2022 Fish Passage Plan

Chapter 6 – Ice Harbor Dam

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Ice Harbor Dam

Project Acronym	IHR *
River Mile (RM)	Snake River – RM 9.7
Reservoir	Lake Sacajawea
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 0 kcfs \ Mar–Jul: 9.5 kcfs \ Aug–Nov: 7.5 kcfs
Forebay Normal Operating Range (ft)	437’ – 440’
Tailrace Rate of Change Limit (ft)	1.5’/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**.

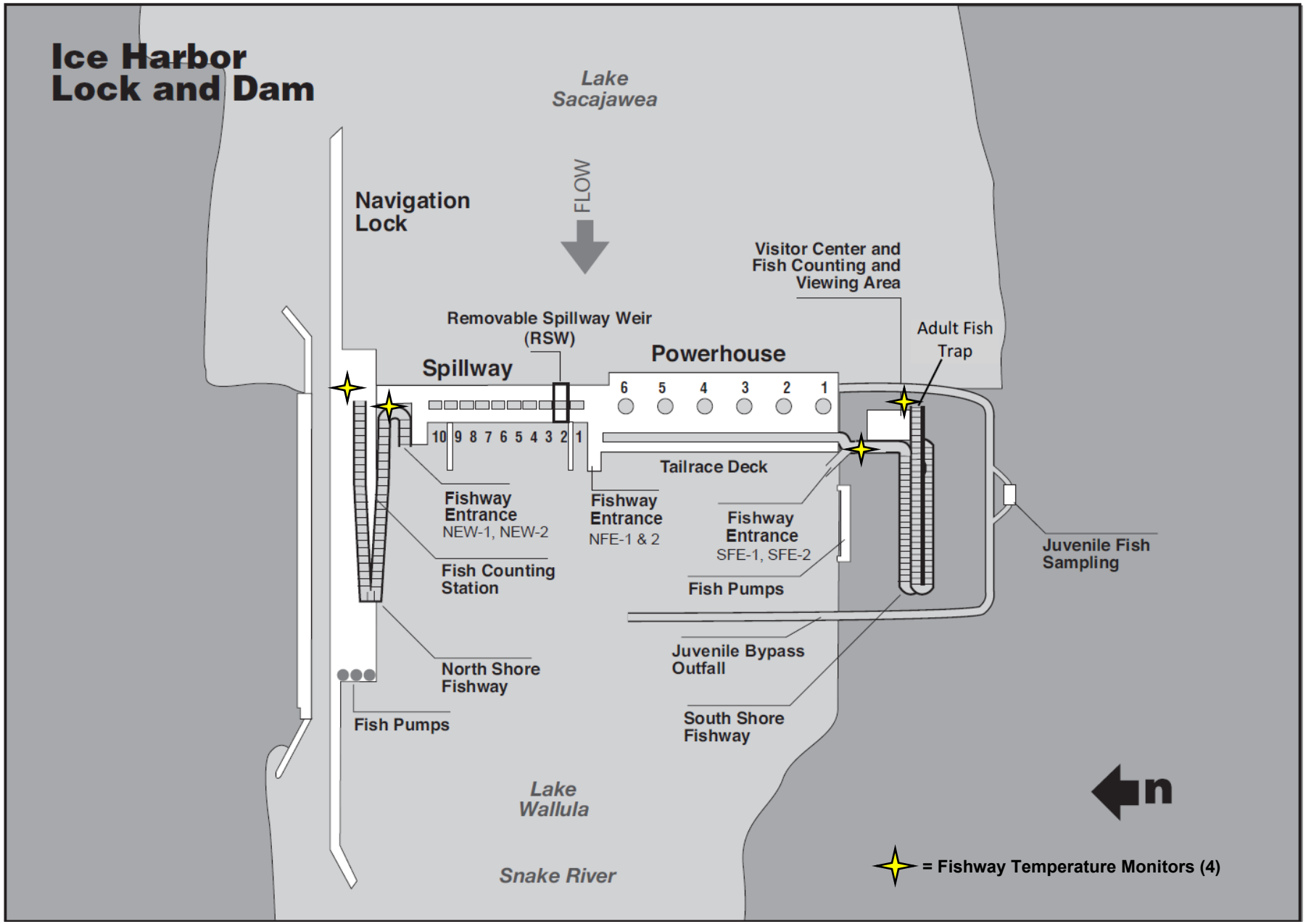
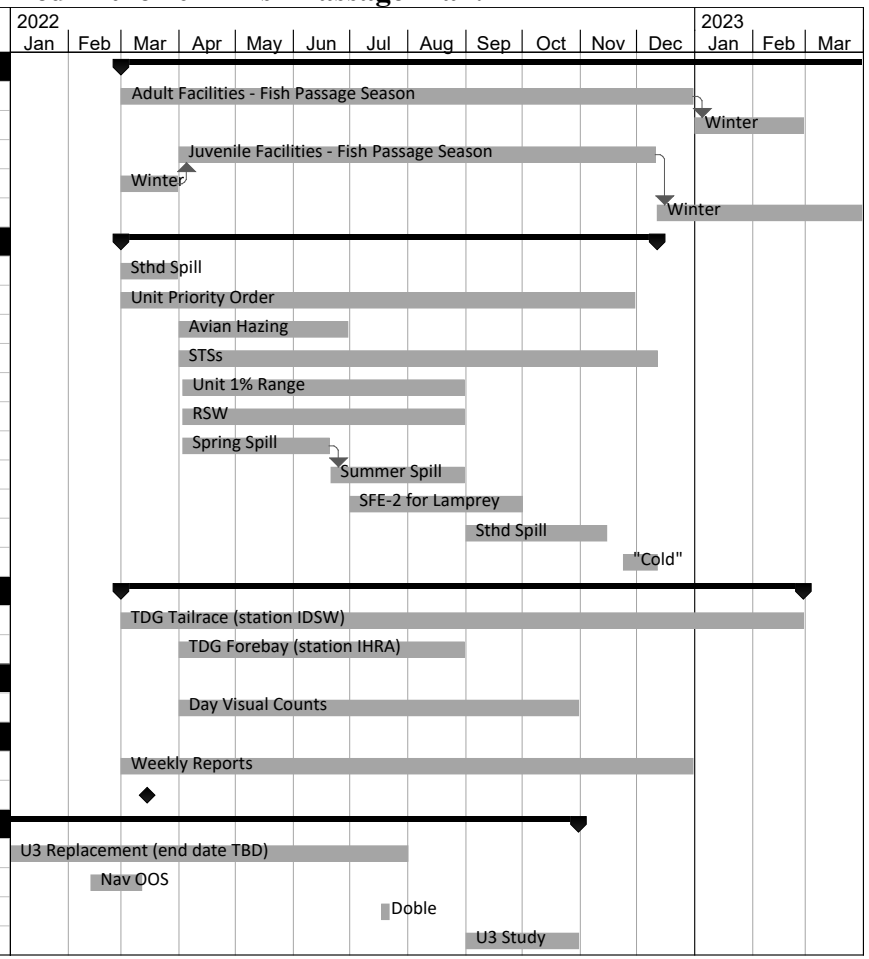


Figure IHR- 1. Ice Harbor Lock and Dam General Site Plan.

Table IHR-1. Ice Harbor Dam Schedule of Operations and Actions Defined in the 2022 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**Tue 3/1/22**	**Fri 3/31/23**	
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 4/1/22	Sun 12/11/22	2.3.2
Juvenile Facilities - Winter Maintenance	Tue 3/1/22	Thu 3/31/22	2.3.1
	Mon 12/12/22	Fri 3/31/23	
PROJECT OPERATIONS FOR FISH PASSAGE	**Tue 3/1/22**	**Mon 12/12/22**	
RSW Spill for Adult Steelhead	Tue 3/1/22	Thu 3/31/22	2.2.2
Turbine unit priority order	Tue 3/1/22	Wed 11/30/22	4.1
Avian hazing	Fri 4/1/22	Thu 6/30/22	Appendix L
STSs	Fri 4/1/22	Mon 12/12/22	2.3.2
Turbine unit 1% operating range	Sun 4/3/22	Wed 8/31/22	4.2
RSW in service (end date approx)	Sun 4/3/22	Wed 8/31/22	2.3.2.6
Spring Spill	Sun 4/3/22	Mon 6/20/22	App E (FOP)
Summer Spill	Tue 6/21/22	Wed 8/31/22	App E (FOP)
Lamprey Entrance Structure Open at SFE-2	Fri 7/1/22	Sat 10/1/22	2.4.2.5.iv
RSW Spill for Adult Steelhead	Thu 9/1/22	Tue 11/15/22	2.2.2
STS 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 (year-round)	Tue 3/1/22	Tue 2/28/23	2.2
TDG Monitoring - Forebay	Fri 4/1/22	Wed 8/31/22	2.2
ADULT FISH COUNTING	**Fri 4/1/22**	**Mon 10/31/22**	
Day Visual 0500-2100 PDT	Fri 4/1/22	Mon 10/31/22	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)	**Sat 1/1/22**	**Mon 10/31/22**	
Unit 3 Replacement (end date approx)	Sat 1/1/22	Mon 8/1/22	App A 6.1
Navigation Lock annual outage	Sun 2/13/22	Sat 3/12/22	App A 1.4
Doble testing	Mon 7/18/22	Fri 7/22/22	App A 1.5 & 6.1
U3 Direct Injury & Sensor Fish Study	Thu 9/1/22	Mon 10/31/22	App A 1.5 & 6.1



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 six and eight are normally used to provide the required flow. Excess water from the juvenile fish passage facilities is routed into the fish pump discharge chamber to provide additional attraction flow. The upper ends of both ladders have PIT-tag detectors.

1.2.2. Adult Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult fish facilities are operated year-round. Adult salmon, steelhead, 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 *
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 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

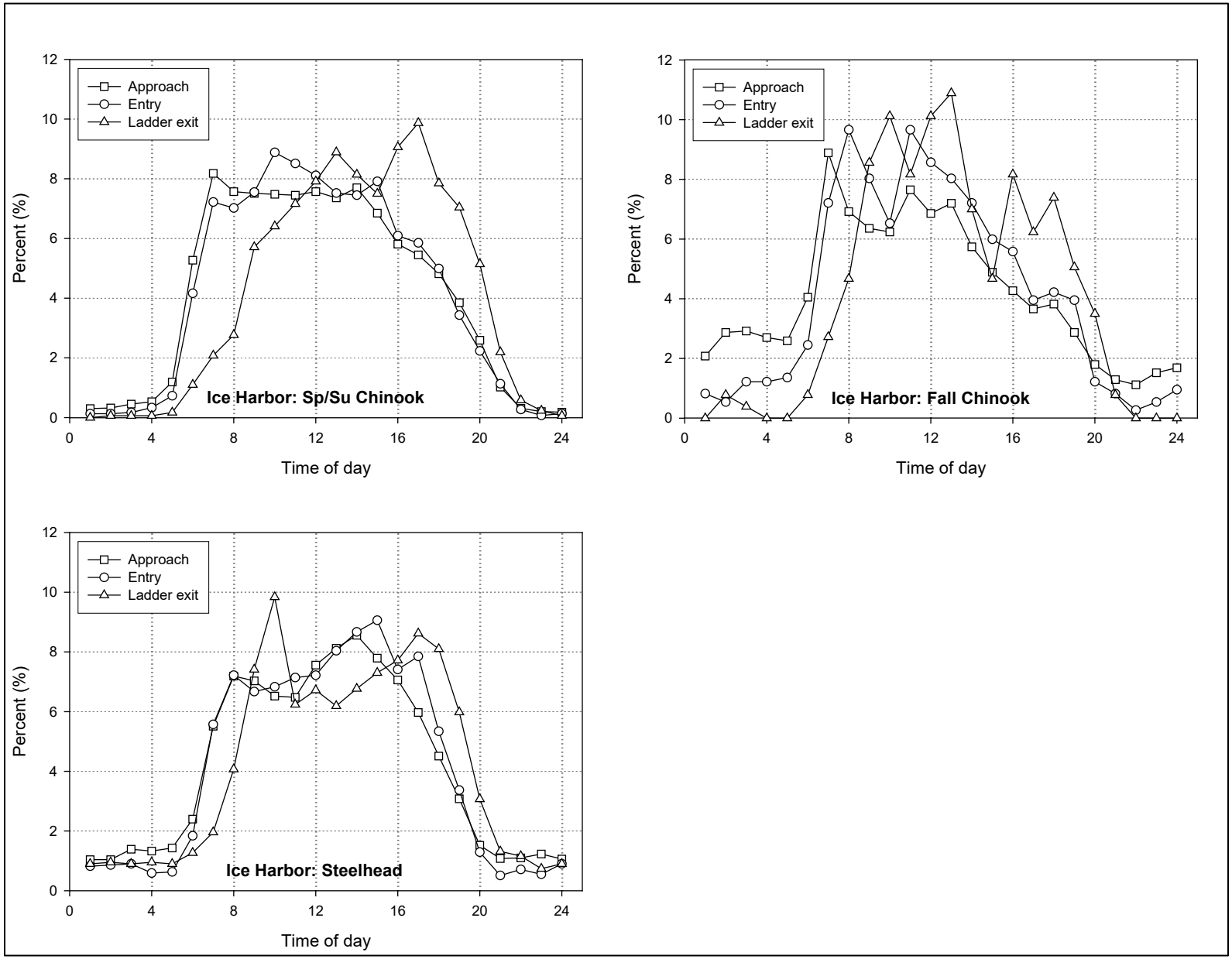


Figure IHR-2. Diel Distribution of Adult Salmonids at Ice Harbor Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

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. 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 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[3] 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

[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 (CRS).[4] 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 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.

ii. Maintain orifice lights operational.

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

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. 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 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.

[6] NWS weather forecast for Ice Harbor Dam: forecast.weather.gov/MapClick.php?lat=46.2469&lon=-118.8807

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 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.

[7] NWRFC inflow forecast for Ice Harbor Dam: www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?IHDW1

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.

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

iii. Adult fishway control calibrations.

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

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.

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

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

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. 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.

4.2.2.2. 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 (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 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:

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

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
	IHR Unit 3 [c]											
	Out of service until 2022 for installation of a new adjustable-blade runner design.											

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 (Mar 2007), as updated for Unit 2 with new runner design (Sep 2021) 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 2022 for installation of a new Voith Kaplan (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 in 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)	(%) [b]	IHR Spill Patterns for 30% Spill - # Gate Stops per Spillbay 1	2 [c]	3	4	5	6	7	8	9	10	Total Stops (#)
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**.