2022 Fish Passage Plan

Chapter 9 – Lower Granite Dam

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Lower Granite Dam

Project Acronym	LWG *
River Mile (RM)	Snake River – RM 107.5
Reservoir	Lake Lower Granite
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 0 kcfs \ Mar–Nov: 11.5 kcfs
Forebay Normal Operating Range (ft)	733’ – 738’
Tailrace Rate of Change Limit (ft/hr)	1.5’/hr
Powerhouse Length (ft)	656’
Powerhouse Hydraulic Capacity (kcfs)	130 kcfs
Turbine Units (#)	6 (Units 1-3 BLH Kaplan; Units 4-6 Allis Chalmers Kaplan)
Turbine Unit Generating Capacity (MW)	Rated: 810 MW (135 MW/unit) \ Maximum: 930 MW (155 MW/unit)
Gatewell Orifices	36 orifices (2 per gatewell = 6 per unit) - 18 w/10” diameter; 18 w/14” diameter
Spillway Length (ft)	512’
Spillway Hydraulic Capacity (kcfs)	850 kcfs
Spillbays (#)	8
Spillway Weirs (#)	1 Removable Spillway Weir (RSW) in Bay 1
Navigation Lock Length x Width (ft)	650’ x 84’ (Usable Space)
Navigation Lock Max. Lift (ft)	105’
	FISH STRUCTURE/OPERATION START DATE
Transportation Research Program – NMFS **	1975
Submersible Traveling Screens (STS)	1978
Extended-Length Submersible Bar Screens (ESBS)	1996
Juvenile Fish Transportation Program – Corps **	1981
Removable Spillway Weir (RSW)	2003
Adult Fish Counts	1969 (North Shore); 1975 (South Shore)

*Project acronym designated by US Army Corps of Engineers, Northwestern Division, Columbia Basin Water Management Division. Due to the large number of projects managed by NWD, this acronym may differ from other acronyms used in the region. For example, a common acronym for Lower Granite is **LGR**. However, that acronym is assigned to another NWD project, so the official Corps NWD acronym is **LWG**.

**Smolt transportation and research done by NMFS via truck until 1978 when barges purchased. Corps began implementing transportation program in 1981.

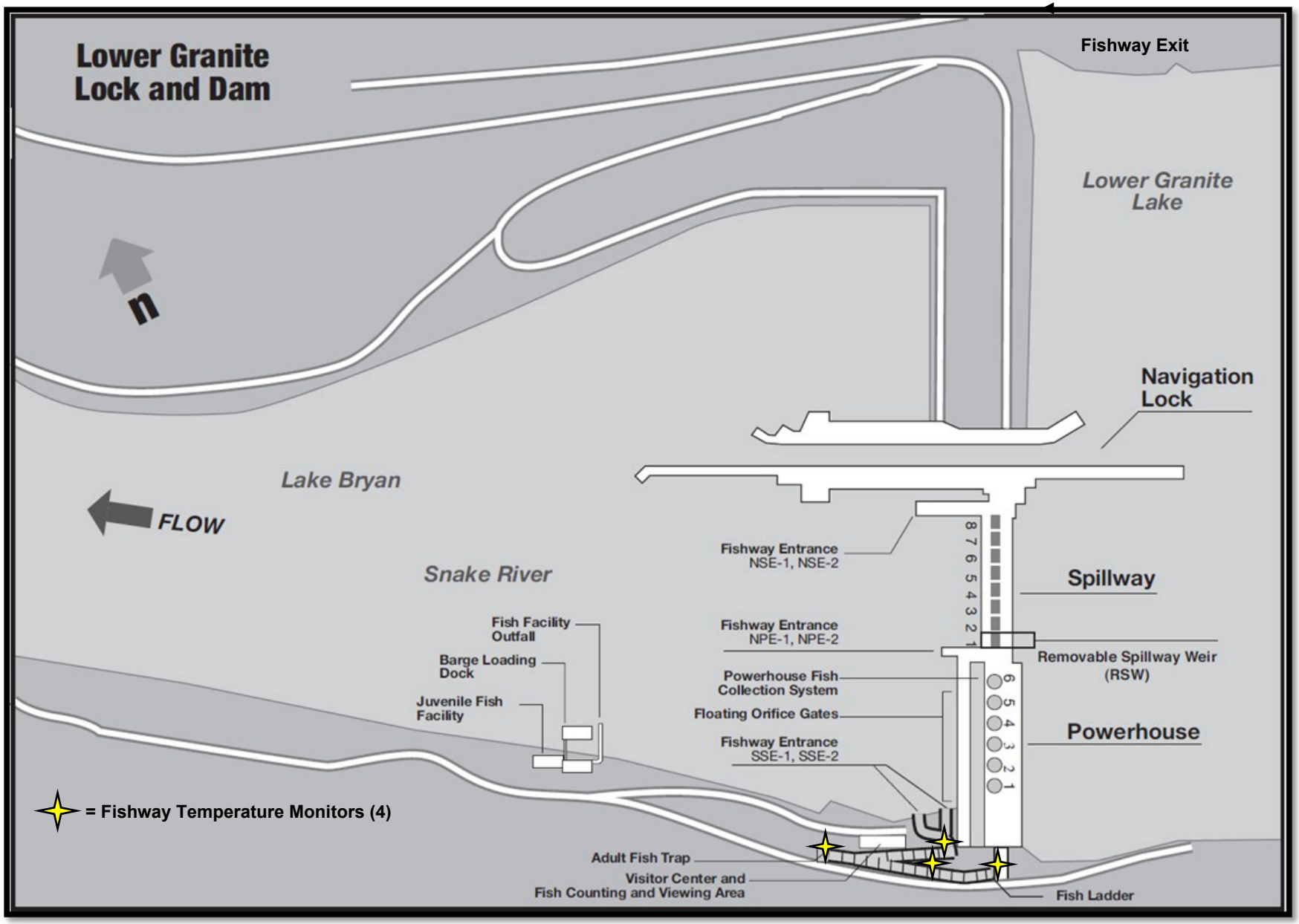
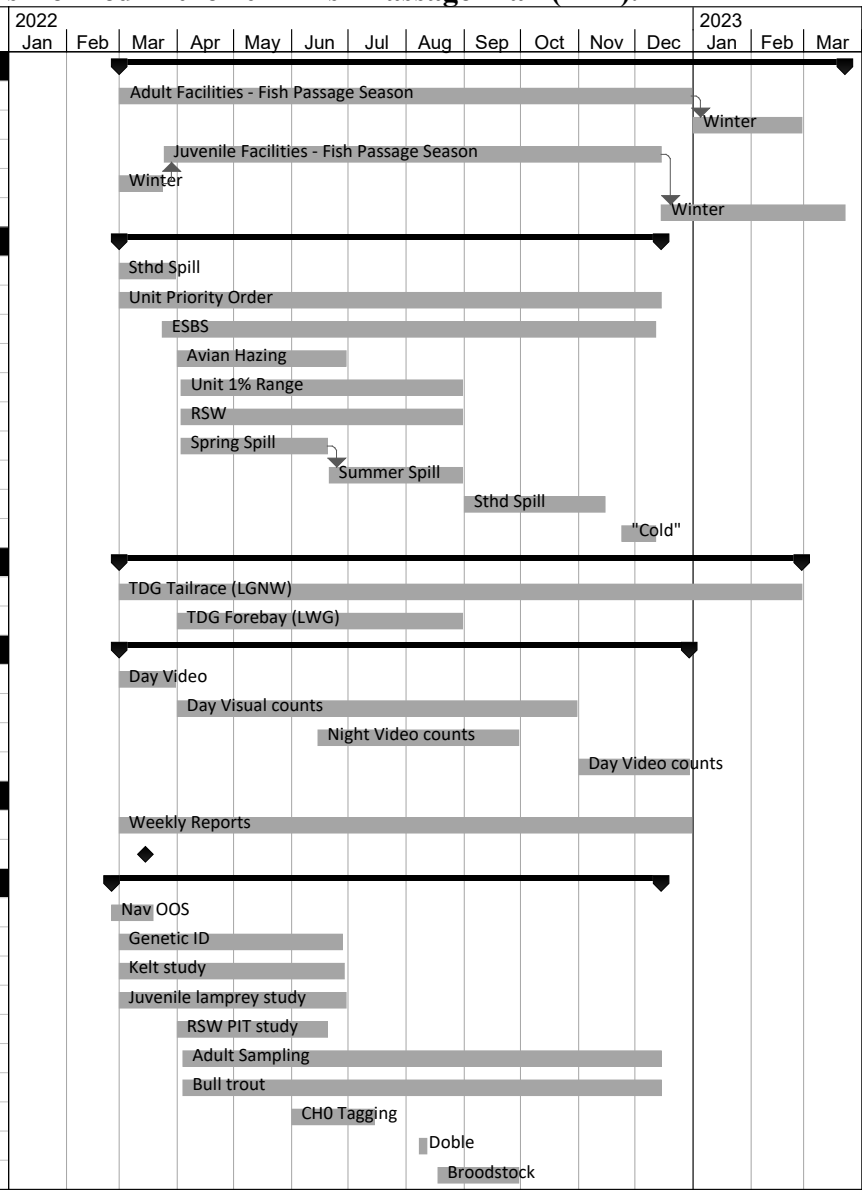


Figure LWG-1. Lower Granite Lock & Dam General Site Plan.

Table LWG-1. Lower Granite Dam Schedule of Operations and Actions Defined in the 2022 Fish Passage Plan (FPP).

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**Tue 3/1/22**	**Thu 3/23/23**	
Adult Facilities - Fish Passage Season	Tue 3/1/22	Sat 12/31/22	2.4.2
Adult Facilities - Winter Maintenance	Sun 1/1/23	Tue 2/28/23	2.4.1
Juvenile Facilities - Fish Passage Season	Fri 3/25/22	Thu 12/15/22	2.3.2
Juvenile Facilities - Winter Maintenance	Tue 3/1/22	Thu 3/24/22	2.3.1
	Thu 12/15/22	Thu 3/23/23	
PROJECT OPERATIONS FOR FISH PASSAGE	**Tue 3/1/22**	**Thu 12/15/22**	
RSW Spill for Adult Steelhead	Tue 3/1/22	Thu 3/31/22	2.2.2
Turbine unit priority order	Tue 3/1/22	Thu 12/15/22	4.1
ESBSs	Thu 3/24/22	Mon 12/12/22	2.3.1.2, 2.3.2.2
Avian hazing	Fri 4/1/22	Thu 6/30/22	Appendix L
Turbine unit 1% operating range	Sun 4/3/22	Wed 8/31/22	4.2
RSW Spill	Sun 4/3/22	Wed 8/31/22	2.3.2.6
Spring Spill	Sun 4/3/22	Mon 6/20/22	Appendix E (FOP)
Summer Spill	Tue 6/21/22	Wed 8/31/22	Appendix E (FOP)
RSW Spill for Adult Steelhead	Thu 9/1/22	Tue 11/15/22	2.2.2
ESBS removal during cold weather	Thu 11/24/22	Mon 12/12/22	2.3.2.2
TDG MONITORING	**Tue 3/1/22**	**Tue 2/28/23**	
TDG Monitoring - Tailrace (LGNW)	Tue 3/1/22	Tue 2/28/23	2.2.4
TDG Monitoring - Forebay (LWG)	Fri 4/1/22	Wed 8/31/22	2.2.4
ADULT FISH COUNTING	**Tue 3/1/22**	**Fri 12/30/22**	
Day Video 0400-2000 PST (0500-2100 PDT)	Tue 3/1/22	Thu 3/31/22	1.2.2
Day Visual 0500-2100 PDT	Fri 4/1/22	Mon 10/31/22	1.2.2
Night Video 2100-0500 PDT	Wed 6/15/22	Fri 9/30/22	1.2.2
Day Video 0400-2000 PST (0500-2100 PDT)	Tue 11/1/22	Fri 12/30/22	1.2.2
REPORTS	**Tue 3/1/22**	**Sat 12/31/22**	
Weekly Reports	Tue 3/1/22	Sat 12/31/22	2.5.2
Annual Report due (for previous year)	Tue 3/15/22	Tue 3/15/22	2.5.2
SPECIAL OPS & STUDIES (Appendix A)	**Fri 2/25/22**	**Thu 12/15/22**	
Navigation Lock OOS	Fri 2/25/22	Sat 3/19/22	App A 1.4
Genetic Stock ID	Tue 3/1/22	Tue 6/28/22	App A 9.2
Kelt Study	Tue 3/1/22	Wed 6/29/22	App A 9.2
Juvenile Lamprey Assessment	Tue 3/1/22	Thu 6/30/22	App A 9.2
RSW PIT Evaluation	Fri 4/1/22	Mon 6/20/22	App A 9.2
Adult Sampling	Mon 4/4/22	Thu 12/15/22	App A 9.2
Bull Trout PIT-tagging and Genetic Sampling	Mon 4/4/22	Thu 12/15/22	App A 9.2
Subyearling Parentage-Based Tagging	Wed 6/1/22	Fri 7/15/22	App A 9.2
Doble Testing	Mon 8/8/22	Fri 8/12/22	App A 1.5 & 9.1
Broodstock Collection (end date TBD)	Thu 8/18/22	Fri 9/30/22	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)			
2012	14-Apr	27-Apr	17-May	33	29-May	13-Jun	11-Jul	43
2013	19-Apr	8-May	14-May	25	30-May	9-Jun	1-Aug	63
2014	19-Apr	4-May	17-May	28	28-May	1-Jun	12-Jul	45
2015	3-Apr	26-Apr	11-May	38	26-May	5-Jun	19-Jul	54
2016	13-Apr	26-Apr	9-May	26	27-May	10-Jun	4-Jul	38
2017	15-Apr	29-Apr	10-May	25	28-May	6-Jun	13-Jul	46
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
10-Yr	**13-Apr**	**1-May**	**13-May**	**30**	**27-May**	**6-Jun**	**12-Jul**	**50**
10-Yr MIN	**3-Apr**	**26-Apr**	**9-May**	**25**	**28-Apr**	**29-May**	**2-Jul**	**38**
10-Yr MAX	**19-Apr**	**8-May**	**18-May**	**38**	**6-Jun**	**27-Jun**	**6-Aug**	**65**
	Unclipped Steelhead				Clipped Steelhead			
2012	18-Apr	3-May	24-May	36	16-Apr	27-Apr	19-May	33
2013	22-Apr	13-May	19-May	27	20-Apr	9-May	17-May	27
2014	23-Apr	9-May	26-May	33	21-Apr	2-May	22-May	31
2015	16-Apr	8-May	24-May	38	11-Apr	27-Apr	18-May	37
2016	14-Apr	2-May	17-May	33	15-Apr	26-Apr	12-May	27
2017	16-Apr	8-May	24-May	38	8-Apr	26-Apr	11-May	33
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
10-Yr	**16-Apr**	**6-May**	**23-May**	**36**	**13-Apr**	**27-Apr**	**17-May**	**32**
10-Yr MIN	**10-Apr**	**26-Apr**	**17-May**	**27**	**8-Apr**	**18-Apr**	**6-May**	**26**
10-Yr MAX	**23-Apr**	**13-May**	**26-May**	**39**	**21-Apr**	**9-May**	**24-May**	**40**
	Coho (wild & hatchery)				Sockeye (wild & hatchery)			
2012	28-Apr	18-May	26-May	28	5-May	19-May	26-May	21
2013	8-May	14-May	18-May	10	15-May	17-May	19-May	4
2014	3-May	19-May	26-May	23	8-Apr	3-May	19-May	41
2015	27-Apr	13-May	23-May	26	9-May	17-May	20-May	11
2016	26-Apr	8-May	15-May	19	17-May	22-May	28-May	11
2017	29-Apr	13-May	28-May	29	15-Apr	8-May	21-May	36
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
10-Yr	**29-Apr**	**13-May**	**26-May**	**27**	**11-May**	**17-May**	**20-May**	**11**
10-Yr MIN	**11-Apr**	**8-May**	**15-May**	**10**	**8-Apr**	**3-May**	**18-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 2022 – Feb 2023.

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

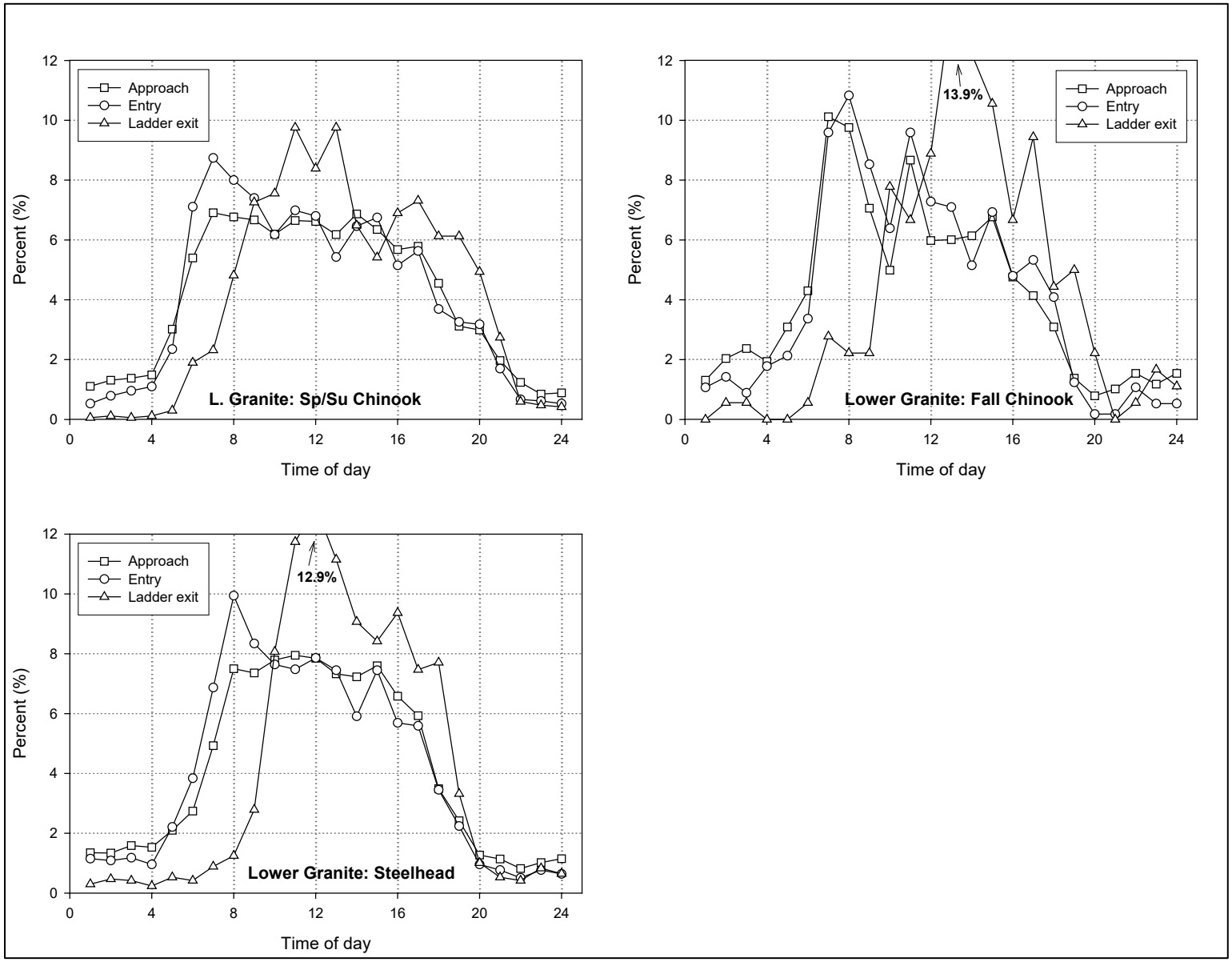


Figure LWG-2. Diel Distribution of Adult Salmonids at Lower Granite Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

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. 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 from March 1 through March 30 and from October 1 through 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 2022, surface spill in the fall will begin September 1 (instead of October 1) to comply with the Agreement for short-term operations of the Columbia River

[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

System (CRS).[3] As such, in 2022, surface spill for adult steelhead will occur March 1–30 and September 1–November 15.

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.

ii. Complete maintenance on all screens.

[3] See Term Sheet, section B (PDF page 7): http://pweb.crohms.org/tmt/JointMotion_TermSheet_CourtOrder_OCT2021.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

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) April 1–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. Between Thanksgiving and December 15, 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.

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

[5] NWS weather forecast for Lower Granite:
forecast.weather.gov/MapClick.php?lat=46.658178954000505&lon=-117.43311929599969

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

[6] NWRFC inflow forecast for Lower Granite Dam: www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?LGDW1

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.

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. Fish Facility Monitoring & Reporting.

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	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	
(feet)	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).