore Entrances (NEW-1 and NEW-2).

i. Operate downstream gate closest to shore (NEW-1). NEW-2 will only be operated for adult salmonid passage if NEW-1 gate is not functioning properly to maintain criteria. Repair NEW-1 gate and return to service as soon as possible.

ii. Elevation at top of gate on sill = 332.25’.

iii. Weir depth 8' or greater below tailwater. At tailwaters less than 340.25’, weirs should be on sill. Note that at low flow and tailwater, some of the diffusers are above tailwater and the project may only be able to maintain a 6’ weir depth.

iv. 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.

2.4.2.4. North Powerhouse Entrances (NFE-1&2).

i. Operate one downstream gate.

ii. Elevation at top of gate on sill = 332.25’.

iii. Weir depth ≥ 8’ below tailwater. At tailwater lower 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*.]

2.4.2.5. South Shore Entrances (SFE-1 and SFE-2).

i. Operate entrance closest to powerhouse (SFE-1). SFE-2 will only be operated for adult salmonid passage in the event SFE-1 gate is not functioning properly to maintain criteria. Repair SFE-1 gate and return to service as soon as possible.

ii. Elevation of top of SFE-1 gate on sill = 332.25’. Elevation of top of SFE-2 gate on sill = 333.25’ with the installation of the lamprey passage structure.

iii. Weir depth 8’ or greater below tailwater. At tailwater lower than elevation 340.25’ for SFE-1 and 341.25’ for SFE-2, weirs should be on sill. *[Note: At low tailwater, weirs will bottom out and will be less than 8’ below tailwater.]*

iv. From July 1 to October 1, operate entrance furthest from powerhouse (SFE-2) for adult lamprey passage.

- To facilitate lamprey passage, set the telescoping weir top leaf to approximately 358.34' elevation. The lower leaf elevation will thus be approximately 333.25', which will provide a 1.25' opening between the lower leaf and concrete sill. The aluminum entrance structure, which provides a 1' opening and vertical salmon exclusion bars spaced at 1.5" will allow for lamprey entrance into the ladder by reducing flow velocities to roughly 2-4 fps. There will be no flow over the top of the telescoping weirs in this configuration.

- If SFE-1 weir experiences operational problems during the adult lamprey passage period, lower SFE-2 to shut off lamprey passage and operate to facilitate salmon passage. Once SFE-1 is back in operation, resume operating SFE-2 for lamprey passage.

2.4.2.6. Channel Velocity. Maintain water velocities in the range of 1.5 - 4.0 feet per second (fps). Ice Harbor 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 based on the single most representative position, but also the placement for ease of installation and maintenance. In addition, head is measured at the north, north powerhouse, and south fishway entrances.

2.4.2.7. Operate four floating orifices gates (FOGs): OG1, 4, 10, and 12.

2.4.2.8. Operate with trashracks and picketed leads correctly installed. The correct position for the trashrack at each ladder exit is at the bottom of the guide slot. Maximum head on ladder exits and picketed leads is 0.3'.

2.4.2.9. Maintain all staff gauges in readable condition at all water levels encountered during the fish passage period. Repair or clean as necessary.

2.4.2.10. Counting Windows. Counting slots at Ice Harbor are fixed at a width of 19.5". When not counting, open the crowder to full count slot width and remove the picketed leads. During counting, open the crowder as far as possible to allow accurate counting. Maintain all equipment in good condition and clean the counting window and backboard as needed to maintain good visibility.

2.4.2.11. PIT-Tag System. 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. Inspect picketed leads during all inspections to ensure they are clean and in the correct position (all the way down).

iv. Check calibration of fishway control system twice per month to ensure 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, immediately take corrective actions.

vi. Record all inspections.

2.4.2.13. Fishway Temperature Monitoring. From June 1 through September 30, measure water temperature at adult fishway entrances and exits and submit data to the Fish Passage Center (FPC) weekly for posting online.[8] Ensure the location of the monitors meets the following criteria:

i. Within 10 meters of all shore-oriented entrances and exits.

ii. Entrance monitor within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers, if possible, to allow for sufficient mixing with surface water.

iii. Exit monitor 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, verify that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.5. Fish Facility Monitoring & Reporting.

2.5.1. Monitoring.

2.5.1.1. Project biologists shall inspect fish passage facilities at the frequencies described above in the juvenile and adult fish facilities operating criteria, **sections 2.3 and 2.4**.

2.5.1.2. Project biologists inspect project facilities once per month and during dewaterings for the presence of zebra and Quagga mussels. Biologists shall provide a monthly report to CENWW-OD-T summarizing mussel inspections.

2.5.2. Reporting.

2.5.2.1. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31 summarizing project and fish facility operations for each week (Friday through Thursday), along with an evaluation of resulting fish passage conditions. The reports will be e-mailed CENWW-OD-T by noon the following Monday. The weekly reports will include:

i. Out-of-criteria situations and subsequent corrective actions taken.

[8] FPC ladder temperature data: www.fpc.org/smolt/smolt_queries/Q_ladderwatertempgraphv2.php

ii. Equipment malfunctions, breakdowns, or damage, with a summary of repairs.

iii. Adult fishway control calibrations.

iv. STS and VBS inspections.

v. Unusual activities that at the project that may have affected fish passage.

2.5.2.2. In-Season. Any adverse or negative impact to fish or fishways shall be reported in a *Memorandum for the Record* (MFR) prepared by Project biologists and sent to FPOM by the next working day, pursuant to the coordination process and template in **FPP Chapter 1 – Overview** (section 2.3.2).

2.5.2.3. Annual Reports. Project biologists shall prepare a draft annual report by February 10 and a final report by March 15 summarizing fish facility operations 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 actions.

3. FISH FACILITIES MAINTENANCE

3.1. Dewatering & Fish Handling.

3.1.1. Dewatering (also referred to as "unwatering") shall be accomplished pursuant to approved *Dewatering Guidelines and Fish Salvage Plans* in **Appendix F**. Project *Dewatering Plans*[9] were reviewed and revised in 2011 to ensure they comply with **Appendix F**.

3.1.2. Project biologists should be present to provide guidance at all project activities that may involve fish handling. 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.

3.2.1.1. Scheduled maintenance of juvenile facilities is conducted year-round.

3.2.1.2. Long-term maintenance or modifications that require facilities out of service for extended periods of time are conducted during the winter maintenance period, beginning as early as the Monday of the 3rd week of December through March 31.

3.2.1.3. During fish passage season, parts of the facilities are maintained on a daily, weekly, or longer interval to keep them in proper operating condition.

[9] Project Dewatering Plans: pweb.crohms.org/tmt/documents/FPOM/2010/

3.2.2. Unscheduled Maintenance.

3.2.2.1. Unscheduled maintenance is the correction of any situation that prevents facilities from operating within criteria or that will impact fish passage or survival.

3.2.2.2. Maintenance of facilities such as STSs that 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.

3.2.2.3. 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.

3.2.2.4. 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.

3.2.2.5. 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.

3.2.2.6. 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**.

3.2.2.7. 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.

3.3.1.1. Scheduled maintenance that will have no effect on fish passage may be conducted at any time.

3.3.1.2. Scheduled maintenance of a facility that must be dewatered, or maintenance that will have a significant effect on fish passage, will be done during the January–February winter maintenance period. Winter maintenance is normally conducted one fish ladder at a time to maintain fish passage.

3.3.1.3. When facilities are not being worked on 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. 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.

3.3.2.3. 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.

3.3.2.4. 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.

i. If a pump fails during 2-pump operation, the pump on standby will be operated to provide the necessary flows.

ii. If two or all three pumps fail, the NEW1 weir will be maintained at a level of 6' below tailwater until repairs are made.

3.3.2.5. 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.

i. 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.

ii. If criteria cannot be met within 24 hours, the floating orifices should be closed in the following order: OG-12 and OG-10.

iii. 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.

iv. 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.

3.3.2.6. Fishway Entrances. The fishway entrances consist of main entrance weirs with hoists and automatic controls, and floating orifices which auto-regulate with tailwater fluctuations. If any of the automatic controls malfunction, Project personnel will operate the weirs manually to maintain within criteria. If there is a failure that prevents manual operation of the entrance, an alternate entrance will be opened until repairs can be made. If a floating orifice fails, it will be pulled out of the water and the entrance bulkheaded off until the floating orifice is repaired.

3.3.2.7. Diffuser Gratings.

3.3.2.7.a. 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.

3.3.2.7.b. 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.**). 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 in **Table IHR-4** to enhance adult and juvenile fish passage. Model studies of Ice Harbor show that spill at low flows can cause eddying in front of the powerhouse. The unit priority order is defined to minimize eddies during spill and provide the best fish passage conditions. If a 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 needed 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 operation of a single unit on the line jeopardizes BPA system reliability. Therefore, IHR should not be run as a single-unit 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. Turbine unit flow and power output at the lower and upper limits of the ±1% peak efficiency range are defined in **Table IHR-5**. Turbine units will be operated within these ranges according to *BPA's Load Shaping Guidelines* (**Appendix C**), as summarized below.

4.2.2. In-Season: April 3–August 31 (Spring/Summer Spill for Juvenile Fish Passage).

4.2.2.1. Ice Harbor Unit 3 was rebuilt with a new adjustable-blade runner design and will have a restricted in-season operating range within the 1%, as defined in **Table IHR-5**. Based on CFD and physical modeling, flow quality in the Unit 3 draft tube is optimized for fish passage by establishing the minimum blade angle as the lower limit, which is about 200–400 cfs above the 1% lower limit. Therefore, the in-season operating range for Unit 3 will be between the Fish Passage (FP) Lower Limit (minimum blade angle) and the 1% Upper Limit. This range may be adjusted based on results of index testing in spring 2023 and biological testing in September 2023. During periods of minimum generation with a single unit in use, Unit 3 will be operated at the 1% lower limit to provide more flow for spill, in accordance with **section 4.2.2.3** below.

4.2.2.2. Turbine units will be operated within ±1% of peak turbine efficiency (1% range), except under limited conditions and durations when turbines may be operated above the 1% range for the use of reserves or for TDG management during high flows (refer to **Appendix C** for more information). All required fish passage spill operations will be met prior to operating turbines above the 1% range. If in-season 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 4.3.7**), 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 to flush fish from the unit.

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

iv. Comply with other coordinated fish measures.

4.2.2.3. Minimum Generation. During low flows, all lower Snake River projects may be required to keep one generating unit online to maintain power system reliability. The minimum generation flow range for each unit is defined in FOP Table 1 (**Appendix E**), as derived from the lower limit of the 1% range and actual unit operations. During spring and summer spill for juvenile fish passage, if there is not enough river flow to meet this generation requirement and the FOP spill target, the project will operate the first available priority unit at minimum generation and spill the remainder of outflow. Actual attainable minimum generation values may vary depending on real-time conditions.

4.2.3. Off-Season: September 1–April 2. 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. Unit 3 is still recommended to operate within the FP range defined above in **section 4.2.2**. Operation outside the 1% range is allowed if needed for power generation or other needs.

4.3. Turbine Unit Maintenance.

4.3.1. Turbine unit maintenance schedules will be reviewed annually by Project and Operations Division biologists for fish impacts. If the maintenance requires operating outside of FPP criteria, the work will be coordinated with regional salmon managers via FPOM (see coordination process in **FPP Chapter 1 – Overview** (section 2.3).

4.3.2. Priority unit maintenance will be scheduled for the winter maintenance period or when there are few fish passing the project, to the extent possible. Impacts to migrating adults should be minimized.

4.3.3. 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. Annual maintenance of priority units for adult passage is normally conducted in November or December but can be completed in mid-August.

4.3.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take more than one year to accomplish.

4.3.5. 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's Load Shaping Guidelines* (**Appendix C**) to minimize impacts on juvenile fish.

4.3.6. 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.

i. Pre-Maintenance: Units 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 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 4.3.7**.

ii. Post-Maintenance: 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 to get the unit up to operational temperature.

4.3.7. Unwatering Units. Unwatering turbine units (also referred to as "dewatering") in accordance with project *Dewatering Plans*.[9] If the turbine unit scroll case and/or draft tube is to be dewatered, operate the unit at full load for a minimum of 15 minutes prior to installing tail logs or lowering head gates.[10] If not 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 scroll case prior to installing stop logs. If a turbine unit is out of service for maintenance for an extended period 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.

4.3.8. Doble Testing. The yearly outage schedule is defined in **Appendix A**. Doble testing of transformers 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.

4.3.9. 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

[10] Head gates may also be referred to as "operating" gates at some projects. The terms are interchangeable.

facilities are working correctly and not injure 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.

4.3.9.1. 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.

4.3.9.2. 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.

4.3.9.3. When inspection or repair work can be scheduled ahead of time, Project personnel shall schedule unit outages through the approved outage scheduling procedure by noon Tuesday of the week prior to the outage. Project personnel shall also notify CENWW-OD-T and RCC of the intended work by the same time. RCC will coordinate the work activities through TMT, then issue a teletype issuing instructions to project and BPA personnel for the scheduled work, as follows:

i. Spill will be increased by one gate stop (about 1.7 kcfs) above passing inflow to slowly lower the Ice Harbor pool to MOP prior to scheduled work taking place.

ii. 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 work started). At this point, screen inspections shall stop. (At Snake River projects, this should allow about one normal workday for the scheduled work.)

iii. At the conclusion of the work, the reservoir shall be drafted back down to MOP utilizing a one spillbay stop increase above passing inflow.

iv. If work, such as screen inspections, is incomplete, Project personnel shall schedule another turbine unit outage for a date where it can be implemented.

4.3.9.4. If the required work is of an emergency nature that does not normally require the unit 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 drafted back to MOP using one spillbay stop setting above passing inflow.

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 [b]		1% Lower Limit		1% Upper Limit		Operating Limit [b]	
	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	103.6	16,568
88	54.2	8,494	86.6	13,574	97.3	16,144	54.3	8,417	93.1	14,436	104.1	16,420
89	55.0	8,518	87.6	13,569	99.0	16,187	55.1	8,441	94.2	14,430	104.5	16,252
90	55.8	8,542	88.6	13,563	100.1	16,158	55.9	8,465	95.3	14,424	104.5	16,034
91	56.5	8,548	89.8	13,585	101.0	16,058	56.6	8,471	96.5	14,448	104.5	15,822
92	57.1	8,554	90.9	13,607	101.9	15,960	57.3	8,477	97.8	14,471	104.5	15,614
93	57.8	8,559	92.1	13,628	102.8	15,864	58.0	8,482	99.0	14,494	104.5	15,411
94	58.5	8,565	93.2	13,649	103.6	15,769	58.6	8,488	100.3	14,516	104.5	15,213
95	59.2	8,570	94.4	13,669	104.5	15,675	59.3	8,493	101.5	14,537	104.5	15,019
96	59.9	8,589	95.3	13,662	104.5	15,425	60.1	8,511	102.5	14,530	104.5	14,845
97	60.7	8,607	96.3	13,655	104.5	15,180	60.8	8,529	103.6	14,522	104.5	14,676
98	61.5	8,624	97.3	13,648	104.5	14,941	61.6	8,546	104.6	14,515	104.5	14,509
99	62.2	8,641	98.2	13,641	104.5	14,708	62.4	8,563	105.7	14,508	104.5	14,347
100	63.0	8,658	99.2	13,634	104.5	14,481	63.1	8,580	106.7	14,500	104.5	14,187
101	64.0	8,707	99.9	13,590	104.5	14,318	64.1	8,629	107.4	14,454	104.5	14,037
102	65.0	8,756	100.6	13,547	104.5	14,158	65.2	8,677	108.2	14,408	104.5	13,890
103	66.0	8,804	101.3	13,505	104.5	14,001	66.2	8,725	108.9	14,363	104.5	13,746
104	67.0	8,850	102.0	13,463	104.5	13,847	67.2	8,771	109.7	14,319	104.5	13,605
105	68.0	8,896	102.6	13,422	104.5	13,697	68.2	8,816	110.4	14,275	104.5	13,466
	IHR Unit 2 [c] – with STS						IHR Unit 2 [c] – No STS					
85	77.2	12,179	87.1	13,753	89.4	14,254	77.9	12,193	88.1	13,795	91.2	14,392
86	78.5	12,225	88.3	13,750	90.8	14,290	79.1	12,232	89.4	13,810	92.7	14,389
87	79.8	12,265	89.5	13,759	92.2	14,333	80.4	12,272	90.7	13,835	94.2	14,509
88	81.1	12,303	90.8	13,769	93.6	14,363	81.7	12,310	92.1	13,877	95.6	14,511
89	82.4	12,339	92.0	13,776	95.0	14,474	82.9	12,336	93.6	13,924	97.1	14,500
90	83.7	12,373	93.2	13,777	96.4	14,508	84.1	12,351	95.1	13,963	98.6	14,619
91	85.0	12,399	94.5	13,778	97.8	14,526	85.1	12,349	96.6	14,006	100.1	14,643
92	86.1	12,401	95.8	13,800	99.2	14,536	86.3	12,364	98.0	14,049	101.5	14,762
93	86.8	12,354	96.9	13,803	100.6	14,623	87.3	12,366	98.9	14,007	103.0	14,787
94	87.5	12,325	98.3	13,845	102.0	14,619	87.9	12,307	100.3	14,050	103.5	14,628
95	88.8	12,381	99.3	13,835	103.2	14,568	89.4	12,368	101.6	14,062	103.5	14,300
96	89.8	12,389	100.8	13,907	103.5	14,469	90.6	12,393	103.0	14,083	103.5	14,024
97	90.8	12,389	102.0	13,917	103.5	14,229	92.1	12,455	104.3	14,110	103.5	13,782
98	91.9	12,384	103.6	13,970	103.5	13,977	93.4	12,491	105.8	14,146	103.5	13,576
99	92.9	12,374	105.1	14,006	103.5	13,744	94.2	12,466	107.2	14,182	103.5	13,404
100	93.8	12,364	106.4	14,033	103.5	13,543	95.4	12,501	108.6	14,225	103.5	13,254
101	94.7	12,358	107.8	14,068	103.5	13,365	96.7	12,541	110.0	14,266	103.5	13,114
102	95.8	12,364	109.2	14,088	103.5	13,205	97.5	12,520	111.4	14,310	103.5	12,979
103	96.9	12,370	110.5	14,107	103.5	13,061	98.3	12,503	112.9	14,357	103.5	12,852

Project	IHR Unit 3 c – with STS								IHR Unit 3 c – No STS							
Head	1% Lower Limit		FP Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		FP Lower Limit		1% Upper Limit		Operating Limit	
(feet)	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	55.3	8,657	57.3	8,894	86.1	13,473	94.1	14,920	55.1	8,585	57.3	8,858	89.0	13,862	93.6	14,681
86	56.4	8,708	58.0	8,904	87.4	13,501	95.5	14,990	56.2	8,647	58.2	8,878	90.4	13,903	95.1	14,709
87	57.3	8,748	59.0	8,935	88.9	13,572	96.6	15,007	57.4	8,714	59.2	8,914	91.3	13,855	96.4	14,703
88	58.0	8,754	59.6	8,930	90.4	13,626	97.9	14,992	58.3	8,733	60.0	8,927	93.2	13,966	97.6	14,699
89	58.6	8,741	60.6	8,953	92.0	13,712	99.3	14,944	59.0	8,744	60.7	8,921	94.8	14,035	98.9	14,708
90	59.3	8,734	61.4	8,953	93.9	13,831	100.6	14,944	59.8	8,749	61.6	8,938	96.6	14,138	100.2	14,725
91	60.0	8,741	62.2	8,963	95.5	13,904	101.9	14,937	60.5	8,755	62.4	8,939	98.4	14,237	101.5	14,721
92	60.8	8,749	62.9	8,962	97.2	13,980	103.1	14,949	61.3	8,767	63.1	8,945	100.3	14,331	103.1	14,765
93	61.8	8,784	63.8	8,983	98.3	13,975	104.4	14,966	62.2	8,794	63.9	8,962	101.5	14,346	104.5	14,795
94	62.9	8,828	65.2	9,071	99.5	13,981	104.5	14,797	63.2	8,826	64.9	8,993	102.9	14,374	104.5	14,617
95	63.8	8,858	66.5	9,157	101.0	14,018	104.5	14,587	64.2	8,862	65.8	9,029	104.4	14,426	104.5	14,435
96	64.7	8,877	67.8	9,225	103.1	14,152	104.5	14,375	65.1	8,895	66.8	9,066	105.9	14,468	104.5	14,253
97	65.6	8,909	69.1	9,308	105.6	14,355	104.5	14,180	66.1	8,930	67.8	9,105	107.6	14,549	104.5	14,075
98	66.4	8,936	70.1	9,349	107.8	14,502	104.5	13,999	67.0	8,954	68.8	9,135	109.2	14,602	104.5	13,903
99	67.5	8,981	70.8	9,342	109.2	14,519	104.5	13,827	67.8	8,969	69.8	9,170	111.0	14,689	104.5	13,738
100	68.4	9,002	71.3	9,310	110.9	14,593	104.5	13,666	68.7	8,999	70.9	9,211	113.0	14,797	104.5	13,575
101	69.3	9,021	71.9	9,290	112.5	14,636	104.5	13,515	69.7	9,030	71.7	9,218	114.5	14,831	104.5	13,418
102	70.3	9,047	72.6	9,283	114.0	14,684	104.5	13,372	70.7	9,058	72.4	9,219	115.8	14,846	104.5	13,275
103	71.4	9,093	73.2	9,254	114.9	14,641	104.5	13,236	71.8	9,102	73.4	9,249	117.3	14,872	104.5	13,138

NOTE: Unit 3 lower limit is set at the Fish Passage (FP) Lower Limit, which is about 200-400 cfs above the 1% Lower Limit. The intent is to optimize flow conditions in the draft tube for fish that pass through Unit 3. During minimum generation, Unit 3 will be operated at the 1% Lower Limit to provide more flow for spill. See **section 4.2** for more information.

Project Head (feet)	IHR Unit 4 (Blades Locked @ 22.3°) – with STS [d]						IHR Unit 4 (Blades Locked @ 22.3°) – No STS [d]					
	1% Lower Limit		Peak Efficiency		1% Upper Limit		1% Lower Limit		Peak Efficiency		1% Upper Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	76.2	12,151	80.0	12,687	82.8	13,195	76.4	12,147	80.1	12,667	83.3	13,243
86	77.7	12,228	81.3	12,726	83.8	13,196	77.8	12,225	81.4	12,708	84.4	13,259
87	79.1	12,302	82.5	12,764	84.9	13,197	79.3	12,299	82.6	12,747	85.6	13,274
88	80.5	12,374	83.8	12,800	85.9	13,196	80.7	12,371	83.9	12,784	86.7	13,287
89	82.0	12,441	85.0	12,836	86.9	13,193	82.2	12,439	85.5	12,869	87.8	13,298
90	83.3	12,494	86.3	12,870	87.9	13,186	83.5	12,493	86.4	12,856	88.9	13,305
91	84.5	12,523	87.5	12,905	88.9	13,184	84.7	12,520	87.7	12,893	90.1	13,317
92	85.6	12,547	88.5	12,893	89.9	13,181	85.8	12,547	88.6	12,883	91.2	13,330
93	86.7	12,562	89.4	12,882	91.0	13,179	87.0	12,565	89.6	12,873	92.3	13,342
94	87.8	12,574	90.6	12,915	92.0	13,177	88.0	12,579	90.9	12,908	93.5	13,355
95	88.8	12,580	91.6	12,903	93.0	13,173	89.1	12,590	91.8	12,897	94.6	13,365
96	89.9	12,597	92.5	12,895	94.2	13,203	90.2	12,606	92.8	12,892	96.0	13,411
97	91.0	12,614	93.8	12,932	95.4	13,231	91.3	12,624	94.0	12,929	97.3	13,454
98	92.1	12,633	94.7	12,923	96.6	13,255	92.4	12,643	95.0	12,923	98.6	13,493
99	93.2	12,654	95.9	12,958	97.8	13,278	93.5	12,665	96.2	12,959	99.9	13,531
100	94.3	12,679	97.2	12,990	98.9	13,297	94.7	12,691	97.5	12,993	101.2	13,565
101	95.4	12,687	98.1	12,986	100.1	13,317	95.7	12,695	98.5	12,986	102.3	13,570
102	96.4	12,694	99.1	12,982	101.3	13,339	96.7	12,699	99.4	12,979	103.4	13,577
103	97.4	12,700	100.1	12,978	102.5	13,364	97.7	12,701	100.4	12,973	104.5	13,587
104	98.4	12,705	101.0	12,974	103.7	13,389	98.7	12,703	101.3	12,966	105.6	13,597
105	99.4	12,711	102.3	13,010	104.9	13,413	99.7	12,706	102.6	13,000	106.7	13,604
	IHR Units 5, 6 (Blades Locked @ 23.8°) – with STS [d]						IHR Units 5, 6 (Blades Locked @ 23.8°) – No STS [d]					
85	77.9	12,446	83.6	13,280	87.3	13,956	79.2	12,624	83.0	13,156	87.7	13,974
86	79.6	12,565	85.0	13,343	88.5	13,970	80.6	12,691	84.3	13,199	89.1	14,023
87	81.3	12,678	86.4	13,404	89.6	13,980	82.0	12,752	85.6	13,240	90.5	14,074
88	82.9	12,768	87.9	13,464	90.8	13,989	83.3	12,807	86.9	13,281	91.9	14,124
89	84.4	12,848	89.3	13,522	91.9	13,995	84.6	12,847	88.2	13,320	93.3	14,171
90	85.6	12,880	90.4	13,530	93.0	13,997	85.8	12,878	89.5	13,358	94.7	14,214
91	87.1	12,957	91.9	13,589	94.2	14,007	87.0	12,900	90.8	13,396	96.3	14,276
92	88.6	13,033	93.3	13,646	95.3	14,017	88.1	12,921	91.8	13,386	97.8	14,335
93	90.2	13,109	94.4	13,654	96.5	14,029	89.3	12,941	93.1	13,422	99.3	14,397
94	91.7	13,185	95.9	13,710	97.7	14,041	90.4	12,956	94.1	13,411	100.9	14,455
95	93.3	13,260	97.4	13,765	98.9	14,053	91.5	12,966	95.4	13,446	102.4	14,512
96	94.1	13,230	98.2	13,739	100.0	14,062	92.4	12,951	96.4	13,438	103.3	14,486
97	94.9	13,199	99.1	13,712	101.1	14,073	93.3	12,939	97.4	13,430	104.3	14,460
98	95.6	13,167	100.3	13,732	102.3	14,080	94.2	12,925	98.7	13,466	105.2	14,430
99	96.4	13,134	101.2	13,705	103.4	14,088	95.1	12,911	99.7	13,458	106.1	14,401
100	97.1	13,097	102.0	13,678	104.5	14,096	96.0	12,905	101.0	13,493	106.9	14,371
101	98.1	13,086	102.9	13,651	105.7	14,099	97.2	12,931	101.9	13,483	107.8	14,332
102	99.0	13,075	104.1	13,668	106.8	14,100	98.4	12,957	102.9	13,474	108.6	14,294
103	99.9	13,063	104.9	13,641	107.8	14,102	99.6	12,980	103.9	13,465	109.4	14,257
104	100.8	13,052	105.7	13,613	108.9	14,103	100.8	13,004	105.2	13,498	110.2	14,217
105	101.7	13,040	106.9	13,628	110.1	14,107	102.0	13,026	106.2	13,488	111.0	14,176

a. Values provided by HDC, as updated for Unit 2 (Sep 2021) and Unit 3 (Nov 2022) with new runner design and Units 4, 5, 6 with locked blades (May 2022). Flow (cfs) was calculated based on turbine efficiency, project head, and power output (MW).

b. "Operating Limit" is the maximum safe operating point based on cavitation or generator limit (added Feb 2018). IHR Units 1-3 generator limit restricts turbine output at higher heads. Values shaded in gray indicate Operating Limit is below 1% Upper Limit.

c. Unit 2 was rebuilt with a new Voith non-adjustable runner design to reduce impacts to fish (completed May 2019). Unit 3 is out of service until 2023 for installation of a new Voith Kaplan adjustable runner design. When Unit 3 returns to service, Unit 1 will be taken out of service to install a new adjustable runner design.

d. Units 4, 5, and 6 have locked runner blades and a restricted operating range until the blade seals are repaired or replaced. Table values are based on abbreviated index tests for U4 (hydraulic) in 2021, U5 (welded) in 2017, and U6 (hydraulic) in 2019, as updated May 2022.

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. [*page 1 of 2*] 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**

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	6	7		6	1	**44**	**74.1**
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 low flow criteria are met (below 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns in this table.

Table IHR-7. [*page 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**

Total Outflow (kcfs)	Spill [a] (kcfs)	Spill (%) [b]	1	2 [c]	3	4	5	6	7	8	9	10	Total Stops (#)
			IHR Spill Patterns for 30% Spill - # Gate Stops per Spillbay										
164.6	81.5	49.5%		RSW	6	5	6	6	6	6	6	2	43
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'.
b. At total outflow > ~118.7 kcfs, spill will be > 30% (project at max turbine capacity).
c. RSW in Bay 2 = ~8.4 kcfs spill at forebay 438.0'. When low flow criteria are met (below 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns **Table IHR-6**.

Table IHR-8. [*page 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'.

b. RSW in Bay 2 = ~8.4 kcfs spill at forebay 438.0 ft. When low flow criteria are met (below 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns **Table IHR-6**.

2023 Fish Passage Plan

Chapter 7 – Lower Monumental Dam

Table of Contents

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’/hour
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**.

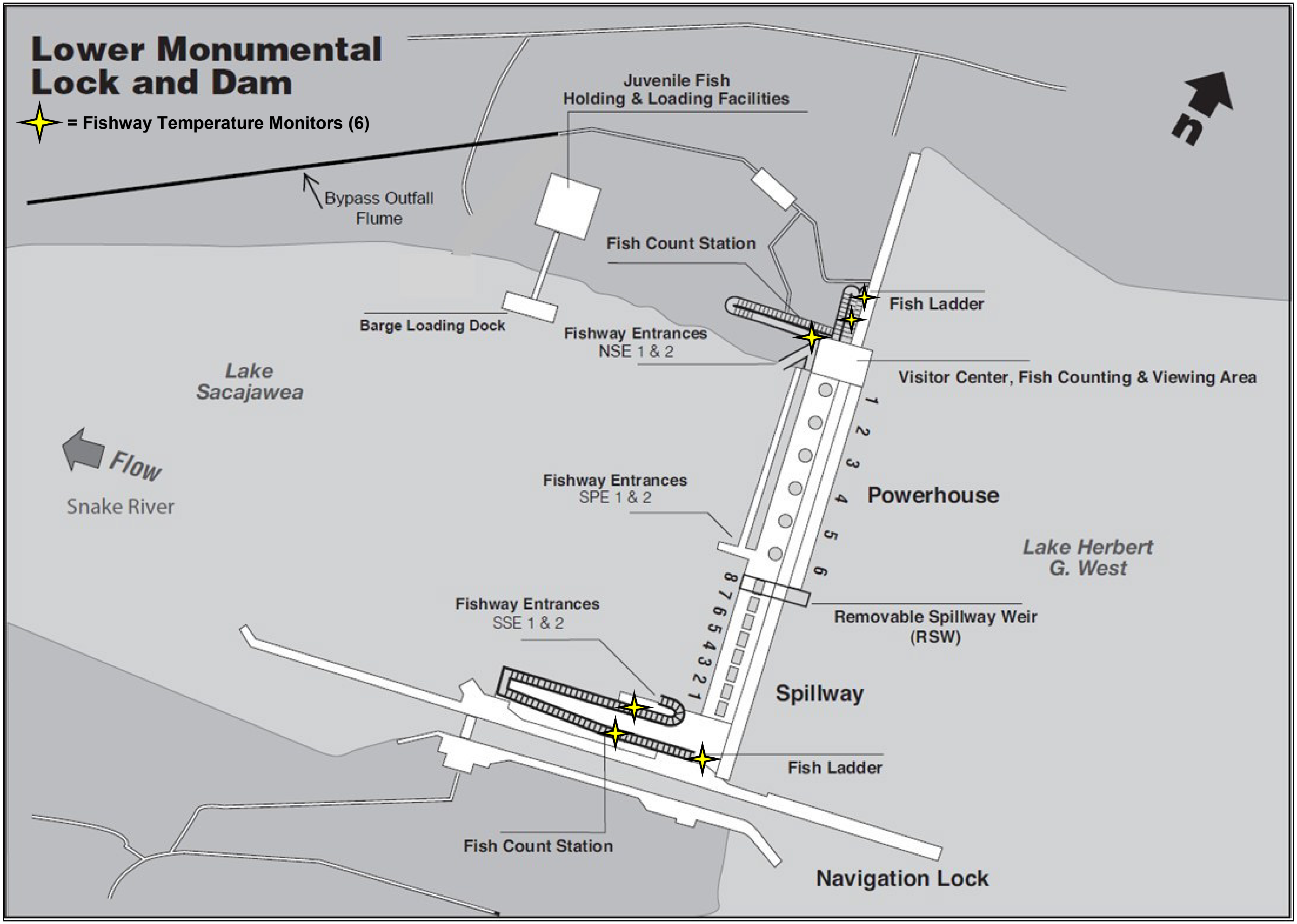
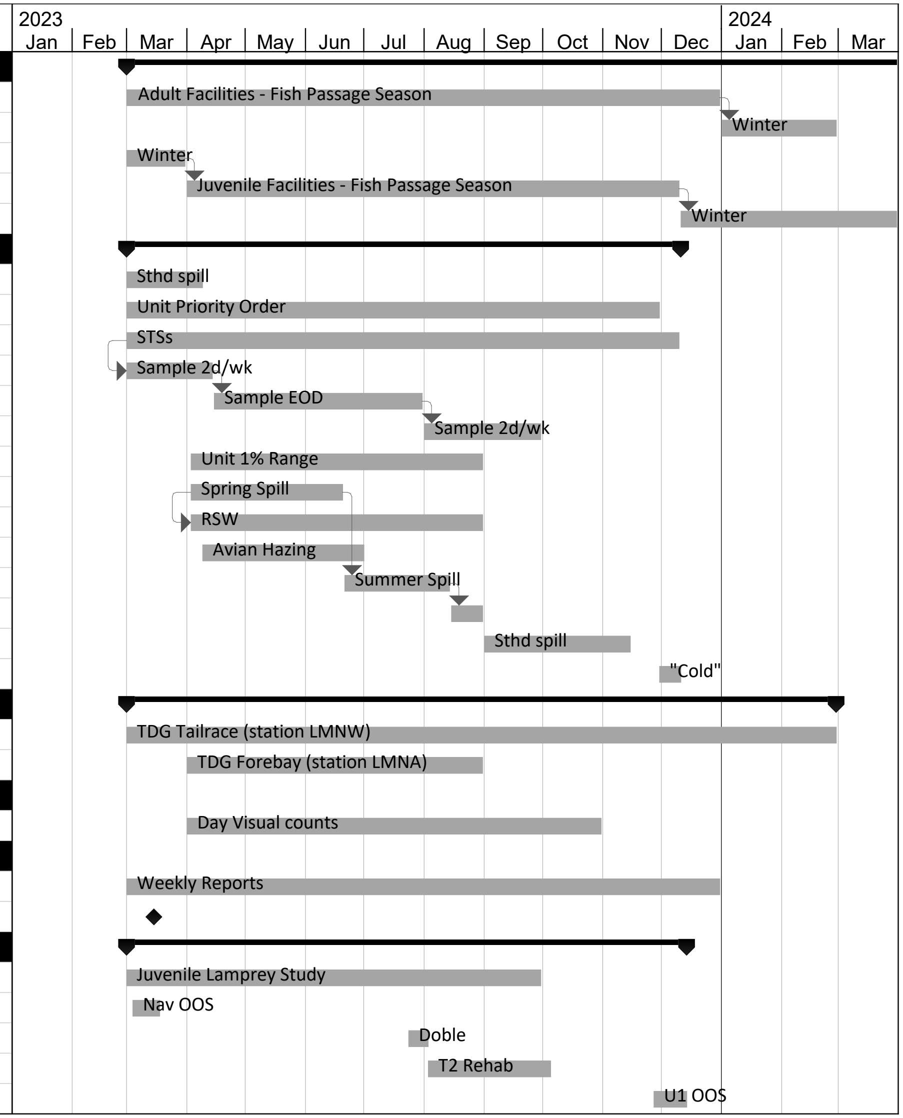


Figure LMN-1. Lower Monumental Lock & Dam General Site Plan.

Table LMN-1. Lower Monumental Dam Schedule of Operations and Actions Defined in the 2023 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**Wed 3/1/23**	**Sun 3/31/24**	
Adult Facilities - Fish Passage Season	Wed 3/1/23	Sun 12/31/23	2.4.2
Adult Facilities - Winter Maintenance	Mon 1/1/24	Thu 2/29/24	2.4.1
Juvenile Facilities - Winter Maintenance	Wed 3/1/23	Fri 3/31/23	2.3.1
Juvenile Facilities - Fish Passage Season	Sat 4/1/23	Sun 12/10/23	2.3.2
	Mon 12/11/23	Sun 3/31/24	2.3.1
PROJECT OPERATIONS FOR FISH PASSAGE	**Wed 3/1/23**	**Mon 12/11/23**	
RSW Spill for Adult Steelhead	Wed 3/1/23	Sun 4/9/23	2.2.2
Turbine unit priority order	Wed 3/1/23	Thu 11/30/23	4.1
STSs (early start in 2023)	Wed 3/1/23	Sun 12/10/23	2.3.2
Condition Sampling 2 days/week	Wed 3/1/23	Fri 4/14/23	App J 5.1
Condition Sampling every other day	Sat 4/15/23	Mon 7/31/23	App J 5.1
Condition Sampling 2 days/week	Tue 8/1/23	Sat 9/30/23	App J 5.1
Turbine unit 1% operating range	Mon 4/3/23	Thu 8/31/23	4.2
Spring Spill	Mon 4/3/23	Tue 6/20/23	App E (FOP)
RSW open (end date approx)	Mon 4/3/23	Thu 8/31/23	2.3.2.6
Avian hazing	Sun 4/9/23	Sat 7/1/23	App L
Summer Spill	Wed 6/21/23	Mon 8/14/23	App E (FOP)
Late Summer Spill	Tue 8/15/23	Thu 8/31/23	App E (FOP)
RSW Spill for Adult Steelhead	Fri 9/1/23	Wed 11/15/23	2.2.2
STS removal during cold weather	Thu 11/30/23	Mon 12/11/23	2.3.2.2.viii
TDG MONITORING	**Wed 3/1/23**	**Thu 2/29/24**	
TDG Monitoring - Tailrace (year-round)	Wed 3/1/23	Thu 2/29/24	2.2
TDG Monitoring - Forebay	Sat 4/1/23	Thu 8/31/23	2.2
ADULT FISH COUNTING	**Sat 4/1/23**	**Tue 10/31/23**	
Day Visual 0500-2100 PDT	Sat 4/1/23	Tue 10/31/23	Table LMN-3
REPORTS	**Wed 3/1/23**	**Sun 12/31/23**	
Weekly Reports	Wed 3/1/23	Sun 12/31/23	2.5.2
Annual Report due (for previous year)	Wed 3/15/23	Wed 3/15/23	2.5.2
SPECIAL OPS & STUDIES (Appendix A)	**Wed 3/1/23**	**Thu 12/14/23**	
Juvenile Lamprey Survival Study	Wed 3/1/23	Sat 9/30/23	App A 7.2.1
Navigation Lock annual outage	Sat 3/4/23	Sat 3/18/23	App A 1.4
Doble Testing T1 (Units 1-4)	Mon 7/24/23	Thu 8/3/23	App A 1.5
T2 Rehabilitation (Units 5, 6)	Thu 8/3/23	Thu 10/5/23	App A 7.1.4
U1 Maintenance	Mon 11/27/23	Thu 12/14/23	App A 7.1.5



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 Facilities and Migration Timing.

1.1.1. Juvenile Fish Facilities.

1.1.1.1. The Lower Monumental Dam juvenile fish facilities consist of:

i. standard-length submersible traveling screens (STS),

ii. vertical barrier screens (VBS),

iii. 12" orifices,

iv. collection gallery,

v. dewatering structure,

vi. and a bypass flume to the tailrace.

1.1.1.2. Transportation facilities consist of:

i. a separator to sort by size and separate from adult fish,

ii. sampling facilities,

iii. raceways,

iv. office and sampling building,

v. truck and barge loading facilities,

vi. and PIT-tag detection and deflector systems.

1.1.1.3. 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 [FGE] 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 (wild & hatchery)				Subyearling Chinook (wild & hatchery)			
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
2018	18-Apr	4-May	15-May	27	29-May	2-Jun	5-Jul	37
2019*	3-Apr	30-Apr	18-May	45	28-May	2-Jun	28-Jun	31
2020	28-Apr	14-May	22-May	24	19-May	25-Jun	22-Jul	64
2021	11-Apr	8-May	19-May	38	29-May	29-Jun	3-Jul	35
2022	8-May	15-May	25-May	17	31-May	10-Jun	23-Jun	23
10-Yr MEDIAN	**25-Apr**	**8-May**	**17-May**	**22**	**29-May**	**10-Jun**	**4-Jul**	**36**
10-Yr MIN	**3-Apr**	**30-Apr**	**11-May**	**7**	**18-Apr**	**6-May**	**17-Jun**	**23**
10-Yr MAX	**9-May**	**15-May**	**25-May**	**45**	**5-Jun**	**29-Jun**	**22-Jul**	**64**
	Unclipped Steelhead				Clipped Steelhead			
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
2018	20-Apr	5-May	23-May	33	16-Apr	30-Apr	13-May	27
2019*	17-Apr	25-Apr	19-May	32	13-Apr	25-Apr	13-May	30
2020	30-Apr	10-May	26-May	26	25-Apr	3-May	24-May	29
2021	24-Apr	9-May	23-May	29	20-Apr	29-Apr	20-May	30
2022	9-May	18-May	4-Jun	26	5-May	13-May	31-May	26
10-Yr MEDIAN	**27-Apr**	**9-May**	**23-May**	**26**	**23-Apr**	**2-May**	**19-May**	**25**
10-Yr MIN	**17-Apr**	**25-Apr**	**16-May**	**12**	**13-Apr**	**25-Apr**	**11-May**	**11**
10-Yr MAX	**9-May**	**18-May**	**4-Jun**	**33**	**8-May**	**14-May**	**31-May**	**30**
	Coho (wild & hatchery)				Sockeye (wild & hatchery)			
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
2018	29-Apr	20-May	26-May	27	1-May	13-May	3-Jun	33
2019*	23-Apr	19-May	4-Jun	42	18-May	20-May	22-May	4
2020	3-May	19-May	13-May	10	16-May	19-May	22-May	6
2021	6-May	18-May	9-Jun	34	3-May	13-May	19-May	16
2022	14-May	30-May	13-Jun	30	17-May	19-May	22-May	5
10-Yr MEDIAN	**6-May**	**18-May**	**29-May**	**21**	**16-May**	**19-May**	**22-May**	**6**
10-Yr MIN	**23-Apr**	**9-May**	**13-May**	**10**	**20-Apr**	**13-May**	**19-May**	**4**
10-Yr MAX	**14-May**	**30-May**	**13-Jun**	**42**	**21-May**	**22-May**	**3-Jun**	**36**

*2019 passage data include the early start of Lower Monumental sampling on March 1st.

1.2. Adult Fish Facilities and Migration Timing.

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, bull trout, shad, and lamprey are counted per the schedule in **Table LMN-3** and data are posted daily at: www.fpc.org. The presence of other species (i.e., sturgeon, grass carp, Atlantic salmon, etc.) are recorded as comments and reported in the *Annual Fish Passage Report*. Relatively few fish pass the south ladder so one person can count both ladders from the north shore counting room by direct observation of the north viewing window and by video monitor of 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 Adult Fish Counting Schedule Mar 2023-Feb 2024.

Count Period	Counting Method and Hours *
April 1 – October 31	Day Visual 0500–2100 hours (PDT)

*PST = Pacific Standard Time; PDT = Pacific Daylight Time, in effect during daylight saving time 3/13/22–11/6/22.

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	June 9
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 7	Aug 17

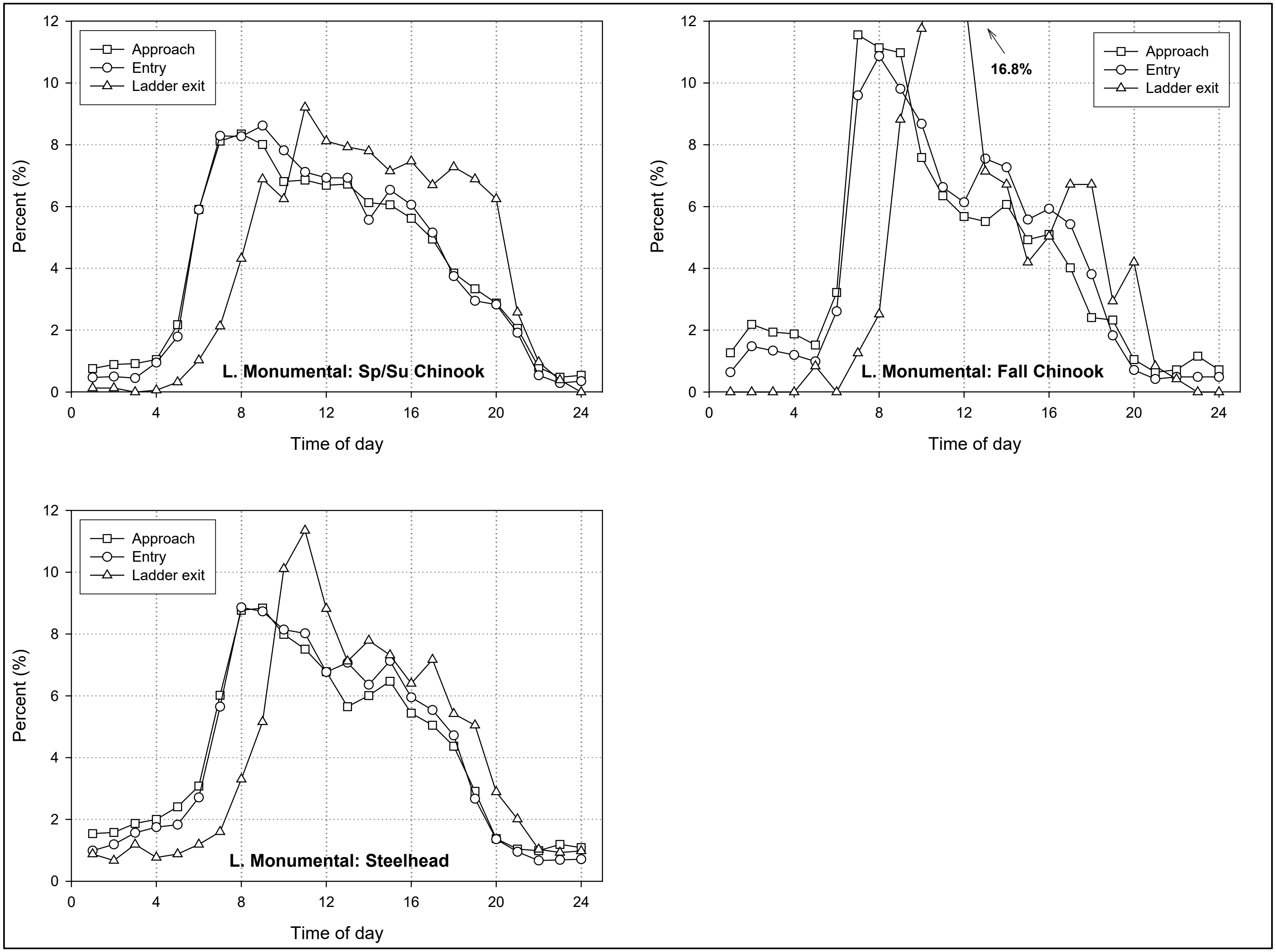


Figure LMN-2. Diel Distribution of Adult Salmonids at Lower Monumental Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

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**.

2.2.2. Spill at Lower Monumental will be distributed in spill patterns defined in **Table LMN-7 through LMN-9**.

2.2.3. Spill for Adult Steelhead Overshoots. Surface spill will be implemented at McNary and the four lower Snake River dams as a means of providing non-powerhouse downstream passage for adult steelhead that overshoot natal tributaries prior to spawning or that strive to repeat a subsequent reproduction cycle (iteroparity). This operation is pursuant to non-discretionary terms and conditions in the 2020 NOAA Fisheries Columbia River System (CRS) Biological Opinion[1], which calls for surface spill via the spillway weir at each of the five projects **March 1–30 and October 1–November 15, three times each week on non-consecutive days for four hours in the morning** (generally between 05:00 and 11:00). This operation is also considered in the 2020 USFWS CRS Biological Opinion[2] as a means of providing safe and effective downstream passage for adult steelhead and other fish.

[1] NOAA CRS BiOp, section 2.17.4.G, "*Reduce Take of Overshoot Adult Steelhead*": https://www.fisheries.noaa.gov/webdam/download/109136871

[2] USFWS CRS BiOp, section 5.7.4, "*Off-season Surface Spill for Downstream Passage of Adult Steelhead*": https://ecos.fws.gov/tails/pub/document/17101031

i. In 2023, spring surface spill will continue through the start of spring spill for juvenile fish on April 10, and fall surface spill will begin on September 1, to comply with the Agreement for short-term operations of the Columbia River System.[3] As such, in 2023, surface spill for adult steelhead will occur at the four Lower Snake River dams **March 1–April 2** **and September 1–November 15, three times each week on non-consecutive days for four hours in the morning**.

2.2.4. 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.

2.2.5. Total dissolved gas (TDG) is monitored at Lower Monumental Dam during the periods defined in **Table LMN-1**, pursuant to the Corps' annual *TDG Management Plan* and current *Dissolved Gas Monitoring Plan of Action*.[4]

2.2.6. 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 maintain 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.

2.3. Operating Criteria – Juvenile Fish Facilities

2.3.1. Juvenile Facilities – Winter Maintenance Period (third week of Dec – March 24*)

In 2023, the bypass system will begin operation March 1, as described in* ***section 2.3.2* *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 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. Removal of STSs may begin on the Monday of the 3rd week of December.

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[3] Stay Agreement: pweb.crohms.org/tmt/JointMotion_TermSheet_CourtOrder_and_Extensions_2023_0831.pdf

[4] TDG Management Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/.
TDG Monitoring Plan of Action: www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality/

ii. Maintenance completed on all screens.

iii. Inspect STSs prior to installation and operate one trial run (dogged off on deck) to ensure proper operation. 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. Maintain water-up valve capable of operating when needed.

ii. Maintain orifice lights operational.

iii. Maintain orifices clean and valves operating correctly.

iv. Maintain orifice air backflush system working correctly.

2.3.1.4. Transportation Facilities.

i. Maintain primary bypass flume switch gate in good operating condition.

ii. Maintain flume interior smooth with no rough edges.

iii. Maintain perforated plate edges smooth with no rough edges.

iv. Maintain the wet separator and fish distribution system ready for operation.

v. Maintain brushes and screens on crowders in good condition with no holes in screens or rough edges.

vi. Maintain and test crowders to ensure operating correctly.

vii. Maintain all valves, slide gates, and switch gates in good operating condition.

viii. Maintain retainer screens in place with no holes or sharp wires protruding.

ix. Maintain barge and truck loading pipes free of debris, cracks, or blockages. Truck and barge loading hose couplings should have no rough edges. Test and maintain barge loading boom.

x. Maintain all sampling equipment 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. Maintain mini- and midi-tanks in good operating condition.

2.3.1.5. Dewatering Structure and Flume.

i. Clean and maintain inclined screen in good condition with no gaps between screen panels, damaged panels, or missing silicone.

ii. Maintain screen cleaning system (brush and air flush) operating correctly.

iii. Test and maintain overflow weirs in good operating condition.

iv. Maintain all valves operating correctly.

v. Maintain flume interior smooth with no rough edges.

2.3.1.6. Record all maintenance and inspections.

2.3.1.7. Perform RSW inspections and maintenance as described below in **section 2.3.2.7**.

2.3.1.8. Inspect bird wires, avian deterrent devices, and other deterrents, and repair or replace as needed. Where possible, install additional bird wires or other deterrents to cover areas of known avian predation. Prepare avian abatement contract as needed. For information on avian management at Lower Monumental Dam, see the *Predation Monitoring and Deterrence Action Plans* in **Appendix L** (Table 2 and section 8).

2.3.2. Juvenile Facilities – Fish Passage Season (March 25* – third week of December)

**In 2023, the bypass system will begin operation March 1 with screens installed in at least the first three priority units. Condition sampling will occur as described in Appendix J.*

Operate in accordance with criteria defined below for juvenile fish bypass, collection, and transport March 25 through September 30 *(except in 2023 when bypass operations begin March 1)*, and for adult fallbacks October 1 until Monday of the third week of December. Also operate according to criteria in the Corps of Engineers Juvenile Fish Transportation Plan (**Appendix B**). The transportation program may be revised in accordance with the 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, clean at least once daily. If flows through an orifice or fish conditions give indications that an orifice may be partially obstructed with debris, close and backflush the orifice to remove the obstruction. If the obstruction cannot be removed, close the orifice and operate the alternate orifice for that gatewell slot. If both orifices become obstructed or plugged with debris, do not operate the turbine unit 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, immediately close the gatewell orifices and shut down the turbine unit 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. Take action as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow fish to exit the gatewell. Do not close orifices for longer than 48 hours.

iv. Log gatewell drawdown differentials in bulkhead slots at least once a week April 1 through June 30 *(except in 2023 when bypass operations begin March 1)* and once every two weeks (bi-weekly) for the remainder of the operating season. At least one measurement each month will be at the measured MW load compared to the clean trash rack differential.

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. STSs and VBSs.

i. Operate STSs in cycle mode when average fork length of subyearling 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 April through November (*except in 2023 when bypass operations begin March 1*). 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 for unscheduled maintenance 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. Between spring and summer, inspect at least two VBSs in two different turbine units that were operated frequently in the spring. If a debris accumulation is noted, inspect other VBSs and clean debris as necessary.

vii. After October 1, up to half of the STSs may be pulled for maintenance as long as unscreened turbine units are not operated.

viii. Between Thanksgiving and the Monday of the 3rd week of December, if the National Weather Service forecast for Lower Monumental Dam[5] is below 20°F for the 24 hours or longer, the STSs may be removed. Prior to removing screens, request special permission from CENWW-OD-T, who will then inform NOAA Fisheries and FPOM.

ix. At the end of the season, make a formal determination as to the adequacy of STS mesh and any replacement needs.

2.3.2.3. Collection Channel.

i. Ensure orifices are clean and operating. 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, see **section 3.2.2.4** to determine if the turbine unit must be shut down and if fish must be dipped from the gatewell(s).

ii. Ensure orifice lights are functioning and operating in open orifices 24 hrs/day. Replace all burned out orifice lights within 24 hours of notification. Orifice lights and area lights may be turned off the evening before dewatering the channel at the end of the season (the Monday of the 3rd week of December or later) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

iii. Orifice jets must hit no closer than 3' from the back wall with the collection channel full.

iv. Orifice valves must be either fully open or fully closed.

v. Backflush orifices at least once per day and more frequently if required. During periods of high debris volumes and fish numbers, from March 25 through July 31 *(except in 2023 when bypass operations begin March 1)*, inspect and backflush

[5] NWS weather forecast for Lower Monumental Dam: forecast.weather.gov/MapClick.php?lat=46.56353885200048&lon=-118.53924714099969

orifices once per 8-hour shift or more frequently as determined by the Project biologist, to keep orifices clean.

vi. Ensure the water-up valve is capable of operating when needed.

2.3.2.4. Dewatering Structure.

i. Ensure 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. Inspect all screens to make sure there are no holes or sharp edges.

ii. Maintain crowder screen brushes 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. Maintain 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 be 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. Removable Spillway Weir (RSW).

i. Lower Monumental Dam has one removable spillway weir (RSW) in spillbay 8 that, when open, provides a surface route for fish passage. The RSW can be opened and closed from the control room.

ii. The spill rate through the RSW is a function of the forebay elevation – as the pool elevation increases, more water is spilled over the RSW:

LMN Forebay Elevation (ft)	RSW Spill Rate (kcfs)
537	6.7
537.5	7.1
538	7.5
538.5	8.0
539	8.5
539.5	9.0
540	9.5

iii. The RSW will be in the raised position and operational during spill for juvenile passage (**Appendix E**) and spill for adult steelhead (**section 2.2.2**):

- Raise the spill gate to where it does not touch flow passing down the RSW.
- During high flows, if the Northwest River Forecast Center (NWRFC) inflow forecast for Lower Monumental[6] is above 200 kcfs, initiate aggressive forebay debris removal to avoid impeding RSW operation. Coordinate with RCC and CENWW-OD-T. If inflow exceeds 260 kcfs, the upstream river gauge flow is increasing, and the NWRFC inflow forecast for Lower Monumental is above 300 kcfs, stow the RSW (complete rotation to the landing pad).
- During summer spill (June 21-August 31), when daily average total project outflow is less than 30 kcfs and inflow is forecasted to remain below 30 kcfs for at least three days on a declining hydrograph, close the RSW and spill according to patterns with no RSW in **Table LMN-10**. If daily average project outflow subsequently increases above 30 kcfs and inflow is forecasted to remain above 30 kcfs for at least three days, re-open the RSW. Continue to open and close the RSW according to these criteria throughout summer spill.

iv. Outside of spill season when transport is occurring, the RSW may be operated for short periods upon request by the Project Biologist through CENWW if it appears the juvenile transportation facility and barge holding capacities will be exceeded, as defined in the *Juvenile Fish Transportation Plan* (**Appendix B**).

2.3.2.7. RSW Inspections and Maintenance (September 1 – March 31).

i. Prior to the inspections listed below, if a debris raft is present in the forebay and will interfere with defined operations, coordinate a debris spill in accordance with **section 5**. Debris in the RSW seals or between the transition plate and ogee will adversely impact operation of the RSW.

ii. Annually inspect the Transition Plate 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. (1) If divers are used, Units 5&6 and spillbays 7&8 must be removed

[6] NWRFC inflow forecast for Lower Monumental Dam: www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?id=LMNW1

from service. Coordinate unit outages following normal outage notification guidelines. Coordinate with RCC to open bay 8 one or two stops for up to one week before the inspection to facilitate clearing of debris and silt from the Transition Plates. (2) If an ROV is used, bay 8 will be removed from service. Coordinate with RCC to open bay 8 one or two stops on the morning of the inspection to facilitate clearing of debris and silt from the Transition Plates.

iii. Transition Plate bolts, umbilical and seal inspection will be done by divers and requires the RSW to be disengaged from the face of the dam and tipped back to the pierce point. Coordinate with RCC to open bay 8 one or two stops for up to a week before the inspection in order 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. For the dive inspection, coordinate with RCC to remove Units 5&6 and spillbays 7&8 from service. Upon completion of the dive, prior to stowing the RSW, open bay 8 up to three 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.

iv. 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 the annual inspection (**ii**). The repair and replacement effort will be similar to Transition Plate Bolt, Umbilical and seal inspection above (**iii**). The timeframe will be longer to repair and/or install new plate(s) or seals. Required outages will be coordinated as listed above for the necessary actions.

2.3.2.8. Inspect fish facilities at least once every 8 hours. Inspect all facilities according to fish facilities monitoring program. Record all maintenance and inspections.

2.3.2.9. Avian Predation Management. Operate in accordance with *Predation Monitoring and Deterrence Action Plans* for Lower Monumental Dam in **Appendix** L (Table 2 and section 8). Monitor bird wires and other avian deterrent devices to ensure good condition and replace any broken wires or devices as soon as possible. Implement harassment program to deter avian predation in areas actively used by birds and not covered by bird wires or other devices. 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.

2.4. <u>Operating Criteria - Adult Fish Facilities.</u>

2.4.1. <u>Adult Fish Facilities – Winter Maintenance Period (January 1 – end of February).</u>

2.4.1.1. Inspect all staff gauges and water level indicators. Repair and/or clean where necessary. Calibrate all water level measuring devices as necessary for proper operations.

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. Inspect all spill gates and ensure they are operable.

2.4.1.5. Maintain fish pumps ready for operation.

2.4.1.6. Maintain adult PIT-tag system as required. Coordinate with PSMFC.

2.4.2. <u>Adult Fish Facilities – Adult Fish Passage Season (March 1 – December 31).</u>

Note: Operating the Ice Harbor forebay within the Minimum Operating Pool (MOP) 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. Maintain all staff gauges in readable condition at all water levels encountered during fish passage period. Repair or clean as necessary.

2.4.2.2. Maintain water depth over fishway ladder weirs in the range of 1.0'–1.3'.

2.4.2.3. Maintain head on all fishway entrances in the range of 1' to 2'.

2.4.2.4. North Shore Entrances (NSE 1&2).

i. Operate both gates.

ii. Top of gate elevation on sill = 429'.

iii. Weir depth ≥ 8' below tailwater.

2.4.2.5. South Powerhouse Entrances (SPE 1&2).

i. Operate both downstream gates.

ii. Top of gate elevation on sill = 432'.

iii. Weir depth ≥ 8' below tailwater. At tailwater below elevation 440', weirs should be on sill.

2.4.2.6. South Shore Entrances (SSE 1&2).

i. Operate both downstream gates.

ii. Top of gate elevation on sill = 431'.

iii. Operate SSE 1 at ≥ 8' below tailwater. Raise SSE 2 above sill 6'. At tailwater below elevation 439', SSE 1 weir should be on sill.

2.4.2.7. Channel Velocity. Maintain water velocities in the range of 1.5–4.0 feet per second (fps). At Lower Monumental, a "*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 three 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.

2.4.2.8. No floating orifice gates will be operated.

2.4.2.9. Correctly install trashracks and picketed leads. Maximum head on ladder exits is 0.5'. Maximum head on south shore picketed leads is 0.3'. Maximum head on north shore picketed leads is 0.4'.

2.4.2.10. All counting slots at Lower Monumental Dam are fixed at a width of 19". Maintain all equipment in good condition. Clean the counting window and backboard as needed to maintain good visibility.

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, measure water temperature at adult fishway entrances and exits and submit data to the Fish Passage Center (FPC) weekly for posting online.[7] Ensure the location of the monitors meets the following criteria:

i. Within 10 meters of all shore-oriented entrances and exits.

ii. Entrance monitor within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers, if possible, to allow for sufficient mixing with surface water.

iii. Exit monitor 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, verify that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.5. Fish Facility Monitoring and Reporting.

2.5.1. Monitoring.

2.5.1.1. Project biologists shall inspect fish passage facilities at the frequencies described above in the juvenile and adult fish facilities operating criteria, **sections 2.3 and 2.4**.

2.5.1.2. 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.

2.5.2. Reporting.

2.5.2.1. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31 summarizing project and fish facility operations for each week (Friday through Thursday), along with an evaluation of resulting fish passage conditions. The reports will be e-mailed CENWW-OD-T by noon the following Monday. The weekly reports will include:

i. Out-of-criteria situations and subsequent corrective actions taken.

ii. Equipment malfunctions, breakdowns, or damage, with a summary of repairs.

iii. Adult fishway control calibrations.

iv. STS and VBS inspections.

v. Unusual activities that at the project that may have affected fish passage.

2.5.2.2. In-Season. Any adverse or negative impact to fish or fishways shall be reported in a *Memorandum for the Record* (MFR) prepared by Project biologists and sent to FPOM by the

[7] FPC ladder temperature data website: www.fpc.org/smolt/smolt_queries/Q_ladderwatertempgraphv2.php

next working day, pursuant to the coordination process and template in **FPP Chapter 1 – Overview** (section 2.3.2).

2.5.2.3. 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.

3. FISH FACILITIES MAINTENANCE

3.1. Dewatering & Fish Handling.

3.1.1. All dewatering (also referred to as "unwatering") shall be accomplished in accordance with approved *Dewatering Guidelines and Fish Salvage Plans* in **Appendix F**. *Dewatering Plans*[8] were reviewed and revised in 2011 to ensure that they comply with **Appendix F**.

3.1.2. Project biologists should be present to provide technical guidance at all project activities that may involve fish handling. When river temperatures reach 70°F or greater, all adult fish handling will be coordinated through CENWW-OD-T.

3.2. Maintenance - Juvenile Fish Facilities.

3.2.1. Scheduled Maintenance.

3.2.1.1. Scheduled maintenance of juvenile facilities is conducted throughout the year.

3.2.1.2. Long-term maintenance or modifications that require facilities out of service for extended periods of time are conducted during the winter maintenance period, beginning as early as the Monday of the third week of December through March 24 *(except in 2023 when bypass operations begin March 1)*.

3.2.1.3. 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.

3.2.2.1. Unscheduled maintenance is to correct any situation that prevents facilities from operating according to criteria or that will impact fish passage or survival.

3.2.2.2. Maintenance of facilities such as STSs that 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,

[8] Project Dewatering Plans: pweb.crohms.org/tmt/documents/FPOM/2010/

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.

3.2.2.3. 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.

3.2.2.4. 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 that operates the orifice fails, the orifice should be closed and the alternate orifice for that gatewell operated until repairs can be made. If both air-valves that operate the orifices in a gatewell fail and the orifice cannot be fully operated, or must be kept closed, the turbine unit will normally be taken out of service until repairs can be made. At the discretion of the Project Biologist, both orifices in a gatewell may be closed for up to 5 hours in an operating turbine unit with STSs in place, but orifice closure times may need to be less depending on fish numbers and condition. Reduce turbine unit loading to the lower end of the 1% efficiency range if deemed necessary by the Project Biologist. If both orifices remain closed after 5 hours, the turbine unit will be taken out of service. During any orifice closure, gatewells shall be monitored hourly (unit is operating) or at least every two hours (unit is not operating) by project personnel for signs of fish problems or mortality. If repairs are to take longer than 48 hours and both orifices in a gatewell need to remain closed, juvenile fish will be dipped from the gatewell with a gatewell dip basket in accordance with the project dewatering and fish-handling plan. 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 prior to the 48 hours.

3.2.2.5. 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.

3.2.2.6. 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.

3.2.2.7. 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.

3.3.1.1. Scheduled maintenance that will have no effect on fish passage may be conducted at any time.

3.3.1.2. Scheduled maintenance of a facility that must be dewatered, or maintenance that will have a significant effect on fish passage, will be done during the January–February winter maintenance period. Winter maintenance is normally conducted one fish ladder at a time to maintain fish passage.

3.3.1.3. When facilities are not being worked on during the winter maintenance period, they will be operated according to normal criteria unless otherwise coordinated with NOAA Fisheries and FPOM.

3.3.1.4. Auxiliary water for 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. 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**. 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.

3.3.2.3. 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.

3.3.2.4. 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.

ii. 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.

iii. If it cannot be maintained at a depth greater than 6', the weirs should be maintained at 6' regardless of head differential.

3.3.2.5. 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.

3.3.2.6. 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, 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**. 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. Unit priority order may be coordinated differently to allow for fish research, construction, or project maintenance activities.

4.1.2. 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 starts with Unit 1, then proceeds in order from north to south.

Table LMN-5. Lower Monumental Dam Turbine Unit Priority Order.

Season	Unit Priority Order
March 1 – November 30 Fish Passage Season	1, 2, 3, 4, 5, 6
December 1 – End of February Winter Maintenance Period	Any Order

4.2. Turbine Unit Operating Range

4.2.1. Turbine unit flow and power output at the lower and upper limits of the ±1% peak efficiency range, and at the operating limit, are defined in **Table LMN-6**. Turbine units will be operated within these ranges according to *BPA's Load Shaping Guidelines* (**Appendix C**), as summarized below.

4.2.2. In-Season: April 3–August 31 (Spring/Summer Spill for Juvenile Fish Passage).

4.2.2.1. Turbine units will be operated within ±1% of peak turbine efficiency (1% range), except under limited conditions and durations when turbines may be operated above the 1% range for the use of reserves or for TDG management during high flows (refer to **Appendix C** for more information). All required fish passage spill operations will be met prior to operating turbines above the 1% range. If in-season 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 4.3.9**), 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 to flush fish from the unit.

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

iv. Comply with other coordinated fish measures.

4.2.2.2. Minimum Generation. During low flows, all lower Snake River projects may be required to keep one generating unit online to maintain power system reliability. The minimum generation flow range for each unit is defined in FOP Table 1 (**Appendix E**), as derived from the lower limit of the 1% range and actual unit operations. During spring and summer spill for juvenile fish passage, if there is not enough river flow to meet this generation requirement and the FOP spill target, the project will operate the first available priority unit at minimum generation and spill the remainder of outflow. Actual attainable minimum generation values may vary depending on real-time conditions.

4.2.3. Off-Season: September 1–April 2. 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 Head (feet)	LMN Units 1, 2, and 3 – with STS						LMN Units 1, 2, and 3 – 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	72.0	11,693	112.0	18,173	130.9	22,028	71.2	11,499	115.4	18,636	134.3	22,368
86	73.0	11,706	114.4	18,332	133.2	22,163	71.9	11,471	117.9	18,805	136.8	22,503
87	74.0	11,717	116.6	18,458	135.7	22,324	72.7	11,447	120.3	18,937	139.3	22,621
88	75.0	11,727	118.7	18,554	136.8	22,146	73.4	11,417	122.6	19,061	140.6	22,460
89	76.0	11,739	120.5	18,611	138.0	21,996	74.2	11,392	124.6	19,136	141.8	22,279
90	77.0	11,750	122.4	18,681	139.4	21,901	74.9	11,369	126.4	19,179	142.9	22,114
91	78.0	11,764	124.1	18,715	140.7	21,803	75.6	11,344	128.0	19,200	143.9	21,961
92	79.0	11,772	126.0	18,782	141.6	21,646	76.4	11,321	129.3	19,168	145.0	21,827
93	80.0	11,780	128.1	18,864	142.5	21,463	77.1	11,294	130.6	19,132	146.0	21,676
94	81.0	11,793	129.9	18,922	143.4	21,266	77.8	11,268	131.8	19,091	146.8	21,487
95	82.0	11,809	132.0	19,003	144.3	21,079	78.6	11,251	132.8	19,009	147.4	21,298
96	83.1	11,831	134.2	19,101	144.9	20,880	79.4	11,240	133.8	18,926	148.0	21,121
97	84.3	11,862	136.3	19,176	145.5	20,689	80.3	11,233	134.9	18,860	148.5	20,945
98	85.5	11,896	138.6	19,272	146.1	20,509	81.2	11,230	136.0	18,806	149.0	20,763
99	86.7	11,929	141.0	19,387	146.6	20,314	82.2	11,229	137.4	18,782	149.4	20,575
100	88.0	11,963	143.3	19,487	147.1	20,101	83.0	11,224	139.1	18,800	149.8	20,387
101	88.8	11,941	142.7	19,195	147.6	19,973	84.1	11,238	138.9	18,573	150.1	20,224
102	89.6	11,920	142.1	18,904	148.0	19,841	85.1	11,255	138.6	18,332	150.5	20,064
103	90.4	11,898	141.5	18,626	148.3	19,707	86.1	11,269	138.4	18,111	150.9	19,901
104	91.2	11,876	141.0	18,373	148.7	19,567	87.1	11,281	138.5	17,933	151.2	19,735
105	91.8	11,835	140.9	18,172	149.1	19,419	88.0	11,279	138.9	17,803	151.4	19,566
	LMN Units 4, 5, and 6 – with STS						LMN Units 4, 5, and 6 – No STS					
85	86.7	13,771	108.3	17,190	126.7	20,417	90.5	14,545	120.9	19,416	125.8	20,379
86	88.0	13,802	109.7	17,206	128.2	20,417	91.6	14,534	121.3	19,251	127.2	20,380
87	89.2	13,826	111.3	17,252	129.8	20,416	92.6	14,521	121.9	19,103	128.7	20,380
88	90.4	13,844	113.0	17,312	131.3	20,415	93.7	14,511	122.8	19,020	130.2	20,380
89	91.6	13,864	114.7	17,363	132.9	20,415	94.7	14,506	124.3	19,034	131.8	20,380
90	92.8	13,888	116.3	17,402	134.4	20,414	95.9	14,505	126.4	19,126	133.4	20,380
91	94.0	13,908	117.9	17,445	136.0	20,415	97.0	14,507	128.5	19,223	135.0	20,380
92	95.1	13,923	119.4	17,473	137.5	20,414	98.2	14,514	130.3	19,268	136.6	20,380
93	96.3	13,936	120.8	17,491	139.1	20,414	99.3	14,524	131.8	19,266	138.1	20,380
94	97.4	13,945	122.6	17,556	140.7	20,414	100.5	14,539	133.0	19,232	139.6	20,380
95	98.5	13,956	124.5	17,643	142.2	20,414	101.8	14,565	134.0	19,168	141.0	20,380
96	99.6	13,974	126.8	17,780	143.7	20,415	103.1	14,596	134.7	19,068	142.4	20,380
97	100.8	13,995	129.3	17,947	145.2	20,416	104.4	14,620	135.2	18,938	143.8	20,380
98	102.0	14,014	131.4	18,064	146.7	20,416	105.6	14,625	135.7	18,793	145.2	20,380
99	103.1	14,031	133.2	18,120	148.2	20,417	106.6	14,610	136.1	18,649	146.7	20,379
100	104.2	14,039	134.7	18,143	149.7	20,417	107.5	14,581	136.6	18,528	148.3	20,382
101	105.2	14,026	136.0	18,134	151.2	20,421	108.4	14,545	138.1	18,539	149.9	20,379
102	106.4	14,042	137.1	18,106	152.6	20,422	109.2	14,515	139.7	18,558	151.6	20,379
103	107.6	14,058	138.1	18,047	154.1	20,424	110.2	14,496	141.1	18,564	153.1	20,380
104	108.6	14,051	138.8	17,968	155.5	20,426	111.2	14,483	142.5	18,568	154.7	20,380
105	109.3	14,006	139.3	17,844	157.4	20,531	112.2	14,476	143.8	18,561	156.0	20,356

a. Values provided by HDC (May 2022). Flow (cfs) was calculated based on turbine efficiency, project 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. Turbine unit maintenance schedules will be reviewed annually by Project and Operations Division biologists for fish impacts. If the maintenance requires operating outside of FPP criteria, the work will be coordinated with regional salmon managers via FPOM, per the coordination process in **FPP Chapter 1 – Overview** (section 2.3).

4.3.2. Priority unit maintenance will be scheduled for the winter maintenance period or when there are few fish passing the project, to the extent possible. Impacts to migrating adults should be minimized.

4.3.3. 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.

4.3.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take over one year to accomplish.

4.3.5. 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.

4.3.6. 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.

> **i.** Pre-Maintenance: Units may be operationally tested for up to 30 minutes by running the unit at speed-no-load and various loads within the 1% range for measurements and testing, and to allow all fish to move through the unit.
>
> **ii.** 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.

4.3.7. 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 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 that minimizes impacts to fish. The work will start as recommended in **section 4.3.1**.

> **i.** 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.

ii. 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 4.3.6** 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.

4.3.8. Head Gates.[9] Turbine units may be operated with head gates either in the *raised or 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.

4.3.9. Dewatering Units. Dewatering (also referred to as "unwatering") should be accomplished in accordance with project *Dewatering Plans*.[8] 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.

4.3.10. Doble Testing. The yearly outage schedule is defined in **Appendix A**. 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 7 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.

4.3.11. Turbine Unit Outages during High Flows. During high spring flows, turbine unit outages for inspecting fish screens, repairing research equipment (e.g., hydroacoustic or radiotelemetry), 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

[9] Head gates may also be referred to as "operating" gates at some projects. The terms are interchangeable.

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 to pass woody debris accumulating in front of the spillbay weir and compromising the safe unobstructed fish passage. The project will immediately spill woody debris obstructing fish passage and notify CENWW-OD-T of the emergency spill as soon as possible to notify RCC, NOAA Fisheries, and FPOM.

Table LMN-7. [page *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 = 6.7 kcfs spill at forebay 537.0 ft. Raise Bay 8 tainter gate above stop 9 to ensure free surface and debris passage. When low flow criteria are met (< 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns defined in **Table LMN-10**.

Table LMN-8. Lower Monumental Uniform Spill Patterns with RSW. [a, b]

LMN Uniform Spill Patterns - # Gate Stops per Spillbay								Total Stops	Total 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**	**46.0**
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**	**57.0**
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**	**74.0**
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**
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**
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 (based on interim spillway rating table 2-Apr-2009).

b. Bay 8 w/ RSW = 7.5 kcfs spill at forebay 538.0 ft. Raise Bay 8 tainter gate above stop 9 to ensure free surface and debris passage. When low flow criteria are met (< 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns defined in **Table LMN-10.**

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 low flow criteria are met (< 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns defined in this table.

2023 Fish Passage Plan

Chapter 8 – Little Goose Dam

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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'/hour
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**.

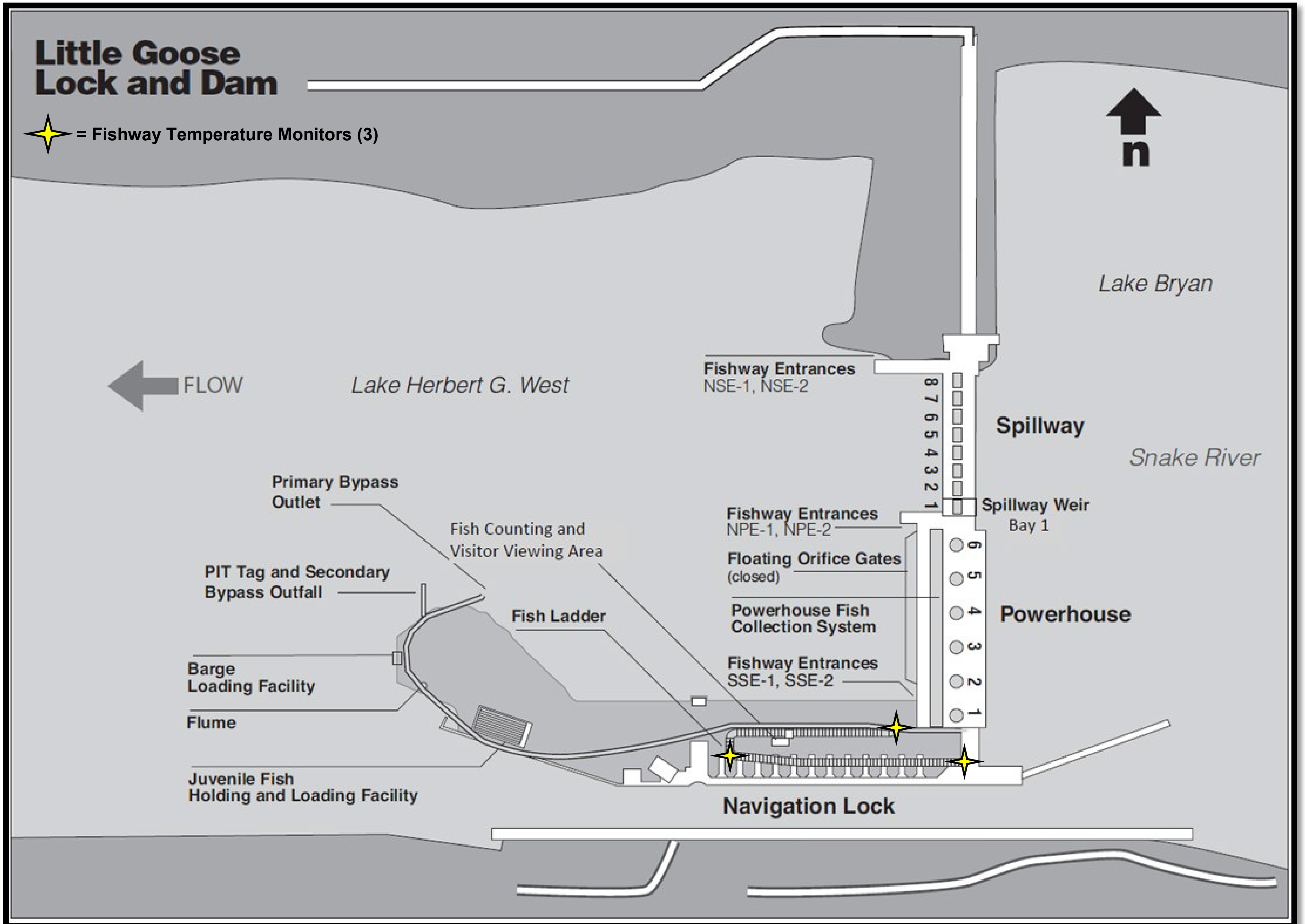
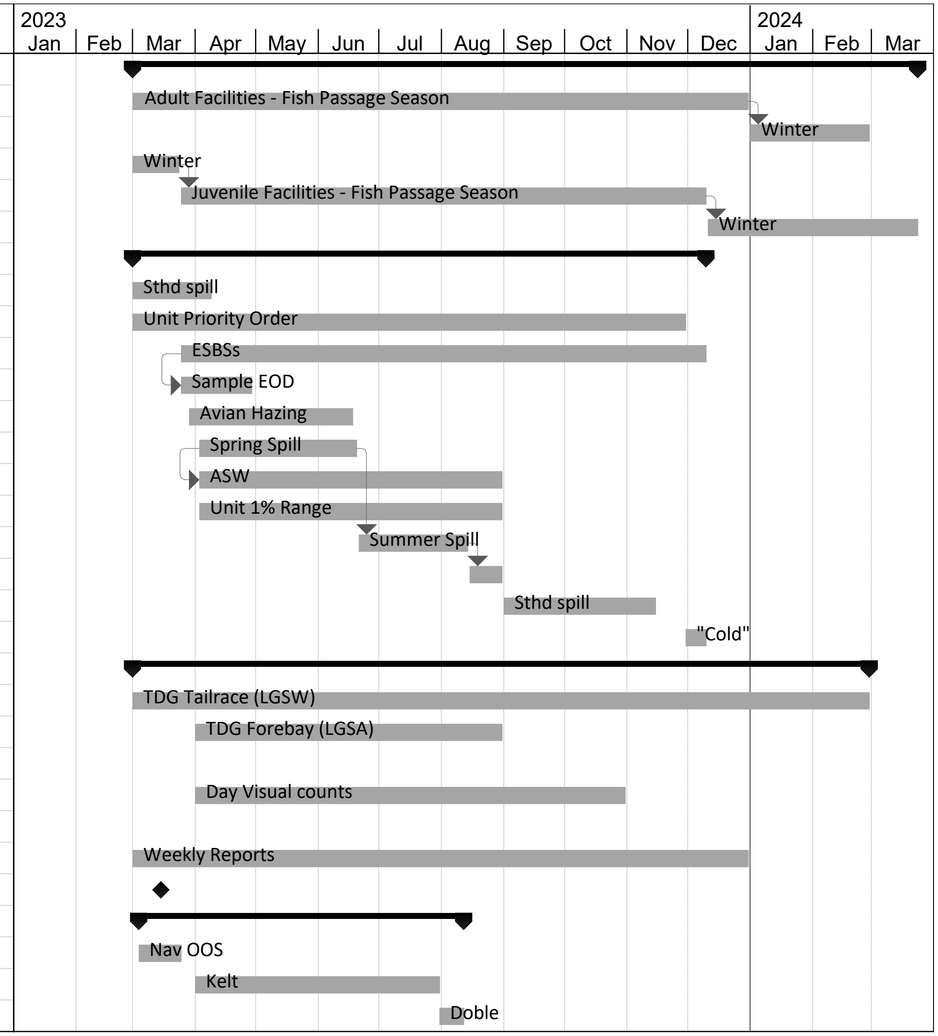


Figure LGS-1. Little Goose Lock & Dam General Site Plan.

Table LGS-1. Little Goose Dam Schedule of Operations and Actions Defined in the 2023 Fish Passage Plan.

Task Name	Start	End
FISH PASSAGE FACILITIES	**Wed 3/1/23**	**Sun 3/24/24**
Adult Facilities - Fish Passage Season	Wed 3/1/23	Sun 12/31/23
Adult Facilities - Winter Maintenance	Mon 1/1/24	Thu 2/29/24
Juvenile Facilities - Winter Maintenance	Wed 3/1/23	Fri 3/24/23
Juvenile Facilities - Fish Passage Season	Sat 3/25/23	Sun 12/10/23
Juvenile Facilities - Winter Maintenance	Mon 12/11/23	Sun 3/24/24
PROJECT OPERATIONS FOR FISH PASSAGE	**Wed 3/1/23**	**Sun 12/10/23**
ASW Spill for Adult Steelhead	Wed 3/1/23	Sun 4/9/23
Turbine unit priority order	Wed 3/1/23	Thu 11/30/23
ESBSs	Sat 3/25/23	Sun 12/10/23
Condition Sample every other day (end date TBD)	Sat 3/25/23	Sat 4/29/23
Avian hazing	Wed 3/29/23	Sun 6/18/23
Spring Spill	Mon 4/3/23	Tue 6/20/23
ASW open (end date approx)	Mon 4/3/23	Thu 8/31/23
Turbine unit 1% operating range	Mon 4/3/23	Thu 8/31/23
Summer Spill	Wed 6/21/23	Mon 8/14/23
Late Summer Spill	Tue 8/15/23	Thu 8/31/23
ASW Spill for Adult Steelhead	Fri 9/1/23	Wed 11/15/23
ESBS removal during cold weather	Thu 11/30/23	Sun 12/10/23
TDG MONITORING	**Wed 3/1/23**	**Thu 2/29/24**
TDG Monitoring - Tailrace (LGSW)	Wed 3/1/23	Thu 2/29/24
TDG Monitoring - Forebay (LGSA)	Sat 4/1/23	Thu 8/31/23
ADULT FISH COUNTING	**Sat 4/1/23**	**Tue 10/31/23**
Day Visual 0500-2100 PDT	Sat 4/1/23	Tue 10/31/23
REPORTS	**Wed 3/1/23**	**Sun 12/31/23**
Weekly Reports	Wed 3/1/23	Sun 12/31/23
Annual Reports due (for previous year)	Wed 3/15/23	Wed 3/15/23
SPECIAL OPS & STUDIES (Appendix A)	**Sat 3/4/23**	**Sat 8/12/23**
Navigation Lock annual outage	Sat 3/4/23	Sat 3/25/23
Kelt Collection & Reconditioning	Sat 4/1/23	Mon 7/31/23
Doble Testing T1 (Units 1-4)	Mon 7/31/23	Sat 8/12/23



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 Facilities and Migration Timing.

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 (wild & hatchery)				Subyearling Chinook (wild & hatchery)			
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
2018*	17-Apr	6-May	16-May	29	28-May	3-Jun	6-Jul	39
2019	18-Apr	30-Apr	18-May	30	22-May	7-Jun	13-Jul	52
2020	30-Apr	13-May	22-May	22	1-Jun	17-Jun	31-Jul	60
2021	29-Apr	9-May	19-May	20	8-Jun	29-Jun	8-Aug	61
2022	4-May	14-May	26-May	22	1-Jun	15-Jun	23-Jul	52
10-Yr MEDIAN	**26-Apr**	**8-May**	**17-May**	**22**	**31-May**	**13-Jun**	**14-Jul**	**49**
10-Yr MIN	**16-Apr**	**28-Apr**	**10-May**	**11**	**22-May**	**3-Jun**	**4-Jul**	**30**
10-Yr MAX	**5-May**	**14-May**	**26-May**	**30**	**8-Jun**	**29-Jun**	**8-Aug**	**61**
	Unclipped Steelhead				Clipped Steelhead			
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
2018*	17-Apr	5-May	22-May	35	9-Apr	29-Apr	14-May	35
2019	14-Apr	26-Apr	17-May	33	12-Apr	24-Apr	10-May	28
2020	26-Apr	6-May	26-May	30	22-Apr	2-May	23-May	31
2021	20-Apr	7-May	23-May	33	16-Apr	3-May	17-May	31
2022	5-May	14-May	4-Jun	30	28-Apr	9-May	25-May	27
10-Yr MEDIAN	**23-Apr**	**9-May**	**24-May**	**32**	**20-Apr**	**2-May**	**17-May**	**30**
10-Yr MIN	**14-Apr**	**26-Apr**	**17-May**	**15**	**9-Apr**	**24-Apr**	**10-May**	**14**
10-Yr MAX	**6-May**	**28-Apr**	**4-Jun**	**39**	**4-May**	**12-May**	**26-May**	**35**
	Coho (wild & hatchery)				Sockeye (wild & hatchery)			
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
2018*	4-May	13-May	28-May	24	21-Apr	20-May	25-May	34
2019	25-Apr	17-May	2-Jun	38	18-May	20-May	24-May	6
2020	5-May	22-May	1-Jun	27	16-May	18-May	22-May	6
2021	4-May	12-May	19-Jun	46	3-May	11-May	25-May	22
2022	8-May	29-May	17-Jun	40	15-May	18-May	5-Jun	21
10-Yr MEDIAN	**5-May**	**17-May**	**29-May**	**25**	**14-May**	**18-May**	**25-May**	**16**
10-Yr MIN	**25-Apr**	**9-May**	**21-May**	**12**	**21-Apr**	**9-May**	**21-May**	**5**
10-Yr MAX	**10-May**	**29-May**	**19-Jun**	**46**	**18-May**	**22-May**	**5-Jun**	**38**

*2018 passage data include the early start of Little Goose sampling on March 1st.

1.2. Adult Fish Facilities and Migration Timing.

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 facilities are operated year-round. Adult salmon, steelhead, bull trout, shad, and lamprey are counted per the schedule in **Table LGS-3** and data are posted daily at www.fpc.org. The presence of other species (i.e., sturgeon, grass carp, Atlantic salmon, etc.) are recorded as comments and reported 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**.

1.2.2.3. . 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 March 2023 – Feb 2024.

Count Period	Counting Method and Hours *
April 1 – October 31	Day Visual 0500–2100 hours (PDT)

*PST = Pacific Standard Time; PDT = Pacific Daylight Time, in effect during daylight saving time 3/13/22–11/6/22.

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 3
Summer Chinook	Jun 16 – Aug 15	Jun 16	Jul 12
Fall Chinook	Aug 16 – Oct 31	Sep 2	Sep 30
Steelhead	Apr 1 – Oct 31	Sep 6	Oct 14
Sockeye	Jun 15 – Oct 31	Jun 24	Aug 3
Lamprey	Apr 1 – Oct 31	Jul 5	Aug 20

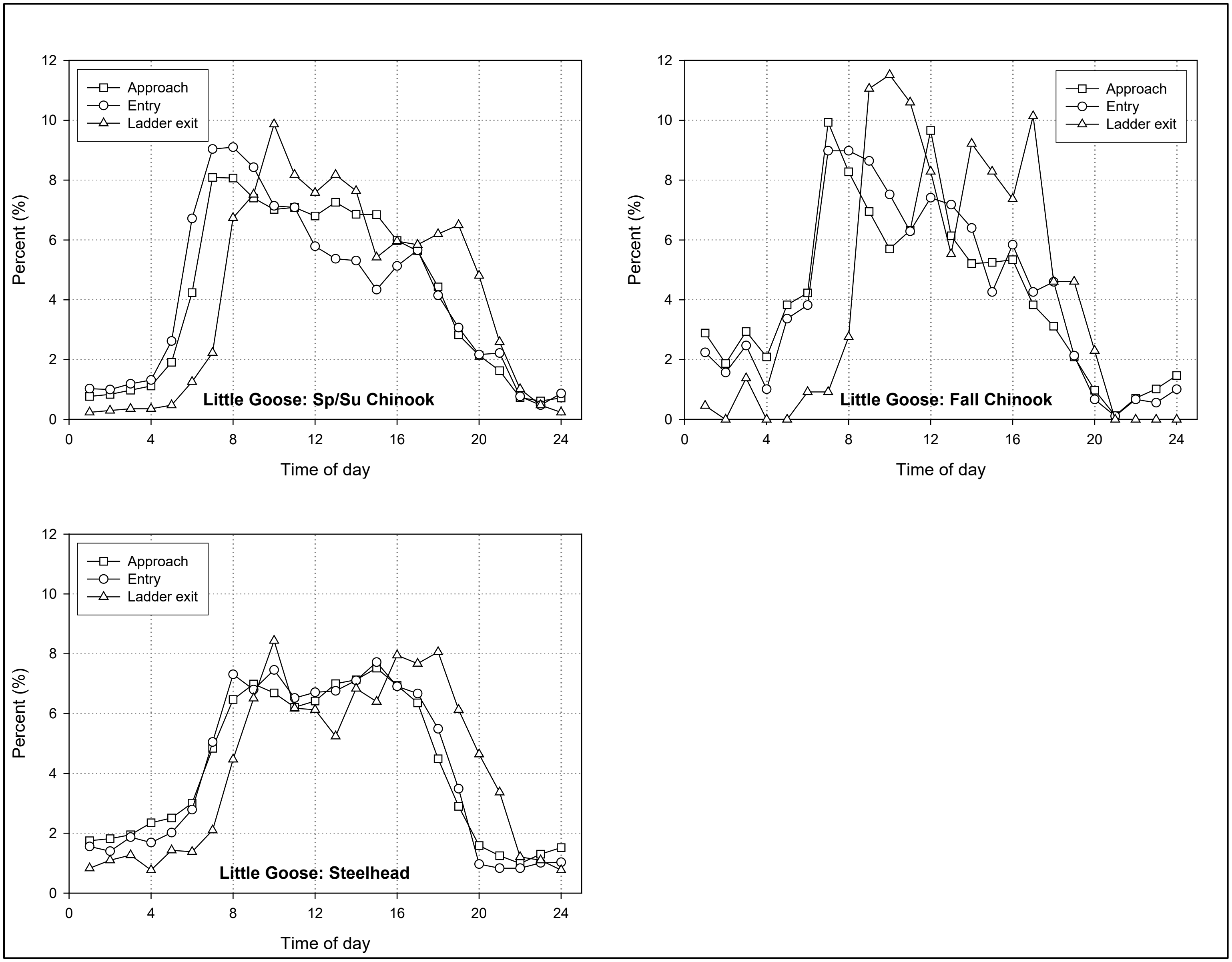


Figure LGS-2. Diel Distribution of Adult Salmonids at Little Goose Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

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 deemed an emergency, per coordination guidance in **FPP 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 at Little Goose will be distributed in spill patterns defined in **Table LGS-8** through **LGS-10**.

2.2.2. Spill for Adult Steelhead Overshoots. Surface spill will be implemented at McNary and the four lower Snake River dams as a means of providing non-powerhouse downstream passage for adult steelhead that overshoot natal tributaries prior to spawning or that strive to repeat a subsequent reproduction cycle (iteroparity). This operation is pursuant to non-discretionary terms and conditions in the 2020 NOAA Fisheries Columbia River System (CRS) Biological Opinion[1], which calls for surface spill via the spillway weir at each of the five projects **March 1–30 and October 1–November 15, three times each week on non-consecutive days for four hours in the morning** (generally between 05:00 and 11:00). This operation is also considered in the 2020 USFWS CRS Biological Opinion[2] as a means of providing safe and effective downstream passage for adult steelhead and other fish.

[1] NOAA CRS BiOp, section 2.17.4.G, "*Reduce Take of Overshoot Adult Steelhead*": https://www.fisheries.noaa.gov/webdam/download/109136871
[2] USFWS CRS BiOp, section 5.7.4, "*Off-season Surface Spill for Downstream Passage of Adult Steelhead*": https://ecos.fws.gov/tails/pub/document/17101031

i. At Little Goose Dam, off-season surface spill will occur with the spillway weir in "high crest" (approximately 7 kcfs spill).

ii. In 2023, spring surface spill will continue through the start of spring spill for juvenile fish on April 10, and fall surface spill will begin on September 1, to comply with the Agreement for short-term operations of the Columbia River System.[3] As such, in 2023, surface spill for adult steelhead will occur at the four Lower Snake River dams **March 1–April 2 and September 1–November 15, three times each week on non-consecutive days for four hours in the morning**.

2.2.3. 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.

2.2.4. Total dissolved gas (TDG) is monitored at Little Goose Dam during the periods defined in **Table LGS-1**, pursuant to the Corps' annual *TDG Management Plan* and current *Dissolved Gas Monitoring Plan of Action*.[4]

2.2.5. 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.

2.3. Operating Criteria – Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance Period (3rd week of December–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 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.

i. Removal of ESBSs may begin Monday of the third week of December. Within a week after ESBSs are removed for winter maintenance (or as soon as practical), inspect for juvenile salmonid mortalities and all other incidental fish mortalities.

[3] Stay Agreement: pweb.crohms.org/tmt/JointMotion_TermSheet_CourtOrder_and_Extensions_2023_0831.pdf
[4] TDG Management Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/
TDG Monitoring Plan of Action: www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality

Count all mortalities (or best estimate) for each ESBS and report to CENWW-OD-T.

ii. Complete maintenance on all screens.

iii. Inspect ESBSs prior to installation and operate debris cleaner (dogged off on deck) to ensure proper operation. Log results of trial run.

iv. Inspect VBSs with underwater video camera at least once/year. Repair as needed.

v. 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. Maintain water-up valve capable of operating when needed.

ii. Maintain orifice lights operational.

iii. Maintain orifices clean and valves operating correctly.

iv. Maintain orifice cycling and air backflush system operating correctly.

2.3.1.4. Transportation Facilities.

i. Maintain flume switch gate in good operating condition.

ii. Maintain flume interior smooth with no rough edges.

iii. Maintain perforated plate smooth with no rough edges.

iv. Maintain wet separator and fish distribution system ready for operation.

v. Maintain brushes and screens on crowders in good condition with no holes in screens or rough edges.

vi. Maintain and test crowders to ensure operating correctly.

vii. Maintain all valves, slide gates, and switch gates in good operating condition.

viii. Maintain retainer screens in place with no holes or sharp wires protruding.

ix. Maintain barge and truck loading pipes free of debris, cracks, or blockages. Test and maintain barge loading boom.

x. Maintain all sampling equipment 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. Maintain mini- and midi-tanks in good operating condition.

2.3.1.5. Dewatering Structure and Flume.

i. Clean and maintain inclined screen in good condition with no gaps between screen panels or damaged panels.

ii. Maintain cleaning brush and air burst systems operating correctly.

iii. Maintain and test overflow weirs to ensure operating correctly.

iv. Maintain all valves operating correctly.

v. Maintain baffle boards under inclined screen in good condition.

vi. Maintain flume interior smooth with no rough edges.

2.3.1.6. Record all maintenance and inspections.

2.3.1.7. 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. For information on avian management at Little Goose Dam, see the *Predation Monitoring and Deterrence Action Plans* in **Appendix L** (Table 2 and section 9).

2.3.2. <u>Juvenile Facilities – Fish Passage Season (March 25 – 3rd week of December).</u>

Operate according to criteria below March 25–October 31 for juvenile bypass, collection, and transport, and November 1 until Monday of the 3rd week of December for adult fallbacks. Also operate according to criteria in the *Corps of Engineers Juvenile Fish Transportation Plan* in **Appendix B**. The transportation program may be revised in accordance with the ESA Section 10 permit and NOAA Fisheries Biological Opinion.

2.3.2.1. Inspect fish facilities at least once every 8 hours. Inspect all facilities according to the fish facilities monitoring program. Record all maintenance and inspections and include in reports as described in **section 2.5**.

2.3.2.2. 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, clean at least once daily. If orifice flow or fish conditions are observed that indicate an orifice may be obstructed with debris, close and backflush the orifice to remove the obstruction. If the obstruction cannot be removed, close the orifice and operate the alternate orifice for that gatewell slot. If both orifices become obstructed or plugged with debris, do not operate the turbine unit 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 that cannot be removed within 24 hours, immediately close the gatewell orifices and shut down the turbine unit within one hour until the material has been removed and all 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. Take action as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow fish to exit the gatewell. Do not close orifices for longer than 48 hours.

iv. Log drawdown differentials in bulkhead slots at least once per week through June 30 and once every two weeks (biweekly) 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.

2.3.2.3. ESBSs and VBSs.

i. Install ESBSs 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 passage condition. Change cleaning frequency as needed.

iv. Monitor ESBS operating status regularly throughout work shifts via the ESBS operating computer display located in the control room. ESBS cleaning brushes are monitored real-time via PLC in the control room each time a brush cycles.

v. 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. Little Goose staff check cleaning brush trouble lights during orifice inspections multiple times during a 24-hour shift.

vi. If an ESBS is damaged or fails during juvenile fish passage season, follow procedures for unscheduled maintenance in **section 3.2.2**. In no case should a turbine unit be operated with a missing, damaged, or a known non-operational ESBS, except as noted.

vii. Inspect ESBS by underwater video during turbine unit annual maintenance (more frequently if required). Thoroughly inspect VBSs at the same time.

viii. Log VBS head differentials at least once per week through June 30 (more frequently if required) and once every two weeks (biweekly) for the remainder of the operating season. When a head differential of 1.5' is reached, operate the respective turbine unit 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. Between spring and summer, use underwater video to inspect at least two VBSs in two different turbine units that were operated frequently in the spring. If debris accumulation is noted, inspect other VBSs and clean debris as necessary.

x. After October 1, up to half of the ESBSs may be pulled for maintenance as long as unscreened turbine units are not operated.

xi. Between Thanksgiving and the Monday of the 3rd week of December, if the National Weather Service forecast for Little Goose Dam[5] is below 20°F for 24 hours or longer, screens may be removed. Prior to removing screens, request special permission from CENWW-OD-T, who will then inform NOAA Fisheries and FPOM.

xii. At the end of the season, make a formal determination on the adequacy of ESBS bar screen panels and debris cleaner brushes. Replace components as necessary.

2.3.2.4. Collection Channel.

i. Ensure orifices are 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, see **section 3.2.2.4**. to determine if the unit must be shut down and if fish must be dipped from the gatewell(s).

ii. Ensure orifice lights are functioning and operating on open orifices 24 hrs/day. Replace all burned out orifice lights within 24 hours of notification. Orifice lights

[5] NWS weather forecast for Little Goose Dam: forecast.weather.gov/MapClick.php?lat=46.5874&lon=-118.0261

and area lights may be turned off the evening before dewatering the channel at the end of season (Monday of the 3rd week of December or later) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

iii. Orifice jets hitting no closer than 3' from back wall, collection channel full.

iv. Orifice valves are either fully open or closed.

v. Backflush orifices at least once per day and more frequently if required. During periods of high fish and debris passage, March 25 through July 31, inspect and backflush orifices 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, restrict the respective turbine unit 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.

vi. Ensure the water-up valve is capable of operating when needed.

2.3.2.5. Transportation Facilities.

i. Operate wet separator and fish distribution system as designed.

ii. Maintain crowder screen brushes 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. Maintain barge and truck loading pipes and related equipment free of debris, cracks, or blockages, and in good condition. Maintain the 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).

2.3.2.6. Dewatering Structure.

i. Ensure the trash sweep and air burst systems are operating correctly. Set the frequency of screen cleaning as necessary to maintain a clean screen.

ii. Hand clean trapezoidal section at least once per day or more as often as required to maintain in clean condition.

iii. Check overflow weirs to make sure they are operating correctly. Perform maintenance as required.

iv. Ensure there are no gaps between screen panels or damaged panels in the inclined screen and that the screen panels are in place and tightly secured.

v. Turn off lights at the dewatering structure at night, unless needed for personnel access, to encourage fish to move downstream volitionally.

2.3.2.7. Adjustable Spillway Weir (ASW).

2.3.2.7.a. Little Goose has one adjustable spillway weir (ASW) in spillbay 1 that provides a surface route for fish passage. The ASW can be operated from the control room and the crest elevation can be adjusted lower or higher to pass more water or less water, respectively, according to the flow and forebay criteria defined below.

2.3.2.7.b. The ASW spill rate is a function of the crest elevation versus forebay elevation – as the pool elevation over the crest increases, more water is spilled over the ASW. Therefore, to maintain the intended spill rate over the ASW (approximately 7-8 kcfs at high crest and 11-12 kcfs at low crest), the ASW crest elevation will be set relative to the current forebay operating range, as defined below in **Table LGS-5**:

Table LGS-5. ASW Crest Elevation Relative to Forebay Range to Maintain High Crest Spill at ~7-8 kcfs and Low Crest Spill at ~11-12 kcfs.

LGS Forebay Operating Range (ft)	ASW High Crest Elevation (ft) = ~7-8 kcfs spill	ASW Low Crest Elevation (ft) = ~11-12 kcfs spill
MOP (633.0 - 634.5)	622’	618’
0.5’ Raised MOP (633.5 - 635.0)	622.5’	618.5’
1’ Raised MOP (634.0 - 635.5)	623’	619’
1.5’ Raised MOP (634.5 - 636.0)	623.5’	619.5’
2’ Raised MOP (635.0 - 636.5)	624’	620’
2.5’ Raised MOP (635.5 - 637.0)	624.5’	620.5’
3’ Raised MOP (636.0 - 637.5)	625’	621’
3.5’ Raised MOP (636.5 - 638.0)	625.5’	621.5’

2.3.2.7.c. High Crest (ASW-Hi):

i. The ASW high crest spills approximately 7–8 kcfs when operated relative to the forebay operating range (**Table LGS-5**). High crest spill patterns are in **Table LGS-8** and **Table LGS-9** (30% Spill).

ii. *Unless flow conditions defined below are met, ASW spill for fish passage will occur with the ASW at high crest (approximately 7-8 kcfs spill).*

2.3.2.7.d. Low Crest (ASW-Lo):

i. The ASW low crest spills approximately 11–12 kcfs when operated relative to the forebay operating range (**Table LGS-5**). Low crest spill patterns are in **Table LGS-8** and **Table LGS-10** (30%).

ii. Change the ASW to low crest elevation relative to forebay (**Table LGS-5**) to pass more water during high flow (i.e., spring freshet) when the following flow criteria are met: 1) day average total project outflow above 85 kcfs, and 2) NWRFC inflow forecast above 85 kcfs for at least the next 3 days.

iii. When the previous day's average outflow drops below 85 kcfs and is forecasted to stay below 85 kcfs for at least the next three days, change back to high crest elevation relative to the forebay range.

2.3.2.7.e. No ASW (Bay 1 Closed):

i. On or after August 1, when day average project outflow drops below 35 kcfs and is forecasted to stay below 35 kcfs for at least 3 days, close the ASW and spill per patterns in **Table LGS-11** (No ASW).

ii. The ASW will not be closed before August 1 even if the low flow criteria are achieved to avoid impacting subyearling migration unless an adult passage delay is observed or due to unit operational constraints at low flow. Closing the ASW prior to August 1 will be coordinated through FPOM by CENWW-OD-T.

iii. Re-open the ASW in high crest if day average project outflow subsequently increases above 35 kcfs and is forecasted to stay above 35 kcfs for 3 or more days. Continue to open and close the ASW according to these criteria for the remainder of the summer spill season.

2.3.2.8. Avian Predation Management. Operate in accordance with *Predation Monitoring and Deterrence Action Plans* for Little Goose in **Appendix L** (Table 2 and section 9). Monitor bird wires and other avian deterrent devices to ensure good condition and replace any broken wires or devices as soon as possible. Implement harassment program to deter avian predation in areas actively used by birds and not covered by bird wires or other devices. 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.

2.4. <u>Operating Criteria - Adult Fish Facilities.</u>

2.4.1. <u>Adult Facilities - Winter Maintenance Period (January 1 – end of February).</u>

2.4.1.1. Inspect all staff gauges and water level indicators. Repair and/or clean as necessary. Calibrate all water level measuring devices as necessary for proper facility operations.

2.4.1.2. Dewater the ladder and inspect all dewatered sections of fish facilities for projections, debris, or plugged orifices that could injure fish or impede fish passage. The 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. Annually inspect all diffuser gratings and chambers and the fallout fence by dewatering or by using divers or video inspection techniques. Dewater and physically inspect all diffuser gratings and chambers at least every 3 years. Repair deficiencies.

2.4.1.3. Inspect for and clean debris from the fish ladder exit. Ensure the trashrack and picketed leads are clean and installed correctly.

2.4.1.4. Inspect all spill gates and ensure they are operable.

2.4.1.5. Maintain fish pumps ready for operation.

2.4.1.6. Inspect ladder netting and repair prior to fish passage season.

2.4.2. Adult Facilities – Adult Fish Passage Season (March 1 – December 31).

***Note*:** The Lower Monumental forebay may be operated within the Minimum Operating Pool (MOP) 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. Maintain all staff gauges in readable condition at all water levels encountered during the fish passage period. Repair or clean as necessary.

2.4.2.2. Maintain water depth over fishway ladder weirs in the range of 1.0’–1.3’.

2.4.2.3. Maintain head on all fishway entrances in the range of 1’ to 2’.

2.4.2.4. Ensure trashracks and picketed leads are installed correctly. Maximum head on ladder exit is 0.5’. Maximum head on picketed leads is 0.3’.

2.4.2.5. North Shore Entrances (NSE-1&2).

i. Operate both downstream gates.

ii. Top of gate elevation on sill = 529’.

iii. Weir depth ≥ 6’ below tailwater.

2.4.2.6. North Powerhouse Entrances (NPE-1&2).

i. Operate both downstream gates.

ii. Top of gate elevation on sill = 532’.

iii. Weir depth ≥ 7’ below tailwater (tailwater permitting). At tailwater below elevation 539’, entrance weirs should be on sill.

2.4.2.7. South Shore Entrances (SSE-1&2).

i. Operate both gates.

ii. Top of gate elevation on sill = 529'.

iii. Weir depth ≥ 8' below tailwater.

2.4.2.8. No FOGs will be operated.

2.4.2.9. Channel Velocity.

i. Maintain water velocities in the adult collection channel in the range of 1.5–4.0 feet per second (fps). This is the optimum velocity for returning adult salmon and steelhead to migrate upstream through the fishway.

ii. Measure surface water velocities in the open access area near the north powerhouse weir/fish entrance using a piece of woody debris (stick, bark) or water bubble timed over a marked fixed distance. Water velocity measurements at this location typifies the velocity conditions throughout the length of the channel.

iii. Measure subsurface water velocity and report once per month using an underwater flowmeter. Calculate the average velocity using several measurements taken at various depths across the width of the channel that best represents the average subsurface flow. Take measurements at a location in the channel that represents the overall flow characteristic.

iv. Include velocity readings in required fishway inspections and weekly and annual reports.

2.4.2.10. Ensure lights are functioning in the tunnel section under the spillway during fish passage season.

2.4.2.11. The Little Goose counting window slot is fixed at a width of no less than 18". Clean the counting window and backboard as needed to maintain good visibility. Maintain all equipment in good condition.

2.4.2.12. Facility Inspections.

i. Inspect fish fallout fence for debris buildup, holes, etc.

ii. Powerhouse operators shall inspect facilities once per day shift and check computer monitor information at least once during each back shift.

iii. Project biologists shall inspect facilities three times per week. Inspect all facilities according to fish facilities monitoring program.

iv. Check picketed leads during all inspections to ensure they are clean and in the correct position (all the way down and vanes in line with flow).

v. Project personnel shall check calibration of fishway control system twice per month to ensure it is kept within calibration. This may be done as part of routine fishway inspections.

vi. Inspect fishways daily for foreign substances (particularly oil). If substances are found, corrective actions should be undertaken immediately.

vii. Record all inspections.

2.4.2.13. Fishway Temperature Monitoring. From June 1 through September 30, measure water temperature at adult fishway entrances and exits and submit data to the Fish Passage Center (FPC) weekly for posting online.[6] Ensure the location of the monitors meets the following criteria:

i. Within 10 meters of all shore-oriented entrances and exits.

ii. Entrance monitor within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers, if possible, to allow for sufficient mixing with surface water.

iii. Exit monitor 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, verify that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.4.2.14. Adult Ladder Exit Pool Cooling Pump. Operate the 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 minimum operating pool elevation 633'.

i. Begin operation of exit pool cooling pump after June 1 and no later than the day after the Little Goose forebay temperature string[7] at 0.5 meters exceeds 64°F (18°C) at any time.

ii. Continue this operation until September 1 and until the Little Goose forebay temperature string at 0.5 m is below 68°F (20°C) for 3 consecutive days. Restart pumps if the temperature at 0.5 m reaches 68°F (20°C) at any time and follow above criteria on when to discontinue 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.

[6] FPC ladder temperature data: www.fpc.org/smolt/smolt_queries/Q_ladderwatertempgraphv2.php
[7] Corps temperature string data: pweb.crohms.org/ftppub/water_quality/tempstrings/

2.5. Fish Facility Monitoring & Reporting.

2.5.1. Monitoring.

2.5.1.1. Project biologists shall inspect fish passage facilities at the frequencies described above in the juvenile and adult fish facilities operating criteria, **sections 2.3 and 2.4**.

2.5.1.2. Project biologists also inspect project facilities once per month and during dewaterings for the presence of zebra and Quagga mussels. Biologists shall provide a monthly report to CENWW-OD-T summarizing mussel inspections.

2.5.2. Reporting.

2.5.2.1. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31 summarizing project and fish facility operations for each week (Friday through Thursday), along with an evaluation of resulting fish passage conditions. The reports will be e-mailed CENWW-OD-T by noon the following Monday. The weekly reports will include:

i. Out-of-criteria situations and corrective actions taken.

i. Equipment malfunctions, breakdowns, or damage along with a summary of resulting repairs.

ii. Adult fishway control calibrations.

iii. ESBS and VBS inspections.

iv. Unusual activities at the project that may have affected fish passage.

2.5.2.2. In-Season. Any adverse or negative impact to fish or fishways shall be reported in a *Memorandum for the Record* (MFR) prepared by Project biologists and sent to FPOM by the next working day, pursuant to the coordination process and template in **FPP Chapter 1 – Overview**.

2.5.2.3. 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 actions.

3. FISH FACILITIES MAINTENANCE

3.1. Dewatering & Fish Handling

3.1.1. Dewatering (also referred to as "unwatering") shall be accomplished pursuant to approved *Dewatering Guidelines and Fish Salvage Plans* in **Appendix F**. Project *Dewatering Plans*[8] were reviewed and revised in 2011 to ensure they comply with **Appendix F**.

[8] Project Dewatering Plans: pweb.crohms.org/tmt/documents/FPOM/2010/

3.1.2. Project biologists should be present to provide guidance at all project activities that may involve fish handling. 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.

3.2.1.1. Scheduled maintenance of juvenile facilities is conducted throughout the year.

3.2.1.2. Long-term maintenance or modifications that require facilities out of service for extended periods are conducted during winter maintenance period, beginning on Monday of the third week of December through March 24.

3.2.1.3. 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.

3.2.2.1. Unscheduled maintenance is the correction of any situation that prevents facilities from operating according to criteria or that will impact fish passage or survival.

3.2.2.2. Maintenance of facilities such as ESBSs that 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.

3.2.2.3. ESBS.

3.2.2.3.a. 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 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.

3.2.2.3.b. 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 or unsafe operation of the power plant such as, but not limited to, unstable station service power, 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. FPOM will be notified via MFR, per **FPP Chapter 1 – Overview**.

3.2.2.4. 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 that operates the orifice fails, the orifice should be closed and the alternate orifice and air valve for that gatewell operated until repairs can be made. If both air-valves that operate the orifices in a gatewell fail and the orifice cannot be fully operated, or must be kept closed, the turbine unit will normally be taken out of service until repairs can be made. At the discretion of the Project Biologist, both orifices in a gatewell may be closed for up to 5 hours in an operating turbine unit with ESBSs in place, but orifice closure times may need to be less depending on fish numbers and condition. Turbine unit loading will be reduced to the lower end of the 1% range if deemed necessary by the Project Biologist. If both orifices remain closed after 5 hours, the turbine unit will be taken out of service. During any orifice closure, gatewells shall be monitored hourly (unit is operating) or at least every 2 hours (unit is not operating) by Project personnel for signs of fish problems or mortality. If repairs are anticipated to take longer than 48 hours and both orifices in a gatewell need to remain closed, juvenile fish will be dipped from the gatewell with a gatewell dip basket in accordance with the project dewatering and fish-handling plan. 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 prior to the 48 hours.

3.2.2.5. 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 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.

3.2.2.6. 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 fish in the bypass system diverted to the river below the project through a 30” pipe while repairs are made.

3.2.2.7. 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. <u>Maintenance - Adult Fish Facilities.</u>

3.3.1. Scheduled Maintenance.

3.3.1.1. Maintenance that will have <u>no effect</u> on fish passage may be conducted at any time.

3.3.1.2. Scheduled maintenance of a facility that must be dewatered, or maintenance that may have a <u>significant effect</u> on fish passage, will be done during the winter maintenance period (January–February).

3.3.1.3. When facilities are not being worked on 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. 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.

3.3.2.3. 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.

3.3.2.4. 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). Then, as necessary, close NSE-2 and NPE-2 and operate NPE-1 to provide the required 1' to 2' head differential.
>
> **ii.** If the desired head differential cannot be maintained at a depth of 5' or greater, raise NSE-1 until a depth of 5' below tailwater is reached.
>
> **iii.** If the head differential cannot be maintained at this point, raise SSE-1 and -2 at 1' increments until 6' below tailwater is reached.
>
> **iv.** If the head differential still cannot be maintained, bulkhead off the transportation channel to the north shore at the end of the powerhouse collection channel. Next, close NPE-1 and bulkhead off the powerhouse collection channel at the junction pool. Then, operate SSE-1 and -2 as deep as possible to maintain the head, but not shallower than 6' regardless of the head.

3.3.2.5. 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 water redistributed to other entrances while repairs are made.

3.3.2.6. 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-6** 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. Unit priority order may be coordinated differently for fish research, construction, or project maintenance activities.

4.1.2. 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. See **section 4.2.2.2** for more information.

Table LGS-6. Little Goose Dam Turbine Unit Priority Order.

Dates	Unit Priority Order
March 1 – November 30 Fish Passage Season	1[a], 2, 3, 4, 5, 6 *During ASW spill and outflow >38 kcfs, maximize discharge through highest priority unit*
December 1 – end of February Winter Maintenance Period	Any Order

a. **Unit 1 special operation (section 4.2.2.2) – does not apply during hours of spring gas cap spill:** When the ASW is open and total outflow is > 38 kcfs, Unit 1 will be manually 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 discharging < 16.0 kcfs, assume Unit 1 is at the lower end of the upper 1% (~16.0 kcfs). When average unit discharge is > 16.0 kcfs, assume all units are operating uniformly.

4.2. Turbine Unit Operating Range.

4.2.1. Turbine unit flow and power output at the lower and upper limits of the ±1% peak efficiency range, and at the operating limit, are defined in **Table LGS-7**. Turbine units will be operated within these ranges according to *BPA's Load Shaping Guidelines* (**Appendix C**), as summarized below.

4.2.2. In-Season: April 3–August 31 (Spring/Summer Spill for Juvenile Fish Passage).

4.2.2.1. Turbine units will be operated within ±1% of peak turbine efficiency (1% range), except under limited conditions and durations when turbines may be operated above the 1% range for the use of reserves or for TDG management during high flows (see **Appendix C** for more information). All required fish passage spill operations will be met prior to operating turbines above the 1% range. If in-season 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 4.3.8**), 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 to flush fish from the unit.

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

iv. Comply with other coordinated fish measures.

4.2.2.2. Unit 1 Special Operation. *The operation described in this section does **not** apply during spring spill to the gas cap (April 3–June 20). During these hours, if flow is too low to achieve the spill cap target, Unit 1 will be operated in the lower 1% (minimum generation) and the remaining outflow spilled, in accordance with **section 4.2.2.3** below.*

When the ASW is open and total project outflow is greater than 38 kcfs, Unit 1 will be manually operated in the upper 25% of the 1% range to smooth out the eddy that forms during ASW spill (*except during hours of spring gas cap spill, as noted above*). 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 to optimize tailrace conditions for both adult passage and juvenile egress. When the ASW is closed, the tailrace eddy is mostly non-existent and all 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 avoid turbine dead-bands and to maintain MOP and spill operations.

4.2.2.3. Minimum Generation. During low flows, all lower Snake River projects may be required to keep one generating unit online to maintain power system reliability. The minimum generation flow range for each unit is defined in FOP Table 1 (**Appendix E**), as derived from the lower limit of the 1% range and actual unit operations. During spring and summer spill for juvenile fish passage, if there is not enough river flow to meet this generation requirement and the FOP spill target, the project will operate the first available priority unit at minimum generation and spill the remainder of outflow. Actual attainable minimum generation values may vary depending on real-time conditions.

4.2.3. Off-Season: September 1–April 2. 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.

4.3. Turbine Unit Maintenance.

4.3.1. Turbine unit maintenance schedules will be reviewed annually by Project and Operations Division biologists for fish impacts. If the maintenance requires operating outside of FPP criteria, the work will be coordinated with regional salmon managers via FPOM, per the coordination process in **FPP Chapter 1 – Overview** (section 2.3).

4.3.2. Priority unit maintenance will be scheduled for the winter maintenance period or when there are few fish passing the project, to the extent possible. Impacts to migrating adults should be minimized.

4.3.3. 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.

4.3.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator that may take over a year to accomplish.

4.3.5. 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.

4.3.6. 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.

i. Pre-Maintenance: Units may be operationally tested for up to 30 minutes by running at speed-no-load and various loads within the 1% range for measurements and testing and to allow all fish to move through the unit, per section **4.3.8**.

ii. 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.

4.3.7. Operating Gates.[9] Operate turbine units with operating gates in the stored position, as originally designed, to ensure the safety of project personnel and facilities.

4.3.8. Dewatering Units. Dewater units (also referred to as "unwatering") in accordance with project *Dewatering Plans*.[8] 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 possible to load, run unit at speed no load for a minimum of 15 minutes 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 without tailrace stoplogs in place, make best efforts to not open the wicket gates if the scrollcase must be dewatered at a later date without the unit being spun beforehand.

4.3.9. 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.

4.3.9.1. 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.

4.3.9.2. 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.

[9] Operating gates may also be referred to as "head" gates at some projects. The terms are interchangeable.

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.

vii. 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.

4.3.10. Doble Testing. The yearly outage schedule is defined in **Appendix A**. 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 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.

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 spilling 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. 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	72.2	11,780	107.1	17,475	127.8	21,500	71.4	11,517	115.9	18,699	135.2	22,515
86	73.3	11,809	109.1	17,569	129.7	21,526	72.1	11,492	118.3	18,846	137.0	22,483
87	74.4	11,832	111.0	17,663	131.0	21,416	72.9	11,467	120.6	18,973	138.2	22,334
88	75.5	11,861	112.6	17,692	132.3	21,316	73.6	11,443	122.8	19,077	139.5	22,224
89	76.6	11,885	114.3	17,749	133.7	21,225	74.4	11,420	124.8	19,152	140.8	22,111
90	77.7	11,913	116.0	17,789	134.8	21,103	75.2	11,400	126.5	19,185	141.8	21,969
91	78.8	11,939	117.8	17,854	135.9	20,970	75.9	11,377	128.2	19,206	142.8	21,830
92	79.8	11,959	119.9	17,960	137.0	20,865	76.7	11,355	129.4	19,169	143.9	21,705
93	80.9	11,983	121.8	18,041	138.2	20,776	77.4	11,333	130.6	19,109	144.8	21,575
94	82.0	12,007	124.0	18,146	139.1	20,658	78.2	11,312	131.6	19,033	145.5	21,415
95	83.2	12,035	126.2	18,267	140.0	20,529	79.0	11,296	132.3	18,924	146.2	21,246
96	84.4	12,073	128.4	18,365	140.8	20,396	79.9	11,288	132.8	18,771	146.8	21,084
97	85.7	12,118	130.6	18,469	141.5	20,259	80.8	11,285	133.3	18,618	147.5	20,922
98	87.0	12,162	133.0	18,592	142.2	20,109	81.7	11,283	133.9	18,496	148.0	20,756
99	87.7	12,126	132.7	18,344	142.8	19,998	82.7	11,295	133.5	18,226	148.5	20,586
100	88.4	12,090	132.3	18,093	143.5	19,885	83.7	11,306	133.4	18,010	149.0	20,416
101	89.1	12,051	131.9	17,846	144.1	19,775	84.7	11,315	133.5	17,822	149.5	20,253
102	89.8	12,016	131.4	17,588	144.7	19,664	85.8	11,329	133.4	17,623	149.9	20,094
103	90.5	11,983	130.9	17,328	145.3	19,549	86.8	11,342	133.5	17,437	150.4	19,936
104	91.1	11,941	130.5	17,105	145.8	19,428	87.8	11,351	133.8	17,299	150.8	19,776
105	91.6	11,891	130.5	16,933	146.3	19,304	88.6	11,344	134.5	17,221	151.2	19,615
	LGS Units 4, 5, 6 – with ESBS						LGS Units 4, 5, 6 – No ESBS					
85	88.1	14,446	113.1	18,533	129.4	21,904	89.5	14,348	121.0	19,385	130.8	21,320
86	89.1	14,428	113.0	18,299	130.8	21,904	90.3	14,288	121.3	19,204	132.4	21,333
87	90.1	14,409	113.0	18,077	132.2	21,905	91.0	14,232	121.7	19,032	134.0	21,343
88	91.0	14,389	113.2	17,903	133.7	21,905	91.7	14,175	122.6	18,939	135.6	21,341
89	92.0	14,375	113.7	17,773	135.2	21,905	92.5	14,126	124.0	18,944	137.3	21,331
90	92.9	14,360	114.5	17,696	136.8	21,904	93.3	14,082	126.0	19,016	139.0	21,323
91	93.9	14,346	115.5	17,639	138.3	21,904	94.1	14,042	127.9	19,085	140.8	21,319
92	94.9	14,338	116.2	17,558	139.7	21,904	95.0	14,004	129.5	19,105	142.4	21,319
93	95.9	14,331	116.9	17,459	141.1	21,904	95.8	13,969	130.8	19,077	144.1	21,324
94	96.9	14,329	117.4	17,355	142.5	21,904	96.6	13,939	131.8	19,015	145.7	21,329
95	98.0	14,334	117.9	17,250	143.8	21,905	97.6	13,920	132.6	18,919	147.2	21,335
96	99.1	14,345	118.3	17,129	145.1	21,906	98.5	13,907	133.1	18,787	148.7	21,340
97	100.2	14,354	118.5	16,974	146.4	21,903	99.5	13,887	133.4	18,630	150.1	21,347
98	101.2	14,349	118.5	16,789	147.8	21,909	100.3	13,848	133.7	18,467	151.7	21,352
99	102.3	14,344	120.1	16,837	149.6	21,896	101.5	13,867	135.4	18,506	153.3	21,295
100	103.3	14,333	121.6	16,872	151.4	21,900	102.6	13,876	137.3	18,563	155.0	21,269
101	104.2	14,318	123.2	16,927	152.5	21,744	103.8	13,884	139.3	18,640	156.7	21,246
102	105.2	14,311	125.0	16,993	153.9	21,686	104.9	13,900	141.2	18,707	158.3	21,225
103	106.3	14,308	126.8	17,079	155.4	21,642	106.2	13,924	143.0	18,754	160.0	21,219
104	107.3	14,311	128.8	17,175	156.8	21,610	107.5	13,957	144.5	18,768	161.6	21,225
105	108.4	14,319	130.8	17,274	158.3	21,586	108.8	13,993	146.0	18,775	163.2	21,240

a. Values from HDC (May 2022). Flow (cfs) calculated based on turbine efficiency, project head, and power output (MW). "Operating Limit" is the maximum safe operating point based on cavitation or generator limit (added Feb 2018).

Table LGS-8. Little Goose Dam Spill Patterns with ASW in High Crest (ASW-Hi), Low Crest (ASW-Lo), and No ASW (Bay 1 Closed).

# 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**

[a] Total Spill (kcfs) is calculated as a function of total # of gate stops in Bays 2–8 + ASW spill at forebay elevation 633.5’ (in MOP). ASW spill is a function of crest and forebay elevation (see **section 2.3.2.7**).

# 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	5	5	40	**84.1**	**88.1**	**76.9**
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-9. [*page 1 of 3*] Little Goose Dam Spill Patterns for 30% Spill with ASW in High Crest (ASW-Hi). [a, b, c]

ASW-Hi 30% Spill Patterns (# Gate Stops/Spillbay)								Total Stops	Total Spill	Example Turbine Outflow [b] (kcfs)						TOTAL PH	TOTAL Project	% Spill	
1 [a]	2	3	4	5	6	7	8	(#)	(kcfs)	1	2	3	4	5	6	(kcfs)	(kcfs)	(%)	Comments (see footnotes)
ASW-Hi								0	7.2	16.7						16.7	23.9	30.1%	Min. Q w/ SW-Hi
ASW-Hi							1	1	8.9	17.5						17.5	26.4	33.7%	1 unit + 1 stop = ~34% Spill
ASW-Hi							1	1	8.9	11.3	11.3					22.6	31.5	28.3%	2 units at min. 1% + 1 stop = ~28% Spill
ASW-Hi	1						1	2	10.7	13.0	11.3					24.3	35.0	30.6%	Min. Q w/ SW-Hi per FPP
ASW-Hi	1						1	2	10.7	13.6	11.3					24.9	35.6	30.1%	
ASW-Hi	1						1	2	10.7	16.0	11.3					27.3	38.0	28.2%	Min. Q w/ U1 in upper 1%
ASW-Hi	1						2	3	12.6	16.0	13.3					29.3	41.9	30.1%	
ASW-Hi	1		1				2	4	14.3	17.5	15.9					33.4	47.7	30.0%	
ASW-Hi	1		1		1		2	5	16.1	17.5	17.5					35.0	51.1	31.5%	2 units + 5 stops = ~31% Spill
ASW-Hi	1		1		1		2	5	16.1	16.0	11.3	11.3				38.6	54.7	29.4%	3 units + 5 stops = ~29% Spill
ASW-Hi	1	1	1		1		2	6	17.9	16.0	12.9	12.8				41.7	59.6	30.0%	
ASW-Hi	1	1	1		1	1	2	7	19.6	16.0	14.9	14.9				45.8	65.4	30.0%	
ASW-Hi	1	1	1	1	1	1	2	8	21.4	16.6	16.7	16.6				49.9	71.3	30.0%	
ASW-Hi	1	1	1	1	1	1	2	8	21.4	17.5	17.5	17.5				52.5	73.9	29.0%	Max. Q w/ 3 units = ~29% Spill
ASW-Hi	1	1	1	1	1	1	2	8	21.4	16.0	11.3	11.3	13.9			52.5	73.9	29.0%	Min. Q w/ 4 units = ~29% Spill
ASW-Hi	2	1	1	1	1	1	2	9	23.3	16.0	12.2	12.2	13.9			54.3	77.6	30.0%	
ASW-Hi	2	1	2	1	1	1	2	10	25.2	16.0	14.3	14.2	14.2			58.7	83.9	30.0%	
ASW-Hi	2	1	2	1	1	1	2	10	25.2	16.0	14.6	14.6	14.6			59.8	85.0	29.6%	Spring flow trigger for SW crest change
ASW-Hi	2	1	2	1	2	1	2	11	27.1	16.0	15.8	15.7	15.7			63.2	90.3	30.0%	
ASW-Hi	2	2	2	1	2	1	2	12	29.0	16.9	16.9	16.9	16.9			67.6	96.6	30.0%	
ASW-Hi	2	2	2	1	2	1	2	12	29.0	17.5	17.5	17.5	18.9			71.4	100.4	28.9%	Max. Q w/ 4 units+12 stops = ~29% Spill
ASW-Hi	2	2	2	1	2	1	2	12	29.0	16.0	13.9	13.8	13.8	13.9		71.4	100.4	28.9%	5 units + 12 stops = ~29% Spill
ASW-Hi	2	2	2	2	2	1	2	13	30.9	16.0	14.0	14.0	14.0	14.0		72.0	102.9	30.0%	
ASW-Hi	2	2	2	2	2	2	2	14	32.8	16.0	15.2	15.1	15.1	15.1		76.5	109.3	30.0%	
ASW-Hi	3	2	2	2	2	2	2	15	34.8	16.3	16.2	16.2	16.2	16.2		81.1	115.9	30.0%	
ASW-Hi	3	3	2	2	2	2	2	16	36.8	17.2	17.2	17.2	17.1	17.1		85.8	122.6	30.0%	
ASW-Hi	3	3	3	2	2	2	2	17	38.8	16.0	14.9	14.9	14.9	14.9	14.8	90.4	129.2	30.0%	
ASW-Hi	3	3	3	3	2	2	2	18	40.8	16.0	15.9	15.8	15.8	15.8	15.8	95.1	135.9	30.0%	
ASW-Hi	3	3	3	3	3	2	2	19	42.7	16.7	16.6	16.6	16.6	16.6	16.6	99.7	142.4	30.0%	
ASW-Hi	3	3	3	3	3	3	2	20	44.7	17.4	17.4	17.4	17.4	17.4	17.4	104.4	149.1	30.0%	

ASW-Hi 30% Spill Patterns (# Gate Stops/Spillbay)								Total Stops	Total Spill	Example Turbine Outflow [b] (kcfs)						TOTAL PH	TOTAL Project	% Spill	
1 [a]	2	3	4	5	6	7	8	(#)	(kcfs)	1	2	3	4	5	6	(kcfs)	(kcfs)	(%)	Comments (see footnotes)
ASW-Hi	3	3	3	3	3	3	3	21	46.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	155.9	30.0%	Max. PH capacity for 30% Spill.
ASW-Hi	4	3	3	3	3	3	3	22	48.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	157.9	30.8%	
ASW-Hi	4	4	3	3	3	3	3	23	50.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	159.9	31.7%	
ASW-Hi	4	4	4	3	3	3	3	24	52.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	161.8	32.5%	
ASW-Hi	4	4	4	4	3	3	3	25	54.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	163.8	33.3%	
ASW-Hi	4	4	4	4	4	3	3	26	56.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	165.8	34.1%	
ASW-Hi	4	4	4	4	4	4	3	27	58.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	167.8	34.9%	
ASW-Hi	4	4	4	4	4	4	4	28	60.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	169.7	35.7%	
ASW-Hi	5	4	4	4	4	4	4	29	62.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	171.7	36.4%	
ASW-Hi	5	5	4	4	4	4	4	30	64.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	173.7	37.1%	
ASW-Hi	5	5	5	4	4	4	4	31	66.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	175.6	37.8%	
ASW-Hi	5	5	5	5	4	4	4	32	68.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	177.6	38.5%	
ASW-Hi	5	5	5	5	5	4	4	33	70.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	179.6	39.2%	
ASW-Hi	5	5	5	5	5	5	4	34	72.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	181.5	39.8%	
ASW-Hi	5	5	5	5	5	5	5	35	74.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	183.5	40.5%	
ASW-Hi	6	5	5	5	5	5	5	36	76.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	185.4	41.1%	
ASW-Hi	6	6	5	5	5	5	5	37	78.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	187.4	41.7%	
ASW-Hi	6	6	6	5	5	5	5	38	80.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	189.4	42.3%	
ASW-Hi	6	6	6	6	5	5	5	39	82.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	191.3	42.9%	
ASW-Hi	6	6	6	6	6	5	5	40	84.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	193.3	43.5%	
ASW-Hi	6	6	6	6	6	6	5	41	86.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	195.2	44.1%	
ASW-Hi	6	6	6	6	6	6	6	42	88.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	197.2	44.6%	
ASW-Hi	7	6	6	6	6	6	6	43	89.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	199.1	45.2%	
ASW-Hi	7	7	6	6	6	6	6	44	91.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	201.1	45.7%	
ASW-Hi	7	7	7	6	6	6	6	45	93.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	203.0	46.2%	
ASW-Hi	7	7	7	7	6	6	6	46	95.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	205.0	46.7%	
ASW-Hi	7	7	7	7	7	6	6	47	97.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	206.9	47.2%	
ASW-Hi	7	7	7	7	7	7	6	48	99.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	208.9	47.7%	
ASW-Hi	7	7	7	7	7	7	7	49	101.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	210.8	48.2%	
ASW-Hi	8	7	7	7	7	7	7	50	103.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	212.8	48.7%	
ASW-Hi	8	8	7	7	7	7	7	51	105.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	214.7	49.1%	
ASW-Hi	8	8	8	7	7	7	7	52	107.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	216.7	49.6%	

ASW-Hi 30% Spill Patterns (# Gate Stops/Spillbay)								Total Stops	Total Spill	Example Turbine Outflow [b] (kcfs)						TOTAL PH	TOTAL Project	% Spill	Comments (see footnotes)
1 [a]	2	3	4	5	6	7	8	(#)	(kcfs)	1	2	3	4	5	6	(kcfs)	(kcfs)	(%)	
ASW-Hi	8	8	8	8	7	7	7	53	109.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	218.7	50.1%	
ASW-Hi	8	8	8	8	8	7	7	54	111.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	220.6	50.5%	
ASW-Hi	8	8	8	8	8	8	7	55	113.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	222.6	50.9%	
ASW-Hi	8	8	8	8	8	8	8	56	115.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	224.6	51.4%	
ASW-Hi	9	8	8	8	8	8	8	57	117.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	226.5	51.8%	
ASW-Hi	9	9	8	8	8	8	8	58	119.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	228.4	52.2%	
ASW-Hi	9	9	9	8	8	8	8	59	121.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	230.4	52.6%	
ASW-Hi	9	9	9	9	8	8	8	60	123.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	232.3	53.0%	
ASW-Hi	9	9	9	9	9	8	8	61	125.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	234.2	53.4%	
ASW-Hi	9	9	9	9	9	9	8	62	127.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	236.2	53.8%	
ASW-Hi	9	9	9	9	9	9	9	63	128.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	238.1	54.1%	
ASW-Hi	10	9	9	9	9	9	9	64	130.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	240.1	54.5%	
ASW-Hi	10	10	9	9	9	9	9	65	132.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	242.1	54.9%	
ASW-Hi	10	10	10	9	9	9	9	66	134.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	244.1	55.3%	
ASW-Hi	10	10	10	10	9	9	9	67	136.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	246.1	55.6%	
ASW-Hi	10	10	10	10	10	9	9	68	138.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	248.1	56.0%	
ASW-Hi	10	10	10	10	10	10	9	69	140.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	250.1	56.3%	
ASW-Hi	10	10	10	10	10	10	10	70	143.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	252.2	56.7%	

a. Total Spill (kcfs) is calculated as a function of total # of gate stops in Bays 2–8 + ASW spill at forebay elevation 633.5’ (in MOP). ASW spill is a function of crest and forebay elevation (see **section 2.3.2.7**).

b. Turbine outflow is shown only to provide an example of how the special Unit 1 operation will look (see **section 4.2.2.2**) and is not a precise requirement. Actual turbine outflow will vary based on project head and turbine unit capabilities. See **Table LGS-7** for the current turbine operating range values.

c. Spill is > 30% when Total Outflow is > 156 kcfs (assuming all turbines available and max powerhouse capacity is approx. 109 kcfs).

Table LGS-10. [*page 1 of 3*] Little Goose Dam Spill Patterns for 30% Spill with ASW in Low Crest (ASW-Lo). [a, b, c]

ASW-Lo 30% Spill Patterns (# Gate Stops/Spillbay) 1 [a]	2	3	4	5	6	7	8	Total Stops (#)	Total Spill (kcfs)	Example Turbine Outflow [b] (kcfs) 1	2	3	4	5	6	TOTAL PH (kcfs)	TOTAL Project (kcfs)	% Spill (%)	Comments (see footnotes)
ASW-Lo								0	11.2	14.8	11.3					26.1	37.3	30.0%	Min. Q at SW-Lo
ASW-Lo								0	11.2	16.0	11.3					27.3	38.5	29.1%	Min. Q w/ U1 in upper 1%
ASW-Lo							1	1	13.0	16.0	14.2					30.2	43.2	30.1%	
ASW-Lo	1						1	2	14.7	17.2	17.1					34.3	49.0	30.0%	
ASW-Lo	1						1	2	14.7	17.5	17.5					35.0	49.7	29.6%	Max. Q w/ 2 units + 2 stops = ~30% Spill
ASW-Lo	1						1	2	14.7	16.0	11.3	11.3				38.6	53.3	27.6%	Min. Q w/ 3 units + 2 stops = ~28% Spill
ASW-Lo	1						2	3	16.6	16.0	11.4	11.4				38.8	55.4	30.0%	
ASW-Lo	1		1				2	4	18.4	16.0	13.5	13.4				42.9	61.3	30.0%	
ASW-Lo	1		1		1		2	5	20.1	16.0	15.5	15.5				47.0	67.1	30.0%	
ASW-Lo	1	1	1		1		2	6	21.9	17.1	17.0	17.0				51.1	73.0	30.0%	
ASW-Lo	1	1	1		1		2	6	21.9	17.5	17.5	17.5				52.5	74.4	29.4%	Max. Q w/ 3 units + 6 stops = ~29% Spill
ASW-Lo	1	1	1		1		2	6	21.9	16.0	11.3	11.3	13.9			52.5	74.4	29.4%	Min. Q w/ 4 units + 6 stops = ~29% Spill
ASW-Lo	1	1	1		1	1	2	7	23.7	16.0	12.7	12.6	13.9			55.2	78.9	30.0%	
ASW-Lo	1	1	1	1	1	1	2	8	25.4	16.0	14.5	14.4	14.4			59.3	84.7	30.0%	Spring flow trigger for SW crest change
ASW-Lo	2	1	1	1	1	1	2	9	27.3	16.0	15.9	15.9	15.9			63.7	91.0	30.0%	
ASW-Lo	2	1	2	1	1	1	2	10	29.2	17.1	17.1	17.0	17.0			68.2	97.4	30.0%	
ASW-Lo	2	1	2	1	1	1	2	10	29.2	17.5	17.5	17.5	18.9			71.4	100.6	29.0%	Max. Q w/ 4 units+10 stops = ~29% Spill
ASW-Lo	2	1	2	1	1	1	2	10	29.2	16.0	13.9	13.8	13.8	13.9		71.4	100.6	29.0%	5 units + 10 stops = ~29% Spill
ASW-Lo	2	1	2	1	2	1	2	11	31.1	16.0	14.2	14.2	14.1	14.1		72.6	103.7	30.0%	
ASW-Lo	2	2	2	1	2	1	2	12	33.0	16.0	15.3	15.3	15.2	15.2		77.0	110.0	30.0%	
ASW-Lo	2	2	2	2	2	1	2	13	34.9	16.3	16.3	16.3	16.3	16.3		81.5	116.4	30.0%	
ASW-Lo	2	2	2	2	2	2	2	14	36.8	17.2	17.2	17.2	17.2	17.1		85.9	122.7	30.0%	
ASW-Lo	3	2	2	2	2	2	2	15	38.8	16.0	15.0	14.9	14.9	14.9	14.9	90.6	129.4	30.0%	
ASW-Lo	3	3	2	2	2	2	2	16	40.8	16.0	15.9	15.9	15.8	15.8	15.8	95.2	136.0	30.0%	
ASW-Lo	3	3	3	2	2	2	2	17	42.8	16.7	16.7	16.7	16.6	16.6	16.6	99.9	142.7	30.0%	
ASW-Lo	3	3	3	3	2	2	2	18	44.8	17.5	17.4	17.4	17.4	17.4	17.4	104.5	149.3	30.0%	
ASW-Lo	3	3	3	3	3	2	2	19	46.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	156.0	30.0%	Max. PH capacity
ASW-Lo	3	3	3	3	3	3	2	20	48.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	158.0	30.9%	
ASW-Lo	3	3	3	3	3	3	3	21	50.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	160.0	31.8%	
ASW-Lo	4	3	3	3	3	3	3	22	52.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	162.0	32.6%	

ASW-Lo 30% Spill Patterns (# Gate Stops/Spillbay)							Total Stops	Total Spill	Example Turbine Outflow [b] (kcfs)						TOTAL PH	TOTAL Project	% Spill	
1 [a]	2	3	4	5	6	7	8 (#)	(kcfs)	1	2	3	4	5	6	(kcfs)	(kcfs)	(%)	Comments (see footnotes)
ASW-Lo	4	4	3	3	3	3	3	23	54.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	163.9	33.4%
ASW-Lo	4	4	4	3	3	3	3	24	56.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	165.9	34.2%
ASW-Lo	4	4	4	4	3	3	3	25	58.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	167.9	35.0%
ASW-Lo	4	4	4	4	4	3	3	26	60.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	169.8	35.7%
ASW-Lo	4	4	4	4	4	4	3	27	62.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	171.8	36.4%
ASW-Lo	4	4	4	4	4	4	4	28	64.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	173.8	37.2%
ASW-Lo	5	4	4	4	4	4	4	29	66.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	175.7	37.8%
ASW-Lo	5	5	4	4	4	4	4	30	68.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	177.7	38.5%
ASW-Lo	5	5	5	4	4	4	4	31	70.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	179.7	39.2%
ASW-Lo	5	5	5	5	4	4	4	32	72.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	181.6	39.9%
ASW-Lo	5	5	5	5	5	4	4	33	74.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	183.6	40.5%
ASW-Lo	5	5	5	5	5	5	4	34	76.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	185.6	41.2%
ASW-Lo	5	5	5	5	5	5	5	35	78.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	187.5	41.8%
ASW-Lo	6	5	5	5	5	5	5	36	80.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	189.5	42.4%
ASW-Lo	6	6	5	5	5	5	5	37	82.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	191.5	43.0%
ASW-Lo	6	6	6	5	5	5	5	38	84.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	193.4	43.5%
ASW-Lo	6	6	6	6	5	5	5	39	86.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	195.4	44.1%
ASW-Lo	6	6	6	6	6	5	5	40	88.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	197.3	44.7%
ASW-Lo	6	6	6	6	6	6	5	41	90.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	199.3	45.2%
ASW-Lo	6	6	6	6	6	6	6	42	92.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	201.3	45.8%
ASW-Lo	7	6	6	6	6	6	6	43	94.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	203.2	46.3%
ASW-Lo	7	7	6	6	6	6	6	44	95.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	205.1	46.8%
ASW-Lo	7	7	7	6	6	6	6	45	97.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	207.1	47.3%
ASW-Lo	7	7	7	7	6	6	6	46	99.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	209.0	47.8%
ASW-Lo	7	7	7	7	7	6	6	47	101.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	211.0	48.2%
ASW-Lo	7	7	7	7	7	7	6	48	103.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	212.9	48.7%
ASW-Lo	7	7	7	7	7	7	7	49	105.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	214.9	49.2%
ASW-Lo	8	7	7	7	7	7	7	50	107.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	216.8	49.6%
ASW-Lo	8	8	7	7	7	7	7	51	109.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	218.8	50.1%
ASW-Lo	8	8	8	7	7	7	7	52	111.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	220.8	50.5%
ASW-Lo	8	8	8	8	7	7	7	53	113.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	222.7	51.0%
ASW-Lo	8	8	8	8	8	7	7	54	115.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	224.7	51.4%

ASW-Lo 30% Spill Patterns (# Gate Stops/Spillbay)							Total Stops	Total Spill	Example Turbine Outflow [b] (kcfs)						TOTAL PH	TOTAL Project	% Spill	
1 [a]	2	3	4	5	6	7	8 (#)	(kcfs)	1	2	3	4	5	6	(kcfs)	(kcfs)	(%)	Comments (see footnotes)
ASW-Lo	8	8	8	8	8	8	7	55	117.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	226.7	51.8%	
ASW-Lo	8	8	8	8	8	8	8	56	119.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	228.6	52.2%	
ASW-Lo	9	8	8	8	8	8	8	57	121.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	230.6	52.6%	
ASW-Lo	9	9	8	8	8	8	8	58	123.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	232.5	53.0%	
ASW-Lo	9	9	9	8	8	8	8	59	125.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	234.4	53.4%	
ASW-Lo	9	9	9	9	8	8	8	60	127.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	236.3	53.8%	
ASW-Lo	9	9	9	9	9	8	8	61	129.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	238.3	54.2%	
ASW-Lo	9	9	9	9	9	9	8	62	131.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	240.2	54.5%	
ASW-Lo	9	9	9	9	9	9	9	63	132.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	242.1	54.9%	
ASW-Lo	10	9	9	9	9	9	9	64	134.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	244.1	55.3%	
ASW-Lo	10	10	9	9	9	9	9	65	137.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	246.2	55.6%	
ASW-Lo	10	10	10	9	9	9	9	66	139.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	248.2	56.0%	
ASW-Lo	10	10	10	10	9	9	9	67	141.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	250.2	56.4%	
ASW-Lo	10	10	10	10	10	9	9	68	143.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	252.2	56.7%	
ASW-Lo	10	10	10	10	10	10	9	69	145.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	254.2	57.0%	
ASW-Lo	10	10	10	10	10	10	10	70	147.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	256.2	57.4%	

a. Total Spill (kcfs) is calculated as a function of total # of gate stops in Bays 2–8 + ASW spill at forebay elevation 633.5' (in MOP). ASW spill is a function of crest and forebay elevation (see **section 2.3.2.7**).

b. Turbine outflow is shown only to provide an example of how the special Unit 1 operation will look (see **section 4.2.2.2**) and is not a precise requirement. Actual turbine outflow will vary based on project head and turbine unit capabilities. See **Table LGS-7** for the current turbine operating range values.

c. Spill is > 30% when Total Outflow is > 156 kcfs (assuming all turbines available and max powerhouse capacity is approx. 109 kcfs).

Table LGS-11. [*page 1 of 3*] Little Goose Dam Uniform Spill Patterns for 30% Spill with No ASW (Bay 1 Closed).

No ASW 30% Spill Patterns (# Gate Stops/Spillbay)								Total Stops	Total Spill	Example Turbine Outflow [b] (kcfs)						TOTAL PH	TOTAL Project	% Spill	
1 [a]	2	3	4	5	6	7	8	(#)	(kcfs)	1	2	3	4	5	6	(kcfs)	(kcfs)	(%)	Comments (see footnotes)
Closed								0	0.0	11.3						11.3	11.3	0.0%	Min. Q w/ SW closed and no spill.
Closed							1	1	1.8	11.3						11.3	13.1	13.5%	
Closed	1						1	2	3.5	11.3						11.3	14.8	23.8%	
Closed	1						2	3	5.4	12.6						12.6	18.0	30.0%	Min. Q w/ no SW and 30% spill.
Closed	1		1				2	4	7.2	16.8						16.8	24.0	29.9%	
Closed	1		1		1		2	5	8.9	17.5						17.5	26.4	33.8%	1 unit + 5 stops = ~34% spill
Closed	1		1		1		2	5	8.9	11.3	11.3					22.6	31.5	28.3%	2 units + 5 stops = ~28% spill
Closed	1	1	1		1		2	6	10.7	13.7	11.3					25.0	35.7	30.0%	
Closed	1	1	1		1		2	6	10.7	16.0	11.3					27.3	38.0	28.2%	Min. Q w/ U1 in upper 1%
Closed	1	1	1		1	1	2	7	12.5	16.0	13.1					29.1	41.6	30.0%	
Closed	1	1	1	1	1	1	2	8	14.2	16.6	16.6					33.2	47.4	30.0%	
Closed	2	1	1	1	1	1	2	9	16.1	17.5	17.5					35.0	51.1	31.5%	2 units + 9 stops = ~31% spill
Closed	2	1	1	1	1	1	2	9	16.1	16.0	11.3	11.3				38.6	54.7	29.5%	3 units + 9 stops = ~29% spill
Closed	2	1	2	1	1	1	2	10	18.0	16.0	13.0	13.0				42.0	60.0	30.0%	
Closed	2	1	2	1	2	1	2	11	19.9	16.0	15.3	15.2				46.5	66.4	30.0%	
Closed	2	2	2	1	2	1	2	12	21.8	17.0	17.0	16.9				50.9	72.7	30.0%	
Closed	2	2	2	1	2	1	2	12	21.8	17.5	17.5	17.5				52.5	74.3	29.4%	Max. Q w/ 3 units = ~29% spill
Closed	2	2	2	2	2	1	2	13	23.7	16.0	11.3	11.3	13.9			52.5	76.2	31.1%	Min. Q w/ 4 units = ~31% spill
Closed	2	2	2	2	2	1	2	13	23.7	16.0	12.7	12.7	13.9			55.3	79.0	30.0%	
Closed	2	2	2	2	2	2	2	14	25.6	16.0	14.6	14.6	14.6			59.8	85.4	30.0%	
Closed	3	2	2	2	2	2	2	15	27.6	16.1	16.1	16.1	16.1			64.4	92.0	30.0%	
Closed	3	3	2	2	2	2	2	16	29.6	17.3	17.3	17.3	17.2			69.1	98.7	30.0%	
Closed	3	3	3	2	2	2	2	17	31.6	16.0	14.5	14.4	14.4	14.4		73.7	105.3	30.0%	
Closed	3	3	3	3	2	2	2	18	33.6	16.0	15.6	15.6	15.6	15.6		78.4	112.0	30.0%	
Closed	3	3	3	3	3	2	2	19	35.6	16.7	16.6	16.6	16.6	16.6		83.1	118.7	30.0%	
Closed	3	3	3	3	3	3	2	20	37.6	17.5	17.5	17.5	17.5	17.5		87.5	125.1	30.1%	
Closed	3	3	3	3	3	3	3	21	39.6	16.0	15.3	15.3	15.3	15.3	15.2	92.4	132.0	30.0%	
Closed	4	3	3	3	3	3	3	22	41.6	16.2	16.2	16.2	16.2	16.1	16.1	97.0	138.6	30.0%	
Closed	4	4	3	3	3	3	3	23	43.5	17.0	17.0	16.9	16.9	16.9	16.9	101.6	145.1	30.0%	
Closed	4	4	4	3	3	3	3	24	45.5	17.5	17.5	17.5	17.9	17.9	17.9	106.2	151.7	30.0%	

No ASW 30% Spill Patterns (# Gate Stops/Spillbay)								Total Stops	Total Spill	Example Turbine Outflow [b] (kcfs)						TOTAL PH	TOTAL Project	% Spill	
1 [a]	2	3	4	5	6	7	8	(#)	(kcfs)	1	2	3	4	5	6	(kcfs)	(kcfs)	(%)	Comments (see footnotes)
Closed	4	4	4	4	3	3	3	25	47.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	156.7	30.3%	Max. PH capacity for 30% Spill. c
Closed	4	4	4	4	4	3	3	26	49.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	158.6	31.2%	
Closed	4	4	4	4	4	4	3	27	51.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	160.6	32.0%	
Closed	4	4	4	4	4	4	4	28	53.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	162.6	32.8%	
Closed	5	4	4	4	4	4	4	29	55.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	164.5	33.6%	
Closed	5	5	4	4	4	4	4	30	57.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	166.5	34.4%	
Closed	5	5	5	4	4	4	4	31	59.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	168.5	35.2%	
Closed	5	5	5	5	4	4	4	32	61.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	170.4	35.9%	
Closed	5	5	5	5	5	4	4	33	63.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	172.4	36.7%	
Closed	5	5	5	5	5	5	4	34	65.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	174.4	37.4%	
Closed	5	5	5	5	5	5	5	35	67.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	176.3	38.1%	
Closed	6	5	5	5	5	5	5	36	69.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	178.3	38.8%	
Closed	6	6	5	5	5	5	5	37	71.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	180.3	39.4%	
Closed	6	6	6	5	5	5	5	38	73.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	182.2	40.1%	
Closed	6	6	6	6	5	5	5	39	75.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	184.2	40.7%	
Closed	6	6	6	6	6	5	5	40	76.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	186.1	41.3%	
Closed	6	6	6	6	6	6	5	41	78.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	188.1	41.9%	
Closed	6	6	6	6	6	6	6	42	80.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	190.1	42.5%	
Closed	7	6	6	6	6	6	6	43	82.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	192.0	43.1%	
Closed	7	7	6	6	6	6	6	44	84.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	193.9	43.7%	
Closed	7	7	7	6	6	6	6	45	86.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	195.9	44.3%	
Closed	7	7	7	7	6	6	6	46	88.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	197.8	44.8%	
Closed	7	7	7	7	7	6	6	47	90.6	17.5	17.5	17.5	18.9	18.9	18.9	109.2	199.8	45.3%	
Closed	7	7	7	7	7	7	6	48	92.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	201.7	45.9%	
Closed	7	7	7	7	7	7	7	49	94.5	17.5	17.5	17.5	18.9	18.9	18.9	109.2	203.7	46.4%	
Closed	8	7	7	7	7	7	7	50	96.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	205.6	46.9%	
Closed	8	8	7	7	7	7	7	51	98.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	207.6	47.4%	
Closed	8	8	8	7	7	7	7	52	100.4	17.5	17.5	17.5	18.9	18.9	18.9	109.2	209.6	47.9%	
Closed	8	8	8	8	7	7	7	53	102.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	211.5	48.4%	
Closed	8	8	8	8	8	7	7	54	104.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	213.5	48.9%	
Closed	8	8	8	8	8	8	7	55	106.3	17.5	17.5	17.5	18.9	18.9	18.9	109.2	215.5	49.3%	
Closed	8	8	8	8	8	8	8	56	108.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	217.4	49.8%	

No ASW 30% Spill Patterns (# Gate Stops/Spillbay)							Total Stops	Total Spill	Example Turbine Outflow [b] (kcfs)						TOTAL PH	TOTAL Project	% Spill	Comments (see footnotes)
1 [a]	2	3	4	5	6	7	8	(#)	(kcfs)	1	2	3	4	5	6	(kcfs)	(kcfs)	(%)
Closed	9	8	8	8	8	8	8	57	110.2	17.5	17.5	17.5	18.9	18.9	18.9	109.2	219.4	50.2%	
Closed	9	9	8	8	8	8	8	58	112.1	17.5	17.5	17.5	18.9	18.9	18.9	109.2	221.3	50.7%	
Closed	9	9	9	8	8	8	8	59	114.0	17.5	17.5	17.5	18.9	18.9	18.9	109.2	223.2	51.1%	
Closed	9	9	9	9	8	8	8	60	115.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	225.1	51.5%	
Closed	9	9	9	9	9	8	8	61	117.9	17.5	17.5	17.5	18.9	18.9	18.9	109.2	227.1	51.9%	
Closed	9	9	9	9	9	9	8	62	119.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	229.0	52.3%	
Closed	9	9	9	9	9	9	9	63	121.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	230.9	52.7%	
Closed	10	9	9	9	9	9	9	64	123.7	17.5	17.5	17.5	18.9	18.9	18.9	109.2	232.9	53.1%	
Closed	10	10	9	9	9	9	9	65	125.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	235.0	53.5%	
Closed	10	10	10	9	9	9	9	66	127.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	237.0	53.9%	
Closed	10	10	10	10	9	9	9	67	129.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	239.0	54.3%	
Closed	10	10	10	10	10	9	9	68	131.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	241.0	54.7%	
Closed	10	10	10	10	10	10	9	69	133.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	243.0	55.1%	
Closed	10	10	10	10	10	10	10	70	135.8	17.5	17.5	17.5	18.9	18.9	18.9	109.2	245.0	55.4%	

a. Total Spill (kcfs) is calculated as a function of total # of gate stops in Bays 2–8 at forebay elevation 633.5’ (in MOP).

b. Turbine outflow is shown only to provide an example of how the special Unit 1 operation will look (see **section 4.2.2.2**) and is not a precise requirement. Actual turbine outflow will vary based on project head and turbine unit capabilities. See **Table LGS-7** for the current turbine operating range values.

c. Spill is > 30% when Total Outflow is > 156 kcfs (assuming all turbines available and max powerhouse capacity is approx. 109 kcfs).

2023 Fish Passage Plan

Chapter 9 – Lower Granite Dam

Table of Contents

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.

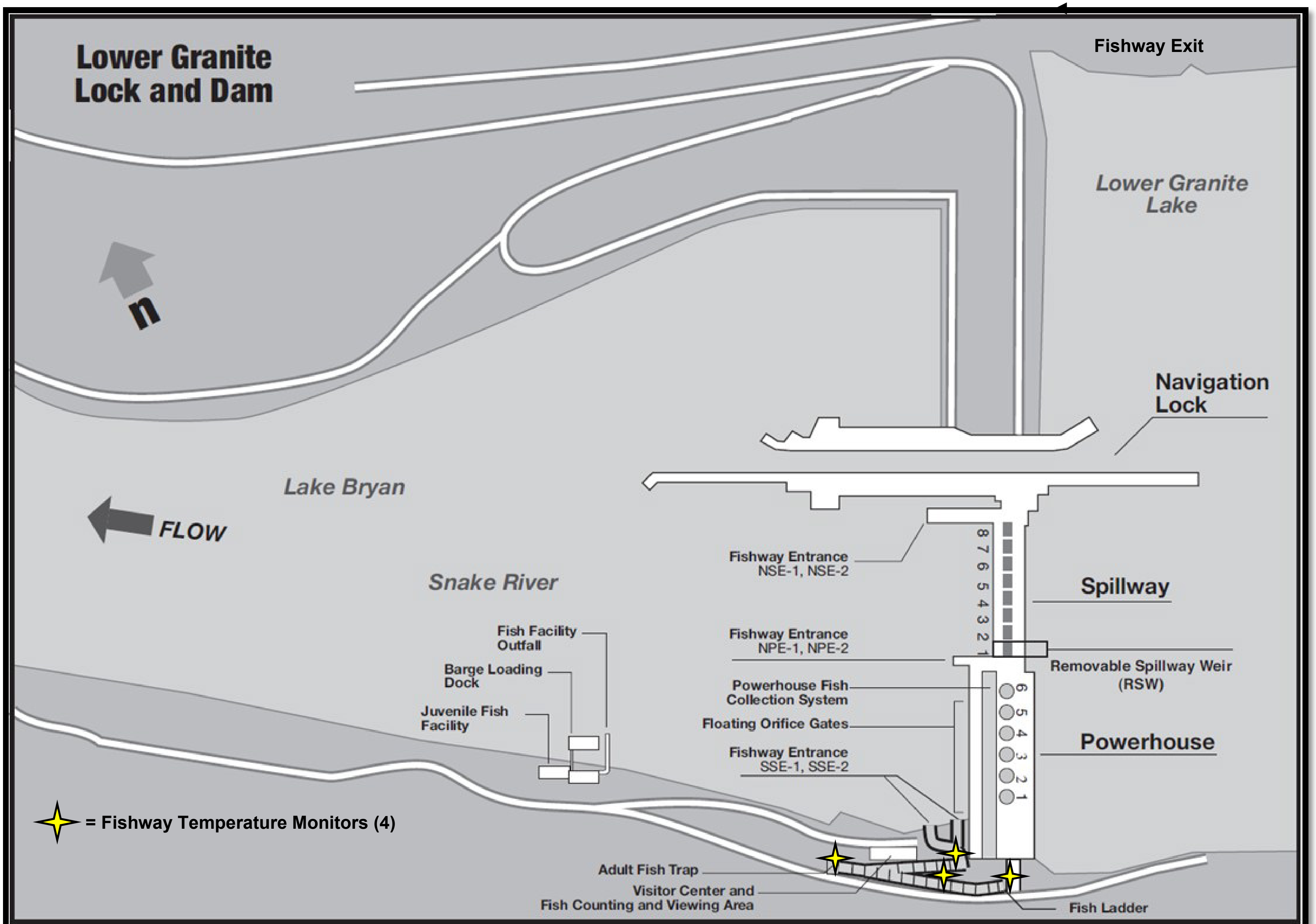
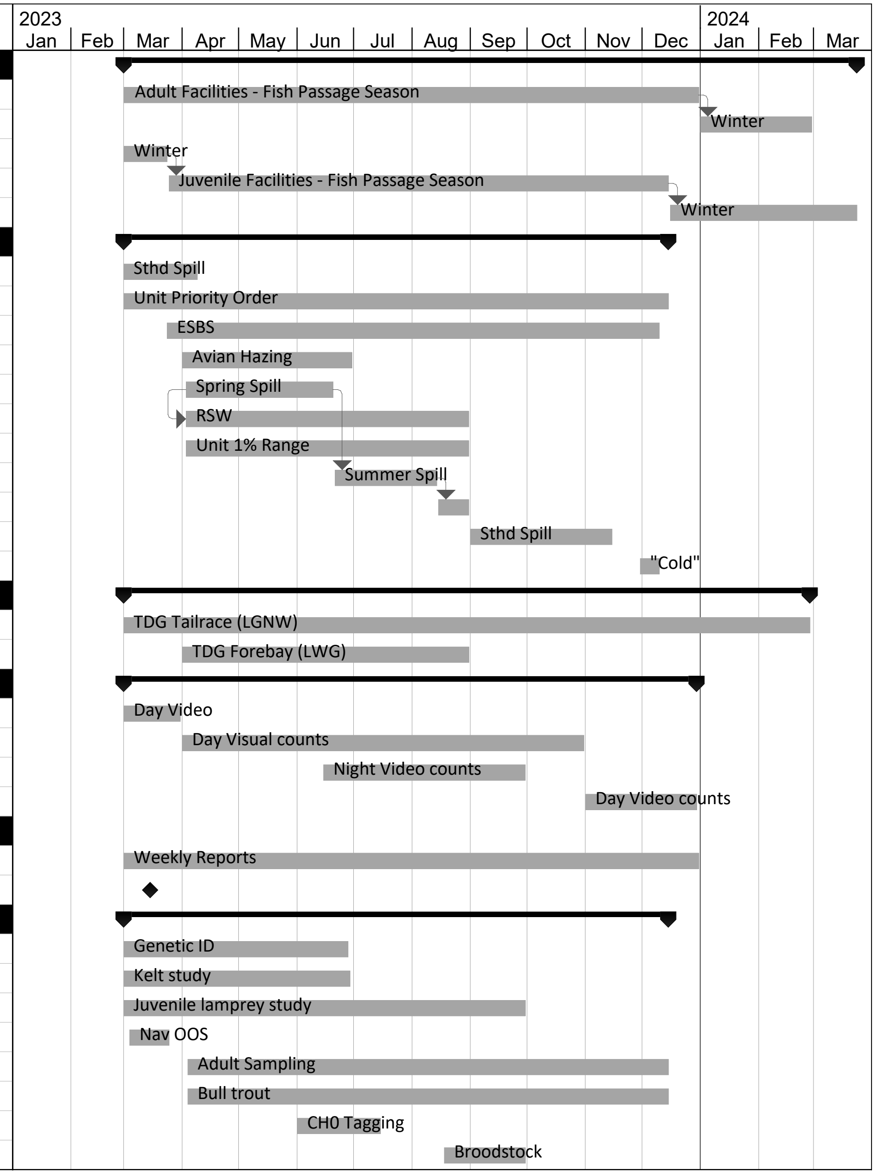


Figure LWG-1. Lower Granite Lock & Dam General Site Plan.

Table LWG-1. Lower Granite Dam Schedule of Operations and Actions Defined in the 2023 Fish Passage Plan (FPP).

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**Wed 3/1/23**	**Sun 3/24/24**	
Adult Facilities - Fish Passage Season	Wed 3/1/23	Sun 12/31/23	2.4.2
Adult Facilities - Winter Maintenance	Mon 1/1/24	Thu 2/29/24	2.4.1
Juvenile Facilities - Winter Maintenance	Wed 3/1/23	Fri 3/24/23	2.3.1
Juvenile Facilities - Fish Passage Season	Sat 3/25/23	Fri 12/15/23	2.3.2
	Sat 12/16/23	Sun 3/24/24	2.3.1
PROJECT OPERATIONS FOR FISH PASSAGE	**Wed 3/1/23**	**Fri 12/15/23**	
RSW Spill for Adult Steelhead	Wed 3/1/23	Sun 4/9/23	2.2.2
Turbine unit priority order	Wed 3/1/23	Fri 12/15/23	4.1
ESBSs	Fri 3/24/23	Sun 12/10/23	2.3.1.2, 2.3.2.2
Avian hazing	Sat 4/1/23	Fri 6/30/23	Appendix L
Spring Spill	Mon 4/3/23	Tue 6/20/23	Appendix E (FOP)
RSW Spill	Mon 4/3/23	Thu 8/31/23	2.3.2.6
Turbine unit 1% operating range	Mon 4/3/23	Thu 8/31/23	4.2
Summer Spill	Wed 6/21/23	Mon 8/14/23	Appendix E (FOP)
Late Summer Spill	Tue 8/15/23	Thu 8/31/23	Appendix E (FOP)
RSW Spill for Adult Steelhead	Fri 9/1/23	Wed 11/15/23	2.2.2
ESBS removal during cold weather	Thu 11/30/23	Sun 12/10/23	2.3.2.2
TDG MONITORING	**Wed 3/1/23**	**Wed 2/28/24**	
TDG Monitoring - Tailrace (LGNW)	Wed 3/1/23	Wed 2/28/24	2.2.4
TDG Monitoring - Forebay (LWG)	Sat 4/1/23	Thu 8/31/23	2.2.4
ADULT FISH COUNTING	**Wed 3/1/23**	**Sat 12/30/23**	
Day Video 0400-2000 PST/ 0500-2100 PDT	Wed 3/1/23	Fri 3/31/23	Table LWG-3
Day Visual 0500-2100 PDT	Sat 4/1/23	Tue 10/31/23	Table LWG-3
Night Video 2100-0500 PDT	Thu 6/15/23	Sat 9/30/23	Table LWG-3
Day Video 0500-2100 PDT / 0400-2000 PST	Wed 11/1/23	Sat 12/30/23	Table LWG-3
REPORTS	**Wed 3/1/23**	**Sun 12/31/23**	
Weekly Reports	Wed 3/1/23	Sun 12/31/23	2.5.2
Annual Report due (for previous year)	Wed 3/15/23	Wed 3/15/23	2.5.2
SPECIAL OPS & STUDIES (Appendix A)	**Wed 3/1/23**	**Fri 12/15/23**	
Genetic Stock ID	Wed 3/1/23	Wed 6/28/23	App A 9.2
Kelt Study	Wed 3/1/23	Thu 6/29/23	App A 9.2
Juvenile Lamprey Survival Study	Wed 3/1/23	Sat 9/30/23	App A 9.2
Navigation Lock OOS	Sat 3/4/23	Sat 3/25/23	App A 1.4
Adult Sampling	Tue 4/4/23	Fri 12/15/23	App A 9.2
Bull Trout PIT-tagging and Genetic Sampling	Tue 4/4/23	Fri 12/15/23	App A 9.2
Subyearling Parentage-Based Tagging	Thu 6/1/23	Sat 7/15/23	App A 9.2
Broodstock Collection (end date TBD)	Fri 8/18/23	Sat 9/30/23	App A 9.2



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 Facilities and Migration Timing.

1.1.1. Juvenile Fish Facilities. The Lower Granite Dam juvenile fish facilities consist of a bypass system and juvenile transportation facilities. Maintenance of juvenile passage facilities that may impact juvenile fish or facility operations should be conducted during winter maintenance.

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.
- Collection channel running the length of the powerhouse.
- Primary and secondary dewaterers (PDW and SDW).
- Full-flow PIT-tag detection system.
- Transport flume with switch gate to direct fish to collection and transportation facilities or directly back to the river via primary bypass pipe.
- Emergency bypass route at upstream end of the PDW that allows fish to be returned to river in the event the PDW or transport flume upstream of the switch gate become unsuitable for fish passage.

The transportation facilities include:

- Water supply system and separator structure to separate juveniles from excess water and adult fish.
- Raceways for holding fish.
- Distribution system to distribute fish among raceways, to the barge, or 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%	#	10%	50%	90%	#
	Yearling Chinook (wild & hatchery)				Subyearling Chinook (wild & hatchery)			
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
2018	13-Apr	4-May	13-May	30	20-May	29-May	3-Jul	44
2019	10-Apr	29-Apr	15-May	35	28-Apr	4-Jun	2-Jul	65
2020*	18-Apr	5-May	18-May	30	22-May	8-Jun	21-Jul	60
2021*	10-Apr	5-May	13-May	33	6-Jun	27-Jun	6-Aug	61
2022	26-Apr	9-May	19-May	23	16-May	11-Jun	1-Aug	77
10-Yr	**14-Apr**	**4-May**	**13-May**	**29**	**26-May**	**6-Jun**	**13-Jul**	**57**
10-Yr MIN	**3-Apr**	**26-Apr**	**9-May**	**23**	**28-Apr**	**29-May**	**2-Jul**	**38**
10-Yr MAX	**26-Apr**	**9-May**	**19-May**	**38**	**6-Jun**	**27-Jun**	**6-Aug**	**77**
	Unclipped Steelhead				Clipped Steelhead			
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
2018	17-Apr	9-May	22-May	35	11-Apr	1-May	18-May	37
2019	10-Apr	26-Apr	17-May	37	10-Apr	22-Apr	6-May	26
2020*	18-Apr	5-May	24-May	36	14-Apr	3-May	24-May	40
2021*	11-Apr	5-May	20-May	39	12-Apr	18-Apr	9-May	27
2022	4-May	11-May	3-Jun	30	22-Apr	9-May	31-May	39
10-Yr	**16-Apr**	**8-May**	**23-May**	**36**	**13-Apr**	**29-Apr**	**17-May**	**32**
10-Yr MIN	**10-Apr**	**26-Apr**	**17-May**	**27**	**8-Apr**	**18-Apr**	**6-May**	**26**
10-Yr MAX	**4-May**	**13-May**	**3-Jun**	**39**	**22-Apr**	**9-May**	**31-May**	**40**
	Coho (wild & hatchery)				Sockeye (wild & hatchery)			
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
2018	2-May	11-May	27-May	25	13-May	17-May	21-May	8
2019	11-Apr	14-May	3-Jun	53	15-May	18-May	20-May	5
2020*	30-Apr	21-May	31-May	31	14-May	14-May	18-May	5
2021*	3-May	12-May	8-Jun	36	3-May	10-May	22-May	19
2022	8-May	10-May	7-Jun	30	13-May	14-May	17-May	4
10-Yr	**1-May**	**13-May**	**27-May**	**28**	**13-May**	**15-May**	**20-May**	**10**
10-Yr MIN	**11-Apr**	**8-May**	**15-May**	**10**	**8-Apr**	**3-May**	**17-May**	**4**
10-Yr MAX	**8-May**	**21-May**	**8-Jun**	**53**	**17-May**	**22-May**	**28-May**	**41**

* 2020 and 2021 passage data include early start of Lower Granite sampling on March 1st.

1.2. Adult Fish Facilities and Migration Timing.

1.2.1. Adult Fish Facilities.

1.2.1.1. Lower Granite Dam adult passage facilities are made up of one south shore 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.

1.2.1.2. 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.

1.2.1.3. 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.

1.2.1.4. Auxiliary water is supplied from the tailrace by three electric pumps and from the forebay through diffuser-14. When the juvenile bypass system is operating, 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.

1.2.1.5. 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.

1.2.1.6. 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 facilities are operated year-round. Adult salmon, steelhead, bull trout, shad, and lamprey are counted per the schedule in **Table LWG-3** and data are posted daily at www.fpc.org. The presence of other species (i.e., sturgeon, grass carp, Atlantic salmon, etc.) are recorded as comments and reported 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 passage in **Table LWG-4**.

1.2.2.3. 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 March 2023 – Feb 2024.

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 15 – 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 3/13/22–11/6/22.

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 18

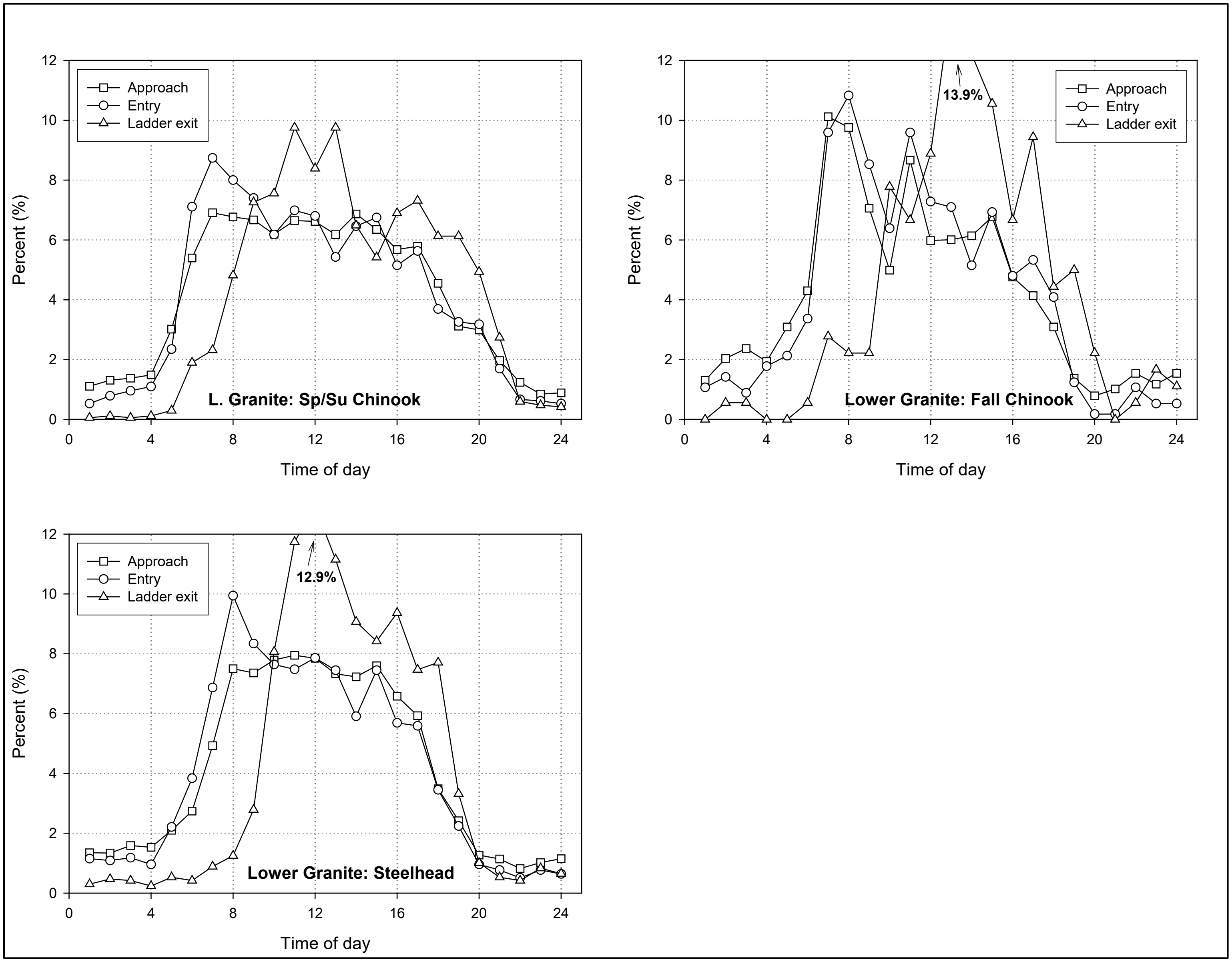


Figure LWG-2. Diel Distribution of Adult Salmonids at Lower Granite Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

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 **Tables LWG-7 and LWG-8**.

2.2.2. Spill for Adult Steelhead Overshoots. Surface spill will be implemented at McNary and the four lower Snake River dams as a means of providing non-powerhouse downstream passage for adult steelhead that overshoot natal tributaries prior to spawning or that strive to repeat a subsequent reproduction cycle (iteroparity). This operation is pursuant to non-discretionary terms and conditions in the 2020 NOAA Fisheries Columbia River System (CRS) Biological Opinion[1], which calls for surface spill via the spillway weir at each of the five projects **March 1–30 and October 1–November 15, three times each week on non-consecutive days for four hours in the morning** (generally between 05:00 and 11:00). This operation is also considered in the 2020 USFWS CRS Biological Opinion[2] as a means of providing safe and effective downstream passage for adult steelhead and other fish.

> **i.** In 2023, spring surface spill will continue through the start of spring spill for juvenile fish on April 10, and fall surface spill will begin September 1, to comply

[1] NOAA CRS BiOp, section 2.17.4.G, "*Reduce Take of Overshoot Adult Steelhead*": https://www.fisheries.noaa.gov/webdam/download/109136871

[2] USFWS CRS BiOp, section 5.7.4, "*Off-season Surface Spill for Downstream Passage of Adult Steelhead*": https://ecos.fws.gov/tails/pub/document/17101031

with the Agreement for short-term operations of the Columbia River System.[3] As such, in 2023, surface spill for adult steelhead will occur at the four Lower Snake River dams **March 1–April 2** **and September 1–November 15, three times each week on non-consecutive days for four hours in the morning**.

2.2.3. 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.

2.2.4. Total dissolved gas (TDG) is monitored at Lower Granite Dam during the periods defined in **Table LWG-1**, pursuant to the Corps' annual *TDG Management Plan* and current *Dissolved Gas Monitoring Plan of Action*.[4]

2.2.5. 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.

2.3. Operating Criteria – Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance Period (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. ESBSs may be removed beginning on Monday of the third week of December. Within a week after removing ESBSs for winter maintenance, or as soon as practical, inspect for juvenile salmonid mortalities and all other incidental fish mortalities. Count all mortalities, or otherwise estimate, for each ESBS and report to CENWW-OD-T.

[3] Stay Agreement: pweb.crohms.org/tmt/JointMotion_TermSheet_CourtOrder_and_Extensions_2023_0831.pdf

[4] TDG Management Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/
TDG Monitoring Plan of Action: www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality

ii. Complete maintenance on all screens.

iii. Inspect ESBSs prior to installation and operate debris cleaner (dogged off on deck) to ensure proper operation. Log results of trial run.

iv. Inspect VBSs with underwater video camera at least once per year; repair as needed.

v. Inspect flow vanes to make sure they are in good condition and all surfaces smooth. Repair as needed.

vi. Install ESBSs in at least 4 turbine units (all 6 if possible) by March 24. Install remaining ESBSs prior to April 1.

2.3.1.3. Collection Channel.

i. Maintain make-up water valves and control equipment to be capable of operating when needed.

ii. Maintain orifice lights operational.

iii. Maintain orifices clean and valves operating correctly.

iv. Maintain orifice cycling and air backflush system operational.

2.3.1.4. Primary Dewaterer (PDW) and Flume.

i. Maintain inclined floor screens clean in good condition with no damaged panels and no gaps between screen panels.

ii. Maintain cleaning brush and air burst systems operating correctly.

iii. Maintain and test overflow weirs to ensure operating correctly.

iv. Maintain all valves operating correctly.

v. Maintain baffle boards under inclined screen in good condition, placed appropriately to balance screen approach velocity, and securely attached.

vi. Maintain flume interior 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.

viii. Maintain switch gate in good operating condition.

2.3.1.5. Transportation Facilities.

i. Maintain flume switch gate in good operating condition.

ii. Ensure flume interior is smooth with no rough edges and expansion joints are in good operating condition.

iii. Maintain secondary dewaterer (SDW) clean and in good condition with no damaged panels or gaps between screen panels, air burst system operating correctly, and valves and weirs tested and operating correctly.

iv. Maintain water supply throttling valve and drain sluice gate operating correctly for facility water supply requirements.

v. Perforated plate for porosity control at separator smooth with no rough edges.

vi. Wet separator and fish distribution system ready for operation.

vii. Brushes and screens on crowders in good condition; no holes or rough edges.

viii. Maintain and test crowders to ensure operating correctly.

ix. Maintain all valves, slide gates, and switch gates in good condition.

x. Ensure raceway tail screens are in place with no holes in screens or sharp wires protruding.

xi. Maintain barge and truck loading pipes free of debris, cracks, or blockages. Test and maintain barge loading boom.

xii. Maintain all sampling equipment in good operating condition prior to watering up the facilities.

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.

xiv. Maintain mini- and midi-tanks in good operating condition.

2.3.1.6. Barges.

i. Maintain all engines and pumps in good operating condition.

ii. Maintain fish release openings and related equipment in good condition.

iii. No rough edges or support beams protruding into compartments.

iv. No brass or galvanized fittings in circulation lines.

v. Install all loading hoses properly 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.

2.3.1.7. Record all maintenance and inspections.

2.3.1.8. Implement measures to minimize avian predation as described in the *Predation Monitoring and Deterrence Action Plans* (**Appendix L** Table 2 and section 10). 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.

2.3.2. Juvenile Facilities – Juvenile Fish Passage Season (March 25–December 15).

Operate according to criteria below March 25–October 31 for juvenile bypass, collection, and transport and November 1–December 15 for adult fallbacks. Also operate according to criteria 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.

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 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 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.

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. ESBSs and VBSs.

i. Install ESBSs and flow vanes 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. Measure VBS head differentials at least once per week (more frequently if required) through June 30 and biweekly for the remainder of the operating season. When a head differential of 1.5’ is reached, operate the respective turbine unit 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.

vi. 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, damaged, or a known non-operating ESBS, except as noted.

vii. Between spring and summer, inspect at least two VBSs in two different turbine units that were operated frequently in the spring. If a debris accumulation is noted, inspect other VBSs and clean as necessary.

viii. After October 1, up to half of the project's ESBSs may be pulled for maintenance as long as unscreened turbine units are not operated.

ix. After Thanksgiving, if the National Weather Service forecast for Lower Granite[5] is below 20°F for 24 hours or longer, screens may be removed and the JBS shutdown for the remainder of the season. Prior to removing screens, request special permission from CENWW-OD-T, who will then inform NOAA Fisheries and FPOM.

x. 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.

xi. 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.

2.3.2.3. Collection Channel.

i. Maintain 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, preferably 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. Ensure orifice lights are functioning and operating on open orifices 24 hrs/day. Replace all burned out orifice lights within 24 hours of notification. 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.

[5] NWS weather forecast for Lower Granite: forecast.weather.gov/MapClick.php?lat=46.658178954000505&lon=-117.43311929599969

iii. Orifice jets hitting no closer than 3' from back wall, collection channel full.

iv. Orifice valves are either fully open or closed.

v. 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, inspect orifices and back-flush 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, restrict the respective turbine unit generation to the lower end of the 1% efficiency range to minimize orifice plugging problems.

vi. If utilizing the automatic orifice backflush system, inspect as determined by the Project biologist (at least once per 12-hour shift unless coordinated differently) to ensure 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.

vii. 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. Maintain crowder screen brushes in good operating condition with no holes or sharp edges on crowder screens.

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 Project biologist will set the frequency of screen cleaning as necessary to maintain clean screens.

ii. If utilizing the automatic cleaning system, inspect as determined by the Project biologist (at least once per 12-hour shift unless coordinated differently) to ensure 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.

2.3.2.6. Removable Spillway Weir (RSW).

i. Lower Granite Dam has one removable spillway weir (RSW) in spillbay 1 that provides a surface route for fish passage. The RSW can be opened and closed from the control room.

ii. The spill rate through the RSW is a function of the forebay elevation – as the pool elevation increases, more water is spilled over the RSW:

LWG Forebay Elevation (ft)	RSW Spill Rate (kcfs)
733	5.6
733.5	6.1
734	6.6
734.5	7.1
735	7.6
735.5	8.2
736	8.8
736.5	9.4
737	10.0
737.5	10.7
738	11.4

iii. The RSW will be raised and operational during spill for juvenile fish passage April 3–August 31 (**Appendix E**) and spill for adult steelhead (**section 2.2.2**):

- Raise the spill gate to where it does not touch flow passing down the RSW (at least nine stops) and distribute spill according to patterns in **Table LWG-7**.
- During high flow, if the Northwest River Forecast Center (NWRFC) inflow forecast for Lower Granite[6] is above 200 kcfs, coordinate with RCC and CENWW-OD-T to initiate aggressive forebay debris removal so that RSW operation will not be impeded. If inflow exceeds 260 kcfs, the upstream river gauge flow is increasing, and the NWRFC inflow forecast is above 300 kcfs, stow the RSW (complete rotation to the landing pad).
- If river flow is too low to maintain RSW spill and minimum generation requirements, close the RSW and spill the remaining outflow according to "No RSW" patterns in **Table LWG-8**. Re-open the RSW if flows increase sufficiently to support both RSW spill and minimum generation. The intent is to keep the RSW open to maintain PIT-tag detection to the extent possible as flows allow.

iv. When not spilling for fish passage, the RSW may be operated for short durations during low flows at the request of 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**).

2.3.2.7. Inspect fish facilities at least once every 8 hours. Inspect facilities according to fish facilities monitoring program. Record all maintenance and inspections.

2.3.2.8. Operate in accordance with *Predation Monitoring and Deterrence Action Plans* for Lower Granite Dam in **Appendix L** Table 2 and section 10. Monitor bird wires and avian deterrent devices to ensure they are in good condition and replace any broken wires or devices as soon as possible. Implement Harassment program to deter avian predation in areas actively used by birds and not covered by bird wires or other devices. 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.

[6] NWRFC inflow forecast for Lower Granite Dam: www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?LGDW1

2.4. Operating Criteria - Adult Fish Facilities.

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

2.4.1.1. Schedule maintenance to target returning the adult ladder to service by February 15 to the extent possible, and by no later than March 1.

2.4.1.2. Inspect all staff gauges and water level indicators; repair and/or clean as necessary.

2.4.1.3. 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. At least every three years, dewater and physically inspect all diffuser gratings and chambers. Repair deficiencies.

2.4.1.4. Inspect for and clean debris from the fish ladder exit. The trashrack and picketed leads must be clean and installed correctly.

2.4.1.5. Calibrate all water level measuring devices as necessary for proper facility operation.

2.4.1.6. Inspect all spill gates and ensure that they are operable.

2.4.1.7. Fish pumps maintained and ready for operation.

2.4.1.8. Maintain adult PIT-tag system as required. Coordinate with PSMFC.

2.4.1.9. Maintain the adult fish trap as required.

2.4.1.10. 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 Facilities – Adult Fish Passage Season (March 1 – December 31).

Note: Operating the Little Goose forebay within the Minimum Operating Pool (MOP) range 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. Target returning the adult fish ladder to service as early as February 15 to the extent possible, and by no later than March 1.

2.4.2.2. Maintain all staff gauges in readable condition at all water levels encountered during the fish passage season. Repair/clean as necessary.

2.4.2.3. Maintain water depth over ladder weirs in the range of 1.0’–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.

2.4.2.4. Maintain head on all fishway entrances in the range of 1’–2’.

2.4.2.5. Ensure trashracks and picketed leads are installed correctly. Maximum head on ladder exit is 0.5’. Maximum head on picketed leads is 0.3’.

2.4.2.6. North Shore Entrances (NSE-1&2).

i. Operate both downstream gates.

ii. Elevation at top of gates on sill = 625’.

iii. Weir depth 7’ or greater below tailwater.

2.4.2.7. North Powerhouse Entrances (NPE-1&2).

i. Operate both downstream gates.

ii. Elevation at top of gates on sill = 628’.

iii. Weir depth 8’ or greater below tailwater. At tailwater below elevation 636’, weirs should be on sill.

2.4.2.8. South Shore Entrances (SSE-1 & 2).

i. Operate both gates.

ii. Elevation at top of gates on sill = 625’.

iii. Weir depth 8’ or greater below tailwater. At tailwater below elevation 633’ weirs should be on sill.

2.4.2.9. Operate floating orifice gates (FOGs) 1 and 10 (4 and 7 closed).

2.4.2.10. Channel Velocity. Maintain channel velocity in the range of 1.5–4.0 feet per second (fps), 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. 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.

2.4.2.11. Counting Window.

i. Maintain all equipment in good condition. Clean counting window and backboard as needed to maintain good visibility.

ii. The Lower Granite counting window slot has a width range of 12”–30”.

iii. When not counting, open the crowder to full count slot width and remove the picketed leads.

iv. During counting, open the crowder as far as possible to allow accurate counting, at least 18”. Do not close to less than 18”. This will usually occur during high turbidity conditions to allow count accuracy criteria to be achieved.

2.4.2.12. 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).

2.4.2.13. Ensure lights are functioning in the tunnel section under the spillway during fish passage season. Clean and maintain the mirror that is placed so the tunnel lights can be seen.

2.4.2.14. Facility Inspections.

i. Inspect fish fallout fence for debris buildup, holes, etc.

ii. Powerhouse operators shall inspect adult facilities once per day shift and check computer monitor information at least once during each back shift.

iii. Project biologists shall inspect adult facilities at least three times per week. Inspect all facilities according to fish facilities monitoring program.

iv. Picketed leads shall be checked during all inspections to ensure they are clean and in the correct position (all the way down).

v. 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.

vi. Inspect fishways daily for foreign substances (particularly oil). If substances are found, corrective actions should be undertaken immediately.

vii. Record all inspections.

2.4.2.15. Adult Trap Holding Tanks. Protocols for operating the adult trap for research and other activities are covered in **Appendix G**. These criteria supplement that appendix and govern 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.

iii. Prior to and during the period of use of any holding tanks at the Adult Trap, the COE should inspect the intake to the diffuser-14 auxiliary water supply and clean if necessary.

iv. If utilizing the diffuser-14 water supply, no holding tanks can be used prior to September 1 if their usage affects the amount of water passing down the fish ladder and a water depth of less than 12" is maintained over the ladder weirs. JBS water supply does not impact fish ladder water depth over the weirs.

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.

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.

2.4.2.16. Fishway Temperature Monitoring. From June 1 through September 30, measure water temperature at adult fishway entrances and exits and submit data to the Fish Passage Center (FPC) weekly for posting online.[7] Ensure the location of the monitors meets the following criteria:

i. Within 10 meters of all shore-oriented entrances and exits.

[7] FPC ladder temperature data: www.fpc.org/smolt/smolt_queries/Q_ladderwatertempgraphv2.php

ii. Entrance monitor within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers, if possible, to allow for sufficient mixing with surface water.

iii. Exit monitor 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, verify that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.4.2.17. Adult Ladder Exit Pool Cooling Pumps. Operate the 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 minimum of 733'. This action requires both pumps to be operational at the same time for optimal cooling.

i. Begin operation of exit pool cooling pumps no later than one day following when the Lower Granite forebay temperature string[8] at 0.5 meters exceeds 64°F (18°C) at any time.

ii. Continue this operation until September 1 and until the Lower Granite forebay temperature string at 0.5 m is less than 68°F (20°C) for 3 consecutive days. Restart pumps if 0.5 m temperature reaches 68°F (20°C) at any time and follow above criteria on when to discontinue pump operation.

iii. 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.

2.5. <u>Fish Facility Monitoring & Reporting.</u>

2.5.1. Monitoring.

2.5.1.1. Project biologists shall inspect fish facilities at the frequencies defined above in the juvenile and adult fish facilities operating criteria **sections 2.3 and 2.4**.

2.5.1.2. Project biologists also inspect project facilities once per month and during dewaterings for the presence of zebra and Quagga mussels. Biologists shall provide a monthly report to CENWW-OD-T summarizing mussel inspections.

[8] Corps temperature string data: pweb.crohms.org/ftppub/water_quality/tempstrings/

2.5.2. Reporting.

1.1.1.1. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31 summarizing project and fish facility operations for each week (Friday through Thursday), along with an evaluation of resulting fish passage conditions. The reports will be e-mailed CENWW-OD-T by noon the following Monday. The weekly reports will include:

i. Out-of-criteria situations and corrective actions taken.

i. Equipment malfunctions, breakdowns, or damage along with a summary of resulting repairs.

ii. Adult fishway control calibrations.

iii. ESBS and VBS inspections.

iv. Unusual activities at the project that may have affected fish passage.

2.5.2.1. In-Season. Any adverse or negative impact to fish or fishways shall be reported in a *Memorandum for the Record* (MFR) prepared by Project biologists and sent to FPOM by the next working day, pursuant to the coordination process and template in **FPP Chapter 1 – Overview** (section 2.3.2).

2.5.2.2. 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 passage facilities for the previous year and a brief overview of 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 actions.

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*[9] were reviewed and revised in 2011 to ensure they comply with **Appendix F**.

3.2. Maintenance - Juvenile Fish Facilities.

3.2.1. Scheduled Maintenance.

3.2.1.1. Scheduled maintenance of juvenile facilities is conducted throughout the year.

[9] Project Dewatering Plans: pweb.crohms.org/tmt/documents/FPOM/2010/

3.2.1.2. Long-term maintenance or modifications of facilities that require facilities out of service for extended periods are conducted during the winter maintenance period, December 16–March 24.

3.2.1.3. 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.

3.2.2.1. Unscheduled maintenance is the correction of any situation that prevents facilities from operating within criteria or that will impact fish passage or survival.

3.2.2.2. Maintenance of facilities such as ESBSs that 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.

3.2.2.1. ESBSs.

3.2.2.1.a. 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.b. 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 pneumatically operated valves in the bulkhead slot for allowing the fish enter the juvenile bypass system. LWG gatewell slots have one 10” orifice (north side) and one 14” orifice (south side). A minimum of 18 orifices (one per gatewell slot) are operated with the 14” orifice in each gatewell prioritized to minimize debris obstruction. Additional orifices are operated to hasten fish departure based on forebay elevation and bypass system hydraulic capacity. Orifices are backflushed at least once per day to clear debris blockage that may or may not be visible during visual inspections. A damaged orifice will be closed and the alternate orifice for that gatewell operated until repairs can be made. Orifices shall not be closed for longer than 5 hours in an operating turbine unit with ESBSs in place. Gatewells with both orifices closed shall be monitored hourly (operating unit) or every 2 hours (non-operating unit). The unit may be removed from service at the Project Biologist discretion depending on fish numbers and condition in the gatewell slot. If repairs 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. Gatewells will be dipped sooner if any signs of fish stress, condition issues, or high densities are observed at the Project Biologist discretion.

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 most of its length before transitioning to 10’ 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).

3.2.2.4.a. 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.

3.2.2.4.b. 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 flow 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.

3.2.2.5. 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 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.

3.2.2.6. 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. 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.

3.3.1.1. Scheduled maintenance of facilities that will have no effect on fish passage may be conducted at any time.

3.3.1.2. Scheduled maintenance of a facility that must be dewatered, or maintenance that will have a significant effect on fish passage, will be done during the January–February winter maintenance period.

3.3.1.3. 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.

3.3.1.4. When facilities are not being worked on 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. 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.

3.3.2.3. Hazardous Materials Spill. In the event of a hazardous materials spill, the Project biologist has 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.

3.3.2.4. Auxiliary Water Supply (AWS). Three electric pumps supply auxiliary water for the fish ladder and powerhouse collection system. Two pumps can provide required flows during normal operations and most flow conditions. 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. If one pump fails during the two-pump operation, the pump on standby will be operated to make up flows.

ii. 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.

iii. 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.

iv. 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 an MFR to CENWW-OD-T for distribution to FPOM.

3.3.2.5. 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 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.

3.3.2.6. 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 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.

3.3.2.7. 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** 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. 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 hydraulically locked blades (non-adjustable) and operates in the upper 1% range. The priority order minimizes Unit 2 starts/stops and allows for the longest runtime once Unit 2 is started. 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. Turbine unit flow and power output at the lower and upper limits of the 1% range, and at the operating limit, are defined in **Table LWG-6**. Turbine units will be operated within these ranges according to *BPA's Load Shaping Guidelines* (**Appendix C**), as summarized below.

4.2.2. In-Season: April 3–August 31 (Spring/Summer Spill for Juvenile Fish Passage).

4.2.2.1. Turbine units will be operated within ±1% of peak turbine efficiency (1% range), except under limited conditions and durations when turbines may be operated above the 1% range for the use of reserves or for TDG management during high flows (see **Appendix C** for more information). All required fish passage spill operations will be met prior to operating turbines above the 1% range. If in-season 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 4.3.8**), 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 to flush fish from the unit.

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

iv. Comply with other coordinated fish measures.

4.2.2.2. Minimum Generation. During low flows, all lower Snake River projects may be required to keep one generating unit online to maintain power system reliability. The minimum generation flow range for each unit is defined in FOP Table 1 (**Appendix E**), as derived from the lower limit of the 1% range and actual unit operations. During spring and summer spill for juvenile fish passage, if there is not enough river flow to meet this generation requirement and the FOP spill target, the project will operate the first available priority unit at minimum generation and spill the remainder of outflow. Actual attainable minimum generation values may vary depending on real-time conditions.

4.2.3. Off-Season: September 1–April 2. 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.

4.3. Turbine Unit Maintenance.

4.3.1. Turbine unit maintenance schedules will be reviewed annually by Project and Operations Division biologists for fish impacts. If the maintenance requires operating outside of FPP criteria, the work will be coordinated with regional salmon managers via FPOM, per the coordination process in **FPP Chapter 1 – Overview** (section 2.3).

4.3.2. Maintenance of priority units will be scheduled for winter maintenance period or when there are few fish passing the project, to the extent possible.

4.3.3. 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.

4.3.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take over one year to accomplish.

4.3.5. 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.

4.3.6. 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.

4.3.6.1. 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 measurements and testing and to allow all fish to move through the unit, per **section 4.3.8**.

4.3.6.2. 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.

4.3.7. Operating Gates (may also be referred to as Head Gates). 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.

4.3.8. Dewatering Units. Dewatering turbine units (also referred to as "unwatering") should be accomplished in accordance with project *Dewatering Plans*.[9] 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 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.

4.3.9. 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.

4.3.9.1. At Lower Granite, this special operation shall take place when outflow is more than 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.

4.3.9.2. 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 timeframe to 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 occurring.

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 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.

viii. 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.

4.3.10. Doble Testing. The yearly outage schedule is defined in **Appendix A**. 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 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.

4.3.10.1. Lower Granite transformer T1 or T2 bank Doble testing requires daily full line outages. Unit 5 will run at speed-no-load 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 5-6) will remain OOS for the duration of the Doble test. Doble testing 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.

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 Head (feet)	LWG Units 1 and 3 – with ESBS						LWG Units 1 and 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	71.1	11,651	101.5	16,631	123.8	21,027	71.6	11,545	115.0	18,536	135.5	22,715
86	72.0	11,651	103.2	16,705	126.1	21,185	72.4	11,527	117.1	18,642	138.0	22,897
87	72.9	11,651	104.7	16,746	128.5	21,354	73.2	11,509	119.2	18,734	140.4	23,071
88	73.8	11,652	106.2	16,779	129.9	21,301	74.0	11,492	121.1	18,799	141.7	22,950
89	74.7	11,651	107.8	16,822	131.2	21,234	74.8	11,476	122.8	18,840	142.8	22,796
90	75.6	11,654	109.4	16,866	132.6	21,187	75.7	11,463	124.3	18,838	143.9	22,644
91	76.4	11,650	111.3	16,964	133.8	21,120	76.5	11,447	125.7	18,823	145.0	22,518
92	77.3	11,648	113.2	17,052	134.9	21,009	77.3	11,432	126.8	18,757	146.2	22,405
93	78.2	11,642	115.3	17,167	136.0	20,912	78.1	11,417	127.6	18,664	147.1	22,232
94	79.0	11,637	117.5	17,302	137.2	20,842	78.9	11,403	128.4	18,553	147.8	22,036
95	80.0	11,641	119.6	17,406	138.3	20,770	79.8	11,393	128.9	18,415	148.5	21,847
96	81.0	11,652	121.7	17,518	139.2	20,656	80.7	11,393	129.1	18,226	149.2	21,639
97	82.0	11,665	124.0	17,643	140.0	20,526	81.7	11,397	129.2	18,033	149.7	21,401
98	83.1	11,686	126.1	17,746	140.8	20,396	82.6	11,401	129.6	17,875	150.2	21,144
99	84.2	11,708	128.3	17,853	141.5	20,244	83.7	11,410	130.1	17,740	150.6	20,959
100	85.2	11,725	130.6	17,970	142.1	20,057	84.6	11,418	130.9	17,659	151.1	20,805
101	86.1	11,715	130.4	17,749	142.7	19,961	85.6	11,420	131.2	17,506	151.5	20,627
102	86.9	11,708	130.1	17,519	143.3	19,857	86.6	11,427	131.5	17,345	151.9	20,435
103	87.8	11,698	129.8	17,304	143.9	19,738	87.6	11,436	131.8	17,202	152.3	20,231
104	88.5	11,681	129.7	17,114	144.5	19,603	88.5	11,432	132.3	17,094	152.6	20,033
105	89.3	11,659	129.7	16,943	145.0	19,459	89.3	11,418	133.3	17,052	152.8	19,839
	LWG Units 4, 5, 6 – with ESBS						LWG Units 4, 5, 6 – No ESBS					
85	87.4	14,320	113.8	18,634	126.8	21,269	89.4	14,354	122.2	19,630	129.4	21,042
86	88.3	14,281	113.9	18,427	128.2	21,273	90.1	14,292	122.9	19,492	130.8	21,014
87	89.1	14,241	114.1	18,234	129.6	21,279	90.8	14,234	123.5	19,361	132.2	20,982
88	89.9	14,199	114.5	18,086	131.0	21,282	91.5	14,175	124.7	19,310	133.6	20,935
89	90.7	14,163	115.1	17,983	132.6	21,283	92.3	14,124	126.5	19,356	135.0	20,877
90	91.5	14,126	116.1	17,933	134.1	21,284	93.1	14,078	128.8	19,478	136.3	20,816
91	92.3	14,091	117.3	17,903	135.6	21,287	93.9	14,035	131.1	19,597	137.7	20,762
92	93.1	14,061	118.2	17,848	137.1	21,292	94.7	13,995	133.1	19,668	139.1	20,718
93	94.0	14,032	119.0	17,777	138.6	21,300	95.5	13,957	134.7	19,690	140.5	20,683
94	94.8	14,007	119.8	17,702	140.0	21,309	96.3	13,926	136.1	19,674	141.9	20,656
95	95.7	13,990	120.6	17,627	141.4	21,322	97.3	13,905	137.2	19,623	143.3	20,634
96	96.6	13,980	121.2	17,533	142.8	21,335	98.2	13,890	138.1	19,536	144.7	20,614
97	97.5	13,966	121.6	17,408	144.2	21,348	99.1	13,867	138.8	19,421	146.0	20,594
98	98.4	13,938	121.8	17,252	145.6	21,359	99.9	13,825	139.4	19,300	147.4	20,571
99	99.1	13,893	121.8	17,080	147.1	21,368	100.5	13,761	140.2	19,196	148.8	20,542
100	99.8	13,842	121.8	16,894	148.6	21,377	101.0	13,686	141.1	19,113	150.2	20,512
101	100.9	13,850	123.2	16,922	150.2	21,362	102.1	13,698	142.7	19,142	151.6	20,475
102	102.0	13,866	124.8	16,958	151.8	21,351	103.3	13,716	144.4	19,164	153.0	20,443
103	103.2	13,885	126.4	17,018	153.3	21,340	104.6	13,742	145.8	19,164	154.4	20,418
104	104.3	13,910	128.1	17,084	154.8	21,330	105.9	13,778	147.0	19,134	155.7	20,400
105	105.5	13,940	129.9	17,157	156.2	21,304	107.2	13,816	148.2	19,098	157.1	20,385

a. Values provided by HDC (May 2022). Flow (cfs) was calculated based on turbine efficiency, project 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 has hydraulically locked runner blades and is restricted to the operating range defined below in **Table LWG-6-A**.

Table LWG-6-A. Temporary Operating Range Values for Lower Granite Unit 2 with Blades Hydraulically Locked @ 28.3° (Non-Adjustable). [a]

Project Head (feet)	LWG Unit 2 (Locked Blades) – With ESBS						LWG Unit 2 (Locked Blades) – No ESBS					
	Lower Limit		Peak Efficiency		Upper Limit		Lower Limit		Peak Efficiency		Upper Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	108.2	18,622	110.7	18,936	112.4	19,355	109.0	18,416	111.2	18,665	113.2	19,123
86	109.4	18,589	111.6	18,857	113.7	19,326	110.4	18,402	112.7	18,679	114.6	19,108
87	110.6	18,558	113.0	18,850	114.9	19,288	111.8	18,388	114.3	18,690	116.0	19,085
88	111.8	18,524	114.4	18,843	116.2	19,249	113.1	18,373	115.8	18,698	117.4	19,061
89	113.0	18,488	115.8	18,834	117.3	19,206	114.5	18,355	117.4	18,705	118.7	19,032
90	114.1	18,450	117.1	18,822	118.5	19,161	115.9	18,340	118.4	18,637	120.1	19,004
91	114.9	18,361	118.0	18,748	119.4	19,081	116.8	18,271	119.5	18,584	121.1	18,945
92	115.7	18,271	118.5	18,605	120.3	19,005	117.7	18,203	120.6	18,530	122.2	18,888
93	116.4	18,183	119.4	18,531	121.2	18,925	118.7	18,134	121.6	18,477	123.2	18,833
94	117.2	18,093	120.2	18,458	122.0	18,849	119.6	18,065	122.7	18,423	124.3	18,779
95	117.9	18,004	121.1	18,384	122.9	18,774	120.5	17,996	123.7	18,370	125.4	18,726
96	118.9	17,964	122.0	18,307	123.9	18,714	121.7	17,973	124.7	18,310	126.5	18,684
97	120.0	17,924	123.2	18,295	124.9	18,657	122.9	17,947	125.8	18,252	127.8	18,648
98	121.1	17,882	124.1	18,217	125.9	18,604	124.2	17,922	127.2	18,256	129.0	18,616
99	122.1	17,841	124.9	18,139	127.0	18,555	125.4	17,897	128.2	18,196	130.3	18,591
100	123.1	17,798	126.1	18,123	128.1	18,518	126.6	17,870	129.3	18,137	131.6	18,574
101	125.0	17,886	127.9	18,189	130.1	18,609	128.4	17,932	131.4	18,236	133.4	18,635
102	126.9	17,969	130.1	18,319	132.1	18,707	130.2	17,991	133.0	18,273	135.3	18,698
103	128.8	18,057	131.9	18,385	134.1	18,802	132.0	18,051	135.1	18,371	137.2	18,763
104	130.7	18,140	134.2	18,513	136.2	18,903	133.8	18,108	136.8	18,408	139.1	18,830
105	132.6	18,225	136.0	18,580	138.3	19,005	135.6	18,164	138.9	18,503	141.1	18,900

a. As of April 2017, Unit 2 has hydraulically locked (non-adjustable) runner blades due to failed blade packing sleeves and is restricted to a smaller operating range until the blade seals are repaired or replaced. Values provided by HDC based on the 1975 Model Test and 2018 U2 Index Test, as updated in May 2022.

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 to avoid passing debris to the next downstream project when possible. 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 Spill Patterns with RSW. [a, b]

LWG 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 (RSW-only)**	**6.6**
RSW		1						**1**	**8.3**
RSW		2						**2**	**10.1**
RSW		3						**3**	**12.0**
RSW		4						**4**	**13.8**
RSW		1		1	1	1	1	**5**	**15.1**
RSW		1	1	1	1	1	1	**6**	**16.8**
RSW	1	1	1	1	1	1	1	**7**	**18.5**
RSW	1	1	2	1	1	1	1	**8**	**20.3**
RSW	1	1	2	1	1	1	2	**9**	**22.1**
RSW	1	1	2	2	1	1	2	**10**	**23.9**
RSW	1	1	2	2	2	1	2	**11**	**25.7**
RSW	1	2	2	2	2	1	2	**12**	**27.6**
RSW	2	2	2	2	2	1	2	**13**	**29.4**
RSW	2	2	2	2	2	2	2	**14**	**31.2**
RSW	2	2	3	2	2	2	2	**15**	**33.0**
RSW	2	2	3	3	2	2	2	**16**	**34.9**
RSW	2	2	3	3	3	2	2	**17**	**36.8**
RSW	2	3	3	3	3	2	2	**18**	**38.6**
RSW	3	3	3	3	3	2	2	**19**	**40.5**
RSW	3	3	4	3	3	2	2	**20**	**42.3**
RSW	3	3	4	4	3	2	2	**21**	**44.2**
RSW	3	3	4	4	4	2	2	**22**	**46.1**
RSW	3	4	4	4	4	2	2	**23**	**47.9**
RSW	4	4	4	4	4	2	2	**24**	**49.8**
RSW	4	4	4	4	4	2	3	**25**	**51.6**
RSW	4	4	4	4	4	3	3	**26**	**53.5**
RSW	4	4	5	4	4	3	3	**27**	**55.4**
RSW	4	4	5	5	4	3	3	**28**	**57.2**
RSW	4	4	5	5	5	3	3	**29**	**59.1**
RSW	4	5	5	5	5	3	3	**30**	**60.9**
RSW	5	5	5	5	5	3	3	**31**	**62.8**
RSW	5	5	5	5	5	3	4	**32**	**64.7**
RSW	5	5	5	5	5	4	4	**33**	**66.5**
RSW	5	5	6	5	5	4	4	**34**	**68.4**
RSW	5	5	6	6	5	4	4	**35**	**70.2**
RSW	5	5	6	6	6	4	4	**36**	**72.1**
RSW	5	6	6	6	6	4	4	**37**	**74.0**
RSW	6	6	6	6	6	4	4	**38**	**75.8**
RSW	6	6	6	6	6	5	4	**39**	**77.7**
RSW	6	6	6	6	6	5	5	**40**	**79.5**

LWG 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	6	6	6	6	6	5	**41**	**81.4**
RSW	6	6	6	6	6	6	6	**42**	**83.3**
RSW	6	6	7	6	6	6	6	**43**	**85.1**
RSW	6	6	7	7	6	6	6	**44**	**87.0**
RSW	6	7	7	7	6	6	6	**45**	**88.8**
RSW	6	7	7	7	7	6	6	**46**	**90.7**
RSW	6	7	7	7	7	7	6	**47**	**92.5**
RSW	6	7	7	7	7	7	7	**48**	**94.4**
RSW	7	7	7	7	7	7	7	**49**	**96.2**
RSW	7	7	8	7	7	7	7	**50**	**98.1**

a. Spill (kcfs) is calculated as a function of the total number of stops + RSW spill at forebay elevation 734.0 ft.

b. RSW spill rate varies with forebay elevation, from 5.6 kcfs at forebay el. 733 ft to 11.4 kcfs at forebay el. 738 ft (see **section 2.3.2.6**). The tainter gate does not regulate flow and should be raised ≥ 9 stops to not interfere with RSW flow. For lower spill rates, the RSW must be closed and spill distributed in patterns in **Table LWG-8**.

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	5	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	15	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	25	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	35	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).

2023 Fish Passage Plan

Appendix A

Special Project Operations & Studies

Table of Contents

1. INTRODUCTION

1.1. Purpose

This Appendix to the annual *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 defined 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.

1.4. Navigation Lock Maintenance

Annual navigation lock outages are scheduled for routine maintenance and inspections, as well as non-routine work (e.g., gate cleaning, structural inspections and repairs, and equipment/machinery repair and replacement). In 2023, the outage schedule is as follows:

Project	Lock Outage
BON	March 4 - 18
TDA	March 4 - 18
JDA	March 4 - 18
MCN	March 4 - 18

Project	Lock Outage
IHR	March 4 - 25
LMN	March 4 - 18
LGS	March 4 - 25
LWG	March 4 - 25

1.5. Doble Testing[1]

The current year's transformer outage schedule for Doble testing at lower Snake projects and Dworshak Dam is in **Table A-1**.

1.5.1. Lower Snake River Projects:

At the Lower Snake projects, Doble testing of transformers is required every three years to ensure they are functioning correctly and to identify 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. In years that Doble testing isn't required, the project may still require an outage during the same timeframe to perform necessary transformer maintenance and repairs that were identified in previous Doble tests and inspections. For more information, see project-specific **sections 6-9** below.

1.5.2. Dworshak Dam:

At Dworshak Dam, required transformer maintenance and Doble testing occurs every two out of three years starting September 21. For more information on Dworshak maintenance and testing, see **Appendix I**.

Table A-1. Doble Testing Schedule in 2023.[a]

Project	Dates	Outage (Transformer & Units)	Notes [b]
IHR	July 18–22	TW3 & TW4 (Units 3, 4) all hours	Remaining available units (2, 5, 6) operated per FPP priority order.
LMN	July 24 – August 3	T1 (Units 1–4) all hours T2 (Units 5, 6) first/last day	On first and last day, all units OOS 0530–1800 with Unit 5 at speed no load (8 kcfs) for station service. During all other hours, T2 (Units 5 & 6) available and operated per FPP priority order.
LGS	July 31 – August 12	T1 (Units 1–4) all hours T2 (Units 5, 6) 0500-1700	During the daily T2 outage, Unit 6 or 5 (if available) will be operated at Speed-no-Load for station service. T2 RTS nightly and Unit 6 and Unit 5 (if available) operated per FPP priority order.
LWG	N/A	N/A	No Doble testing in 2023
DWR	Sep 25-28	T2 (Unit 1) all hours	

a. The lower Columbia projects (BON, TDA, JDA, MCN) perform Doble testing concurrent with outages for maintenance and do not have specific outages for Doble tests.

b. OOS = Out of Service (unavailable to operate); RTS = Return to Service (available to operate).

[1] "Doble test" is a common term referring to a power factor test of transformers to measure performance of electrical insulation. Doble is the name of 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 either by inclusion in this Appendix or in-season via a Memo of Coordination (MOC), pursuant to **FPP Chapter 1 (Overview)**. See **section 1** above for special operations related to spill for juvenile fish passage and navigation lock maintenance.

2.1.1. Powerhouse 2 Fish Guidance Efficiency (FGE) Program.

a) Dates: Construction work is scheduled to occur December 2022 – November 2023.

b) Description: The B2FGE Program PDT has contracted work to install concrete gatewell flow modification devices in place of the metal plates that were installed and then removed due to structural failure. Installation was completed in Unit 15 during 2021 and hydraulically tested in 2022. The remaining units are scheduled for construction with unit outages occurring one at a time in sequence while being efficient with Bonneville Dam's regularly scheduled work such as annual overhauls and thrust collar bearing inspections. The goal is to keep unit outages in the spring to one at a time. Schedule updates will be provided to FPOM.

c) Impacts to FPP Criteria: A MOC will be provided to FPOM in the event FPP violations are identified as result of scheduling and require coordination.

2.2. BON Studies

There are no studies planned at Bonneville Dam in 2023.

3. THE DALLES DAM

3.1. TDA 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 **section 1** above for special operations related to spill for juvenile fish passage and navigation lock maintenance.

3.2. TDA Studies

There are no studies planned at The Dalles Dam in 2023.

4. JOHN DAY DAM

4.1. JDA 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 **section 1** above for special operations related to spill for juvenile fish passage and navigation lock maintenance.

4.1.1. Blalock Islands Operation

a) Dates: April 10 – June 1 (or as feasible based on river flows).

b) Description: As described in the 2020 CRS BA (page 2-57), the John Day reservoir will be held between elevation 264.5 feet and 266.5 feet (an average of 265.5 feet) from April 10 through June 1 (or as feasible based on river flows) to deter Caspian terns from nesting in the Blalock Islands Complex. The Action Agencies intend to begin increasing the forebay elevation prior to initiation of nesting by Caspian terns to avoid take of tern eggs; operations may begin earlier than April 10 (when the reservoir is typically operated between 262.0 to 266.5 feet). The operation may be adaptively managed due to changing run timing; however, the intent of the operation is to begin returning to reservoir elevations of 262.5–264.5 feet on June 1, but no later than June 15, which generally captures 95% of the annual juvenile steelhead migration. The results of this action will be monitored and communicated with USFWS and NMFS. During the operation, safety-related restrictions will continue, including but not limited to maintaining ramp rates for minimizing project erosion and maintaining power grid reliability. Following this operation, the John Day reservoir elevation will return to MIP through August 31.

c) Impacts to FPP Criteria: None planned.

4.2. JDA Studies

There are no studies planned at John Day Dam in 2023.

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 **section 1** above for special operations related to spill for juvenile fish passage and navigation lock maintenance.

5.1.1. Fish Ladder Exit, Entrance, Regulating/Tilting Weir Maintenance

a) Dates: Monthly (Long-Term).

b) Description: The *Oil Accountability Program* PMs maintenance efforts require the project 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 the winter outage to exercise seals.

c) Impacts to FPP Criteria: None planned. Minimal impact due to coordination of outages and use of non-peak adult fish passage times. Any modification or deviation from FPP criteria will be coordinated with FPOM.

5.1.2. Spillway Safety Restrictions

a) Dates: Long Term (year-round).

b) Description: Spillway Hoist and Spillway Crane maintenance requires HECP safety boundaries to include the hoist being worked upon and the adjacent hoists on both sides of the affected hoist and the Spillway Cranes are both being set to step 4 and dogged in position to limit excessive actuation of the crane's electrical equipment. Also, due to the overloaded condition of the spillway hoists, it has been determined that any preventative or corrective maintenance will require spillway hoists to be lowered on seal and tagged out prior to any access onto hoists or gates. This ensures the safety of personnel and equipment.

c) Impacts to FPP Criteria: None planned. Minimal impact due to spill pattern changes to support spillway cranes and potential intermittent spill pattern changes due to unforeseen hoist maintenance. Any modification or deviation from FPP criteria will be coordinated with FPOM.

5.1.3. Outages for Digital Excitation/Governor Upgrades.

a) Dates: FY22 – FY26

b) Description: Replacing Exciters and Governors with digital systems to upgrade generators to current electrical standards, Mechanical Governor Upgrades, Power House Control Systems Upgrades, Isophase, HV Bus and XJ Switch upgrades.

c) Impacts to FPP Criteria: Unit priority will be affected and commissioning requirements will require exceeding 1% generation during testing of Over Speed Protection, Upper and Lower Excitation Limits, Mechanical Governor Response Times, and other reliability tests necessary. Some specific testing will require raising ESBSs during testing periods, especially when determining new Generator Capability Curve data. Due to the extended period of these contracts, raising ESBSs and exceeding 1% may occur at any unknown time of the year.

5.1.4. Waterfowl Nesting

a) Dates: April through July (annually).

b) Description: Since 1982, McNary pool is operated for waterfowl nesting on Lake Wallula annually from 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 only.

5.1.5. Transformer Gasket Replacement, Capitol Project.

a) Dates: April to October.

b) Description: Transformer gasket replacement will occur with associated unit outages.

c) Impacts to FPP Criteria: When a unit is out of service for transformer gasket replacement, the next available unit in the priority order will be operated.

5.2. MCN Studies

There are no studies planned at McNary Dam in 2023.

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 **section 1** above for special operations related to spill for juvenile fish passage, navigation lock maintenance, and Doble testing.

6.1.1. Unit 1 Turbine Runner Replacement

a) Dates: 2023 through 2025.

b) Description: Unit 1 will be out of service through 2025 to replace the runner. After the unit is returned to service, commissioning will require full load rejection testing (10 days), which needs to be completed with no submerged traveling screens (STS) installed.

c) Impacts to FPP Criteria: While Unit 1 is out of service and unavailable for operation, the project will operate the next available unit in the FPP priority order. Full load rejection testing will be coordinated with FPOM via a separate MOC.

6.1.2. LSP-1 Switchgear Testing

a) Dates: March 17 and 18, 2023

b) Description: LSP-1 switchgear will be out of service each workday for electrical testing. There will be no power to the entire north shore of the dam, including the north fish ladder entrance weir gates, the north fish count station, upper diffuser valve, and AWS pumps, and spill gates. Spill gate 2 will be powered by the emergency diesel generator to open and close the RSW. A portable generator will power the video camera system and lights at the fish count station. The upper diffuser valve will be set at the percent open that should provide the proper amount of water. The north shore entrance weir will be set at a level that should provide the proper entrance weir depth.

c) Impacts to FPP Criteria: With the AWS pumps out of service, the channel/tailwater head will be well under criteria. This will be coordinated via a separate MOC.

6.1.3. Lines 1 and 2 Maintenance

a) Dates: April 14, 2023

b) Description: BPA will be conducting maintenance on 115 kv lines 1 and 2. Units 1, 2, 3, and 4 will be out of service as a result of the line outage. Unit 2 will be run at speed-no-load to provide station service to power the plant.

c) Impacts to FPP Criteria: Units 6 will be first in unit operating priority, followed by unit 5. This will be coordinated with FPOM via a separate MOC.

6.1.4. Doble Testing (see section 1.5 above for more information)

a) Dates: Summer (annually). In 2023, the outage is scheduled for July 17-21.

b) Description: The outage in 2023 is required to perform Doble testing of TW3 and TW4, which will take Units 3 and 4 out of service continuously during testing. Doble testing conducted in conjunction with the scheduled 6-year overhaul on Unit 4. Remaining available units (2, 5, 6) will be operated per FPP priority order.

c) Impacts to FPP Criteria: None. Since Ice Harbor has multiple transformer banks and transmission lines and redundant switching capability, remaining available units will be available and operated pursuant to FPP priority order.

6.2. IHR Studies

6.2.1. IHR Unit 3 Direct Injury and Sensor Fish Characterization.

a) Dates: September–October 2023

b) Description: Juvenile spring Chinook and Sensor Fish will be directly released into unit 3 to evaluate the new Kaplan 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 3 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 3 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.

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 **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 2029.

b) Description: Under the BPA Large Cap Program, parts and materials have been acquired to rehabilitate the Lower Monumental head gates. The work started in December 2012. 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.

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 outage is expected to be one day.

7.1.2. Model Validation Testing

a) Dates: September through March (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 one to two-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 (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: May require running a unit out of FPP priority and outside 1%.

7.1.3. Doble Testing (see section 1.5 above for more information)

a) Dates: Summer (annually). In 2023, the outage is scheduled for July 24–August 3.

b) Description: During the 2023 outage, the project will upgrade the T1 iso-phase bus, which will consist of replacing the doghouse covers, replacing gaskets with upgraded materials, cleaning, and inspections. The outage will require T1 and T2 (all units) out of service for up to 11.5 hours (0530-1800) on the first and last day of the outage to hang clearances. During these hours, all project outflow will be spilled except 8 kcfs through Unit 5 for station service power. During all other hours, T2 (Units 5 and 6) will be available and operated per FPP priority order.

c) Impacts to FPP Criteria: All units will be out of service for up to 11.5 hours (0530-1800) and all project outflow will be spilled except approximately 8 kcfs through Unit 5 for station service.

7.1.4. T-2 Rehabilitation

d) Dates: August 3 - October 5, 2023

e) Description: Units 1-4 will be out of service from 0700-1700 on August 3 and from 0700-1700 on September 28 to support opening of T-2 modification. Units 5-6 will be out of service during the duration of the outage for refurbishment, Doble testing, XJ5 breaker annual for Unit 5 and the Unit 6 annual.

f) Impacts to FPP Criteria: Units 1-4 will be out of service for up to ten hours on August 3 and October 5. Units 5-6 will be out of service during the length of the outage.

7.1.5. MU1 Maintenance

g) Dates: November 27 - December 14, 2023.

h) Description: Unit 1 will be out of service from November 27 to December 14, 2023, to complete unit annual maintenance.

i) Impacts to FPP Criteria: From November 27-30, deviation from FPP unit priority order will be necessary in order to complete the maintenance. The priority order for fish passage starts with Unit 1, then proceeds in order from north to south. Removing unit 1 from service will change the attraction flow to the north adult fish ladder. Starting December 1, there is no FPP priority order (units may be operated in any order).

7.2. LMN Studies

7.2.1. Lower Monumental Dam Juvenile Lamprey Survival

a) Dates: March through Sept 2023

b) Description: From March through September 2023, juvenile lamprey will be tagged and released upstream of the Lower Monumental Dam. The removable spillway weir (RSW) may need be taken out of service for a few hours for one day in March or April to test the acoustic arrays in the forebay with a remote operated boat. This study will help inform juvenile Pacific Lamprey passage conditions, migration behavior, and fate. The objectives of this are to:

- Determine distribution and approach routes (including vertical, horizontal, and temporal) of juvenile lamprey in the forebay of Lower Monumental Dam.
- Determine passage and proportions through all fish passage routes to include the RSW, conventional spill bays, juvenile bypass systems (JBS), and turbines by juvenile lamprey throughout fish passage season.
- Calculate whole project survival of juvenile lamprey (from forebay to tailrace)
- Relate project operations (including hydrograph) to passage and route selection
- Determine reach survival of juvenile lamprey and reservoir residence time through the lower Snake River.

c) Impacts to FPP Criteria: To be determined. Any modification to or deviation from FPP criteria will be coordinated with FPOM.

8. LITTLE GOOSE DAM

8.1. LGS 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 **section 1** above for special operations related to spill for juvenile fish passage, navigation lock maintenance, and Doble testing.

8.1.1. Doble Testing & T1 Isophase Bus Upgrades (see section 1.5 above for more information)

a) Dates: Summer (annually). In 2023, the outage is scheduled for July 31–August 12.

b) Description: During the 2023 outage, the project will upgrade T1 iso-phase bus, which will consist of replacing doghouse covers and replace thru-bushing bus ducting. The upgrades will reduce risk of water intrusion and increase efficiency in future outages. While some of the Doble and maintenance are conducted concurrently, portions of both will need to be conducted at the beginning and end of the required outage. Access to these areas requires significant transformer outages, thus combining maintenance and Doble efforts reduces future impacts. T1 will be Doble tested and Units 1-4 will be out of service continuously from July 31 through August 12. T2 (Units 5, 6) will also be out of service daily from 0500-1700, with Unit 5 (or Unit 6 if Unit 5 is unavailable) at 8 kcfs for station service power. T2 will return to service nightly from 1700-0500 and Units 5, 6 operated as available per FPP priority order.

c) Impacts to FPP Criteria: Daily from 0500-1700, all units will be out of service and all project outflow spilled except 8 kcfs for station service through Unit 5 (or Unit 6 if Unit 5 is unavailable).

8.2. LGS Studies

8.2.1. Kelt Collection & Reconditioning

a) Dates: April to July

b) Description: The Nez Perce Tribe (NPT) Department of Fisheries Resources Management will collect wild/natural post-spawned, emigrating steelhead from the separator at Little Goose Juvenile Fish Facility. These fish will be transported to the Nez Perce Tribal Hatchery (NPTH) or Dworshak National Fish Hatchery (DNFH) to be utilized in the kelt reconditioning program.

c) Impacts to FPP Criteria: None.

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 **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. Replace Powerhouse 480 Volt and 125 Volt DC Control Voltage Switchgear

a) Dates: 2020–2023 (dates to be determined).

b) Description: Replace all PH 480 Volt and 125 Volt DC control voltage switchgear. This work will involve multiple outages on various units and systems over the next 3 years. Outage times and dates have not been determined and will be dependent on the contractor's schedule. Available units will be operated in FPP unit priority order during outages.

c) Impacts to FPP Criteria: None. When a unit is out of service, the next unit in the FPP priority order will be operated.

9.1.4. Doble Testing (see section 1.5 above for more information)

a) Dates: N/A (no Doble testing scheduled in 2023).

b) Description: N/A

c) Impacts to FPP Criteria: N/A

9.2. LWG Studies

9.2.1. Genetic Stock Identification (Idaho Department of Fish & Game)

a) Dates: March 1 – June 28

b) Description: Fish collected as part of the Lower Granite juvenile condition sample are used to enumerate and characterize age composition and genetic stock profiles of naturally producing yearling Chinook and juvenile steelhead. IDFG will sample Monday through Friday through mid-June with a goal of collecting 2,000-5,000 yearling Chinook and juvenile steelhead genetic samples.

c) Impacts to FPP Criteria: None.

9.2.2. Kelt Study (Nez Perce Tribe, University of of Idaho, CRITFC)

a) Dates: March 1 – June 29

b) Description: This research investigates steelhead kelt physiology and endocrinology to evaluate the feasibility and success of rehabilitating strategies. Selected kelts collected at Lower Granite are transported by NPT to Dworshak National Fish Hatchery for reconditioning and later release as part of this study.

c) Impacts to FPP Criteria: None.

9.2.3. PIT-Tag Adult Wild Chinook and Adult Steelhead for ISEMP-Related Dispersal Monitoring (NOAA Fisheries)

a) Dates: TBD

b) Description: The goal of this project is to PIT-tag up to 4,000 unclipped adult Chinook and 4,000 unclipped adult steelhead collected in the adult trap daily sample for dispersal monitoring.

c) Impacts to FPP Criteria: None.

9.2.4. Lower Granite Dam Juvenile Lamprey Survival

a) Dates: March through Sept 2023

b) Description: From March through September of 2023, juvenile lamprey will be tagged and released upstream of the Lower Granite Dam. The removable spillway weir (RSW) may need be taken out of service for a few hours for one day in March or April to test the acoustic arrays in the forebay, with a remote operated boat. This study will help inform juvenile Pacific Lamprey passage conditions, migration behavior, and fate. The objectives of this Juvenile Lamprey passage and survival study at Lower Granite are to:

- Determine distribution and approach routes (including vertical, horizontal, and temporal) of juvenile lamprey in the forebay of Lower Granite Dam.
- Determine passage and proportions through all fish passage routes to include the RSW, conventional spill bays, juvenile bypass systems (JBS), and turbines by juvenile lamprey throughout fish passage season.
- Calculate whole project survival of juvenile lamprey (from forebay to tailrace)
- Relate project operations (including hydrograph) to passage and route selection
- Determine reach survival of juvenile lamprey and reservoir residence time through the lower Snake River.

c) Impacts to FPP Criteria: To be determined. Any modification to or deviation from FPP criteria will be coordinated with FPOM.

9.2.5. Sampling of Adult Steelhead, Chinook, and Sockeye for Biological Data Collection (IDFG and NOAA Fisheries)

a) Dates: April 4 – December 15

b) Description: Upriver migrating adult steelhead, spring/summer Chinook salmon, and sockeye salmon are collected from the adult trap from April 4 through December 15. The goal is to collect 5–20% of adult steelhead, spring/summer Chinook salmon, and sockeye salmon ascending the ladder. Data collection includes fish scales, genetics tissue, sex and length, wild/hatchery composition, and non-adipose clipped hatchery fish assessment. All natural-origin adult steelhead and spring/summer Chinook salmon trapped will be PIT-tagged to estimate headwater tributary escapement. Sockeye salmon may be PIT-tagged in the future to estimate metrics regarding conversion rates. Some steelhead and spring/summer Chinook salmon may be radio-tagged or spaghetti-tagged. This information on adult fish forms the basis for status information used in several forums including BiOp-RPA identified needs.

c) Impacts to FPP Criteria: None.

9.2.6. Bull Trout PIT-Tagging and Genetic Sample Collection for USFWS

a) Dates: April 4 – December 15

b) Description: Bull trout will be collected as part of the normal adult trap daily sample and using the adult sort-by-code (SbyC) system to recapture previously PIT-tagged fish. Untagged bull trout will be PIT-tagged, fin clipped for genetic analysis, and have morphometric data collected including weight and length, etc. Fin clips will be sent to USFWS to determine the fish's origin. Previously PIT-tagged bull trout will only have morphometric data collected. All fish will be released back into the adult fish ladder.

c) Impacts to FPP Criteria: None.

9.2.7. Subyearling Chinook Parentage-Based Tagging (USGS)

a) Dates: June 1–15 and July 1–15

b) Description: The goal of this project is to determine the abundance of unmarked, untagged, natural- and hatchery-origin subyearling Chinook salmon in Lower Granite sample collection. Fin clips will be taken from 30 unclipped, untagged subyearling Chinook each day from June 1-15 and for another two weeks in July depending in fish passage numbers.

c) Impacts to FPP Criteria: None.

9.2.8. Collection of Adult Fall Chinook and Coho for Hatchery Broodstock – (WDFW and Nez Perce Tribe)

a) Dates: August 18 until broodstock requirements are met

b) Description: Adult fish are collected in the adult trap. Fall Chinook are transported by WDFW employees to Lyons Ferry hatchery and by NPT employees to Dworshak hatchery. Coho are transported by NPT and transported to Dworshak hatchery.

c) Impacts to FPP Criteria: None.

2023 Fish Passage Plan

Appendix B

Corps of Engineers Juvenile Fish Transportation Plan [1]

Table of Contents

[1] If any provisions herein conflict with the current *Fish Operations Plan* (FOP), included in the Fish Passage Plan as **Appendix E**, the current FOP shall prevail.

1. INTRODUCTION

This *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]

The JFTP is conducted by the Corps of Engineers' Walla Walla District (CENWW) under current Endangered Species Act (ESA) Section 7 (a)(2) consultations as an integral component of Columbia River System (CRS) operations. 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, also referred to as NMFS).

On-site biological assistance is provided through contracts procured through BPA and the Corps. BPA arranges biological assistance provided by fishery agencies through a contract with the Pacific States Marine Fisheries Commission (PSMFSC), who 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, while ODFW provides biological assistance at Little Goose. The Corps contract provides additional services at the collector projects in direct support of the juvenile fish transportation program.

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

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.
- **c.** Assuring that collection, transport, and release site facilities are ready for operation prior to the beginning of transport operations.

[2] The annual Fish Passage Plan (FPP) is available online at: pweb.crohms.org/tmt/documents/fpp/

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.

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 for a later start date (no later than May 1) and accompanying alternative operation. Transport at Little Goose and Lower Monumental may begin simultaneously with the start of transport at Lower Granite, or may begin up to 4 days and up to 7 days later, respectively.

3.2. Summer Transport Operations

3.2.1. At Lower Granite and Little Goose, summer operations will begin in coordination and discussions with TMT.[3]

3.2.2. 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

[3] Summer transport operations from Lower Monumental were discontinued on paper in 2023 with FPP Change Form 23AppB001 and discontinued in practice in 2020 with SOR 2020-4.

are determined by SMP biologists to be in poor condition or reverting to the parr stage may be bypassed to the river.

3.3. <u>Ending Operations</u>

3.3.1. Transport operations are anticipated to continue through October 31 at Lower Granite and Little Goose.

3.3.2. Transport may be stopped earlier at any of the projects due to *columnaris* disease (see **section 4.6.5**).

3.4. <u>Emergency Notification</u>

3.4.1. 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. The CENWW Transportation Coordinator will coordinate any emergency termination or modification of the transportation program with NOAA Fisheries and TMT, except as described below in **section 4.6.5** regarding ending collection for transport due to *columnaris* disease or at Lower Monumental due to low fish abundance (see **section 4.6.6**).

3.4.2. If high water temperatures or other factors increase collection mortality to 6% of daily collection (when sample sizes are ≥ 20 fish) for 3 consecutive days, or if mortality rates are increasing at such a rate that these criteria are likely to be met, Project Biologists will report to the CENWW Transportation Coordinator. The Transportation Coordinator will evaluate the situation and notify NOAA Fisheries and may arrange a conference call, if needed, with TMT to discuss options to provide adequate fish protection measures.

3.4.3. In the event of a fish loss exceeding conditions considered in the incidental take statement of the current CRS BiOp, which includes the transportation program, the Corps shall notify NOAA Fisheries and reopen consultation as needed.

4. OPERATING CRITERIA

4.1. <u>Early Season Pre-Transport Operations</u>

Prior to initiation of transport, or when fish are not being transported from the Snake River projects, fish collection facilities will be operated as described in the Smolt Facility Protocols in **Appendix J.**

4.2. <u>Collection & Transportation Operations</u>

4.2.1. Collection of fish for transport will commence on the agreed-to start dates at Lower Granite, Little Goose, and Lower Monumental and barging will begin the following day. Collected juvenile fish will be transported from each facility by barge daily or every other day (depending on the number of fish) throughout the migration season.

4.2.2. Once transport operations begin, all juvenile fish collected shall be transported except for those marked for in-river studies. 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.

4.2.3. Juvenile fish collected for transport will be bypassed back to the river if the number of collected fish exceeds or is expected to exceed facility or barge holding capacities. Holding for transport will resume when capacities are adequate to hold and transport fish according to criteria. Maximum holding time and loading criteria will not be exceeded without CENWW review and approval.

4.2.4. Transport operations will be carried out at each project in accordance with all relevant FPP operating criteria.

4.2.5. Specifics of the transportation program may be altered during the transportation season based on recommendations from the TMT.

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. Flow and fish passage at juvenile fish separators will be monitored at least every 15 minutes during separator operations. Fish that are too large to pass through the separator bars will be bypassed to the river.

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 in the best interests of fish, and then notify CENWW as soon as possible. The CENWW Transportation Coordinator will coordinate changes with NOAA Fisheries and TMT.

4.3.4. If it appears that facility or barge 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 is a better passage route than the bypass system. 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 is adequate 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, 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.

4.3.7. At Lower Granite, 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 fry are observed in the sample. The salmon-criteria screens will be left in place until salmon fry are no longer present in the sample.

4.3.8. 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. <u>Sampling Procedures</u>

4.4.1. Sampling will normally be accomplished in accordance with SMP sampling guidelines recommended by the PSMFC. Sampling guidelines may occasionally be altered if required by the transportation program or fish research activities. Typical alterations of sampling guidelines are to adjust the number of fish sampled to meet approved research needs, to minimize fish handling during warm water 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 per 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 if 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. <u>Loading Criteria</u>

4.5.1. Raceway Capacity:

4.5.1.1. Inflow to raceways is approximately 1,200 gallons per minute (gpm) at Lower Granite and Little Goose, and 2,400 gpm at Lower Monumental.

4.5.1.2. Individual raceway volume is approximately 12,000 gallons at Lower Granite and Little Goose, and 24,000 gallons at Lower Monumental.

4.5.1.3. Maximum raceway capacity is 0.5 pounds (lbs) of fish per gallon of water. This capacity limit 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.

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, except in instances when additional holding time is needed to collect sufficient fish for tagging for 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-Slide on tank	1,000	N/a	500
Truck-Slide on tank	750	n/a	375
Truck - Midi-tank	300	N/a	150
Truck - Mini-tank	150	N/a	75

4.6. <u>Summer Transport Operations</u>

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°F, all personnel handling fish shall take extra care to minimize stress and other impacts on fish.

4.6.5. If 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. Transport will be reinitiated when all following criteria are met:

- **a.** Collection mortality is less than 5% for two consecutive sampling periods.
- **b.** Water temperature in the tailrace is below 65°F.
- **c.** More than 50 fish are collected during the two consecutive daily periods.

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:

- **a. 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) and will note in facility logbooks accomplishment of SOPs 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.
- **b. 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.

c. **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 & BARGE OPERATIONS

5.1. Truck Operations

5.1.1. Trucks. Two 3,500-gallon fish transport trailers and one tractor, one 1000-gallon tank, one 750-gallon tank, 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. In addition, a 1000-gallon tank and truck is based at Lower Granite Dam and a 750-gallon tank and truck is based at Little Goose Dam. 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. When collection numbers are low during truck transportation, midi-tanks and mini-tanks may 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. Barges with 75,000-lb capacity will operate from Lower Granite.

5.2.2. Barge Scheduling:

- **a.** It takes approximately 79 hours to travel from Lower Granite to the release area near the Skamania light buoy below Bonneville Dam and return.
- **b.** The FOP (**Appendix E**) defines the start date of collection for transport in coordination and discussion with RIOG.
- **c.** One barge will leave Lower Granite every other day or daily, beginning on or about the second day after initiation of collection.
- **d.** When fish numbers increase during every other day barging, the transport program will switch to one barge leaving Lower Granite daily. When fish numbers decline in late spring, barging will change to or return to every other day from Lower Granite through June 20.
- **e.** During spring operations, barges will take on additional fish at Little Goose and Lower Monumental as barge capacity allows. The two medium and two small barges may also be used from Lower Granite for additional barging capacity, or they will be used for direct loading of fish at Little Goose.
- **f.** During spring spill at Little Goose, direct loading rather than loading into the raceways will be preferred to reduce exposure duration to high Total Dissolved Gas (TDG) in the raceways that can occur during high spill periods.
- **g.** When daily collection exceeds barge capacity, juvenile fish may be spilled per **section 4** above or bypassed to the river until collection numbers drop to where juvenile fish can be barged within barge capacity criteria.

5.2.3. Barge Loading: Whenever possible, small and large fish will be loaded in separate compartments in barges or until steelhead collection drops below 100 fish collected over a 2-day period. At that time, all fish may be transported in the same compartment.

5.2.4. Barge Riders: Project barge riders will accompany each barge trip, supervising all loading and release operations, and barge operations in progress. 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 data (currently 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, 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

Emergency procedures will be followed any time an emergency occurs, 24 hours per day, 7 days a week, during the transport season. Emergencies will be reported to the CENWW Transportation Coordinator as soon as possible. In the event of an emergency (e.g., equipment failure at a facility, 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 their 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 their own initiative, then report to their supervisor as soon as possible after the action has been completed. A complete list of persons to be notified in case of emergencies, with work 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. To report an emergency, the person involved will immediately notify their 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

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.
- **h.** Preparing accurate text and tabular data in correct format for project annual reports.

8. REPORTING

8.1. Daily Reports

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. On weekdays, 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

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 and Protocols

9.1.1. Agencies and tribes requesting to work at Corps dams will provide early coordination, including work proposals, CBFWA approval, 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 *NWW Guide for Project Access* for researchers is available on the FPOM website.[4]

9.1.2. The Corps expects PSMFC to annually coordinate SMP sampling guidelines with the Corps.

9.1.3. To maintain good working relationships and safe conditions, fishery agencies, tribes, and researchers will be required to adhere to the following courtesy, security, and safety protocols:

- **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* per the Corps Safety Manual, 385-1-1.
- **e.** Notify the Operations Manager or his/her representative of unscheduled or non-routine work and activities.
- **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.

[4] NWW Guide to Researchers for Project Access: pweb.crohms.org/tmt/documents/FPOM/2010/NWW%20Research/Research.html

2023 Fish Passage Plan

Appendix C

Bonneville Power Administration's System Load Shaping Guidelines Regarding Turbine Operation & Peak Efficiency

Table of Contents

1. INTRODUCTION

1.1.1. Out-migrating juvenile salmonids have several potential routes of passage past federal multi-purpose dams on the mainstem Columbia and Snake rivers, including turbines, mechanical bypass, sluiceways, and spillways. Fish passage survival varies depending on the dam and on the route of passage. Regional efforts have focused on providing non-turbine passage routes (e.g., surface spill weirs) for juvenile fish as a means to improve fish survival through the Columbia River System (CRS). Passage of juvenile salmon and steelhead through turbines has also been reduced, but not eliminated, by implementing a modified spring spill operation that includes increased spill of up to 125% total dissolved gas (TDG) in the tailrace of most projects. However, juvenile fish will continue to pass through turbines, even if at smaller proportions, 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 (Bonneville).

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 has historically been described as similar to that of peak efficiency up to generator limits.[1] It was this relationship that resulted in turbine operating restrictions of within ±1% of peak operating efficiency at CRS dams during the annual spring and summer downstream migrations of juvenile salmonids (or in-season peak efficiency operating period as defined in **Section 3.2)**. While peak operating efficiency has not always coincided with peak survival in turbine passage at CRS dams[2]; yet, operating within ±1% of peak efficiency tends to minimize fish mortality and has been followed to minimize turbine passage 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 CRS project in the Fish Passage Plan (FPP). The Corps shall ensure that the 1% range is based on the best available information and that updates are coordinated with Bonneville and the Fish Passage Operations & Maintenance (FPOM) Coordination Team. The new tables will be coordinated with FPOM before distribution to Bonneville and the Corps. Implementation will begin within two weeks of receipt.

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[1] Long, C., and W. Marquette. 1967. *Research on fingerling mortality in Kaplan turbines.* Bureau of Commercial Fisheries, Seattle. *See also*, Bell, M. C. 1981. Unpublished Report: *Updated compendium on the success of passage of small fish through turbines.* U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

[2] Skalski, J., D. Mathur, and P. Heisey. 2002. Effects of turbine operating efficiency on smolt passage survival. *North American Journal of Fisheries Management* 22:1193-1200. Weiland, MA, CM Woodley, TJ Carlson, B Rayamajhi, and J Kim. 2015. *Systematic Review of JSATS Passage and Survival Data at Bonneville and The Dalles Dams during Alternative Turbine and Spillbay Operations from 2008–2012*. PNNL-24260. Report submitted to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, by the Pacific Northwest National Laboratory, Richland, Washington.

2.1.2. Operating efficiency of turbines is a result of wicket gate opening and blade angle for a given head.[3] 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. Generally, the best operating range for turbines is within the 1% range. Operating turbines within the 1% range also typically reduces mortality of out-migrating juvenile salmonids and produces the most power for a given volume of water. During the in-season peak efficiency operating period (defined in **Section 3.2**), Bonneville and the Corps will operate turbines at lower Snake (LSN) and lower Columbia (LCOL) projects as a soft constraint within the 1% range and a hard constraint within and above the 1% range in accordance with the guidelines below. During the off-season operating period (defined in **Section 3.3**), the same soft constraints of operating turbines within the 1% range will be implemented; however, turbines may be operated within the normal operating range (including above and below 1% peak efficiency range when appropriate).

3.2. In-Season Peak Efficiency Operating Period

3.2.1. During the in-season peak efficiency operating period, Bonneville and the Corps will operate as a soft constraint within the 1% range and as a hard constraint within and above the 1% range. Bonneville and the Corps will operate the turbines at LSN and LCOL projects above the 1% range for the deployment of both contingency and balancing reserves and also to mitigate total dissolved gas (TDG) during high flow events. All required fish passage spill operations will be met prior to operating turbines above the 1% range.

During the in-season operating period, 24 hours/day, Bonneville will submit generation requests at all eight LCOL and LSN projects to operate the turbines within the 1% range (or Best Operating Point, BOP[4]) in accordance with the soft constraint. Excursions outside of the 1% range during this period, including those for reserve deployment and TDG mitigation, will be tracked using the codes in **Table C-1**.

3.2.2. The defined start and end dates for the in-season peak efficiency operating period are variable by dam:

(i) Peak efficiency operating period is April 3 through August 31 for all LSN projects.

(ii) Peak efficiency operating period is April 10 through August 31 for all LCOL projects.

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[3] Bell, M. C. 1981. Unpublished Report: *Updated compendium on the success of passage of small fish through turbines.* U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

[4] Best Operating Point (BOP) is used at Bonneville Dam Powerhouse One (Units 1-10).

3.3. <u>Off-Season Operating Period.</u>

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. Bonneville and the Corps will operate turbines at the LCOL and LSN projects outside the 1% range if needed for power generation or mitigation of TDG. 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.

3.3.2. The defined start and end dates for the off-season operating period are variable by dam.

(i) Off-season operating period is September 1 through April 2 for all LSN projects.

(ii) Off-season operating period is September 1 through April 9 for all LCOL projects.

3.4. <u>Unit Priorities.</u>

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).

3.5. <u>Project Priorities.</u>

3.5.1. If units are operated outside of the 1% range, Bonneville will make every effort to assure that generation requests to Corps projects adhere to project priorities (forebay ranges, spill management, research, etc.). These priorities may be modified in season by the Action Agencies through the Regional Forum (e.g., FPOM and/or Technical Management Team (TMT)).

3.6. <u>Coordination.</u>

3.6.1. Coordination will occur through existing interagency mechanisms, such as the in-season adaptive management process described in the 2020 *Biological Assessment for the Operation and Maintenance of the Federal Columbia River* System (2020 CRS BA) prepared by the Corps, U.S. Bureau of Reclamation, and Bonneville (collectively referred to as the 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 (Corps) and the HERMES model (Bonneville). This can take up to two weeks to accomplish. If an emergency situation exists, implementation will begin as soon as practicable given concurrent operations, hydraulic situations, and loads.

3.6.3. Operations outside of the 1% range for limitations listed in **sections 4.1** (**System Reliability**) **4.2** (**Routine Starting**), **4.3** (**Total Dissolved Gas (TDG) Mitigation**), **4.7** (**Contingency Reserves**), and **4.8** (**Balancing Reserves**) are at the discretion of Bonneville and the Corps.

3.6.4. Emergency situations described in **Section 4.1** that require an immediate change in CRS operations will be coordinated directly by the Action Agencies with NOAA Fisheries as soon as practicable. If coordination of an emergency change in CRS operations cannot be completed immediately, information will be supplied to NOAA Fisheries as soon as practicable and then a summary of the emergency will be sent to TMT distribution list on the next working day.

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

Occurrence of the conditions described below may limit the ability of the Action Agencies to operate turbines continuously within the 1% range.

4.1. System Reliability.

4.1.1. Bonneville's ability to operate the CRS in a manner that enables the Corps to maximize operation of turbines within the 1% range is 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 Bonneville over-rides operations proposed for ESA-listed fish in the 2020 CRS BA as an action intended to preserve system reliability, Bonneville will provide an automated e-mail to the Corps and trigger regional notifications described in **Section 3.6.4**. For longer term emergencies, see the current *Water Management Plan,* Appendix 1 (Emergency Protocols)[5].

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*.

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.

[5] Water Management Plan, Appendix 1: Emergency Protocols
pweb.crohms.org/tmt/documents/wmp/2021/Appendices/Appendix_1_Emergency_Protocols_July_16_2008_with-ATTACHMENT-1.pdf

(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) Mitigation.

4.3.1. Turbines may operate above 1% peak efficiency range to mitigate TDG production. The purpose of mitigating TDG production is to reduce the duration and magnitude of water quality standard exceedances in the tailraces of each project. The operation is expected to occur primarily when there is insufficient turbine capacity within the 1% range to generate with the available water *after* providing fish passage spill. This condition occurs most frequently in high flow periods, a time when operating above 1% range would also help manage for high TDG. If load is not available, involuntary spill will likely occur and may result in TDG levels above 125%. If load is available, turbines may operate above the 1% range. TDG management may occur at lower flows if there are a high number of turbine outages; however, the intent of this operation is to distribute flow across all available turbines at each project when possible before TDG mitigation occurs by operating the turbines above the 1% range.

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 the 1% range, operational modifications will be coordinated through processes outlined in **Section 3.6**.

4.5. Transport Projects.

4.5.1. Resolution of conflicts between spill management and turbine operation within the 1% range 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.

4.6. Routine Maintenance and Testing.

4.6.1. All units at all projects must undergo maintenance and associated testing. The testing necessitates deviation from the 1% range for periods of up to two hours and will be reported as described in **Section 5**. Scheduling of maintenance testing that exceeds two hours will be coordinated through the process outlined in **Section 3.6**.

4.7. <u>Contingency Reserves</u>

4.7.1. Bonneville deploys contingency reserves to meet energy demands caused by unexpected events such as transmission interruption or failure of a generator. Bonneville cannot predict the exact timing, magnitude, and the location of the need to deploy contingency reserves, which makes pre-coordination for each individual event impossible. Bonneville may depend on turbine operations above the 1% range for the deployment of contingency reserves.

4.8. <u>Balancing Reserves</u>

4.8.1. Bonneville is responsible for CRS grid reliability, which requires the use of balancing reserves to follow sub-hourly power demand and supply fluctuations. Since supply must equal demand for power second-by-second, power generation must increase and decrease automatically as demand for power changes. Furthermore, within its Balancing Authority, Bonneville integrates the use of other renewable power sources (e.g. wind and solar) and balancing reserves compensate for within-hour changes in wind and solar generation. Bonneville may depend on turbine operations above the 1% range for the deployment of balancing reserves.

4.9. <u>Other.</u>

4.9.1. There may be cases that an excursion was not explainable or caused by human error. Reporting will be consistent with **Section 5**.

5. QUALITY CONTROL

5.1.1. Significant deviations outside of the 1% range as defined below will be recorded. Data on unit status will be compiled by Bonneville during the in-season peak efficiency operating period by project 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 Bonneville using the reason codes listed in **Table C-1**. The Corps will annually provide a report to NOAA Fisheries of reportable excursions from the 1% range during the in-season peak efficiency operating period (defined in **Section 3.2**).

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	Bonneville 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	TDG mitigation
13	Contingency reserve deployment
14	Balancing reserve deployment

2023 Fish Passage Plan

Appendix D

Operations for Non-Listed Species (Lamprey, etc.)

Table of Contents

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:

i) 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.

ii) 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.

iii) 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. Since 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 2.4.2.13**). 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. 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**.**

2.2.2. 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.

2.2.3. 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 the current year is defined in **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. Adequate water depth will be maintained in all LPS flumes for lamprey passage.

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. Weir caps have been added to all entrance weirs on both the east and north ladder.

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 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.

4.1.2. Entrance modifications at the JDA north ladder (JDA-N) were completed in 2013 and included installation of a Lamprey Passage Structure (LPS) immediately upstream of the new variable-width weir. The LPS runs from the entrance to a trap box on the lower fish entrance deck. The trap box is operated by research groups, Tribes in support of Translocation, and when needed, USACE, depending on the year. The operating groups are responsible for monitoring, handling, and transportation of lamprey from the boxes.

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. <u>Improvements for Lamprey</u>

5.1.1. At all projects, horizontal slots were cut at the bottom of the stem walls in the upper section of the ladders to allow adult lamprey attachment along a level pathway through the weirs. 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.

5.1.2. In the McNary (Oregon shore), Ice Harbor, Little Goose, and Lower Granite fish ladders, plating was attached on the diffuser gratings adjacent to the submerged orifices just above tailwater.

5.1.3. At Ice Harbor and Lower Monumental dams, ramps were installed in some of 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.

5.1.4. Lamprey passage structures were installed at one of the south shore entrances of the Oregon fish ladder at McNary and the south shore fish ladder at Ice Harbor.

5.1.5. Lamprey-friendly raceway tailscreens were installed at all of the juvenile fish facilities that collect fish for transportation (Lower Granite, Little Goose, and Lower Monumental). These tailscreens allow collected juvenile lamprey to volitionally pass through the mesh and return to the river rather than be transported. At Lower Granite and Little Goose, the tailscreen wire mesh diameter is 1.6 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%. Lower Monumental changed to 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.

5.1.6. At McNary, the overflow screens in the sample and PIT-tag holding tanks were changed from slotted to round-hole perforated plates. The plates are 1/8" thick with 1/8" staggered holes that are small enough so that lamprey do not get caught in them.

5.1.7. When the adult and juvenile fish facilities are unwatered for annual or periodic maintenance, all projects perform routine maintenance on lamprey passageways.

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 2 and April 15 (about 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 Ice Harbor, 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.

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2023 Fish Operations Plan

1. INTRODUCTION

The 2023 Fish Operations Plan (2023 FOP) describes the U.S. Army Corps of Engineers' (Corps) planned operations for juvenile fish passage at its four lower Snake River and four lower Columbia River dams during the 2023 spring and summer fish migration seasons, generally April 3 through August 31. The 2023 FOP is consistent with spill operations for juvenile fish passage and the regional forum process for adaptive management and in-season management provisions outlined in the Record of Decision for the Columbia River System Operations Environmental Impact Statement (CRSO EIS ROD) dated September 28, 2020, CRSO Final EIS, 2020 National Marine Fisheries Service (NMFS) Columbia River System and U.S. Fish and Wildlife Service (USFWS) Biological Opinions (2020 BiOps)[1], the Extensions of the 2008 Columbia Basin Fish Accords (Accord Extensions), the Corps' requirements under the Endangered Species Act (ESA), and the ongoing consultation and communications with the relevant wildlife agencies to ensure consistency with the Act. The 2023 FOP also incorporates operations outlined in the Term Sheet for Stay of Preliminary Injunction Motion and Summary Judgment Schedule for the *NWF et al. v. NMFS et al.* (3:01-cv-00640-SI) litigation, as extended and modified through the Administration's Commitments in Exhibit 2 of the Joint Motion to Extend the Litigation Stay filed August 4, 2022 (referred to collectively as 2022 Agreement). Other project operations and water management actions not specifically addressed in this document will be consistent with other guiding operative documents, including the 2023 Water Management Plan (WMP), seasonal WMP updates, and the 2023 Fish Passage Plan (FPP).

In addition to discussing project-specific fish passage spill operations, the 2023 FOP identifies factors that the Corps, the Bureau of Reclamation (Reclamation), and the Bonneville Power Administration (Bonneville) (collectively referred to as the "Action Agencies") must address in the context of operating this complex system of fourteen multiple purpose projects. The 2023 FOP includes a discussion of how the Corps manages fish passage spill and total dissolved gas (TDG), identifies Planned and Routine Operational Adjustments (Section 4) 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 Corps, in coordination with the other Action Agencies, and NMFS, employs the Regional Implementation Oversight Group (RIOG) and technical teams including the Technical Management Team (TMT) and Fish Passage Operations & Maintenance (FPOM) coordination group, to coordinate with state, tribal and other federal experts for recommendations for implementing operations consistent with the 2020 BiOps.

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 2023 consistent with the State of Washington and the State of Oregon total dissolved gas (TDG) water quality standards (WQS).[2,3] The State of Washington, Department of Ecology (WADOE) adopted a WQS rule change which became effective in 2020 allowing spring juvenile fish passage spill operations to generate specified TDG levels in project tailraces (up to 125% TDG 12 hours, 126% TDG 2 hours), so long as the specified conditions are met, including that spring juvenile fish passage spill operations do not exceed the spill levels and durations reviewed in applicable ESA consultation documents. The Environmental Protection Agency (EPA) subsequently approved the rule change and found that the ESA consultation documents ensure that any spring spill regime using the revised criteria must be performed in accordance with the spill levels and durations evaluated in ESA consultation documents for effects to ESA-listed species of all life stages, including juvenile out-migrating salmonids, resident salmonids, and adult migrating salmonids. EPA's approval of the rule further states that "compliance with the ESA consultation documents is a condition precedent for the revised criteria and so the criteria are not applicable for the purposes of the [Clean Water Act (CWA)] (i.e., have no effect for CWA purposes) without the ESA consultation documents addressing spill operations that result in TDG saturation levels above the pre-existing criterion." *Letter to WADOE from EPA Re: The EPA's Action on Revisions to the [WADOE's] Surface Water Quality Standards for the Site-Specific Total Dissolved Gas Criteria in the Columbia and Snake Rivers, and Other Water Quality Standards Revisions* dated March 5, 2020, page 9.

The State of Oregon, through its Environmental Quality Commission, approved a modification to its TDG WQS (up to 125% TDG 12 hours, 127% TDG 2 hours), so long as spring spill is "applied in a manner consistent with the applicable requirements of the federal [ESA]." *Order Approving a Modification to the Oregon's Water Quality Standard for Total Dissolved Gas in the Columbia River Mainstem* dated February 11, 2020, page 4. Both states have thus accommodated levels of TDG above 110% for fish passage spill operations for ESA-listed juvenile salmonids at Corps projects on the lower Snake and lower Columbia rivers, as follows:

Washington Administrative Code:

<u>WAC 173-201A-200(1)(f)(ii) and WAC 173-201A-200(1)(f)(ii)(A)</u>

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[2] 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. *See* https://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A-200.

[3] 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* https://www.oregon.gov/deq/wq/Documents/columbiaUSACEtmdlorder.pdf

(ii) The TDG criteria may be adjusted to aid fish passage over hydroelectric dams that spill for anadromous juvenile fish as of the 2020 spill season. The elevated TDG levels are intended to allow increased fish passage without causing more harm to fish populations than caused by turbine fish passage. The following special fish passage exemptions for the Snake and Columbia Rivers apply when spilling water at dams is necessary to aid fish passage:

(A) TDG must not exceed:

• An average of 115 percent as measured in the forebays of the next downstream dams and must not exceed an average of 120 percent as measured in the tailraces of each dam (these averages are calculated as an average of the 12 highest hourly readings in a calendar day, relative to atmospheric pressure); and
• A maximum TDG saturation level of 125 percent calculated as an average of the two highest hourly TDG measures in a calendar day during spillage for fish passage.

WAC 173-201A-200(1)(f)(ii)(B)

(B) To further aid fish passage during the spring spill season (generally from April through June), spill may be increased up to the following levels as measured at the tailrace fixed site monitoring location:

• A maximum TDG saturation level of 125 percent calculated as an average of the 12 highest hourly TDG measures in a calendar day: and
• A maximum TDG saturation level of 126 percent calculated as an average of any two-consecutive hourly TDG measures. These TDG criteria may be applied in place of (f)(ii)(A) of this subsection during spring spill operations when applied in accordance with the following conditions:

(I) In addition to complying with the requirements of this chapter, the tailrace maximum TDG criteria at hydropower dams shall be applied in accordance with Endangered Species Act consultation documents associated with spill operations on the Snake and Columbia rivers, including operations for fish passage. The Endangered Species Act consultation documents are those by which dams may legally operate during the time that the adjusted criteria in (f)(ii)(B) of this subsection are in use.

(II) Application of the tailrace maximum TDG criteria must be accompanied by a department approved biological monitoring plan designed to measure impacts of fish exposed to increased TDG conditions throughout the spring spill season. Beginning in the year 2021, plans must include monitoring for non-salmonid fish species and must continue for a minimum of five years, and thereafter as determined by the department.

(III) TDG must be reduced to allowances specified in (f)(ii)(A) of this subsection if the calculated incidence of gas bubble trauma in salmonids (with a minimum sample size of 50 fish required weekly) or non-salmonids (with a minimum sample size of 50 fish required weekly) exceeds:

• Gas bubble trauma in non-paired fins of 15 percent; or

• Gas bubble trauma in non-paired fins of five percent and gas bubbles occlude more than 25 percent of the surface area of the fin.

If gas bubble trauma exceeds these biological thresholds, additional monitoring must demonstrate the incidence of gas bubble trauma below biological thresholds before TDG can be adjusted to allowances specified in this subsection. Gas bubble trauma monitoring data shall be excluded from comparison to biological thresholds when higher than normal river flow contributes to excess spill above the ability to meet (f)(ii)(B) of this subsection. This monitoring data exclusion shall apply for one full calendar day after reduced river flow allows attainment of (f)(ii)(B) of this subsection.

Oregon Water Quality Standard Modification:

The Environmental Quality Commission approves the following modification to the statewide standard for total dissolved gas (OAR 340-41-0031(2)) of 110 percent for the lower Columbia River at McNary, John Day, The Dalles and Bonneville dams, as provided for in OAR 340-41-0104(3):

1. The total dissolved gas standard for the Columbia River as measured in the tailraces of McNary, John Day, The Dalles, and Bonneville dams is 125 percent for the period from April 1 through June 15.

2. The total dissolved gas standard for the Columbia River as measured in the tailraces of McNary, John Day, The Dalles, and Bonneville dams is 120 percent for the period from June 16 through Aug. 31.

3. These limits do not apply when the stream flow exceeds the seven-day, ten-year frequency flood.

4. The DEQ Director may approve additional periods of application of this modification, beyond the April 1 to Aug. 31 period, subject to subsections 7.a) to 7.d) for reasons including passing Spring Creek Hatchery fish releases, maintenance activities, and biological or physical studies of spillway structures and prototype fish passage devices. The Corps must notify DEQ in writing describing the purposed action, the purpose of the action and dates of action at least one week prior to the spill. The Corps must obtain written approval from the Director prior to such spill.

5. The modified total dissolved gas standards will apply for five years, 2020, 2021, 2022, 2023 and 2024.

6. Voluntary fish passage spill during the spring spill season, occurring from April 1 through June 15, is subject to the following conditions:

a) Spill at a dam must be reduced when:

i. Instantaneous total dissolved gas levels exceed 127 percent of saturation, calculated as the average of any two-consecutive hourly TDG measurements in the tailrace of the dam; or

ii. The average of the twelve highest hourly TDG measurements in the tailrace of the dam in a calendar day exceeds 125 percent.

b) Spill at a dam must be reduced to 120 percent as calculated in 7.a) i. when:

i. The calculated incidence of gas bubble trauma in salmonids (with a minimum sample size of fifty fish required weekly) or non-salmonids (with a minimum sample size of fifty fish required weekly) exceeds gas bubble trauma in non-paired fins of fifteen percent, or gas bubble trauma in non-paired fins of five percent and gas bubbles occlude more than twenty-five percent of the surface area of the fin. If gas bubble trauma exceeds these biological thresholds, additional monitoring must demonstrate the incidence of gas bubble trauma below biological thresholds before TDG can be increased to the level specified in this order. Gas bubble trauma monitoring data shall be excluded from comparison to biological thresholds when higher than normal river flow contributes to excess spill above 125 percent. This monitoring data exclusion shall apply for one full calendar day after reduced river flow allows attainment of 125 percent TDG levels in the tailrace of the dam.

c) The tailrace maximum TDG criteria for spring spill in this modification will be applied in a manner consistent with the applicable requirements of the federal Endangered Species Act.

d) Physical monitoring must occur and be adequate for implementing the requirements of this order.

e) Application of the tailrace maximum TDG criteria must be accompanied by a DEQ-approved biological monitoring plan designed to measure impacts to fish exposed to increased TDG conditions throughout the spring spill season. Beginning in the year 2021, plans must include monitoring for non-salmonid fish species. Gas bubble trauma monitoring for juvenile salmonids may be halted if there is a high mortality risk due to compounded effects of the evaluation procedure and adverse environmental factors such as high stream temperatures.

7. Voluntary fish passage spill during the summer spill season, occurring from June 16 through Aug. 31, is subject to the following conditions:

a) Spill at a dam must be reduced when:

i. The average of the twelve highest hourly TDG measurements in the tailrace of the dam in a calendar day exceeds 120 percent of saturation; or

ii. Instantaneous total dissolved gas levels exceed 125 percent of saturation in the tailrace of the dam, calculated as the average of the two highest hourly total dissolved gas measures in a calendar day.

b) The DEQ Director may halt the voluntary spill program or require reductions in voluntary spill to reduce TDG levels if voluntary spill results in biological threshold exceedances when:

i. More than 15 percent of salmonids examined show signs of gas bubble disease in their non-paired fins, or

ii. More than five percent of salmonids examined show signs of gas bubble trauma in their non-paired fins where more than 25 percent of the surface area of the fin is occluded by gas bubbles.

c) Physical monitoring must occur and be adequate for implementing the requirements set out in this order.

d) Application of the tailrace maximum TDG criteria must be accompanied by a DEQ-approved biological monitoring plan designed to measure impacts to fish exposed to increased TDG conditions throughout the summer spill season. Beginning in the year 2021, plans must include monitoring for non-salmonid fish species. Gas bubble trauma monitoring for juvenile salmonids may be halted if there is a high mortality risk due to compounded effects of the evaluation procedure and adverse environmental factors such as high stream temperatures.

For the purposes of Oregon's Order, ODEQ defines non-salmonid as including non-native species per their 10 June 2022 letter and 18 January 2023 email. Gas bubble trauma monitoring in bi-state waters will include evaluation of non-native species in the population of non-salmonids to comply with Oregon's Order. WADOE's Rule Implementation Plan is unchanged and continues to require GBT evaluation of native non-salmonids.

The terminology that has been adopted to refer to the States' TDG Water Quality Standards (WQS) is the "gas cap." Gas cap spill is spill to the maximum level that meets, but does not exceed, the TDG criteria allowed under state law. In its implementation of spill for fish passage, the Corps will operate its fish passage projects in 2023 to the spill levels identified in the CRSO EIS ROD, 2020 BiOps, 2022 Agreement as extended and modified, and in accordance with the States' 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 determines "spill caps" for each of the Corps' lower Columbia and lower Snake River projects daily throughout the fish passage spill season. Spill caps are the maximum spill level at each project that is estimated to meet, but not exceed, the gas cap. In spring 2023, the spill cap will be the hourly target spill level for a portion of the day as described below in Section 6, Table 3.

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, and incoming TDG from upstream); and (2) project operations (e.g., spill level, spill pattern, tailwater elevation, proportion of flow through the turbines, and project configuration).

During spill for fish passage, the Corps reviews spill caps daily and adjusts as necessary to define the maximum spill level that maintains TDG within applicable State standards. Additional information about how the Corps will manage TDG is described in the 2023 Water Management Plan (see Appendix 4: TDG Management Plan)[4].

Higher spill than the target spill levels identified in Tables 3 and 4 may occur due to high river flow that exceeds powerhouse hydraulic capacity or due to a lack of power demand (load). During periods when spill is greater than the spill cap due to lack of load conditions, the Corps manages excess TDG on a system-wide basis by incrementally increasing spill at projects throughout the system in the order of priority defined in the Spill Priority List[5]. For this purpose, the RCC also defines spill rates to target multiple TDG levels in project tailraces that exceed the gas cap. The order of priority is coordinated with regional sovereigns in the Technical Management Team (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 target spill levels defined in Tables 3 and 4 to the extent feasible; however, actual hourly spill levels at each dam may vary 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[6] 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 the target but may be slightly higher or lower than the target spill level. Due to these physical limitations in spill level precision, the observed hourly average spill level may vary ±2 kcfs when the target spill is a flow rate (e.g., kcfs) and ±1% when the target spill is a percentage. Not all projects are able to achieve this level of precision (e.g. Little Goose, The Dalles, and Bonneville Dams). More information regarding project specific spill precision limitations may be found in Section 8 below.

Snake River projects make spillbay gate setting changes as soon as feasible in response to target spill changes; however, there may be instances when spill level changes are delayed by up to 1 hour or more due to operation of the navigation locks.

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[4] The Water Management Plan (WMP) and associated appendices are updated annually. *See* http://pweb.crohms.org/tmt/documents/wmp/.

[5] http://pweb.crohms.org/tmt/documents/spill-priority/

[6] The FPP is coordinated annually with regional sovereigns through the FPOM. *See* http://pweb.crohms.org/tmt/documents/fpp/.

4. MODIFICATIONS TO PLANNED OPERATIONS AND IN-SEASON MANAGEMENT

For planning purposes, the operations described in the 2023 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, NMFS, and USFWS, coordinates with regional sovereigns on these conditions and other planned operations through the review of the 2023 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.

For unanticipated and unplanned conditions that are not pre-coordinated, the Corps responds as necessary to adjust to the condition, and when possible, will use the existing regional coordination process[7] 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 pool operating ranges).

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.

<u>Planned and Routine Operational Adjustments:</u>[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.

[7] In-season adaptive management changes in spill levels could include adjustments that address unintended biological consequences caused by 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.

[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. 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.

4. Operational limitations, for example physical limitations of gate settings, spill patterns (see section 3), forebay elevation, and deadband[9].
5. Scheduled turbine unit and/or transmission outages that reduce powerhouse hydraulic capacity and require spilling more than the target spill level.*
6. Standard operations for transmission reliability (see section 4.4.1. below)*
7. Navigation safety concerns (see section 4.6. below).*
8. Transition periods between Gas Cap spill and Performance Standard[10] spill hours may result in actual hourly spill levels that are slightly higher or lower than targeted spill levels.

Non-routine or Unplanned Operational Adjustments:[11]
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, adult fish passage blockages, actionable incidence of gas bubble trauma (GBT) incidence rates in either juvenile salmonids or non-salmonids[12], etc.).
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.[13]
4. Other circumstances including human or programming error, unscheduled maintenance or outage, 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 operate the fourteen Columbia River System projects in emergency situations in accordance with the 2023 WMP Emergency Protocol (WMP

[9] Deadbands occur when turbine outflow cannot achieve some flow ranges. When targeting spill as a percent of outflow, these deadbands will result in a spill percentage that is above or below the target percentage at certain outflows.
[10] "Performance standard" spill is a NMFS term and refers to spill levels intended to meet NMFS' performance standard testing, as described in the 2008 Biological Opinion and accompanying administrative record.
[11] 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.
[12] *See* WAC 173-201A-200(1)(f)(ii)(B)(III), including WADOE's Rule Implementation Plan for Chapter 173-201A WAC Water Quality Standards for Surface Waters of the State of Washington (Publication 19-10-048; pages 7-9), and *Order Approving a Modification to the Oregon's Water Quality Standard for Total Dissolved Gas in the Columbia River Mainstem*, page 5, including clarifications from Oregon Department of Environmental Quality email dated 18 January 2023, RE: Request for Clarification of Spring Non-Salmonid Monitoring Requirement.
[13] When a generator requires repair, ongoing operations may require modification in order to prepare a turbine unit for the necessary maintenance without further damaging infrastructure or jeopardizing personnel safety. In order to safely install taillogs in a unit adjacent to the spillway, it may be necessary to cease spill through some spillbays for up to 6 or more hours during the installation of the physical barriers to isolate the area and subsequently dewater the draft tube environment. An alternate spill pattern for use during the maintenance period using the remaining spillbays will be coordinated through FPOM.

Appendix 1). This protocol identifies the process the Action Agencies, in coordination with NMFS and USFWS, 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: https://pweb.crohms.org/tmt/documents/wmp/2023/Appendices/Appendix_1_Emergency_Protocols_February_25_2022_with-ATTACHMENT-1%20clean_2.pdf

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 the lower limit of the ±1% peak efficiency operating range defined in the project-specific chapters of the FPP and from actual generation records (see Table 1). Values stated in Table 1 are approximate ranges 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 reservoir elevation: as reservoirs fluctuate within the operating range, flow rates through the generating unit change.
2. Generating unit governor deadband: the governor controls the number of megawatts the unit should generate but cannot precisely control a unit flow; variations may be 1-2% or more of unit flow. These variations can affect minimum generation ranges 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 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[14] 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 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 operates the lower Snake River and lower Columbia River projects to the unit priority order specified in the FPP and minimum generation ranges identified in Table 1.

[14] Two generating units may be necessary at Ice Harbor Dam during elevated air temperatures in order to meet transmission requirements.

Table 1.─ Minimum generation flow ranges (kcfs) for turbine units at Corps hydropower projects on the lower Snake and lower Columbia rivers.[15]

Project	Turbine Unit	Minimum Generation Flow Range[A] (kcfs)
Lower Granite	1, 3 2[B] 4, 5, 6	11.6 – 12.7 17.8 – 18.8 13.8 – 14.9
Little Goose	1, 2, 3 4, 5, 6	11.8 – 12.3 14.3 – 14.9
Lower Monumental	1, 2, 3 4, 5, 6	11.7 – 12.9 13.8 – 14.6
Ice Harbor	1[C] 2 3[C] 4[B] 5, 6[B]	TBD 12.1 – 14.1 8.6 – 10.3 12.2 – 13.5 12.5 – 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, and Ice Harbor Units 4, 5, and 6 are restricted due to runner blades that are set at a fixed angle (non-adjustable). If a unit is restored to an adjustable-blade Kaplan in-season, the minimum generation range will revert to the lower 1% limit. Also, Ice Harbor Unit 2 has a fixed-blade (non-adjustable) runner design.
C. Ice Harbor Unit 3 is being rebuilt with a runner design that reduces impacts to fish, scheduled for completion in 2023. At that time, testing will be performed to confirm the operating range. After Unit 3 is returned to service, Unit 1 will be taken out of service to install a new runner design.

There may be situations when river flows are insufficient to maintain minimum generation in Table 1 and the target spill level identified in Table 3 and Table 4 every hour. Under these conditions, the lower Snake River projects operate one turbine unit at minimum generation and spill the remainder of outflow. The lower Columbia River projects also operate at minimum generation and pass the remaining outflow as spill down to minimum spill levels. Under low river flow conditions during spring spill operations, the Corps attempts to remain as close as possible to spill target levels for either gas cap spill or performance standard spill, depending on which operation is targeted for a given hour. The inability to meet the target gas cap spill level due to low river flow does not preclude the ability of the Corps to target performance standard spill levels for up to 8 hours a day as specified in Table 3. Additionally, inflow provided by non-Federal projects upstream is often variable and uncertain, and in combination with low flow

[15] The table is accurate as of March 2023 but may change in-season as coordinated through FPOM (see the FPP).

conditions, may result in instances where forebay elevations go outside of the restricted operating ranges for Snake River and Columbia projects described in Section 4.6.[16]

4.3.2. Navigation Lock Operation During Low Flows

At projects that have a target spill level that 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 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 Bonneville plan to allocate generation and spill at the eight Corps projects on the lower Columbia and Snake rivers in accordance with the 2023 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 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 Bonneville 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 are 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:

[16] Lower Snake River projects operate within the minimum operating pool (MOP) range during fish passage season (Table 2).

1. Ensuring sufficient range of generation capability is available to provide the Bonneville balancing authority[17] area with contingency reserves required by North American Electric Reliability Corporation (NERC) reliability standards.[18]
2. Ensuring generation is available to increase or decrease to balance load and generation within the Bonneville 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 Bonneville balancing authority area frequency response obligations, consistent with reliability standard requirements.
4. Bonneville must first meet its reserve obligations for system reliability. Unless unavoidable due to system reliability requirements, Bonneville will make best efforts to minimize the allocation of decremental (DEC) reserves on fish passage projects if carrying these reserves would otherwise result in not meeting the target spill levels defined in Tables 3 and 4.[19]
5. Ensuring that there is generation operating at projects in specific locations sufficient for arming for Remedial Action Schemes (RAS).[20] RAS allow the transmission system to automatically respond to unplanned events on the power system by immediately dropping or reducing generation at those specified locations.
6. Maintaining minimum generation levels (see Table 1) at generators in specific locations to maintain correct voltage levels on the power system to ensure reliability.
7. 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 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 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

[17] 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.

[18] The Federal Energy Regulatory Commission has certified the NERC as the Electric Reliability Organization responsible for establishing and enforcing national reliability standards.

[19] For example, generators may be required to maintain generation levels above minimum generation to provide sufficient capability to reduce generation.

[20] 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.

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., fires, earthquakes, etc.).

These actions are 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 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 unit operating for reliability is at the bottom of the ±1% of peak efficiency range. Water is 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 FPOM. Unit outages for required maintenance are described in FPP Appendix A. Maintenance dates are subject to change.

4.6. Navigation Safety and Minimum Tailwater Elevations

Short-term adjustments in spill or minimum operating pool (MOP) elevations may be required at any of the fish passage projects to address navigation safety concerns.[21] This may include changes in spill patterns, reductions in spill, short-term spill curtailment, or operating above MOP. Adjustments to MOP may also be required to meet minimum tailwater elevations (Table 2). Current spill operations for juvenile fish passage result in complex downstream hydraulics that cause large fluctuations in tailwater elevations. The 2020 BiOps describe MOP at the lower Snake River projects as a 1.5-foot range above the minimum forebay elevation (Table 2). To clearly communicate the implementation of this operation, the term “MOP” will refer to the 1.5-foot operating range above the minimum forebay elevation at the lower Snake River projects (i.e., “MOP” is a 1.5-foot operating range).

As described in the 2022 Agreement, the Corps will operate Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams at MOP with a 1.5 foot forebay operating range and a 1.0 foot range to the extent possible (referred to operationally as a “soft constraint”) from April 3 until August 14, 2023, unless adjusted on occasion to meet authorized project purposes, primarily navigation, except as noted below:

- The following modification will be made to the 2023 operations stemming from the Administration's Commitments in Exhibit 2 of the Joint Motion to Extend the Litigation

[21] 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.

Stay. During 2023 summer spill operations, Lower Granite Dam will be held within MOP through August 31, 2023, unless adjusted on occasion to meet authorized project purposes.

The Corps conducts a bathymetric survey of the federal navigation channel annually to assure a 14-foot depth is maintained in the federal navigation channel. The Corps completed dredging of the federal navigation channel in the Lower Granite pool during winter 2022/2023. This dredging action was done to reestablish the full depth needed for safe navigation and will allow Lower Granite to operate throughout its full normal operating range. With the dredging completed, in 2023 Lower Granite will operate in the normal MOP range (733.0-734.5 feet) from 3 April until 31 August (and within a 1.0 foot soft constraint range to the extent possible).

Table 2.─ Normal and minimum operating pool (MOP) elevation ranges and minimum tailwater elevations for lower Snake River projects. [A]

Project	Normal Operating Elevation Range (ft)[B]		MOP Elevation Range (ft)[C]		Project Tailwater (ft)
	Minimum	Maximum	Minimum	Maximum	Minimum
Lower Granite	733.0	738.0	733.0	734.5	633.0
Little Goose	633.0	638.0	633.0	634.5	537.0
Lower Monumental	537.0	540.0	537.0	538.5	437.0
Ice Harbor	437.0	440.0	437.0	438.5	337.0

A. Elevations provided in feet above mean sea level (NGVD29).
B. August 15 – April 2, except at Lower Granite (September 1-April 2).
C. April 3 – August 14, except at Lower Granite (April 3 – August 31). Projects will be operated within a 1.0-foot range to the extent possible (referred to operationally as a "soft constraint").

Potential in-season adjustments to MOP, if necessary, will be an expanded forebay operating range (Expanded MOP), raised minimum forebay elevation (Raised MOP), as described below.

Expanded MOP: If the 1.5-foot MOP range is insufficient to maintain navigation safety, the range is expanded (e.g., to 2 feet). For instance, some flow conditions may require a 2-foot forebay operating range at Ice Harbor to provide safe conditions for barge traffic at the navigation lock exit. These adjustments may be necessary for both commercial traffic and fish transport barges. Using Ice Harbor as an example, this type of adjustment would be described as "2-foot expanded MOP (437.0-439.0 feet)". Additionally, large within day fluctuations between gas cap spill and performance standard spill may cause operational challenges in meeting MOP and an expanded MOP may be necessary, especially when combined with restricted turbine units that are not able to operate in the full ±1 percent range.

Raised MOP: If the minimum forebay elevation is insufficient to maintain navigation safety or meet project minimum tailwater elevations, the 1.5-foot MOP range is raised as necessary. Adjustments in MOP operations have been necessary at the lower Snake River projects, typically during lower flow conditions. For instance, low flows in combination with fish passage spill operations may impact reservoir elevations and cause dips below project minimum tailwater elevations or inadequate navigation depths. Using Little Goose as an example, this type of adjustment would be described as "1.5-foot raised MOP (634.5-636.0 feet)".

Spill Adjustments: 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 transport 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.

5. JUVENILE FISH TRANSPORTATION PROGRAM

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 2023. Should regional sovereigns recommend adjustments in transportation start dates that differ from those stated herein, the Corps uses the existing regional adaptive management process to reconcile recommended operational adjustments.

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 on April 24 (collection starting on April 23) or as coordinated through the TMT and the RIOG but begin no later than May 1. Transport begins the following day after fish collection 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 of spring migrants ends on June 20. Truck transportation of summer migrants at Lower Granite and Little Goose resumes on August 1 with allowance for TMT adaptive management adjustments and continues through October 31. Transportation operations are carried out at each project in accordance with 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 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 2023 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 17, with marking beginning on April 18.

Depending on the number of fish available, fish will be collected 1-3 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 are expected to be maintained similar to what would occur under normal transport operations at 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. SPRING FISH PASSAGE SPILL OPERATIONS

Spring spill operations 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 initiates spill at 0001 hours, or shortly after midnight, at each of the projects on the start date. Target spill levels for spring 2023 at each project are defined in Table 3. If deleterious impacts of the proposed spill operations are observed in-season, existing adaptive management processes may be employed to address the cause of the impacts. Spill may be temporarily reduced at any project to ensure navigation safety or transmission reliability. In order to operate consistently with state water quality standards, spill may also be reduced if observed GBT levels exceed those identified in state water quality standards (*See* WASH. ADMIN. CODE § 173-201A-200(l)(f)(ii)(B)(III) and *Order Approving a Modification to the Oregon's Water Quality Standard for Total Dissolved Gas in the Columbia River Mainstem*, page 5).

Spill up to the 125% Gas Cap is spill to the maximum level that meets, but does not exceed, the TDG criteria allowed under state laws. This includes a criterion for not exceeding 126% TDG for the average of the two greatest hourly values within a day.

Table 3.─ Summary of 2023 spring target spill levels at lower Snake River (April 3 – June 20) and lower Columbia River (April 10 – June 15) projects.

PROJECT	SPRING SPILL DATES	SPRING SPILL OPERATION
Lower Granite [A, C]	April 3 until adult criteria met (no later than April 24)	24 hours/day: 125% Gas Cap
	Adult criteria met (no later than April 24) – June 20	16 hours/day: 125% Gas Cap 8 hours/day: 20 kcfs Performance Standard
Little Goose [B, C]	April 3 – June 20	16 hours/day: 125% Gas Cap 8 hours/day: 30% Performance Standard
Lower Monumental [A, C]	April 3 until adult criteria met (no later than April 24)	24 hours/day: 125% Gas Cap
	Adult criteria met (no later than April 24) – June 20	16 hours/day: 125% Gas Cap 8 hours/day: 40%
Ice Harbor	April 3 – June 20	24 hours/day: 125% Gas Cap
McNary	April 10 – June 15	24 hours/day: 125% Gas Cap
John Day [D]	April 10 – June 15	16 hours/day: 125% Gas Cap 8 hours/day: 32% Performance Standard
The Dalles [E]	April 10 – June 15	24 hours/day: 40% Performance Standard
Bonneville [F]	April 10 – June 15	24 hours/day: 125% Gas Cap

A. Lower Granite and Lower Monumental Adult Criteria – Within 1 business day of when the earliest of the following conditions occurs: (1) a cumulative total of 25 adult spring Chinook salmon (not including jacks) pass Lower Monumental Dam; or (2) a cumulative total of 50 adult spring Chinook salmon (not including jacks) pass Ice Harbor Dam; or (3) April 24, 2023, the Corps will implement 20 kcfs performance standard spill, up to 40% spill to manage high flows, at Lower Granite and 40% spill at Lower Monumental for 8 consecutive AM hours, 0400–1200, to target hours of peak adult passage. If lack of load conditions precludes the implementation of 20 kcfs performance standard spill at Lower Granite and 40% spill at Lower Monumental during the targeted AM period, those blocks will begin as soon as practicable during AM hours and continue for up to 8 consecutive hours. If a second block is needed, it will start as soon as load conditions allow, continue for at least two consecutive hours, and conclude no later than 2000. During periods of high river flow, the 8-hour Lower Granite performance standard spill may increase from 20 kcfs up to 40% of total river outflow if needed to improve conditions to meet performance standard blocks.
B. Little Goose – The 8 hours of performance standard spill will occur between the hours of 0300 and 2200 in one or two blocks per calendar day. Within 1 business day of a cumulative total of 25 adult spring Chinook salmon (not including jacks) passing Lower Monumental Dam, the Corps will implement performance standard spill at Little Goose Dam for 8 consecutive AM hours (April 3–15 starting at 0500 hours; April 16–June 20 starting at 0400 hours) to target hours of peak adult passage. If lack of load conditions preclude the implementation of performance standard spill during the targeted periods, performance standard spill will begin as soon as practicable during AM hours and continue for up to 8 consecutive hours. If a second block is needed, it will start as soon as load conditions allow, continue for at least two consecutive hours, and conclude no later than 2000.
C. During periods of high river flow that exceeds powerhouse hydraulic capacity, implementing 8 consecutive hours of spill as described in Footnotes A and B may result in storing additional inflow in the forebay above MOP. If it is necessary to pond water to achieve the 8-hour block of spill during high inflow, water stored above MOP should be drafted out over the remaining hours by increasing spill to pass inflow from 1200-1600 hours, then increasing spill as necessary from 1600-0400 to draft the pool back to MOP. If it is forecasted that the drafting spill will result in

exceeding 130% TDG in the tailrace, all 16 hours will be used to return the pool to MOP. In lack of load conditions performance standard spill blocks will be prioritized at Little Goose, Lower Monumental, and Lower Granite dams, in that order.
D. John Day Dam – The 8 hours/day of performance standard spill may occur with some flexibility, in either a single 8-hour block or two separate blocks per calendar day. Performance standard spill will not be implemented between 2200-0300 hours.
E. The Dalles Dam –TDG in The Dalles tailrace may fluctuate up to 125% prior to reducing spill at upstream projects or reducing spill at The Dalles below 40%. Maintain 40% spill for 24 hours at The Dalles and reduce John Day spill below the 125% TDG spill cap as needed for TDG management. Spill above 40%, up to 125% TDG, may occur for TDG management or for carrying reserves.
F. Bonneville Dam – Spill for fish passage should not exceed 150 kcfs due to erosion concerns.

7. SUMMER FISH PASSAGE SPILL OPERATIONS

Summer spill operations 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 initiates spill at 0001 hours, or shortly after midnight, at each of the projects on the start date. Target spill levels for summer 2023 at each project are defined in Table 4. At the Snake River Projects spill may range up to ±1 kcfs during the summer spill operation from August 15 – August 31.

Table 4.─ Summary of 2023 summer target spill levels at lower Snake River and lower Columbia River projects.

PROJECT	SUMMER SPILL[A] (June 21/16 – August 14) (24 hrs/day)	SUMMER SPILL[A] (August 15 – August 31) (24 hrs/day)
Lower Granite [B]	18 kcfs	SW flow (as river flow allows)
Little Goose [B, C]	30%	SW flow or 7 kcfs spill
Lower Monumental [B, D]	17 kcfs	SW flow or 8 kcfs spill
Ice Harbor [B, E]	30%	SW flow or 9 kcfs spill
McNary [F]	57%	20 kcfs
John Day	35%	20 kcfs
The Dalles	40%	30%
Bonneville	95 kcfs	50 kcfs

A. 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.
B. Late summer spill August 15-August 31 will be through the SW or a constant spill rate through conventional spillbays using the appropriate FPP spill pattern. The SW spill rate is a function of forebay elevation (as pool elevation increases, more water is spilled over the SW), as defined in the FPP. The SWs will be operated per FPP criteria and closed when low flow criteria are met. When the SW is closed, the spill target will transition to a constant spill rate through conventional spillbays and will not vary with a fluctuating forebay elevation.
C. Flow corresponds to the SW high crest elevation as adjusted relative to the forebay operating range (see FPP Chapter 8, section 2.3.2.7).
D. Flow corresponds to a forebay elevation of 538.5 feet, the mid-point of the forebay range from 537-540 feet.
E. Flow corresponds to a forebay elevation of 438.5 feet, the mid-point of the forebay range from 437-440 feet.
F. From June 16-August 14, McNary will adjust spill once a day to 57% of the previous day's average project outflow. The intent is to reduce the frequency of spillgate changes while implementing a more uniform pattern to the extent it can be done safely (see FPP Chapter 5, section 2.2.2.1).

8. PROJECT-SPECIFIC OPERATIONS

The following sections describe 2023 spill operations for each project. The Corps implements established spill patterns for all projects as described in the FPP. Additional information regarding spill precision outside these dates may be found in Section 3 above.

8.1. Lower Granite Dam

8.1.1. Spring Spill (Table 3): 125% Gas Cap 24 hours/day until adult salmonid abundance criteria are achieved (Table 3, footnote A), then 125% Gas Cap (see section 2.1), 16 hours/day, and 20 kcfs performance standard spill for up to 8 hours/day. The 8-hour performance standard spill blocks in 2023 can be modified to increase spill from 20 kcfs up to 40% to manage high flows and better meet performance standard spill blocks at Little Goose and Lower Monumental. [22]

8.1.2. Summer Spill (Table 4):

- June 21–August 14: 18 kcfs, 24 hours/day.
- August 15-August 31: SW flow, 24 hours/day.

8.1.3. Operational Considerations: None for 2023.

8.2. Little Goose Dam

8.2.1. Spring Spill (Table 3): 125% Gas Cap (see section 2.1), 16 hours/day, and 30% performance standard up to 8 hours/day between the hours of 0300 and 2200 (may occur in one or two blocks per day). When adult salmonid abundance criteria are met, the 8 hours of performance standard spill will occur in one 8-hour block in the morning (Table 3, footnote B).

8.2.2. Summer Spill (Table 4):

- June 21–August 14: 30% (unless adjusted to a constant spill level during low flows per section 4.3.3), 24 hours/day.
- August 15-August 31: SW flow or approximately 7 kcfs, 24 hours/day.

8.2.3. Operational Considerations:

- When the spillway weir is closed and project outflow is less than or equal to 38 kcfs, actual hourly average spill levels at Little Goose may range up to ±4% according to the spill pattern Table LGS-10 in the FPP (Chapter 8).

[22] The modification to the 8-hr block from 20 kcfs up to 40% spill is intended for use as was coordinated at TMT on Jun 10, 2022 (http://pweb.crohms.org/tmt/agendas/2022/0610_Minutes.pdf).

- During low flow conditions at Little Goose, spill may exceed the target percentage if the spillway weir is in service and the project is restricted to a fixed minimum spill level (i.e., spill cannot be reduced below the spill rate through the spillway weir, which may result in spilling more than the target percentage at lower outflows).

- During the 30% spill operation when project outflows are ≤ 32 kcfs, the spill operation will transition from 30% to a constant spill level of approximately 7-11 kcfs to help stabilize project outflow, meet Lower Monumental target spill levels, and maintain MOP elevation at Little Goose. The constant spill level will be based on the previous day's average total project outflow, as follows: 11 kcfs when total outflow is 28.0 to 32.0 kcfs, 9 kcfs when total outflow is 24.0 to 27.9 kcfs, and 7 kcfs when total outflow is ≤ 23.9 kcfs. Actual spill may range up to ±1 kcfs from the target spill level. Spill changes will be made by 0300 each day.

8.3. Lower Monumental Dam

8.3.1. Spring Spill (Table 3): 24-hour 125% Gas Cap until adult salmonid abundance criteria are achieved (Table 3, footnote B), then 125% Gas Cap (see section 2.1) using the uniform spill pattern, 16 hours/day, and 40% using the uniform spill pattern for up to 8 hours/day.

8.3.2. Summer Spill (Table 4):

- June 21–August 14: 17 kcfs (bulk pattern), 24 hours/day.

- August 15-August 31: SW flow or approximately 8 kcfs, 24 hours/day.

8.3.3. 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 barge loading operations, spill is typically reduced to 15 kcfs using the bulk pattern, 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.[23]

[23] With spill levels in spring 2023 targeting the gas cap for at least 16 hours/day, reducing spill at Lower Monumental for long durations could pose problems for staying within MOP at Ice Harbor Dam, the next downstream project.

8.4. Ice Harbor Dam

8.4.1. Spring Spill (Table 3): 24-hour 125% Gas Cap (see section 2.1).

8.4.2. Summer Spill (Table 4):

- June 21–August 14: 30%, 24 hours/day.
- August 15-August 31: SW flow or approximately 9 kcfs, 24 hours/day.

8.4.3. Operational Considerations:

- When the SW is open, the minimum project spill level is fixed at approximately 7.1-8.7 kcfs, depending on forebay elevation (i.e., spill cannot be reduced below the fixed volume through the SW). This operational limitation results in spilling more than 30% when total outflow drops below approximately 28 kcfs. Per FPP section 2.3.2.7, the SW is closed when day average outflow is below 30 kcfs and forecasted to stay below 30 kcfs for at least 3 days. However, outflow may drop below 28 kcfs on an hourly basis while the SW is still open, resulting in spill greater than 30% for those hours.
- Currently, all but one of the five available turbine units at Ice Harbor have runner blades that are locked at a set angle (non-adjustable) and a smaller operating range (also referred to as “fixed-blade” or “locked-blade” units). Only Unit 1 has adjustable blades. As a result, turbine outflow cannot achieve some flow ranges, referred to as deadbands. When targeting spill as a percent of outflow, these deadbands will result in a spill percentage that is above or below the target percentage at certain outflows. When Unit 3 returns to service in 2023, Unit 1 will be taken out of service to install a new runner design. At that time, Unit 3 will be the only unit available with adjustable blades.

8.5. McNary Dam

8.5.1. Spring Spill (Table 3): 24-hour 125% Gas Cap (see section 2.1). A SW will be operated in both spillbay 19 and spillbay 20 for the period April 10 through June 7 (unless otherwise coordinated with FPOM). As in past years, both spillway weirs will be closed and removed from service starting on June 8 (or next workday) for the benefit of subyearling Chinook salmon. Currently, removing the SWs and reinstalling standard spill gate sections may take up to 5 normal workdays to complete, depending on wind and weather conditions. Temporary spill pattern changes to allow removal of the SWs and installation of standard spill gates will occur as described in FPP Chapter 5 section 2.3.2.6; however, spill will continue at the target level defined in Table 3 during removal of the SWs. Following removal of the SWs and installation of standard spill gates, the spill patterns in Table MCN-9 in FPP Chapter 5 will be used for the remainder of the spring and summer.

8.5.2. Summer Spill (Table 4):

- June 16–August 14: 57% of the previous day's average outflow, 24 hours/day, without SWs (removed in early June). Spill changes will be made by 0300 each day.
- August 15-August 31: 20 kcfs, 24 hours/day.

8.5.3. Operational Considerations:

- Currently, McNary spillbays 2, 6, and 16 are restricted to manual operation to minimize use of hoists that are in need of replacement. As a result, McNary will implement modified spill patterns to minimize the frequency of spillgate adjustments. See FPP Chapter 5, section 2.2.2.1.
- Currently, McNary Dam turbine units 5 and 6 have runner blades that are locked at a set angle (non-adjustable). As a result, the units are restricted to a very narrow ±1% operating range of approximately 10-12 kcfs (see FPP Chapter 5 Table MCN-6-A) and there may instances when the unit is unable to stay within this restricted range.

8.6. John Day Dam

8.6.1. Spring Spill (Table 3): 125% Gas Cap, 16 hours/day, and 32% for up to 8 hours/day with priority to maintain 40% spill for 24 hours at The Dalles Dam as needed for TDG management.

8.6.2. Summer Spill (Table 4):

- June 16–August 14: 35%, 24 hours/day.
- August 15-August 31: 20 kcfs, 24 hours/day.

8.6.3 Operational Considerations:

- Currently, turbine units 3, 8, 9, 10, 11, and 14 at John Day have runner blades that are locked at a set angle (non-adjustable) and a smaller operating range (see FPP Chapter 4 Table JDA-7). As a result, the turbines have a restricted operating range of approximately 17-19 kcfs and may not be able to stay within the narrow 1% turbine band associated with it.
- See sections 6.11.1.4 and Tables 2 and 5 and Section 6.11.1.3 in the WMP for discussion of springtime pool elevations to dissuade nesting of Caspian terns. This operation will increase the flow rate over the SW and may change tailrace flow patterns.

8.7. The Dalles

8.7.1. Spring Spill (Table 3): 40%, 24 hours per day. Maintain 40% spill for 24 hours at The Dalles Dam and reduce John Day 125% TDG spill cap as needed for TDG management.

8.7.2. Summer Spill (Table 4):

- June 16–August 14: 40%, 24 hours/day.
- August 15-August 31: 30%, 24 hours/day.

8.7.3. 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.
- Spill bays 9[24], 10, 11, 13, 16, 18, 19, and 23 are operationally restricted due to wire rope, structural and concrete erosion concerns.

8.8. Bonneville Dam

8.8.1. Spring Spill (Table 3): 24-hour 125% Gas Cap up to maximum of 150 kcfs for fish passage spill (see section 2.1).

8.8.2. Summer Spill (Table 4):

- June 16–August 14: 95 kcfs, 24 hours/day.
- August 15-August 31: 50 kcfs, 24 hours/day.

8.8.3. 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; 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.

[24] Spillbay 9 at The Dalles cannot be used due to failure of the trunnion pin in 2009.

  - Actual hourly average spill levels at Bonneville Dam may range up to ±3 kcfs according to spill pattern tables in FPP Chapter 2.

9. 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 include monthly project plots containing the following information:

- total flow: the total hourly river flow rate;
- generation flow: the hourly flow through the powerhouse turbine units;
- target spill: the spill target for that hour (Tables 3, 4);
- 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);
- actual spill: the hourly flow over the spillway; and,
- resultant 12-hour average TDG for the tailwater at each project.

The reports also provide information on non-routine or unplanned operational adjustments that arise during the spill program and address any spill adjustments due to emergency situations (such as unplanned maintenance or outages), and for contingency operations for transmission reliability. See section 4.1 for more information.

The Corps provides the following data to the public regarding project flow, spill rate, TDG level, and water temperature.

- Hourly flow, generation flow, and spill quantity data for the lower Snake and Columbia River dams are posted to the following website:
  - http://pweb.crohms.org/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 data are received via satellite from TDG Fixed Monitoring Sites (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://pweb.crohms.org/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 calculates both the highest 12-hour average TDG levels (Oregon and Washington spring method) and the highest consecutive 12-hour average TDG levels (Washington summer method) on a daily basis. These averages are reported at: http://pweb.crohms.org/ftppub/water_quality/12hr/.

- Spill cap information is posted to the following site each day: http://pweb.crohms.org/tmt/documents/ops/spill/caps/.

In addition to the monthly FOP Implementation Reports, the Corps provides status updates at the regularly scheduled TMT meetings about the 2023 fish passage spill operations, including reasonably detailed information that is relevant to the Corps' process for implementing fish passage spill.

2023 Fish Passage Plan

Appendix F

Dewatering Guidelines & Fish Salvage Plans

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1. INTRODUCTION

Each Corps mainstem project on the Columbia and Snake rivers has Dewatering and Fish Handling/Salvage Plans that 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.

2.2. At the request of WDFW and ODFW, when and where sturgeon are known or anticipated to be handled and removed, notify WDFW and ODFW FPOM representatives of the scheduled dates of dewatering, handling, and salvage to enable, if feasible, the opportunity for agency sturgeon staff members to be present and sample adult sturgeon prior to their release. Agency staff will coordinate any opportunities with the appropriate project staff to ensure the safety of all involved and establish protocols suitable for any sampling on site.

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 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.

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[1] Project Dewatering Plans and annual schedules are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/Plans%20lists%20charts/

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 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 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 (≥ 300 gallons preferred), in colder water, and with supplemental oxygen or aeration.

(e) If fish are transported in warmer water (>65° 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 2ºF of the river water at the release site.

(k) Fish should be removed prior to debris removal if possible.

(l) Do not release any non-native fish back to the river when encountered. Known predators will be analyzed for diet content. In some cases, they will be left in place due to excessive effort needed for removal.

7. FISH SALVAGE REPORT

The Dewatering and Fish Handling/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.

2023 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 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 ESA-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 ensure safety of fish and personnel. Users may request training through the Project Biologists.

1.1.4. Bridge crane certification is required prior to operating the overhead crane. The Corps will not provide this training.

1.1.5. Hard hats, long pants or raingear, and steel-toed shoes or rubber boots are to be worn at all times. Shorts, tennis shoes, or sandals are not 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 not perform any 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 larger 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 auxiliary anesthetic tanks.

1.2. <u>Notification & Documentation.</u>

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. All mortalities must be immediately reported to a Project Biologist. The Project Biologist will examine the mortality and take 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 will be reported in a *Memo for the Record* (MFRs) sent to the Portland District Columbia River Coordinator for distribution to FPOM.

1.2.6. Project Fisheries will notify FPOM as soon as Weir 37 consistently violates FPP criteria.

1.3. <u>Trapping Protocols – Ladder Water Temperatures < 70°F.</u>

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 one time. This assumes that users can effectively track the duration of time that fish stay in the anesthetic tank.

1.3.3. 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, protocols in* ***section 4*** *go into effect.*

1.3.4. Observation Tanks.

- **a)** There will be no more than 2 adult fish in one observation tank at one time. The brail pool is the primary and preferred recovery area.
- **b)** 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), or fish that are showing symptoms of heavy sedation (e.g., diminishing gill movement, reduced gasp response when out of water).

c) 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, unable to swim upright and swims off course without avoiding obstacles; not strongly trying to break free of handlers.

d) 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.

e) Observation tanks may be used for study objectives such as monitoring recovery time from anesthetic, if approved by FPOM and USACE.

f) Water in the observation tanks will be running continuously to allow a constant exchange of water through the tank.

1.3.5. Personnel shall ensure fish are sampled as quickly as possible. It is recommended that it take no longer than 25 minutes to transition fish from entry into the anesthetic tank to release back into the return ladder or transportation tank.

1.3.6. Personnel shall ensure that fish are fully recovered from anesthesia prior to release into the return ladder. Fish may volitionally leave the brail pool when they are ready.

1.3.7. When trapping is done for the day, users will properly shut down the lab.

1.3.8. 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 one additional hour. The picketed lead operations are as follows[1]:

0–6,000: All 4 picket leads can be lowered for 4 continuous hours.

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.

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.

25,000–35,000: Two picket leads down for four hours.

> 35,000: No picket leads down.

1.3.9. Researchers will also be required to monitor the ladder every hour to ensure there is no crowding. If evidence of crowding is observed, at least two picket leads will be raised.

[1] All counts are of adult salmonids (including jacks) for 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).

1.3.10. 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.

1.4.2. Project Biologists will use the Corps temperature probe reading as the official temperature.

1.4.3. 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.

1.4.4. 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.

1.4.5. 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 lamprey trapping will be permitted above 72°F for tagging and transport purposes.

1.4.6. Researchers may continue to work through fish in the holding pool for one hour after picket leads have been raised.

1.4.7. 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]):

0–3,000: All 4 picket leads can be lowered for 4 continuous hours.

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.

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.

9,000–18,000: 2 leads down for 4 hours. All picket leads raised by 10:30 am.

> 18,000: No picket leads down.

1.4.8. 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

[2] Temperature data for Lower Columbia River projects: pweb.crohms.org/tmt/documents/ops/temp/

steelhead and 1 sockeye, or 1 Chinook or steelhead and 2 sockeye. This assumes users can effectively track the duration of time that fish stay in the anesthetic tank.

1.4.9. The brail pool is the primary and preferred recovery pool.

1.4.10. The observation tanks will be used for fish in distress under guidelines established in 3.3.1 through 3.3.4.

1.4.11. If used, water in the observation tanks will be running continuously allowing a constant exchange of water through the tank.

1.4.12. Ensure 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 ensure this, water in the anesthetic tank will be replaced at least every three hours.

1.4.13. 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.

1.4.14. 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.

1.4.15. Personnel shall ensure fish are fully recovered from anesthetization prior to release. Fish may volitionally leave the brail pool when they are ready.

1.4.16. Project biologists retain the authority to raise additional picket leads depending on fish densities and ladder conditions.

1.5. <u>Winter Trapping Protocols (December 1 – March 14).</u>

1.5.1. 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.

1.5.2. 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 ensures 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.

1.5.3. 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.

1.5.4. There will be no more than three adult salmonids in the anesthetic tank at a time. This assumes users can effectively track the duration of time fish are in the anesthetic tank.

1.5.5. There will be no more than two adult salmonids in the recovery tank at a time.

1.5.6. Water in the recovery tank will be running continuously, allowing a constant exchange of water through the tank.

1.5.7. 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.

1.5.8. Personnel shall ensure fish are fully recovered from anesthesia prior to release.

1.5.9. 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 required by the Ice Harbor Operations Manager (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 workdays/hours (Monday–Thursday, 0630–1700). 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, or anytime Friday–Sunday). If users are on-site outside of regular workdays/hours, specific notification procedures must be worked out with the Ice Harbor Operations Manager *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 by 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 by 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 required by the Lower Granite Operations Manager (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. <u>Notification required for work during workdays/hours (Monday–Thursday, 0630–1700)</u>. Users will notify the project biologist (509-843-1493 x263 or x264) when they arrive on-site and when they depart. 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. <u>Notification required for work during all other hours (Monday–Thursday, 1700–0630, or anytime Friday–Sunday)</u>. If users are on-site outside of normal workdays/hours, specific notification procedures must be worked out with the Lower Granite Operations Manager *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. <u>Trapping Protocols (Mar 1–Dec 15) – Ladder Water Temperatures < 70°F</u>

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 (three days or more), the facility shall be dewatered or the water supply will be shut down no later than 72 hours after the last sample. Prior to dewatering, the turnpool gate position will be changed to ladder passage operation and the trap return channel weir will remain in the fully open position for up to 24 hours to allow fish to volitionally return to the adult fish ladder. The attraction pool, recovery pool, and return channel will be dewatered and a fish rescue will be performed within 48 hours following the time allotted for fish to return to the fish ladder. 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.

3.3.3. 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 by 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 one time. This assumes that users can effectively track the duration 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 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 always ensuring the wellbeing of their fish. 24-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. During normal conditions, the adult trap will cease operations when water temperatures in the flow-through recovery tank reach 70°F, except as noted below in **section 3.4.2**. The NOAA-NWFSC Lead Trap Manager will monitor water temperatures in the flow-through recovery tank (located next to and fed by the trap) using a thermometer with a precision accuracy of ±0.1°F or better and will make the final decision on when to cease trap operations. Temperatures recorded by NOAA may not exactly match Corps data for fish trap temperatures reported online.[3] The Corps' temperature gauge is in the attraction pool where fish enter just prior to moving through the false weirs and into the trap when the trap door is open.

3.4.2. If researchers want to operate the trap when recovery tank temperatures are between 70°F and 72°F, the NOAA-NWFSC Lead Trap Manager must first request and obtain approval from the NOAA West Coast Region ESA Take Coordinator for the CRS Biological Opinion and notify FPOM. *The trap will not be operated at temperatures above 70°F without written approval from NOAA's ESA Take Coordinator for the CRS Biological Opinion.* If the request is approved, NOAA's ESA Take Coordinator will provide advance notification to the Corps project biologist. 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] Lower Granite adult fish trap temperature data: pweb.crohms.org/dd/nww/fl_temps/www/index.html

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 by 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 one time. This assumes that users can effectively track the duration 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 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 always ensuring the wellbeing of their fish. 24- 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 a 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, 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 (FPOM) coordination team 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 10 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.

c. Two 5 gallon buckets to fill water tanks.

d. Large dip nets.

e. Fish bags/large fish stretcher.

f. Rope access ladder and anchors.

g. Rope to assist in hauling fish up ladder.

h. Life vests.

i. Safety belts, 1 per person; also anchored rope or cable for attachment to safety belt during entry and exit.

j. Dollies, one for gallery fish tank and one for transport tank used to take fish up the elevator.

k. 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.

2023 Fish Passage Plan
Appendix I
Dworshak Dam

Table of Contents

Dworshak Dam (DWR)	
Corps Project Acronym	DWR
Location	North Fork Clearwater River (RM 1.9) - Ahsahka, ID
Reservoir	Dworshak Reservoir
Available Flood Storage Space	2,016 kaf
Forebay Normal Operating Range	1,445 ft – 1,600 ft
Minimum Instantaneous Flow	1.0 kcfs
Tailrace Rate of Change Limit	1 ft/hour at Peck gauge
Turbine Units	3 Francis turbines
Turbine Generating Capacity	400 MW (Units 1, 2 @ 90 MW each + Unit 3 @ 220 MW)
Powerhouse Hydraulic Capacity	10.5 kcfs
Spillbays	2 Spill Gates + 3 Regulating Outlets (RO)
Spillway Hydraulic Capacity	Spill Gates = 150 kcfs; Regulating Outlets (ROs) = 40 kcfs

Table 1. Dworshak Dam Details and Information.

1. FISH

1.1. Fish Hatcheries

Dworshak Dam was constructed without fish passage facilities and blocks access to anadromous fish spawning habitat on the North Fork Clearwater River upstream of the dam. To mitigate for the loss of habitat, the Corps built the Dworshak National Fish Hatchery (DNFH) downstream of the dam at the confluence of the North Fork and Clearwater rivers. The DNFH is co-managed by the U.S. Fish & Wildlife Service and Nez Perce Tribe to raise B-run steelhead smolts for annual release. The Nez Perce Tribe also raises coho at DNFH. The DNFH and Clearwater Fish Hatchery (CFH) also raise and release both spring Chinook and B-run steelhead as part of the *Lower Snake River Compensation Plan*[1]. The CFH is solely operated on reservoir water and shares any excess with DNFH. Providing water that is free of IHN disease is critical for successful hatchery operations.

During large hatchery releases, the hatchery will coordinate with the Corps to request sufficient outflow from Dworshak Dam to promote downstream migration. The Corps NWW Water Management will notify hatchery staff when flows in the North Fork Clearwater River are anticipated to have elevated levels of total dissolved gas (TDG).

1.2. Dworshak Board Annual Operation Plan

As part of the Snake River Basin Adjudication (SRBA) settlement, the Nez Perce Tribe and the United States entered into an Agreement[2] for the use of 200,000 acre-feet (200 kaf) of water in the Dworshak Reservoir. The water is to be used for flow augmentation to benefit fish and is implemented pursuant to the operational Memorandum of Agreement (MOA, included in the

[1] Lower Snake River Compensation Plan: https://www.fws.gov/lsnakecomplan/Reports/LSRCPreports.html
[2] SRBA Dworshak Agreement & MOA: http://pweb.crohms.org/tmt/SRBA-Dworshak-Agreement.pdf

SRBA Agreement as Appendix A) between the Nez Perce Tribe, the Corps, NOAA Fisheries, Bonneville Power Administration, and the State of Idaho.

The MOA signatories comprise the Dworshak Board, which is chaired by the Nez Perce Tribe and meets annually to develop the Operational Plan for the release of the 200 kaf each year. The Dworshak Board's annual Operational Plan is presented to regional salmon managers of the Technical Management Team (TMT), typically in August, and posted to the meeting agenda website. The Dworshak Board Annual Operational Plan volume and timing criteria should guide release of the SRBA 200 kaf. Deviation from the planned operations requires Dworshak Board approval.

1.3. Adult Fish

Adult steelhead and spring Chinook often migrate up into the North Fork Clearwater River and hold below the dam as they physiologically stage for spawning then migrate out to spawning areas. Adult steelhead are generally present in the tailrace from **October through March**, and adult spring Chinook from **June through August**.

An investigation into adult steelhead mortalities that occurred in November[3] indicated that fish may be able to swim into the draft tube during extended periods of low flow through a unit (e.g., multiple starts and stops for testing) and come into contact with the spinning turbine runner. As a result of this incident, the fish protection measures described below will be implemented.

2. TURBINE UNIT OPERATIONS & MAINTENANCE (O&M)

2.1. General

Hydroelectric power generation relies on converting mechanical energy, in the form of pressurized water, into electrical energy – water comes into contact with the turbine runner and supplies the mechanical energy to spin the unit. When starting a unit, water fills the draft tube and starts to spin the unit, providing a potential pathway for adult fish to reach the spinning turbine runner at a time when water velocity in the draft tube is relatively slow. To minimize any potential for injuring or killing adult fish, the project will implement fish protection measures during turbine operations, maintenance, and testing, as described below.

2.2. Turbine Unit Operations

a. Turbine units may be operated year-round in any order through their full operating range within the appropriate ramping rates defined in the Water Control Manual (see **Table 1** above).

b. After initial start-up, units are operated at "speed no load" (SNL, opening the wicket gates) during the time it takes to adjust the generator voltage and frequency to synchronize with the grid. Before any generator breaker can be closed, the frequency

[3] FPOM Memo For the Record (MFR) 16DWR01: pweb.crohms.org/tmt/documents/FPOM/2010/NWW%20Memos%20of%20Coordination%20and%20Notification/DWR%20MOC%20and%20MFR/

(which is directly related to the speed the unit is rotating) and voltage must be adjusted to match the frequency and voltage of the Bulk Electrical System (BES) on the other side of the breaker. The time of response to voltage control impulses tends to be similar for various machines; however, the time of response to frequency (speed) control impulses varies fundamentally with the type and size of the machine. The generators at Dworshak Dam have large moments of inertia and long penstocks (water starting time) and the voltage and frequency must be adjusted multiple times to allow the generator to react to each adjustment to match the BES prior to closing the breaker. This process is called synchronizing the unit. *Due to the size and type of machines at Dworshak Dam, the duration of SNL from starting a unit to synchronizing with the grid may be up to 5 minutes.*

c. Whenever starting or stopping a unit, the draft tube depression system will be used before opening the wicket gates (startup) and after closing the wicket gates (shutdown) to prevent adult fish from impacting the runner. The system uses compressed air to maintain the water level in the draft tube below the runner and takes approximately 30 seconds to 1 minute after initiation to lower (depress) the water to about 6 feet below the runner. Fish are prevented from contacting the runner in less time, as soon as the water level is below the runner.

d. BPA may request that a unit operate in "synchronous condensed mode", which spins the turbine as a motor for purposes of stabilizing the transmission system. The draft tube depression system is required during this mode. The request is situational and varies in frequency and duration.

2.3. Turbine Unit Maintenance & Testing

a. Turbine maintenance and testing will be coordinated with FPOM as described below in **section 2.4**.

b. Each unit requires annual preventative maintenance to maintain operational condition. Annual maintenance is typically performed one unit at a time and requires the unit out of service for 2–6 weeks.

c. The annual maintenance period is September 15 through the end of February to coincide with the refill period after summer flow augmentation and before flood risk management operations.

d. Required transformer maintenance and condition (Doble) testing requires one or two generating units out of service beginning September 21 every two out of three years.

e. In addition, one unit each year requires a 4 to 6-week outage for cavitation repair.

f. If maintenance requires unwatering the draft tube, the project will implement procedures defined below in **Section 3** (*Fish Salvage Procedures for Turbine Unwatering*).

g. After maintenance, testing is required to validate the unit is functioning properly. The required testing sequence is defined below in **Section 4** (*Unit Startup Procedure and Return to Service Testing Sequence*).

h. During testing, the project will implement fish protection measures including using the draft tube depression system.

i. The duration of testing will be minimized to the extent possible with no more than 5 minutes at SNL.

j. If testing is anticipated to require more than 5 minutes at SNL, or if the draft tube depression system is out of service, the operation will be coordinated with FPOM per **section 2.4** and monitored by trained staff (NPT or DFH staff will also be invited to assist with observation).

k. Should there be an unplanned need to extend testing at SNL for longer than 5 minutes due to a specific problem, the project may operate at SNL for longer than 5 minutes to assist in the resolution of the problem to limit the starts/stops affiliated with unit shutdown that would occur with the 5-minute threshold.

l. Should further monitoring disclose that unit starts/stops are the primary cause of adult fish mortality, rather than SNL, the restriction on SNL will be reviewed.

m. Cyclical maintenance testing (e.g., model validation and efficiency testing) typically involves starting and stopping a unit, which requires periods of SNL for up to 5 minutes. To the extent possible, cyclical maintenance testing will be performed when fish are less likely to be present in the tailrace (April, May, or September). If testing is performed outside of these months and is anticipated to require more than 5 minutes at SNL, the operation will be monitored by trained staff and coordinated with FPOM, per **Section 2.4**.

2.4. <u>FPOM Coordination</u>

2.4.1. SNL > 5 Minutes

a. All turbine operations, maintenance, or testing that require periods of SNL longer than 5 minutes when adult fish are likely present in the tailrace (October–March and June–August) will be coordinated with FPOM.

b. Prior to the operation, FPOM will be provided with a proposed sequence to review for potential adverse impacts.

c. A Fisheries Biologist will monitor the operation for fish impacts and report findings to FPOM (see template for "*Dworshak Unit Maintenance Monitoring Form*" at the end of this Appendix). In the event of any observations of fish injury or mortality, the monitoring Biologist will immediately contact the Project Chief of Operations or authorized designee to suspend testing.

d. In the event of an emergency that requires operating a unit at SNL for more than 5 minutes or for station power (light load with low flow through the draft tube) when adult fish are likely present in the tailrace (October–March and June–August), project staff will coordinate with CENWW-OD-T and fill out a maintenance monitoring form identifying specific time interval(s) and develop a Memo for the Record (MFR) for distribution to FPOM if any mortality is noticed (see MFR template in **FPP Chapter 1 – Overview**).

2.4.2. September Maintenance

a. Required transformer maintenance and Doble testing occurs every two out of three years starting September 21. The annual Doble testing schedule will be provided to FPOM via the Fish Passage Plan Appendix A (Special Operations & Studies).

b. Other required September maintenance that may impact the Dworshak Board's annual Operation Plan to draft 200 kaf for the benefit of fish (see **section 1.2**) will be pre-coordinated with Nez Perce Tribe and FPOM prior to March of that year, or as soon as the need is known.

3. FISH SALVAGE PROCEDURES FOR TURBINE UNWATERING

OPERATING GUIDANCE #14

Dworshak Dam Fish Protection Procedures for Turbine Maintenance

Dworshak O&M Section Date of Issue: March 2012 Last Revision: 14 February 2019

3.1. 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.

3.2. 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.

3.3. 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.

3.4. 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.

3.5. 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.

3.6. 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.

3.7. 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. At 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.

3.8. 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 the maximum possible 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 stoplogs via staging equipment, support supplies material and crews (units 1 & 2 have two stop logs each and unit 3 has four). 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.

3.9. 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.

3.10. 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.

3.11. 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.

3.12. 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.

3.13. 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.

3.14. 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 endangered species, although BPA power demands, requirements to control TDG and temperature in the river and hatchery, and provide flow augmentation somewhat limit the timing of unit outages. 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.

3.15. 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).

3.16. 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).

3.17. 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 2ºF 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 2ºF 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.

4. DWORSHAK DAM TURBINE UNIT STARTUP PROCEDURE AND RETURN TO SERVICE TEST SEQUENCE

4.1. The following tests are performed without the unit operating:

- **Mechanical Over-speed Device Test:** With the unit shutdown.
- **Anti-creep Test:** With the unit shutdown.

4.2. Incomplete Sequence Test: Start the unit depressed. Unit 1 and 2 should trip after 3 minutes and unit 3 should trip after 5 minutes.

4.3. Auto Sync Test: Start the unit depressed and bring unit to SNL. Put the unit online with auto synchronizer (~ 60 sec).

- **Trip Unit** with lockout relay.

4.4. Depression Test: Start the unit depressed and put the unit online.

- **Synchronous Condense Unit.**
- **Power System Stabilizer (PSS) Test within Exciter limits.**
- **AVR/Capability Curve Testing** (defines boundary within which the unit can operate safely).
- **Maximum MVA Test:** Set the unit to the WECC/NERC requirement loading and run for 1 hour.

RECORD OF FISH SALVAGE OPERATIONS - DWORSHAK DAM

**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.

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	

DWORSHAK UNIT MAINTENANCE MONITORING FORM

Unit Tested: ______

Unit OOS Date / Time ____________/____________

Unit RTS Date / Time ____________/_____________

Monitoring Biologist Name: ____________________

Location(s) of monitoring person observing operation: ______________________________

Operation being monitored: ____________________________________

Comments: ____

____

WEATHER / WATER CONDITIONS

Cloud Cover: Yes / No

Air Temperature: ____°F

Glare on Water: Yes / No

Water Temperature: ____°F

Degree of Turbidity:

Comments: ____

TESTING TYPE

Commissioning: Yes / No

Annual: Yes / No

WECC / NERC: Yes /No

Other: Yes /No (describe: ____)

Comments: ____

____

SNL OPERATIONS

SNL = Speed No Load (if more than one occurrence, use table).

Start time (hh:mm:ss) ________________ End time (hh:mm:ss) ________________ Total time (hh:mm:ss) ________________

Time at SNL per instance (if more than one):

Run Number	Start Time (hh:mm:ss)	End Time (hh:mm:ss)	Total Time (hh:mm:ss)

Other Comments (note here if issues with air depression system):____

____

FISH ISSUES

FISH LOSSES /INJURED

Salmonids Recovered/NOT Recovered					
Chinook Unclipped	Injured ______	Dead ______	Kokanee	Injured ______	Dead ______
AVG SIZE			AVG SIZE		
Chinook Clipped	Injured ______	Dead ______	Steelhead Unclipped	Injured ______	Dead ______
AVG SIZE			AVG SIZE		
Coho	Injured ______	Dead ______	Steelhead Clipped	Injured ______	Dead ______
AVG SIZE			AVG SIZE		

Describe external condition of injured or fish lost and whether recovery occurred: ________________________________

____

Live fish seen in tailrace? Yes / No (if yes, how many? ________)

***** If mortality is observed during testing, contact Operator to suspend testing. Contact District Ops to have them undertake informal consultation and regional coordination. Do not restart testing until District Ops informs on consultation results.**

Ann Setter	509-527-7125
Chris Peery	509-527-7124
Eric Hockersmith	509-527-7122

2023 Fish Passage Plan

Appendix J

Smolt Monitoring Facility Operating Protocols at Lower Columbia and Lower Snake River Dams

Table of Contents

1. BONNEVILLE DAM JUVENILE MONITORING FACILITY

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.

- **a)** Sample rates should not exceed 25% unless collecting research fish when water temperatures are < 70°F.
- **b)** Personnel conducting research or monitoring must be present at the facility to monitor the separator bars for debris and stranded fish.
- **c)** The Corps reserves the right to terminate trapping operations at any time.
- **d)** 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:

- **a)** Users must have appropriate documentation for conducting research at the dam (see *Guide for Researchers at Bonneville Dam*).
- **b)** 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.
- **c)** 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.
- **d)** Hard hats worn outside at all times.
- **e)** Long pants or raingear worn at all times. Shorts not permitted in the lab.
- **f)** Steel-toed shoes or rubber boots worn at all times. Tennis shoes or sandals not permitted.
- **g)** If JMF users supply the Project Biologists with a season schedule, it will not be necessary to notify Project Biologists upon arrival and departure.
- **h)** Users may coordinate sample rates with Smolt Monitoring Program (SMP) personnel.
- **i)** Users are permitted to routinely operate flushing valves, fish lifts, and release pipes/valves within the monitoring building.
- **j)** Any modifications to the building or equipment will first be approved by Bonneville Project through Project Fisheries.
- **k)** All anesthetic water will be emptied into the sewage lift station after running through the activated charcoal filters.

l) 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.

m) The lower switchgate is in automatic control. Users will monitor and report to Project biologists any problems with the lower switchgate.

n) 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.

o) 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.

p) Avian cannons will be operated 24 hours per day from March 1 through November 1.

q) 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).

a) Smolt monitoring personnel will operate the sampling facility as part of the SMP and to collect fish for regionally approved research.

b) Research updates and equipment or sampling trouble reports will go through Project Biologists to FPOM.

c) 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.

d) 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.

e) During August, avian cannons may be shut off if Project Biologists observe no predatory birds at the outfall and coordinate through FPOM.

f) 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.

g) 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.

h) JMF personnel shall monitor kelt passage over the separator.

1.4. BON JMF Sampling at Water Temperature > 70°F.

a) 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.

b) Daily index sampling will be reduced to every-other-day index/condition monitoring.

c) The upper switchgate is used to select between sample and bypass mode.

d) Sample sizes will be reduced to approximately 100 fish per day.

e) Monitoring for gas bubble trauma (GBT) symptoms will continue.

f) An instantaneous temperature of ≥ 70°F taken from 0630–0700 hours will trigger a change in sampling mode after Project Fisheries notify SMP Biologists.

g) Normal index sampling may resume when daily average temperatures are ≤ 69.5°F.

h) 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.

i) If SMP and Project Fisheries biologists suspect a bypass system problem during high temperature sampling, 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).

a) The upper switchgate will be in bypass mode.

b) The Emergency fish release valve will be open.

c) All rotating gates will be set to bypass.

d) The bypass flume gate will be raised.

e) Project Biologists will inspect the facility daily.

1.6. BON JMF System Failure Protocols.

a) 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.

b) If a high or low water situation occurs in the PDS area, operate as follows:

i) Contact the control room immediately.

ii) Switch the upper switchgate to bypass mode until the problem is corrected.

iii) Immediately open the emergency fish release valve.

iv) Raise bypass flume gate. *DO NOT ADJUST ANY WEIRS***.**

[1] Corps temperature data for Lower Columbia River projects: pweb.crohms.org/tmt/documents/ops/temp/

c) If a monitoring facility failure occurs, operate as follows:

i) Open the emergency fish release valve.

ii) Switch the upper switchgate to bypass mode until the problem is corrected.

iii) Raise the bypass flume gate.

iv) Begin fish salvage operations.

d) 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.

e) 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:

i) Switch the upper switchgate to bypass.

ii) Open the emergency fish release valve.

iii) Turn off air to rotating gate and manually rotate half-round pipe section to bypass position.

iv) 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.*

v) 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.

f) 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

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.

- **a)** Sample rates should not exceed 25% unless collecting research fish at water temperatures below 70°F.
- **a)** 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:

- **a)** Users must have appropriate documentation for conducting research at the dam (see *Guide for Researchers at John Day Dam*).
- **b)** 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.
- **c)** Hard hats are to be worn outside at all times.
- **d)** Long pants or raingear worn at all times. No shorts or sweats permitted.
- **e)** Steel-toed shoes or rubber boots worn at all times. No tennis shoes, sandals permitted.
- **f)** If users provide Project Biologists with a schedule, it will not be necessary to notify Project Biologists upon arrival and departure.
- **g)** Users may coordinate sample rates with Smolt Monitoring Program (SMP) personnel.
- **h)** Users are permitted to routinely operate SMF flushing valves and release pipes/valves.
- **i)** Any modifications to the building or equipment will first be approved by The Dalles/John Day/Willow Creek Project through Project Fisheries.
- **j)** All anesthetic water will be emptied into the activated charcoal filters tanks.

2.3. JDA SMF Sample Mode Operations (typically Fish Passage Season Apr 1 – Sep 15).

- **a)** Smolt monitoring personnel will operate the facility as part of Condition Monitoring at John Day Dam.
- **b)** Condition monitoring sampling will occur Monday through Friday (5 days/week) during the spring, April 1–June 15, and Monday, Wednesday, and Friday (3 days/week) after the end of spring spill (June 16–September 15), except during warm water conditions described below.
- **c)** Research updates and trouble reports will go through Project Biologists to FPOM.

2.4. JDA SMF Sampling at Water Temperatures > 70°F.

- **a)** 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.
- **b)** 24-hour index sampling will be reduced to twice per week (preferably Mondays and Thursdays) condition monitoring from 0700–1300 hours.
- **c)** The switchgate is used to select between sample and bypass mode.
- **d)** Sample sizes will be reduced to approximately 100 fish per day.
- **e)** An instantaneous temperature of ≥ 70°F taken between 0630–0700 hours will trigger a change in sampling mode after Project Fisheries notifies SMP Biologists.
- **f)** Normal index sampling may resume when daily average temperatures are ≤ 69.5°F.
- **g)** 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.
- **h)** 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.

- **a)** All rotating gates will be set to bypass.
- **b)** Project Biologists will inspect the facility every two hours.
- **c)** If the full-flow PIT-tag detector is effective, the switch gate will be moved to bypass.

2.6. JDA SMF System Failure Protocols.

- **a)** 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.
- **b)** 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:
    - i) 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.
    - ii) 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

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.

- **a)** Sample rates should not exceed 25% unless collecting research fish at water temperatures < 68.0°F.
- **b)** 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:

- **a)** Have appropriate documentation for conducting research at the dam.
- **b)** Have valid State and Federal permits that cover all ESA-listed species that may occur at the project during the collection period.
- **c)** Comply with all permit conditions, even if more restrictive than protocols herein.
- **d)** Always wear hard hats when outside, in, under, or around the JFF or the dam.
- **e)** Always wear long pants or raingear. No shorts or sweats permitted.
- **f)** Always wear steel-toed shoes (or rubber boots when likely to enter water). No tennis shoes or sandals permitted.
- **g)** If users provide the project biologists with a schedule, it will not be necessary to notify them upon arrival and departure.
- **h)** Users shall coordinate sample rates with Smolt Monitoring Program (SMP) or MCN project biologists.
- **i)** Users are not permitted to routinely operate JFF flushing valves and release pipes/valves without the permission of project biologists.
- **j)** 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.

- **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.

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.

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. Samples for monitoring descaling will include a minimum of 100 fish of the predominant group(s) for which descaling information is recorded. SMP and project staff will monitor descaling every-other-day for facility operations. SMP and project personnel may conduct full sample descaling instead of 100 fish subsamples if it does not adversely affect other facility operations.

d) Where SMP activities are conducted at collector dams, project biologists may utilize daily total information gathered by those personnel.

e) Research updates and trouble reports will go through project biologists to FPOM.

3.4. MCN JFF Sampling at Water Temperatures > 68.0°F.

a) Personnel will obtain daily average river temperatures from the Corps website at: www.nwd-wc.usace.army.mil/ftppub/water_quality/tempstrings/.

b) 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.

c) The switchgate selects between sample and bypass mode.

d) If populations experience high mortality, staff will reduce sample sizes to approximately 100 fish per day, within sampling limitations.

e) 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.

f) 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.

g) Normal index sampling may resume when daily average temperatures are ≤ 68.0°F.[1]

h) If there is a research need to sample at temperatures >68.0°F, the Corps District POC will initiate coordination with FPOM.

i) 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.

j) For additional measures to take when sampling at water temperatures above 68.0°F, see **FPP Chapter 5 - McNary Dam**.

3.5. MCN JFF Bypass Mode Operation.

a) Project personnel will set the switchgate to the appropriate bypass mode.

b) Project personnel will inspect the facility as necessary.

3.6. MCN JFF System Failure Protocols.

a) Personnel shall immediately report any system failure or abnormality to a project biologist, or if unavailable, the control room at ext. 231.

4. ICE HARBOR DAM JUVENILE FISH FACILITY

Agencies conducting research in the Ice Harbor (IHR) 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.

4.1. IHR JFF Sampling at Water Temperature > 70.0°F.

a) An instantaneous sample/holding temperature of 70.0°F or greater taken within the JFF between 0630 and 0700 hours will trigger the suspension of condition sampling at IHR. The Project biologist will notify condition monitoring personnel when this has occurred.

b) Condition sampling at IHR may resume if/when the instantaneous sample/holding temperature taken within the JFF between 0630 and 0700 is ≤ 70.0°F.

c) If there is a research need to sample at temperatures > 70.0°F, the Corps District POC will initiate coordination with FPOM.

d) If the condition monitoring or project 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.

5. LOWER MONUMENTAL DAM JUVENILE FISH FACILITIES

Agencies conducting research in the Lower Monumental (LMN) Juvenile Fish Facilities (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.

5.1. LMN Sampling.

- **a)** Condition samples will be taken if fish are being sampled for barge transport loading purposes (see **Appendix B**); the following criteria will apply when barge transport samples are not taken for any reason.
- **b)** Condition sampling will begin March 25 (*except in 2023 when sampling will begin March 1*) to monitor descaling and other fish condition parameters and to ensure sampling systems are operating correctly prior to transport. Condition sampling will occur at least twice per week through April 14, with no more than three days between samples.
- **c)** From April 15 through July 31, condition sampling will occur every other day.
- **d)** From August 1 through September 30, condition sampling will occur at least twice per week with no more than three days between samples.
- **e)** The sample goal should be 100 fish of the predominant salmonid species.
- **f)** Sampling frequency may be increased if injuries are observed or suspected (e.g., during high debris conditions).
- **g)** Full 24-hour samples may be taken to determine species composition to inform a decision on starting transport at this project.
- **h)** Fish condition reporting will follow the standardized SMP protocol and sent to FPC within 12 hours of sampling.
- **i)** When not condition sampling, the JFF will return to primary (full-flow) bypass and juvenile fish will be routed to the primary outfall and full-flow PIT-tag detection system.

5.2. LMN Sampling at Water Temperature > 68.0°F

- **a)** An instantaneous sample/holding temperature of 68.0°F or greater taken within the JFF between 0630 and 0700 hours will trigger the following changes in sampling after a project biologist notifies SMP biologists:
  - i) If transportation <u>is not</u> occurring, daily index sampling will be reduced to every-other-day index/condition monitoring. Daily sampling may resume up to 3 days prior to beginning fish transport to estimate loading densities.
  - ii) If transportation <u>is</u> occurring, daily index sampling will continue but sample rates will be reduced to target approximately 100 fish per day.
  - iii) Monitoring for gas bubble trauma (GBT) will continue (where/when applicable).

b) Normal index sampling may resume when the instantaneous sample/holding temperature taken within the JFF between 0630 and 0700 is ≤ 67.5°F.

c) If there is a research need to sample at temperatures > 68.0°F, the Corps District POC will initiate coordination with FPOM.

d) If the SMP or project 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.

6. LITTLE GOOSE DAM JUVENILE FISH FACILITIES

Agencies conducting research in the Little Goose (LGS) Juvenile Fish Facilities (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.

6.1. LGS Sampling.

a) From March 25 until the start of transport (see **Appendix B**), condition sampling will occur every other day to monitor descaling and other fish condition parameters, to ensure sampling systems are operating correctly prior to transport, and to train personnel on facility operations and sampling protocol.

b) The sample goal should be 100 fish of the predominant salmonid species.

c) Sampling frequency may be increased if injuries are observed or suspected (e.g., during high debris conditions).

d) Full 24-hour samples may be taken to determine species composition to inform a decision on starting transport at this project.

e) Fish condition reporting will follow the standardized SMP protocol and sent to FPC within 12 hours of sampling.

f) When not sampling, the facility will return to primary (full-flow) bypass and juvenile fish will be routed to the mid-river outfall and full flow PIT-tag detection system.

6.2. LGS Sampling at Water Temperature > 68.0°F

a) An instantaneous sample/holding temperature of 68.0°F or greater taken within the JFF between 0630 and 0700 hours will trigger the following changes in sampling after a project biologist notifies SMP biologists:

- i) If transportation <u>is not</u> occurring, daily index sampling will be reduced to every-other-day index/condition monitoring. Daily sampling may resume up to 3 days prior to beginning fish transport to estimate loading densities.
- ii) If transportation <u>is</u> occurring, daily index sampling will continue but sample rates will be reduced to target approximately 100 fish per day.
- iii) Monitoring for gas bubble trauma (GBT) will continue (where/when applicable).

b) Normal index sampling may resume when the instantaneous sample/holding temperature taken within the JFF between 0630 and 0700 is ≤ 67.5°F.

c) If there is a research need to sample at temperatures > 68.0°F, the Corps District POC will initiate coordination with FPOM.

d) If the SMP or project 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.

7. LOWER GRANITE DAM JUVENILE FISH FACILITIES

Agencies conducting research in the Lower Granite (LWG) Juvenile Fish Facilities (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.

7.1. LWG Sampling.

a) Normal 24-hour sampling for the SMP shall occur.

b) When not sampling, juvenile fish will be bypassed via normal separator operations and routed to the mid-river release outfall and PIT-tag detection system.

7.2. LWG Sampling at Water Temperature > 68.0°F

a) An instantaneous sample/holding temperature of 68.0°F or greater taken within the JFF between 0630 and 0700 hours will trigger the following changes in sampling after a project biologist notifies SMP biologists:

- i) If transportation is not occurring, daily index sampling will be reduced to every-other-day index/condition monitoring. Daily sampling may resume up to 3 days prior to beginning fish transport to estimate loading densities.
- ii) If transportation is occurring, daily index sampling will continue but sample rates will be reduced to target approximately 100 fish per day.
- iii) Monitoring for gas bubble trauma (GBT) will continue (where/when applicable).

b) Normal index sampling may resume when the instantaneous sample/holding temperature taken within the JFF between 0630 and 0700 is ≤ 67.5°F.

c) If there is a research need to sample at temperatures > 68.0°F, the Corps District POC will initiate coordination with FPOM.

d) If the SMP or project 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.

Fish Passage Plan – Appendix K ACRONYMS	
ADCP	Acoustic Doppler Current Profiler
ADV	Acoustic Doppler Velocimeter
AFF	Adult Fish Facility
AFEP	Anadromous Fish Evaluation Program
AWS	Auxiliary Water Supply
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
CRS	Columbia River System
DSM	Downstream Migrant (Channel)
DWR	Dworshak Dam
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
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
IDFG	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

Fish Passage Plan – Appendix K **ACRONYMS**	
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
NDE	North Downstream Entrance
NE	North Entrance
NFE	North Fishway Entrance
NFH	National Fish Hatchery
NOAA Fisheries / NMFS	National Oceanic & Atmospheric Administration's National Marine Fisheries Service
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
PDT	Pacific Daylight Time (in effect during Daylight Saving Time)
PST	Pacific Standard Time
PUD	Public Utility District
RCC	Reservoir Control Center (COE)
RSW	Removable Spillway Weir
SBC	Surface Bypass Collector or Sort-by-Code
SDE	South Downstream Entrance
SE	South Entrance
SFE	South Fishway Entrance
SG	Sluice Gate
SLED	Sea Lion Exclusion Device
SMF	Smolt Monitoring Facility

Fish Passage Plan – Appendix K ACRONYMS	
SNL	Speed No Load
SO	Sluice Oregon
SPE	South Powerhouse Entrance
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	United States Fish & Wildlife Service
VBS	Vertical Barrier Screen
WDFW	Washington Department of Fish & Wildlife
WECC	Western Electricity Coordinating Council

2023 Fish Passage Plan

Appendix L

US Army Corps of Engineers' Predator Monitoring & Deterrence Action Plans at Lower Columbia & Lower Snake River Dams

Table of Contents

1. OVERVIEW

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, and pinniped monitoring and deterrence action plans at Bonneville Dam, in accordance with current and applicable Biological Opinions under the Endangered Species Act Section 7. [1] 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 Wildlife Services (USDA WS) and USACE Fisheries Field Unit employees.

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.

1.8. Avian activities in the estuary are summarized in **Table 1** and described in **section 2**.

1.9. Hazing dates and methods for the eight lower Columbia River and lower Snake River projects are summarized in **Table 2** and described in **sections 3-10**.

[1] Biological Opinions available at: https://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp.aspx

Table 1. Estuary Avian Activities by all Regional Partners (as of January 2021) – see Section 2 below for more information.

Objective	Activity	Location
Monitor avian predators in the estuary and discourage any avian predators that are found nesting at an upland disposal site.	Reconnaissance flights to detect avian predators on upland disposal sites	Disposal sites (estuary-wide)
	Passive and active dissuasion	Rice, Miller Sands, and Pillar Rocks Islands
Maintain no less than 1 acre of Caspian tern habitat on ESI annually to support approximately 3,125 to 4,375 breeding pairs and prevent terns from nesting on ESI outside the designated habitat.	Pre-season site preparation	ESI
	Colony size monitoring (annual peak abundance estimates every three years)	ESI
	Passive and active dissuasion (outside designated habitat)	ESI
Monitor DCCO on ESI and in the Columbia River Estuary annually for colony size and response to management, as necessary in support of the DCCO FEIS.	Weekly reconnaissance flights and aerial photography of DCCO colonies in the estuary	ESI, Astoria-Megler Bridge, Channel Markers, Longview Bridge, Troutdale Towers
	Colony size monitoring	ESI, Astoria-Megler Bridge, Channel Markers, Longview Bridge, Troutdale Towers
	On-island management and response monitoring	ESI
Monitor DCCO on ESI annually to estimate DCCO abundance and nesting density.	Colony size monitoring	ESI
Estimate and assess ESI DCCO and CATE annual predation rates (impacts) on juvenile salmonids in support of the DCCO FEIS and the 2020 CRS BiOp.	Physical recovery of CATE PIT tags	ESI
	Physical recovery of DCCO PIT tags	ESI
	Statistical modeling of DCCO and CATE annual predation rates	ESI

Table 2. Hazing Dates & Methods at Lower Columbia and Lower Snake River Projects in 2023. See Sections 3-10 below for project-specific descriptions.

Dam	Passive Deterrents	Hazing Dates	Location	Hazing hours/day	Hazing Methods	Action Trigger
BON	Avian wires, sprinklers	April 1 – July 31 (Avian)	Shore	8 hours/day	Pyrotechnics, sound, propane cannon (if necessary)	150 birds in a single zone
TDA	Avian wires	April 15 – July 31	Shore, Boat	April & July = 14 hours/day May & June = 16 hours/day	Pyrotechnics	50% of 5-yr average
JDA	Avian wires	April 10 – July 31	Boat	8 hours/day	Pyrotechnics	50% of 5-yr average
MCN	Avian wires, needle strips	April 23– July 22	Shore, Boat	Shore: April 23–July 22 = 12 hours/day Mon–Sat, 8 hours/day on Sundays Boat: April 30–July 8 = 10 hrs/day, 3 days/wk (except Sunday)	Pyrotechnics, sound, lasers, lethal take (if necessary)	N/A
IHR	Avian wires, wire spikes, sprinklers	April 1 – June 30	Shore, Boat	Shore: April 1–8 and June 11–30 = 8 hours/day April 9–June 10 = 16 hours/day Boat: April 9–22 and May 28–June 10 = 8 hrs/day, 3 days/wk April 23–May 27 = 8 hours/day, 5 days/week	Pyrotechnics, sound, laser, lethal take (if necessary)	Daily count twice 3-yr average; unresponsive to hazing.
LMN	Avian wires, sprinklers	April 9 – July 1	Shore	April 9–22 and June 4–July 1 = 8 hours/day April 23–June 3 = 16 hours/day	Pyrotechnics, sound, lethal take (if necessary)	86 gulls, 43 terns, 15 cormorants
LGS	Avian wires, needle strips, sprinklers, visual	March 29 – June 18	Shore, Boat	Shore: March 29–April 10 and May 23–June 18 = 8 hours/day April 11–May 22 = 16 hours/day Boat: March 29–June 18 = 8 hours/day, 3 days/week	Pyrotechnics, sound, lethal take (if necessary)	100 gulls &/or terns, 50 cormorants
LWG	Avian wires, needle strips, sprinklers	April 1 – June 30	Shore	April 1–20 and June 2–30 = 8 hours/day April 20–June 1 = 16 hours/day	Pyrotechnics, sound, lethal take (if necessary)	57 gulls, 110 cormorants

2. ESTUARY

2.1. Estuary-Wide Efforts. Monitor avian predators in the estuary to support the Caspian Tern (CATE) and Double Crested Cormorant (DCCO) monitoring plans and fulfill Term and Condition 1k of the 2012 BiOp[2] for operations and maintenance of federal navigation channels and RPM #3 and T&C #3 of the 2020 CRS BiOp for the maintenance of the Columbia River System. Collectively these requirements direct avian predators to be monitored and dissuaded from select locations in the estuary.

2.2. East Sand Island (ESI) Caspian Terns (CATE) Monitoring and Hazing Plan.

- **a)** Maintain no less than 1 acre of CATE habitat on ESI annually to support approximately 3,125 to 4,375 breeding pairs. Prevent CATE from nesting on ESI outside the designated colony.
- **b)** The Corps Fish Field Unit will conduct the colony counts of CATE on ESI March through August and provide estimates of the number of birds off-colony but on ESI.
- **c)** PIT-tag recovery, reporting, and analysis will occur in 2021.

2.3. Double Crested Cormorants (DCCO) Monitoring Plan.

- **a)** Monitor DCCO on ESI and in the Columbia River estuary annually for colony size and response to management, as necessary in support of the DCCO FEIS.
- **b)** PIT-tag recovery, reporting, and analysis will occur in 2021.

2.4. Rice, Miller Sands, and Pillar Rocks Islands.

- **a)** Monitor avian predators in the estuary and discourage any avian predators that are found nesting at an upland disposal site per the 2012 BiOp for the operations and maintenance of the federal navigation channel and the 2020 CRS BiOp.
- **b)** Under the directing documents of the 2012 and 2020 BiOps, avian predators (i.e., CATE and DCCO) must be monitored for presence and breeding attempts on dredge material placement sites. If observed, a combination of non-lethal dissuasion and lethal egg take must be used to discourage and stop birds from using these sites.
- **c)** FFU will conduct reconnaissance surveys to Rice, Miller Sands, and Pillar Rocks Islands on a weekly basis between March and August to detect CATE and DCCO interest in the sites. On Rice Island, a passive green laser will be beta tested for efficacy in 2021 and ropes, stakes, and flagging will be used to dissuade birds from using western-most area of historical CATE interest. Miller and Pillar Rocks Islands will be monitored and, if necessary, dissuaded.

[2] NMFS. July 11, 2012. ESA Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Columbia River Navigation Channel Operations and Maintenance, Mouth of the Columbia River to Bonneville Dam, Oregon and Washington. (NMFS No: 2011/02095).

3. BONNEVILLE DAM

3.1. Avian 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. Piscivorous birds of interest are gulls & cormorants, though other birds such as mergansers, grebes, osprey, and eagles may occasionally be noted. Demarcated zones are Powerhouse (PH) 1 forebay, PH1 tailrace, Spillway forebay, Spillway tailrace, B2CC outfall, PH2 forebay, PH2 tailrace, and Juvenile Monitoring Facility (JMF) outfall.

3.2. Avian 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.

a) Avian wires are installed each year prior to April 10 in the tailrace of PH1, PH2, spillway and B2CC outfall.

b) Avian hazers are present at the dam April 1 through July 31, 8 hours per day, 7 days a week, between 0800 and 2000 hours. Hours of hazing vary so birds do not acclimate to long periods of no hazing.

c) A hydro-cannon operates continuously on the top JBS outfall flume.

d) 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.

3.3. Avian Incident Response. The trigger for additional action is 150 piscivorous birds in a single zone during a single observation. When the trigger is met, hazing efforts will be increased 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 and would require additional funding. The trigger is only reached a few times a year, usually between mid-September and early October. Hazing concludes on July 31. If the trigger is consistently being met in September and October, adjustment of hazing dates could be pursued.

3.4. Avian Reporting. Avian predation by species and zone will be in the Project Weekly Report. If warranted, a summary could also be included in the Annual Report.

3.5. Pinnipeds.

a) California Sea Lions and Steller Sea Lions shall be hazed at Bonneville Dam daily across daylight hours from March 31 through May 31 and from August 15 through October 31. Hours should vary so that pinnipeds do not acclimate to long periods with no hazing, unless otherwise coordinated with the POC.

b) 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*.

c) 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.

d) 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.

e) Sea Lion Exclusion Devices (SLEDs) will be installed at all adult fishway entrances and floating orifice gates (FOGs). All SLEDs may be left in year-round.

f) The downstream navigation lock gates will be kept closed until necessary to open for a vessel locking through.

4. THE DALLES DAM

4.1. Monitoring. Project Fisheries staff will monitor daily April 1–September 30 and record numbers of piscivorous birds foraging and non-foraging on a standardized form. Data will be provided in the weekly and annual fishway status reports. Observation zones include forebay, powerhouse tailrace, sluiceway outfall tailrace, spillway tailrace outside of the spillwall, spillway tailrace inside the spillwall, spillway tailrace upstream of bridge, and spillway tailrace downstream of bridge.

4.2. Action Plan.

a) 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.

b) 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.

c) Contracted hazing will occur April 15–July 31, 7 days per week, 14-16 hours/day to cover most daylight hours. 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.

d) Hazing will consist of launching pyrotechnics when gulls are present.

e) 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.

f) From August through mid-April, there will be no avian abatement measures other than avian lines. Lines will be repaired and/or reinstalled as soon as possible following damage or removal. New lines will be installed and maintained in locations determined to have significant avian predation.

4.3. Incident Response. The trigger for additional action is 50% of the 5-year average. Lethal removal is being pursued as an option but is not approved by NWP at this time. 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. Handheld lasers are being tested by COE employees and will be used if shown beneficial.

4.4. Discussion. Fish Field Unit (FFU) studies have shown that gulls are not highly efficient predators when looking at the entire juvenile salmonid run as a whole. 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. The zones upstream of the bridge have a much higher predation success rate per gull, but gull numbers are effectively held lower due to avian lines. More recent data from PIT-tag recovery indicates a very high number of ESA-listed species consumed by gulls on the Miller Island colony. These gulls feed primarily below The Dalles and John Day dams. This area is not COE property and this population should be managed by associated wildlife management agencies. This has increased the need for improving avian abatement at the dam.

5. JOHN DAY DAM

5.1. 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. The most commonly observed birds 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. 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.

5.2. 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 believes this is sufficient for deterring gulls, the primary predator at JDA, from feeding in the tailrace.

a) Avian array: 125 lines stretched across the tailrace expanding 2,200’ below the dam.

b) Boat hazing: April 10–July 31, 7 days per week, 8-hour shifts. In the event weather and/or other conditions preclude safe boat operation, hazing shall occur from dam structures and/or adjacent shorelines.

5.3. Incident Response. The trigger for additional action is 50% of the 5-year average. Lethal removal is being pursued as an option but is not approved by NWP at this time. 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. Handheld lasers are being tested by COE employees and will be used if shown beneficial.

6. MCNARY DAM

6.1. 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.

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.

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 USDA Wildlife Services (WS), 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.

Propane cannons, electronic bird alarms and other noisemakers 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.

6.2. 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/non-foraging activity, etc.

6.3. Action Plan.

- **a)** Bird hazing occurs from April 23 through July 22 for 12 hours per day, 6 days per week and 8 hours per day on Sundays.
- **b)** Boat hazing is also used from April 30 through July 8, for 10 hours per day, 3 days per week (except Sundays).
- **c)** Hazing crews may at their discretion deploy limited lethal take of gulls and cormorants, particularly if hazing by itself loses its effectiveness.

d) Project personnel may deploy a limited number of propane cannons and electronic bird alarms from time-to-time, typically early in the season.

e) Overhead avian deterrent wires are located along the powerhouse tailrace.

f) The sprinkler system on the juvenile fish bypass outfall and associated plumbing and electrical supply were lost during higher flows in 2019. Deterrent lasers, long range acoustic device (LRAD), and bird calls are currently being used to reduce avian predators at the outfall pipe.

6.4. Incident Response. When surges of predatory birds become apparent, the project will conduct the following actions based on the number of birds present:

a) When predacious bird numbers at any location exceed 50-100 foraging birds, focus hazers on those locations.

b) When predacious bird numbers at any particular location (most usually the spillway outfall) exceed 100 - 200 foraging birds, increase hazing efforts in those areas and increase the number of long-range pyrotechnic devices. Focus boat hazing in those areas. If hazers have not already initiated lethal take, deploy limited lethal take.

c) 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.

6.5. 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. Records of this monitoring are maintained 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 (FB1); Juvenile Bypass Outfall (JFOF); Powerhouse Tailrace (PHT1); and Spillway Tailrace (SWT1). Reporting is by bird species when clear identification is possible. There is no differentiation between gull species due to the difficulty in determining gull species from a distance. Data are also provided by contract hazing personnel working on the project. During the hazing season, hazing personnel turn in daily and monthly reports.

7. ICE HARBOR DAM

7.1. 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.

7.2. Hazing. Ice Harbor Dam utilizes the U.S. Department of Agriculture's Wildlife Service (WS) 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 WS Specialist 8 hours per day April 1–8 and June 11–30, and 16 hours per day April 9–June 10. Boat-based hazing is conducted 3 days per week April 9–22 and May 28–June 10, and 5 days per week April 23–May 27.

7.3. Action Plan.

- **a)** Birds are actively hazed in the immediate forebay of the dam to the Boat Restrictive Zone (BRZ) and from the immediate tailrace downstream to Eagle Island.
- **b)** Birds are hazed daily using pyrotechnics.
- **c)** If a 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 boat-based hazing crew. This action will occur most sparingly after hazing efforts have failed to move the birds.
- **d)** Data that are noted are the time, avian zone, bird species, number of birds, if they are foraging or not foraging, and control action taken.
- **e)** Bird wires are in place across the turbine discharge area and the spillway area below the dam.
- **f)** A water cannon is located on the juvenile fish bypass pipe terminus.
- **g)** Wire spikes are installed on light poles, forebay buoys, and other bird perching areas.

7.4. Incident Response. If the daily *total* count of gulls, cormorants, and terns increases to twice the most recent 3-year average daily count for the same *week* ("threshold"), the Project Biologist will consult with the WS field crew leader about focusing hazing efforts at problem bird zones (if this has not already occurred). If these focused efforts do not reduce bird numbers below the threshold, Corps personnel will deploy additional bird deterrent devices, including propane cannons, bird distress calls, and/or hand-held lasers. If bird numbers are still not reduced, the Project Biologist will consult with the WS field crew leader about increasing the use of lethal take.

7.5. 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.

8. LOWER MONUMENTAL DAM

8.1. Monitoring. Bird monitoring by Juvenile Fish Facility staff will occur at least once daily from April 1 to September 30, but more frequently if deemed necessary by the Project Biologist. The primary species for monitoring actives include gulls, grebes, Caspian terns, white pelicans, and double-crested cormorants. Data collection will include the number of individuals present in each of five zones as well as bird behavior: foraging (flying, diving or feeding) and non-foraging (resting in/on water, on debris, structures or land, or while scavenging). Zone monitoring will include the forebay (FB1), spillway (SWT1), powerhouse outflow under the bird wires (PH1), powerhouse outflow downstream of the bird wires (PH2) and the juvenile bypass outfall (JFOF).

Additional bird monitoring, as part of standard fish ladder inspections, will occur October 1 through December 30. During those inspections, basic bird abundance observations will be recorded.

8.2. Action Plan.

- **a)** Lower Monumental Dam will have an active hazing program consisting of one 8-hour shift per day from April 9-22 and June 4-July 1 and two 8-hour shifts (non-concurrent) from April 23 - through June 3. Gulls, cormorants, and terns will be the major focus of this hazing effort.
- **b)** Hazing shifts and zones to be emphasized will be adjusted to maximize deterrent effect on feeding bird populations.
- **c)** Lethal take may occur as part of the hazing program and would exclusively be performed and regulated by licensed agencies and/or companies.
- **d)** 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.
- **e)** Bird aversion water cannons will be in operation from April 1 through October 1 at the bypass outfall.
- **f)** Boat hazing is not needed at Lower Monumental as the river is sufficiently narrow to allow effective hazing from the dam structure and shore.

8.3. Incident Response. The following toolbox items will be utilized based on the trigger criteria of birds present and the availability of trained staff.

- **a)** Focus hazing efforts in areas with the greater abundance.
- **b)** Propane cannon placement.
- **c)** COE employee (added) hazing with screamers and poppers fired from shore.

The following action point number is based on the most recent 5-year (2016-2021) dataset and is proposed as a starting point for the toolbox items.

- **a)** Action point for total number of birds including gulls, cormorants, terns, grebes, and pelicans = 90 birds

8.4. Reporting. Bird monitoring data collected from April 1 through September 30 is maintained in an excel spreadsheet. Piscivorous bird abundance along with a summary of hazing effectiveness and deterrent program will be provided on the fish facility weekly report. A summary of seasonal bird abundance and overall effectiveness of the bird deterrent program will be provided in the annual report.

9. LITTLE GOOSE DAM

9.1. 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.

9.2. Action Plan.

- **a)** Little Goose will perform bird hazing March 29 through June 18, 7 days per week, which includes at least 8 hours per day of contracted services.
- **b)** During the peak period for bird abundance, April 11 – May 22, up to 16 hours of hazing will occur.
- **c)** Boat hazing will occur March 29 – June 18, 8 hours per day, three days per week.
- **d)** Gulls, cormorants, and terns will be hazed as needed during juvenile fish passage season.
- **e)** Hazing will be performed using scare products, including consumer fireworks, scare cannons, bird bangers, and bird screamers.
- **f)** Passive deterrents will be used, including needle strips, an overhead bird wire array composed of 12 wires across the turbine discharge area, visual scare devices, and a hydro-cannon located at the juvenile fish bypass outfall.
- **g)** Limited lethal take may occur at the discretion of qualified APHIS Wildlife Services personnel.

9.3. 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.

9.4. 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.

10. LOWER GRANITE DAM

10.1. Monitoring. Monitoring at Lower Granite Dam will be done by COE biologists April 1 through October 31 and by control agents of the USDA conducting bird hazing work at the dam April 1 through June 30. The agencies will conduct independent counts. Hazers will usually be counting birds once daily in all zones, in conjunction with their normal hazing activities. 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.

10.2. Action Plan.

- **a)** Base actions will include the array of methods in long-time use by the USDA WS and will also include limited lethal control when the other methods prove ineffective.
- **b)** Hazing activities will take place 8 hours per day April 1 through April 20 and June 2 through June 30. Hazing will take place 16 hours per day April 20 through June 1 when the maximum numbers of juvenile salmonids are normally passing the dam.
- **c)** Agents will haze birds on both side of the river and will work as far as two miles downstream of the dam.
- **d)** Nonlethal control measures will include 15mm pyrotechnics and Dominator rocket pyrotechnics.
- **e)** Passive avian deterrent structures include the overhead array of 34 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.
- **f)** 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.

10.3. 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 5-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. If the numbers do significantly increase over time, possible control measures would include remote-activated propane canons, biotech hazing with pyrotechnics (in addition to WS), playing remotely activated gull distress sounds and emergency call-out of off-duty JFF personnel to assist with hazing activities.

10.3.1. 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 (WS 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)

10.3.2. If gull numbers reach an average of 95 per day between April 1 and June 30 (10x the 5-year average), the following project toolbox measures would be utilized in combination with WS hazing activities. 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.).

10.4. Reporting. Reporting of bird numbers will consist of a table of average daily bird counts that will be included in each weekly ESA report April 1 through October 31, 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".