2012 Fish Passage Plan
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Section 6 Ice Harbor Dam

1. Fish Passage Information. The locations of fish passage facilities at Ice Harbor Lock and Dam are shown in **Figure IHR-1**. Dates of project operations for fish purposes and special operations are listed in **Table IHR-1**.

1.1. Juvenile Fish Passage.

1.1.1. Facilities Description. The juvenile fish passage facilities at Ice Harbor consist of standard length submersible traveling screens, vertical barrier screens, 12" orifices, collection channel and dewatering structure, sampling facilities, transportation flume/pipe to the tailrace below the project, and a full-flow PIT tag detection system.

1.1.2. Juvenile Migration Timing. Juvenile passage timing at Ice Harbor Dam corresponds closely with juvenile passage at Lower Monumental Dam (**Table LMN-1**). Salmon, steelhead, bull trout, lamprey, and other species are routinely counted when sampling occurs at Ice Harbor. Maintenance of juvenile fish passage facilities that may impact juvenile fish passage or facility operations should be conducted during the winter maintenance season.

1.2. Adult Fish Passage.

1.2.1. Facilities Description. The adult fish passage facilities at Ice Harbor are made up of separate north and south shore facilities. The 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. The 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 from six to eight are normally used to provide the required flows. The 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.

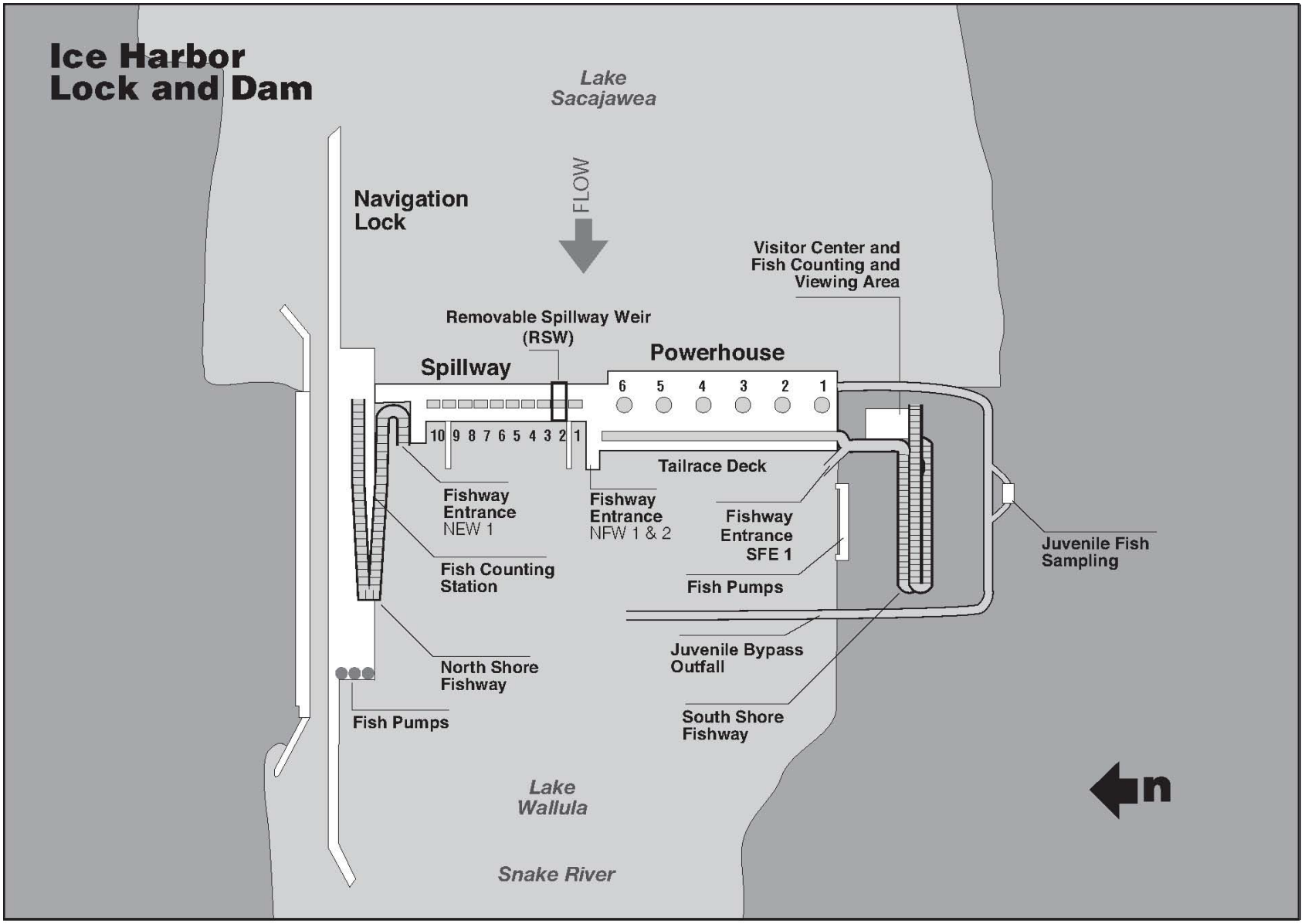
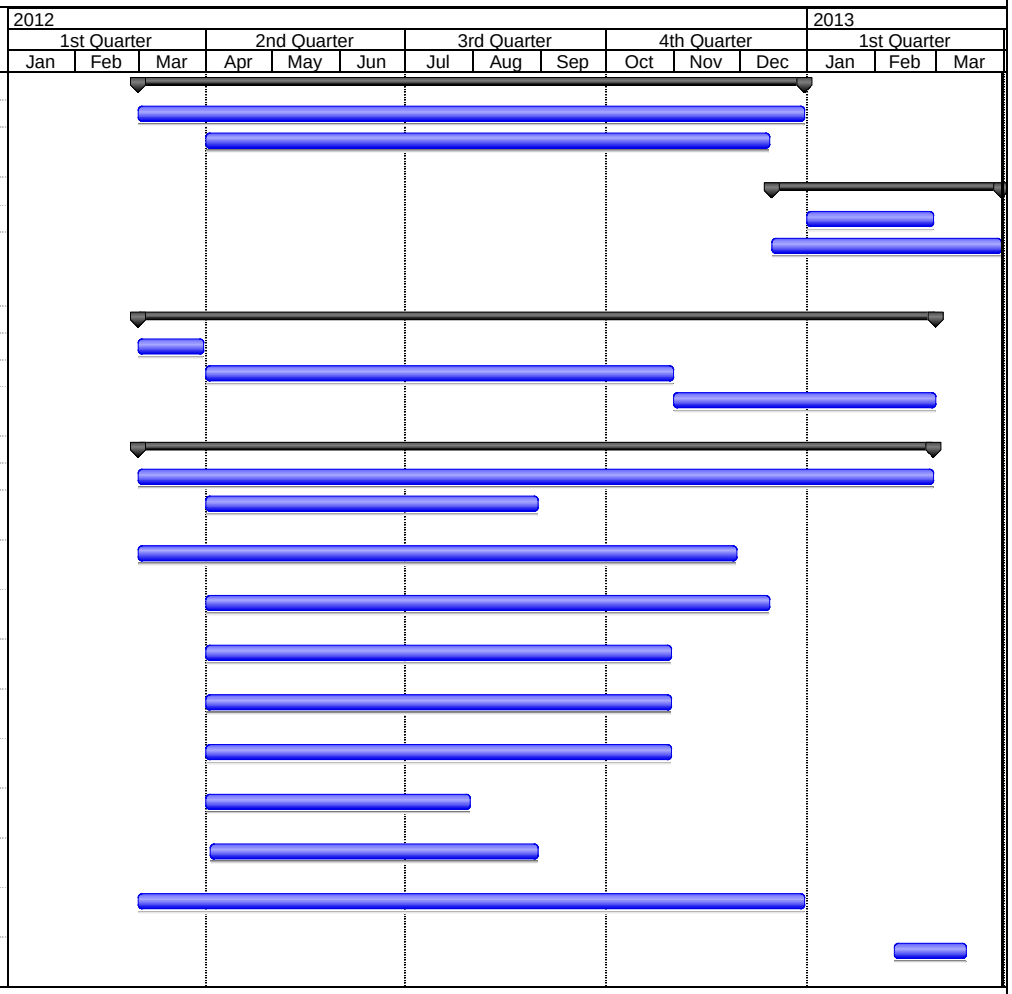


Figure IHR- 1. Ice Harbor Lock and Dam General Site Plan.

Table IHR-1. Dates of Fish-Related Operations at Ice Harbor Dam during the 2012 Fish Passage Season and 2012-2013 Winter Maintenance Period.

Task Name	Start	Finish	Reference
2012 FISH PASSAGE SEASON	**3/1/12**	**12/31/12**	
Adult Fish Passage Season	3/1/12	12/31/12	IHR 2.3.2.2
Juvenile Fish Passage Season	4/1/12	12/15/12	IHR 2.3.1.2
2012-2013 WINTER MAINTENANCE PERIOD	**12/16/12**	**3/31/13**	
Winter Maintenance Adult Fish Facilities	1/1/13	2/28/13	IHR 2.3.2.1
Winter Maintenance Juvenile Fish Facilities	12/16/12	3/31/13	IHR 2.3.1.1
1% Constraints (year-round)	**3/1/12**	**2/28/13**	
1% soft constraint	3/1/12	3/31/12	IHR 4.1.2
1% hard constraint	4/1/12	10/31/12	IHR 4.1.2
1% soft constraint	11/1/12	2/28/13	IHR 4.1.2
TDG Monitoring (year-round)	**3/1/12**	**2/28/13**	
TDG Monitoring - Tailwater (year-round)	3/1/12	2/28/13	App D Table 1 (IDSW)
TDG Monitoring - Forebay	4/1/12	8/31/12	App D Table 1 (IHRA)
Operate Turbines for Fish Passage	3/1/12	11/30/12	IHR 4.1
Operate Juvenile Fish Passage Facilities	4/1/12	12/15/12	IHR 2.3.1
Adult Fish Visual Count 0400-2000 PST	4/1/12	10/31/12	IHR Table IHR-2
Adult Lamprey Passage Study	4/1/12	10/31/12	App A IHR 2.2
Evaluation of Fish Counting Accuracy Study	4/1/12	10/31/12	App A IHR 2.1
Backflush Orifices Once per 8-Hour Shift	4/1/12	7/31/12	IHR 2.3.1.2 c6
Spillway Weir Operation	4/3/12	8/31/12	IHR 2.3.1.2 g
Weekly Reports	3/1/12	12/31/12	IHR 2.3.3.1
Annual Report (for 2012)	2/10/13	3/15/13	IHR 2.3.3.4



1.2.2. Adult Migration Timing. Upstream migrants are present at Ice Harbor Dam throughout the year and adult passage facilities are operated year round. Maintenance of adult fish facilities is scheduled for January and February to minimize impacts on upstream migrants. Facilities are usually shut down one shore at a time for maintenance. Adult salmon, steelhead, shad, and lamprey are counted as per **Table IHR-2**; these data appear daily on the Corps adult count website. Salmon migration timing data appear in **Table IHR-3**. Sturgeon and bull trout are also counted and recorded on the WDFW fish counters' daily summary sheet comments section; and these data are summarized in the Annual Fish Passage Report, but do no appear on the Corps daily website total due to relative infrequency of passage.

Table IHR- 2. Adult Fish Counting Schedule at Ice Harbor Dam.

Period	Counting Method
April 1 – October 31	Visual count 0400 - 2000 PST

Table IHR- 3. Adult Counting Periods and Peak Migration Timing at Ice Harbor Dam (based on fish count data from years 1962-2011).

Species	Counting Period	Date of Peak Passage	
		Earliest	Latest
Spring Chinook	4/1 - 6/11	4/22	5/26
Summer Chinook	6/12 - 8/11	6/12	7/23
Fall Chinook	8/12 - 10/31	9/2	9/30
Steelhead	4/1 – 10/31	9/15	10/12
Sockeye	4/1 – 10/31	7/1	9/22
Lamprey	4/1 – 10/31	7/21	9/3

2. Project Operation.

2.1. Spill Management. See 2010 Fish Operations Plan (**Appendix E**) for more information.

2.1.1. Involuntary spill at Ice Harbor is the result of river flow exceeding powerhouse capacity, insufficient generation loads to pass the river flow, turbine unit outages (forced or scheduled), or the failure of a key component of the juvenile fish passage facility which forces the project to spill to provide juvenile fish passage. Spill at Ice Harbor will be distributed in accordance with the spill patterns listed in **Tables IHR-8, IHR-9, and IHR-10**. Special spills for juvenile fish passage will be provided as detailed in **Appendices A and E**.

2.2. Dissolved Gas Management and Control. Total dissolved gas (TDG) levels at Ice Harbor Dam are monitored in accordance with the Dissolved Gas Monitoring Program, **Appendix D**.

2.3. Operating Criteria.

2.3.1. Juvenile Fish Passage Facilities. Operate from April 1 through October 31 for juvenile fish passage and from November 1 through December 15 for protecting adult fallbacks. The facilities should be operated according to the criteria below.

2.3.1.1. Winter Maintenance Period (December 16 through March 31). Check and perform maintenance as required on the items listed below.

a. Forebay Area and Intakes.

1. Remove debris from forebay and gatewell slots.

2. Rake trashracks just prior to the operating season.

3. Measure drawdown in gatewell slots after cleaning trashracks and with STSs in place.

4. Inspect and repair gatewell dip net as needed.

b. Submersible Traveling Screens and Vertical Barrier Screens.

1. Maintenance completed on all screens.

2. Inspect STSs prior to installation and operate one trial run (dogged off on deck) to ensure proper operation.

3. Log trial Run.

4. Inspect all VBSs at least once per year with an underwater video camera. Repair as needed.

c. Collection Channel.

1. Water-up valve capable of operating when needed.

2. Orifice lights are operational.

3. Orifices clean and valves operating correctly.

4. Orifice air backflush system works correctly.

5. Netting along handrails maintained and in good condition.

6. Netting or covers over orifice chutes maintained and in good condition.

d. Dewatering Structure and Flume.

1. Inclined screen should be clean and in good condition with no gaps between screen panels, damaged panels, or missing silicone.

2. Screen cleaning system (brush and air flush) maintained and operating correctly.

3. Overflow weirs should be maintained, tested, and operating correctly.

4. All valves should be operating correctly.

5. Flume interior should be smooth with no rough edges.

6. Maintain full-flow PIT tag system as required. Coordinate with PSMFC.

e. Sampling Facilities.

1. Flume dewatering structure should be maintained and in good operating condition with no holes or gaps between dewatering screen panels. Silicone sealer should be in good condition.

2. Flume drop gate should be maintained and in good operating condition.

3. The wet separator and fish distribution system should be maintained and ready for operation as designed.

4. All dewatering screens and seals in separator and flume must be in good condition with no holes or gaps between panels, or sharp edges.

5. All valves and switch gates maintained and in good operating condition.

6. All sampling equipment maintained and in good operating condition.

7. Maintain juvenile PIT tag system as required. Coordinate with PSMFC.

f. Avian Predation Areas (Forebay and Tailrace). Inspect bird wires, water cannon, and other deterrent devices and repair or replace as needed. Where possible, install additional bird wires or other deterrent devices to cover areas of known avian predation activity. Prepare avian abatement contract as needed.

g. Maintenance Records. Record all maintenance and inspections.

2.3.1.2. Fish Passage Period (April 1 through December 15).

a. Forebay Area and Intakes.

1. Remove debris from forebay.

2. Remove debris from trashracks as required to maintain less than 1' of additional drawdown in gate slots. 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.

3. Inspect gatewell slots daily for debris, fish buildup, and contaminating substances (particularly oil). Clean gatewells before they become half covered with debris. If, due to the volume of the debris, it is not possible to keep the gatewell surfaces at least half clear, they should be cleaned at least once daily. If flows through an orifice indicate that an orifice may be partially obstructed with debris, the orifice will be closed and backflushed to remove the obstruction. If the obstruction can not be removed, the orifice shall be closed and the alternate orifice for that gatewell slot shall be operated. If both orifices become obstructed or plugged with debris, the turbine unit shall not be operated until the gatewell and orifices are cleared of debris.

4. If a visible accumulation of contaminating substances (such as oil) is detected in a gatewell and it cannot be removed within 24 hours, the gatewell orifices shall

be closed immediately and the turbine unit shut down within one hour until the material has been removed and any problems corrected. A preferred method for removing oil from the water surface is to install absorbent (not adsorbent) socks, booms, or pads capable of encapsulating the material, tied off with a rope for later disposal. Action should be taken as soon as possible to remove the oil from the gatewell so the orifice can be reopened to allow the fish to exit the gatewell. Orifices shall not be closed for longer than 48 hours.

5. Dip bulkhead gatewell slots to remove fish prior to installing bulkhead for dewatering bulkhead slot.

b. Submersible Traveling Screens and Vertical Barrier Screens.

1. Operate STSs in cycling mode when average fork length of sub-yearling chinook or sockeye is greater than 120 mm at Lower Monumental collection facility.

2. Operate STSs in continuous operational mode when average fork length of sub-yearling chinook or sockeye is less than 120 mm at Lower Monumental collection facility, or if there is evidence that smaller juvenile fish are present at the project. Return to cycling mode after one week has passed and re-evaluate.

3. Inspect each STS once per month by means of underwater video. Spot check VBSs at the same time.

4. Record STS amp readings daily.

5. If an STS or VBS is damaged or fails during the juvenile fish passage season, follow procedures detailed under unscheduled maintenance of STSs. In no case should a turbine unit be operated with a missing or a known non-operating or damaged STS or VBS.

6. Up to one-half of the STSs may be removed after October 1 for annual maintenance provided there is no operation of units without screens.

7. Make formal determination at end of season as to adequacy of STS screen mesh and replacement if necessary.

8. Inspect at least 2 VBSs in 2 different turbine units between the spring and summer migration periods. Both turbine units should have been operated frequently during the spring. If a debris accumulation is noted, inspect other VBSs and clean debris as necessary.

9. When extreme cold weather is forecasted (as defined as: anticipated temperatures below 20° Fahrenheit for 24 hours) to occur for an extended period of time between Thanksgiving and December 15, ESBSs and STSs may be removed. The project will first request special permission from CENWW-OD-T. CENWW-OD-T will inform NOAA Fisheries and other FPOM participants of the action.

c. Collection Channel.

1. Orifices clean and operating. Operate at least one orifice per gatewell slot (preferably the north orifice). If the project is operating at MOP, additional orifices may be operated to maintain a full collection channel. If orifices must be closed to repair any part of the facility, monitor the gatewells hourly (unit is operating) or at least every two hours (unit is not operating) for fish condition and behavior. Also see section 3.1.2.2. to determine if the turbine unit must be shut down and if fish must be dipped from the gatewell(s).

2. Orifice lights operational and operating on open orifices. Orifice lights and area lights may be turned off the evening before the channel is dewatered at the end of the season (dewatering occurs on December 16 or later) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

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

4. Orifice jets hitting no closer than 3' from back wall, collection channel full.

5. Orifice valves are either fully open or closed.

6. Backflush orifices at least once per day. During periods of high fish and debris passage, April 1 through July 31, orifices should be inspected and backflushed once per 8-hour shift or more frequently as determined by the project biologist, to keep orifices clean.

7. Water-up valve capable of operating when needed.

8. The netting along handrails should be maintained in good condition with no holes or gaps in the netting.

9. Netting or covers over orifice chutes in good condition.

d. Dewatering Structure.

1. Trash sweep operating correctly. The frequency of sweep should be set as necessary to maintain a clean screen, with a minimum operation of at least once per hour. If automated cleaning system problems occur, operate manually at least once per work shift, or more as necessary, to maintain a clean screen.

2. Clean trapezoidal section at least once per day, and more frequently if required, to maintain a clean condition.

3. Check overflow weirs to make sure they are operating correctly, perform maintenance as required.

4. There should be no gaps between screen panels in the inclined screen or holes in the screen panels.

5. Lights at the dewatering structure should be turned off at night, unless needed for personnel access, to encourage fish to move downstream volitionally.

e. Sampling Facilities.

1. All screens should be inspected to make sure there are no holes or sharp edges.

2. Operate wet separator and fish distribution system as designed. Sample fish twice per week during the main juvenile bypass season to monitor juvenile fish descaling and other fish condition parameters. Sampling is not recommended when water temperatures exceed 70° F unless authorized by an ESA permit. Provide information in weekly report.

3. Crowder screen brushes should be maintained in good operating condition with no holes or sharp edges in the crowder screen.

4. Operate pre-anesthetic system as designed.

5. 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).

f. Avian Predation Areas (Forebay and Tailrace).

1. Bird wires and other avian deterrent devices shall be monitored to assure they are in good condition. Any broken wires or devices shall be replaced as soon as possible.

2. Harassment program in place to deter avian predation in areas actively used by birds and not covered by bird wires or other devices.

3. Project biologists shall routinely monitor project areas to determine areas of active avian predation and, if possible, adjust harassment program to cover these areas or install bird wires or other deterrent devices to discourage avian predation activities.

g. Removable Spillway Weir[1] (RSW). The RSW will be in the raised position and operational on the first day of spill.

1. When the RSW is in operation, the spillgate shall be raised to where it does not touch flow passing down the RSW.

2. When the National Weather Service forecasts Ice Harbor inflows to exceed 200,000 cfs, initiate aggressive forebay debris removal so that RSW operation will not be impeded and coordinate with RCC and CENWW-OD-T.

3. Complete RSW stow (complete rotation to the landing pad) when inflows exceed 260,000 cfs, upstream river gage flows are increasing, and the NWS forecasts Ice Harbor inflow to exceed 300,000 cfs.

[1] Removable spillway weirs (RSWs) are installed at Ice Harbor, Lower Monumental and Lower Granite dams. RSWs are differentiated from Temporary Spillway Weirs (TSWs, installed at McNary, John Day and Little Goose dams) by being designed to be "removable" from the spillbay by controlled descent to the bottom of the forebay.

h. Inspection and Record Keeping. Inspect all facilities according to fish facilities monitoring plans. Record all maintenance and inspections.

2.3.2. Adult Fish Passage Facilities. Operate the adult fish passage facilities according to the following criteria.

2.3.2.1. Winter Maintenance Period (January 1 through February 28).

a. Inspect all staff gages and water level indicators. Repair and/or clean where necessary.

b. 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.

c. Inspect for and clean debris from the fish ladder exits. All trashracks and picketed leads must be clean and installed correctly.

d. Calibrate all water level measuring devices, as necessary, for proper facility operations.

e. Inspect all spill gates and ensure that they are operable.

f. Fish pumps maintained and ready for operation.

g. Maintain adult PIT tag system as required. Coordinate with PSMFC.

h. Maintain the adult fish trap as required. This can also be done outside of the January-February period because the trap is removable.

2.3.2.2. Fish Passage Period (March 1 through December 31). Note: During extremely high flow periods when tailwater level exceeds elevation 353' msl, the fish pumps will be turned off so that the head differential on the auxiliary water supply conduit ceiling slab does not force water into the warehouse inside the dam.

a. Fishway Ladders. Water depth over weirs: 1' to 1.3'.

b. Counting Windows. The minimum counting slot width should be 18". All equipment should be maintained and in good condition. The counting window and backboard should be cleaned as needed to maintain good visibility.

c. Head on all Fishway Entrances. Head range: 1' to 2'.

d. North Shore Entrance (NEW 1). Elevation of top of gate when on sill = 332.25'.

1. Operate downstream gate closest to shore.

2. Weir depth: 8' or greater below tailwater. At tailwaters less than elevation 340.25', weirs should be on sill. Note that at low river flow and tailwater, some of the diffusers are above tailwater and project may only be able to maintain a 6' weir depth.

3. North Shore Lower Diffuser Gates: If the tailwater is below elevation 344', the diffuser gates should be fully open. If the tailwater is above elevation 344', the diffuser gates should be one-half open.

e. North Powerhouse Entrances (NFE 1 and 2). Elevation at top of gate when on sill = 332.25'.

1. Operate 1 downstream gate.

2. Weir depth: 8' or greater below tailwater. At tailwaters less than elevation 340.25', weirs should be on sill. [**Note:** At low tailwater, weirs will bottom out and will be less than 8' below tailwater.]

f. Floating Orifice Gates. Operate 4 floating orifices, OG1, 4, 10, and 12.

g. South Shore Entrance (SFE-1). Elevation of top of gate when on sill = 332.25'.

1. Operate entrance closest to powerhouse.

2. Weir depth: 8' or greater below tailwater. At tailwaters less than elevation 340.25', weirs should be on sill. [**Note:** At low tailwater, weirs will bottom out and will be less than 8' below tailwater.]

h. Channel Velocity. 1.5' to 4' per second. Ice Harbor Dam monitors water velocity at the junction pool in the lower south fish ladder. The current device utilizes Doppler Technology. Decision for placement was not only what was considered to be the single most representative position, but also the placement for maintenance and ease of installation. In addition, head is measured at the north, north powerhouse, and south fishway entrances.

i. Head on Trashracks.

1. Maximum head of 0.5' on ladder exits.

2. Maximum head on picketed leads shall be 0.3'.

3. Trashracks and picketed leads installed correctly.

j. Staff Gages and Water Level Indicators. All staff gages should be readable at all water levels encountered during the fish passage period. Repair or clean as necessary.

k. Inform PSMFC, in advance if possible, of situations that cause the PIT tag system to become inoperable (e.g. power outages) or that could result in confounding the interpretation of PIT tag data (e.g. emergency dewaterings).

l. Facility Inspections.

1. Powerhouse operators shall inspect facilities once per day shift and check computer monitor information at least once during each back shift.

2. Project biologists shall inspect facilities three times per week. Inspect all facilities according to fish facilities monitoring program.

3. Picketed leads shall be inspected during all inspections to ensure they are clean and in the correct position (all the way down).

4. 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.

5. Inspect fishways daily for foreign substances (particularly oil). If substances are found, corrective actions should be undertaken immediately.

6. Record all inspections.

2.3.3. Facility Monitoring and Reporting. Project biologists shall inspect fish passage facilities at the frequencies listed in the juvenile and adult fish facilities operating criteria sections.

2.3.3.1. Project biologists shall prepare weekly reports, from March 1 through December 31, summarizing project operations. The weekly reports should provide an overview of how the project and the fish passage facilities operated during the week and an evaluation of resulting fish passage conditions.

2.3.3.2. The reports shall include:

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

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

c. Adult fishway control calibrations;

d. ESBS and VBS inspections;

g. Any unusual activities which occurred at the project which may affect fish passage.

2.3.3.3. The weekly reports shall cover a Friday through Thursday time period and shall be sent to CENWW-OD-T by noon the following Monday via electronic mail.

2.3.3.4. Project biologists shall prepare a draft annual report by February 10 and a final report by March 15 summarizing the operation of the project fish passage facilities for the previous year. The annual report shall also include a description of all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities in discouraging avian predation.

2.3.3.5. Project biologists also inspect project facilities once per month and during dewaterings for the presence of zebra and quagga mussels. Biologists shall provide a report to CENWW-OD-T on a monthly basis summarizing mussel inspections.

3. Project Maintenance.

Project biologists should be present to provide technical guidance at all project activities that may involve fish handling. All dewaterings shall be accomplished in accordance with approved project dewatering and fish handling plans. When river temperatures reach 70 degrees Fahrenheit or greater, all adult fish handling will be coordinated through CENWW-OD-T. Dewatering and fish handling plans were reviewed and revised in 2011 to ensure that they comply with **Appendix F, Guidelines for Dewatering and Fish Handling Plans.**

3.1. Juvenile Fish Passage Facilities.

3.1.1. Scheduled Maintenance. Scheduled maintenance of the juvenile facilities is conducted during the entire year. Long-term maintenance or modifications of facilities that require them to be out of service for extended periods of time are conducted during the winter maintenance period from December 16 through March 31. During the fish passage season parts of the facilities are maintained on a daily, weekly, or longer interval to keep them in proper operating condition.

3.1.2. Unscheduled Maintenance. Unscheduled maintenance is the correction of any situation that prevents the facilities from operating according to criteria or that will impact fish passage or survival. Maintenance of facilities such as STSs, which sometimes break down during the fish passage season, will be carried out as described below. In these cases, repairs will be made as prescribed and CENWW-OD-T notified for further coordination. Unscheduled maintenance that will have a significant impact on juvenile fish passage shall be coordinated with NOAA Fisheries and other FPOM participants on a case-by-case basis by CENWW-OD-T. CENWW-OD-T will be notified as soon as possible after it becomes apparent that maintenance repairs are required. The Operations Manager has the authority to initiate work prior to notifying CENWW-OD-T when in his opinion delay of the work will result in an unsafe situation for people, property, or fish. Information required by CENWW-OD-T includes:

a. Description of the problem.
b. Type of outage required.
c. Impact on facility operation.
d. Length of time for repairs.
e. Expected impacts on fish passage and proposed measures to mitigate them.

3.1.2.1. Submersible Traveling Screens. 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.

3.1.2.2. 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.

3.1.2.3. 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 foot differential it initiates continuous screen cleaning. If the sensors detect a differential of .30 foot 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.

3.1.2.4. Bypass Flume/Pipe. The bypass flume/pipe transports fish to the sampling facilities and to the tailrace below the project. If there is a problem with the flume/pipe that requires it to be dewatered, procedures will be taken similar to **section 3.1.2.3**.

3.1.2.5. 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.

3.2. Adult Fish Passage Facilities.

3.2.1. Scheduled Maintenance. Scheduled maintenance of a facility that must be dewatered to work on or whose maintenance will have a significant effect on fish passage will be done during the January and February winter maintenance period. Maintenance of facilities that will have no effect on fish passage may be conducted at any time. Maintenance is normally conducted on one fish ladder at a time during the winter to provide some fish passage at the project at all times. When facilities are not being maintained during the winter maintenance period, they will be operated according to normal criteria unless otherwise coordinated with NOAA Fisheries and other FPOM participants.

3.2.2. Unscheduled Maintenance. Unscheduled maintenance that will significantly affect the operation of a facility will be coordinated with NOAA Fisheries and other FPOM participants. Coordination procedures for unscheduled maintenance of adult facilities are the same as for juvenile facilities (see section 3.1.2.). 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.

3.2.2.1. Fish Ladders and Counting Stations. The fish ladders contain fixed weirs, counting stations with picket leads, and fish exits with trashracks. If any part of the ladder fails or is blocked with debris during the fish passage season, efforts will first be made to correct the problem without dewatering 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.

3.2.2.2. 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. If a pump fails during two-pump operation, the pump on standby will be operated to provide the necessary flows. If two or all three

pumps fail, the NEW1 weir will be maintained at a level of 6' below tailwater until repairs are made.

3.2.2.3. South Shore Auxiliary Water Supply System. The south shore auxiliary water is supplied by eight electric pumps and 150-180 cfs of excess water from the juvenile fish passage facilities. Fluctuating water levels can require up to eight pumps to be operated to provide the auxiliary water and meet criteria. 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. If criteria cannot be met due to fish pump outages within 24 hours, the floating orifices should be closed in the following order: OG-12 and OG-10. 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. 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.

3.2.2.4. Fishway Entrances. The fishway entrances consist of main entrance weirs with hoists and automatic controls, and floating orifices which regulate themselves with tailwater fluctuations. If any of the automatic controls malfunction, the weirs can be operated manually by project personnel and kept within criteria. If there is a further failure which prevents the entrance from being operated manually, 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.

3.2.2.5. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to make sure they are in place. These inspections are done by either dewatering and physically inspecting the diffuser gratings, or by using underwater video cameras, divers, or other methods. Diffuser gratings may come loose during the fish passage season due to a variety of reasons. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings. If a diffuser grating is known or suspected to have moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway. Coordination of the problems should begin immediately through the established unscheduled maintenance coordination procedure (see section 3.1.2). If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and tribes through the established coordination procedure. Repairs shall be made as quickly as possible unless coordinated differently.

4. Turbine Unit Operation and Maintenance.

4.1. Turbine Unit Operation. When in operation, Units will be operated to enhance adult and juvenile fish passage from March 1 through November 30. During this time period Units will be operated as needed to meet generation requirements in the priority order shown in **Table IHR-4**. Model studies of Ice Harbor Dam show that spilling at lower river flows can cause eddies in front of the powerhouse. To provide the best fish passage conditions during periods of spill, it is important that the Units operate in a specific operating order to minimize eddying conditions. The original and desired unit prioritization is 1, 3, 6, 4, 2, 5. Unit 6 transformer has an internal fault and is generating gases that are indications of arcing and the levels are increasing with time, so it is desired to run this unit in a "last on, first off" basis.

The Sacajawea 500/115kV transformer is connected to the Ice Harbor-Franklin No. 2 115kV line, and Ice Harbor should not operate a single unit on the Ice Harbor-Franklin No. 2 115 kV line. The operation of a single unit on the Ice Harbor-Franklin No. 2 115kV line jeopardizes BPA system reliability. IHR should not be run as a single or two unit project if that unit(s) is unit 3 and/or 4 without switching those units to the Ice Harbor-Franklin No. 3 115kV line, disconnecting the Ice Harbor-Franklin No. 2 115kV line from Ice Harbor and disabling the transfer trip for the Ice Harbor-Franklin 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 Ice Harbor-Franklin No. 2 115kV line.

If single unit operation is necessary and switching has not occurred in the yard, run unit 1, 2, 5, 6. Running units 3 and 4 alone on the Ice Harbor-Franklin No. 2 115kV line can only occur if the powerhouse operator can accomplish the needed switching. If unit 1 is out of service and switching has not occurred, then operate the following unit priority when operating more than one unit: 2, 3, 4, 5, 6.

Table IHR- 4. Unit Operating Priority for Ice Harbor Dam.

Season	Duration	Unit Priority (see Section 4.1)
January 01 – December 31 Year-round - single unit operation w/ NO switching	24 hours/day	1,2,5,6
March 01 - November 30 Fish Passage Season	24 hours/day	1,3,4,2,5 and 6
December 01 – end of February Winter Maintenance Period	24 hours/day	Any order

4.1.1. The hours of operations may be coordinated and adjusted in-season by CENWW-OD-T (through coordination with TMT) if fish passage or other conditions at the project require it. Unit operating priority may be coordinated differently to allow for fish research, construction, or project maintenance activities. If a turbine unit is taken out of service for maintenance or repair, the next unit in the priority list shall be operated.

4.1.2. Turbine units will be operated within 1% of best efficiency from April 1 through October 31 (as specified in BPA's load shaping guidelines, **Appendix C**) unless operation outside of that range is necessary to:

1) Meet load requirements of the BPA Administrator whose load requests will be made in accordance with BPA's policy, statutory requirements, and load shaping guidelines (**Appendix C**);

2) If the turbine unit draft tube is to be dewatered, operate unit with full load for a minimum of 15 minutes prior to installing tail logs. If not possible to load, run unit at speed-no-load for minimum of 15 minutes. This is to reduce the number of fish in the scrollcase prior to installing stop logs;

3) Operating a turbine unit solely to provide station service; or

4) Be in compliance with other coordinated fish measures. Project personnel shall record when turbine units are operated outside the 1% efficiency range and shall provide the information to BPA on a weekly basis according to the load shaping guidelines. Between November 1 and March 31, turbine units will continue to be operated within the 1% efficiency range except when BPA load requests require the units to be operated outside the 1% range. Guidelines for operation of the turbine units within the 1% efficiency range at various heads are shown in **Tables IHR-5 through IHR-7**.

4.1.3. All of the lower Snake River powerhouses may be required to keep one generating turbine unit on line at all times to maintain power system reliability. During low flows, there may not be enough river flow to meet this generation requirement and required minimum spill. Under these circumstances the power generation requirement will take precedence over the minimum spill requirement. At Ice Harbor Dam, minimum generation requirements are 8.5-10.3 kcfs through turbine units 1 and 3-6, and 11.3-13.1 kcfs for turbine unit 2. Actual attainable minimum generation levels may vary depending on project conditions.

4.2. Turbine Unit Outages During High River Flow Periods. During high spring flows, turbine unit outages for NERC regulatory requirements, inspecting fish screens, repairing research equipment such as hydroacoustic or radio telemetry equipment, and other fish items may cause increased spill at a project in order to maintain reservoir levels within operating levels. This may result in TDG levels exceeding standards. It is important that this work be conducted when scheduled to ensure that facilities are working correctly and not injuring migrating fish, and that important fish research data is collected. To facilitate this work, reservoir storage may be utilized to minimize impacts from taking turbine units out of service and increasing spill. At Ice Harbor, this special operation may take place when river flows are above 100 kcfs or when increasing spill levels will result in TDG levels exceeding standards. The activities covered under these operations will be coordinated with and approved by the TMT whenever possible.

4.2.1. For scheduled inspection or repair of research equipment, reservoirs shall be drafted to MOP and allowed to fill to 1' above the 1’ MOP operating range as the work is accomplished.

After the work, reservoirs will be slowly drafted back to the MOP operating range. When inspection or repair work can be scheduled ahead of time, the following process will be followed:

a. Project personnel shall schedule turbine unit outages through the approved turbine outage scheduling procedure by noon of the Tuesday of the week prior to the outage.

b. Project personnel shall also contact CENWW-OD-T and RCC by the same time period and inform them of the intended work.

c. The RCC will coordinate the work activities through the TMT.

d. After coordination with the TMT, RCC shall issue a teletype through the CBTT issuing instructions to project and BPA personnel for the scheduled work.

e. Spill will be increased by one spill bay stop setting (about 1.7 kcfs) above passing inflow to slowly lower the level of Ice Harbor pool to MOP prior to the scheduled work taking place.

f. 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 the normal MOP range (a 2' pondage from where the pool was when the work started). At this point, screen inspections shall stop. (At Snake River projects, this should allow about one normal workday for the scheduled work.)

g. At the conclusion of the work, the reservoir shall be drafted back down to the MOP range utilizing a one spill bay stop increase in spill above passing inflow.

h. If work, such as screen inspections, is not finished, project personnel shall schedule another turbine unit outage for a date where it can be implemented again.

4.2.2. If the work that needs to be done is of an emergency nature that does not normally require the turbine unit to be taken out of service (such as a failed hydroacoustic transducer versus a 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 approval to do the work is given, the turbine unit shall be taken out of service and the reservoir level allowed to increase until it reaches 1' above the MOP operating range. At this point, the turbine unit must be returned to service and the reservoir will be drafted back to the MOP range using one spill bay stop setting above passing inflows.

4.3. Turbine Unit Maintenance. The project turbine unit maintenance schedule will be reviewed annually by project and Operations Division biologists for fish impacts. If possible, maintenance of priority units will be scheduled for non-fish passage periods, or when there are low numbers of fish passing the project. Each turbine unit requires annual maintenance that may take from several days to two weeks. Annual maintenance of all turbine units is normally scheduled during the mid-July to late November time frame. The maintenance of priority units

for adult passage is normally conducted in November or December but can be conducted in mid-August. Impacts to migrating adults should be minimized. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take over one year to accomplish. Turbine units, governors, exciters, and control systems require periodic maintenance, calibration, and testing which may take them outside of the 1% turbine efficiency range. This work will be scheduled in compliance with BPA load shaping guidelines **(Appendix C)** to minimize impacts on juvenile fish.

4.3.1. Unwatering turbine units should be accomplished in accordance with project dewatering plans. If the turbine unit draft tube is to be dewatered, operate unit with full load for a minimum of 15 minutes prior to installing tail logs. If not possible to load, run unit at speed-no-load for minimum of 15 minutes. This is to reduce the number of fish in the scrollcase prior to installing stop logs. If a turbine unit is out of service for maintenance for an extended period of time without tailrace stoplogs in place, efforts should be made to not open the wicket gates if the scroll case must be dewatered at a later date without the unit being spun before hand.

4.3.2. 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% criteria to allow pre-maintenance measurements and testing AND TO ALLOW ALL FISH TO MOVE THROUGH THE UNIT. 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% criteria) before it is returned to operational status. Operational testing OF UNIT UNDER MAINTENANCE is in addition to a unit in run status (E.G. MINIMUM GENERATION) required for power plant reliability. Operational testing may deviate from fish priority units and may require water that would otherwise be used for spill if the running unit for reliability is at its 1% minimum load. Water will be used from the powerhouse allocation if possible, and water diverted from spill for operational testing will be minimized to that necessary to maintain and assure generation system reliability.

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 impingement, injuries, and descaling of fish. Removing debris at its source in the forebay is sometimes necessary to maintain safe and efficient fish passage conditions, navigation, and other project activities. Debris can be removed from the forebay by: physically encircling the debris with log booms and pulling it to shore with boats where it can be removed with a crane, removing the debris from the top of the dam using a crane and scoop, or passing the debris through the spillway with special powerhouse operations and spill. The preferred option is to remove debris at each project when possible to avoid passing debris on to the next project downstream. This is not always possible at each project, as some projects do not have forebay debris removal capability. In this case, the only viable alternative is to spill the debris. Normally, the project shall contact CENWW-OD-T at least two workdays prior to the day the special operation is required. Using information provided by the project, CENWW-OD-T will notify FPOM and RCC will issue a teletype detailing the special operations.

5.1. 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. CENWW-OD-T shall coordinate the special operations with RCC, NOAA Fisheries, and other FPOM participants. Project personnel shall provide CENWW-OD-T the reason for the debris spill request, including an explanation of project facilities being impacted by the debris, the date and time of the requested spill, and any special powerhouse or other operations required to move the debris to the spillway. When a debris spill is coordinated and approved, RCC shall issue a teletype detailing the specifics of the special operations.

5.1.1. 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- 5. Turbine Unit Operating Range Within 1% of Best Efficiency at Ice Harbor Dam – Units 1 and 3 With and Without STSs Installed.*

Head (feet)	Units 1 & 3 with STSs Installed				Units 1 & 3 with No STSs			
	Lower Limit		Upper Limit		Lower Limit		Upper Limit	
	(MW)	(cfs)	(MW)	(cfs)	(MW)	(cfs)	(MW)	(cfs)
85	**51.7**	**8,417**	**83.6**	**13,590**	**51.9**	**8340**	**89.9**	**14,452**
86	52.6	8,443	84.6	13,585	52.7	8367	91	14,447
87	53.4	8,469	85.6	13,580	53.5	8392	92	14,441
88	54.2	8,494	86.6	13,574	54.3	8417	93.1	14,436
89	55	8,518	87.6	13,569	55.1	8441	94.2	14,430
90	**55.8**	**8,542**	**88.6**	**13,563**	**55.9**	**8465**	**95.3**	**14,424**
91	56.5	8,548	89.8	13,585	56.6	8471	96.5	14,448
92	57.1	8,554	90.9	13,607	57.3	8477	97.8	14,471
93	57.8	8,559	92.1	13,628	58	8482	99	14,494
94	58.5	8,565	93.2	13,649	58.6	8,047	100.3	14,516
95	**59.2**	**8,570**	**94.4**	**13,669**	**59.3**	**8,052**	**101.5**	**14,537**
96	59.9	8,589	95.3	13,662	59	8,070	102.5	14,530
97	60.7	8,607	96.3	13,655	59	8,087	103.5	14,522
98	61.5	8,624	97.3	13,648	60	8,103	104.6	14,515
99	62.2	8,641	98.2	13,641	61	8,119	105.7	14,508
100	**63**	**8,658**	**99.2**	**13,634**	**62**	**8,135**	**106.7**	**14,500**
101	64	8,707	99.9	13,590	62	8,182	107.4	14,454
102	65	8,354	100.6	13,547	63	8,227	108.2	14,408
103	66	8,804	101.3	13,505	64	8,272	108.9	14,363
104	67	8,850	102	13,463	65	8,316	109.7	14,319
105	**68**	**8,896**	**102.6**	**13,422**	**66**	**8,359**	**110.4**	**14,275**

*** NOTE:** Table based on the 1978 model test and 2006 Unit 3 index test (IHR -5&6 revised 2008)

Table IHR- 6. Turbine Unit Operating Range Within 1% of Best Efficiency at Ice Harbor Dam – Units 4 and 6 With and Without STSs Installed.*

Head (feet)	Units 4 & 6 with STSs Installed				Units 4 & 6 with No STSs			
	Lower Limit		Upper Limit		Lower Limit		Upper Limit	
	(MW)	(cfs)	(MW)	(cfs)	(MW)	(cfs)	(MW)	(cfs)
85	**58.9**	**9,369**	**93.1**	**14,810**	**62**	**9,745**	**110.7**	**17,413**
86	59.7	9,380	94.4	14,824	62.8	9,756	112.3	17,430
87	60.6	9,390	95.7	14,838	63.7	9,767	113.8	17,447
88	61.4	9,400	97	14,851	64.5	9,777	115.3	17,462
89	62.2	9,410	98.2	14,864	65.4	9,787	116.8	17,477
90	**63**	**9,419**	**99.5**	**14,876**	**66.3**	**9,797**	**118.3**	**17,492**
91	63.7	9,416	100.7	14,885	67	9,794	119.8	17,503
92	64.5	9,414	102	14,895	67.8	9,792	121.3	17,515
93	65.2	9,411	103.2	14,904	68.6	9,789	122.7	17,525
94	65.9	9,409	104.5	14,912	69.3	9,787	124.2	17,535
95	**66.6**	**9,406**	**105.7**	**14,921**	**70.1**	**9,784**	**125.7**	**17,545**
96	67.5	9,416	106.7	14,892	70.9	9,794	126.8	17,512
97	68.3	9,425	107.7	14,864	71.8	9,804	128	17,479
98	69.1	9,434	108.6	14,836	72.7	9,813	129.2	17,446
99	69.9	9,442	109.6	14,809	73.5	9,822	130.3	17,414
100	**70.7**	**9,451**	**110.6**	**14,782**	**74.4**	**9,831**	**131.5**	**17,382**
101	71.4	9,446	112.9	14,939	75.1	9,825	134.2	17,567
102	72	9,441	115.1	15,093	75.7	9,820	136.9	17,748
103	72.7	9,436	117.4	15,224	76.4	9,815	139.6	17,926
104	73.3	9,431	119.7	15,392	77.1	9,810	142.3	18,100
105	**74**	**9,426**	**121.9**	**15,538**	**77.8**	**9,805**	**145**	**18,271**

*** NOTE:** Table based on the 1978 model test and 2006 Unit 6 index test (IHR -7&8 revised 2008)

Table IHR- 7. Turbine Unit Operating Range Within 1% of Best Efficiency at Ice Harbor Dam – Unit 2 With and Without STSs Installed.*

Head (feet)	Unit 2 with STSs Installed				Unit 2 with No STSs			
	Lower Limit		Upper Limit		Lower Limit		Upper Limit	
	(MW)	(cfs)	(MW)	(cfs)	(MW)	(cfs)	(MW)	(cfs)
85	**67.6**	**10,986**	**72.9**	**11,854**	**68.7**	**11,032**	**74**	**11,896**
86	68.6	11,017	73.9	11,864	69.7	11,064	75	11,905
87	69.6	11,047	74.8	11,873	70.7	11,094	76	11,914
88	70.6	11,077	75.8	11,882	71.8	11,124	76.9	11,923
89	71.7	11,105	76.7	11,890	72.8	11,153	77.9	11,932
90	**72.7**	**11,133**	**77.7**	**11,899**	**73.8**	**11,181**	**78.8**	**11,940**
91	73.4	11,120	78.7	11,917	74.6	11,167	79.9	11,959
92	74.2	11,107	79.8	11,936	75.4	11,154	80.9	11,978
93	75	11,093	80.8	11,953	76.2	11,141	82	11,995
94	75.8	11,080	81.8	11,970	76.9	11,128	83.1	12,013
95	**76.5**	**11,068**	**82.9**	**11,987**	**77.7**	**11,115**	**84.1**	**12,029**
96	77.3	11,071	83.5	11,955	78.6	11,118	84.8	11,998
97	78.2	11,073	84.2	11,924	79.4	11,121	85.4	11,966
98	79	11,076	84.8	11,894	80.2	11,124	86.1	11,936
99	79.8	11,079	85.5	11,864	81.1	11,127	86.7	11,906
100	**80.6**	**11,082**	**86.1**	**11,835**	**81.9**	**11,130**	**87.4**	**11,877**
101	81.5	11,096	87.1	11,852	82.8	11,144	88.4	11,894
102	82.5	11,110	88.1	11,869	83.8	11,158	89.4	11,911
103	83.4	11,124	89.1	11,886	84.7	11,172	90.4	11,928
104	84.3	11,138	90.1	11,902	85.6	11,186	91.4	11,944
105	**85.2**	**11,151**	**91.1**	**11,918**	**86.5**	**11,199**	**92.4**	**11,960**

*** NOTE**: Based on the 1956 Model Test and 2008 Unit 2 Index Test (IHR new 2008).

Table IHR- 8 (pg 1 of 2). Ice Harbor Dam High Spill Gate Pattern – Deflectors in All Spillbays and No Removable Spillway Weir (RSW).

Ice Harbor Dam Spill Pattern w/ Deflectors and No RSW Number of Gate Stops per Spillbay										Total Stops	Total Spill (kcfs)
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	Bay 9	Bay 10		
		5								5	8.5
		5							1	6	10.2
		5						1	1	7	11.9
		5						1.5	1.5	8	13.6
		5						2	2	9	15.4
		5		5						10	17.0
		5		5					1	11	18.7
		5.5		5.5					1	12	20.4
		5.5		5.5				1	1	13	22.1
		5.5		5.5				1.5	1.5	14	23.8
		5		5		5				15	25.5
		5		5		5			1	16	27.2
		5.5		5.5		5			1	17	28.9
		5.5		5.5		5.5			1.5	18	30.5
		6		6		6			1	19	32.0
		5		5		5		5		20	34.0
		5		5		5		5	1	21	35.7
		5.5		5		5		5.5	1	22	37.3
		5.5		5.5		5.5		5.5	1	23	39.0
		6		5.5		5.5		6	1	24	40.6
		6		6		6		6	1	25	42.1
		5	5	5		5		5	1	26	44.2
		5.5	5	5		5		5.5	1	27	45.8
		5.5	5	5.5		5.5		5.5	1	28	47.5
		5.5	5.5	5.5		5.5		6	1	29	49.1
		5.5	5.5	6		6		6	1	30	50.7
		6	6	6		6		6	1	31	52.2
		6	6	6.5		6.5		6	1	32	54.0
		6.5	6.5	6.5		6.5		6	1	33	55.8
		6	6	5	5	5		6	1	34	57.5
		6	6	5	5	6		6	1	35	59.1
		6	6	6	5	6		6	1	36	60.7
		6	6	6	6	6		6	1	37	62.3
		6	6	6	6	7		6	1	38	64.1
		6	6	6	6	7		7	1	39	65.7
		6	6	6	7	7		7	1	40	67.4
		6	6	7	7	7		7	1	41	69.1
		6	7	7	7	7		7	1	42	70.8
		7	7	7	7	7		7	1	43	72.5
6		6	6	6	6	7		6	1	44	74.1
6		6	6	6	7	7		6	1	45	75.8
6		6	6	7	7	7		6	1	46	77.5

Ice Harbor Dam Spill Pattern w/ Deflectors and No RSW Number of Gate Stops per Spillbay										Total Stops	Total Spill (kcfs)
Bay 1	**Bay 2**	**Bay 3**	**Bay 4**	**Bay 5**	**Bay 6**	**Bay 7**	**Bay 8**	**Bay 9**	**Bay 10**		
6		6	7	7	7	7		6	1	47	79.2
6		7	7	7	7	7		6	1	48	80.9
6		6	6	6	6	6	6	6	1	49	82.5
6		6	6	6	6	7	6	6	1	50	84.2
6		6	6	6	7	7	6	6	1	51	85.9
6		6	6	6	7	7	6	7	1	52	87.6
6		6	6	7	7	7	6	7	1	53	89.3
6		6	7	7	7	7	6	7	1	54	91.0
6		7	7	7	7	7	6	7	1	55	92.7

Table IHR- 9 (pg 1 of 2). Ice Harbor Dam Spill Pattern - RSW 30%. Revised May 17, 2011.

Ice Harbor Dam Spill Pattern - RSW 30% Number of Gate Stops per Spillbay										Total # of Stops	Total Spill* (kcfs)	Total River (kcfs)
Bay 1	**Bay 2**	**Bay 3**	**Bay 4**	**Bay 5**	**Bay 6**	**Bay 7**	**Bay 8**	**Bay 9**	**Bay 10**			
0	RSW	0	0	0	0	0	0	0	0	**0**	**8.4**	**28.0**
0	RSW	0	0	0	0	0	0	0	1	**1**	**10.1**	**33.7**
0	RSW	0	0	0	0	0	0	1	1	**2**	**11.8**	**39.3**
0	RSW	0	0	0	0	0	1	1	1	**3**	**13.5**	**45.0**
0	RSW	0	0	0	0	1	1	1	1	**4**	**15.2**	**50.7**
0	RSW	0	0	0	1	1	1	1	1	**5**	**16.9**	**56.3**
0	RSW	5	0	0	0	0	0	0	1	**6**	**18.6**	**62.0**
0	RSW	5	0	0	0	0	0	1	1	**7**	**20.3**	**67.7**
0	RSW	5	0	0	0	0	1	1	1	**8**	**22.0**	**73.3**
0	RSW	5	0	0	0	1	1	1	1	**9**	**23.7**	**79.0**
0	RSW	5	0	0	1	1	1	1	1	**10**	**25.4**	**84.7**
0	RSW	5	0	5	0	0	0	0	1	**11**	**27.1**	**90.3**
0	RSW	5	0	5	0	0	0	1	1	**12**	**28.8**	**96.0**
0	RSW	5	0	5	0	0	1	1	1	**13**	**30.5**	**101.7**
0	RSW	5	0	5	0	0	1	1	2	**14**	**32.2**	**107.3**
0	RSW	5	0	5	0	0	1	2	2	**15**	**33.9**	**113.0**
0	RSW	5	0	5	0	0	2	2	2	**16**	**35.6**	**118.7**
0	RSW	6	0	5	0	0	2	2	2	**17**	**37.3**	**120.4**
0	RSW	6	0	6	0	0	2	2	2	**18**	**39.0**	**122.1**
0	RSW	6	0	6	0	1	2	2	2	**19**	**40.7**	**123.8**
0	RSW	6	0	6	0	2	2	2	2	**20**	**42.4**	**125.5**
0	RSW	5	0	5	0	5	2	2	2	**21**	**44.1**	**127.2**
0	RSW	5	0	5	0	6	2	2	2	**22**	**45.8**	**128.9**
0	RSW	5	0	6	0	6	2	2	2	**23**	**47.5**	**130.6**
0	RSW	6	0	6	0	6	2	2	2	**24**	**49.2**	**132.3**
0	RSW	6	0	6	0	6	2	3	2	**25**	**50.9**	**134.0**
0	RSW	6	0	6	0	6	2	4	2	**26**	**52.6**	**135.7**
0	RSW	6	0	6	0	6	2	5	2	**27**	**54.3**	**137.4**
0	RSW	6	0	6	0	6	2	6	2	**28**	**56.0**	**139.1**
0	RSW	6	0	6	1	6	2	6	2	**29**	**57.7**	**140.8**
0	RSW	6	0	6	2	6	2	6	2	**30**	**59.4**	**142.5**
0	RSW	6	0	6	3	6	2	6	2	**31**	**61.1**	**144.2**
0	RSW	6	0	6	4	6	2	6	2	**32**	**62.8**	**145.9**
0	RSW	6	0	6	5	6	2	6	2	**33**	**64.5**	**147.6**
0	RSW	6	0	6	6	6	2	6	2	**34**	**66.2**	**149.3**
0	RSW	6	0	6	6	6	3	6	2	**35**	**67.9**	**151.0**
0	RSW	6	0	6	6	6	4	6	2	**36**	**69.6**	**152.7**
0	RSW	6	0	6	6	6	5	6	2	**37**	**71.3**	**154.4**
0	RSW	6	0	6	6	6	6	6	2	**38**	**73.0**	**156.1**
0	RSW	6	1	6	6	6	6	6	2	**39**	**74.7**	**157.8**
0	RSW	6	2	6	6	6	6	6	2	**40**	**76.4**	**159.5**
0	RSW	6	3	6	6	6	6	6	2	**41**	**78.1**	**161.2**
0	RSW	6	4	6	6	6	6	6	2	**42**	**79.8**	**162.9**

Ice Harbor Dam Spill Pattern - RSW 30% Number of Gate Stops per Spillbay										Total # of Stops	Total Spill* (kcfs)	Total River (kcfs)
Bay 1	**Bay 2**	**Bay 3**	**Bay 4**	**Bay 5**	**Bay 6**	**Bay 7**	**Bay 8**	**Bay 9**	**Bay 10**			
0	RSW	6	5	6	6	6	6	6	2	**43**	**81.5**	**164.6**
0	RSW	6	6	6	6	6	6	6	2	**44**	**83.2**	**166.3**
0	RSW	7	6	6	6	6	6	6	2	**45**	**84.9**	**168.0**
0	RSW	7	7	6	6	6	6	6	2	**46**	**86.6**	**169.7**
0	RSW	7	7	7	6	6	6	6	2	**47**	**88.3**	**171.4**
0	RSW	7	7	7	7	6	6	6	2	**48**	**90.0**	**173.1**
0	RSW	7	7	7	7	7	6	6	2	**49**	**91.7**	**174.8**
0	RSW	7	7	7	7	7	7	6	2	**50**	**93.4**	**176.5**
0	RSW	8	7	7	7	7	7	7	2	**51**	**95.1**	**178.2**
0	RSW	8	7	7	7	7	7	7	2	**52**	**96.8**	**179.9**
0	RSW	8	8	7	7	7	7	7	2	**53**	**98.5**	**181.6**
0	RSW	8	8	8	7	7	7	7	2	**54**	**100.2**	**183.3**
0	RSW	8	8	8	8	7	7	7	2	**55**	**101.9**	**185.0**
0	RSW	8	8	8	8	8	7	7	2	**56**	**103.6**	**186.7**
0	RSW	8	8	8	8	8	8	7	2	**57**	**105.3**	**188.4**
0	RSW	8	8	8	8	8	8	8	2	**58**	**107.0**	**190.1**
0	RSW	9	8	8	8	8	8	8	2	**59**	**108.7**	**191.8**
0	RSW	9	9	8	8	8	8	8	2	**60**	**110.4**	**193.5**
0	RSW	9	9	9	8	8	8	8	2	**61**	**112.1**	**195.2**
0	RSW	9	9	9	9	8	8	8	2	**62**	**113.8**	**196.9**
0	RSW	9	9	9	9	9	8	8	2	**63**	**115.5**	**198.6**
0	RSW	9	9	9	9	9	9	8	2	**64**	**117.2**	**200.3**
0	RSW	9	9	9	9	9	9	9	2	**65**	**118.9**	**202.0**
0	RSW	10	9	9	9	9	9	9	2	**66**	**120.6**	**203.7**
0	RSW	10	10	9	9	9	9	9	2	**67**	**122.3**	**205.4**
0	RSW	10	10	10	9	9	9	9	2	**68**	**124.0**	**207.1**
0	RSW	10	10	10	10	9	9	9	2	**69**	**125.7**	**208.8**
0	RSW	10	10	10	10	10	9	9	2	**70**	**127.4**	**210.5**
0	RSW	10	10	10	10	10	10	9	2	**71**	**129.1**	**212.2**
0	RSW	10	10	10	10	10	10	10	2	**72**	**130.8**	**213.9**
0	RSW	11	10	10	10	10	10	10	2	**73**	**132.5**	**215.6**
0	RSW	11	11	10	10	10	10	10	2	**74**	**134.2**	**217.3**
0	RSW	11	11	11	10	10	10	10	2	**75**	**135.9**	**219.0**
0	RSW	11	11	11	11	10	10	10	2	**76**	**137.6**	**220.7**
0	RSW	11	11	11	11	11	10	10	2	**77**	**139.3**	**222.4**
0	RSW	11	11	11	11	11	11	10	2	**78**	**141.0**	**224.1**
0	RSW	11	11	11	11	11	11	11	2	**79**	**142.7**	**225.8**
0	RSW	12	11	11	11	11	11	11	2	**80**	**144.4**	**227.5**
0	RSW	12	12	11	11	11	11	11	2	**81**	**146.1**	**229.2**
0	RSW	12	12	12	11	11	11	11	2	**82**	**147.8**	**230.9**
0	RSW	12	12	12	12	11	11	11	2	**83**	**149.5**	**232.6**
0	RSW	12	12	12	12	12	11	11	2	**84**	**151.2**	**234.3**

* **Note**: The normal minimum spill rate is 15.2 kcfs.

Table IHR- 10 (pg 1 of 3). Ice Harbor Dam Spill Pattern - RSW 45 kcfs/Spill Cap.

Ice Harbor Dam Spill Pattern - RSW 45 kcfs/Spill Cap Number of Gate Stops per Spillbay										Total Stops	Total Spill (kcfs)
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	Bay 9	Bay 10		
0	RSW	0	0	0	0	0	0	0	0	0	8.4
0	RSW	0	0	0	0	0	0	0	1	1	10.1
0	RSW	0	0	0	0	0	0	1	1	2	11.8
0	RSW	0	0	0	0	0	1	1	1	3	13.5
0	RSW	0	0	0	0	1	1	1	1	4	15.2
0	**RSW**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**5**	**17**
0	RSW	0	5	0	0	0	0	0	1	6	18.6
0	RSW	0	5	0	0	0	0	1	1	7	20.3
0	RSW	0	5	0	0	0	1	1	1	8	22
0	RSW	0	5	0	0	1	1	1	1	9	23.7
0	**RSW**	**0**	**5**	**0**	**5**	**0**	**0**	**0**	**0**	**10**	**25.3**
0	RSW	0	5	0	5	0	0	0	1	11	27
0	RSW	0	5	0	5	0	0	1	1	12	28.7
0	RSW	0	5	0	5	0	1	1	1	13	30.4
0	RSW	0	5	0	5	1	1	1	1	14	32.1
0	**RSW**	**0**	**5**	**0**	**5**	**1**	**1**	**1**	**2**	**15**	**33.8**
0	RSW	0	5	0	5	1	1	2	2	16	35.5
0	RSW	0	5	0	5	1	2	2	2	17	37.2
0	RSW	0	5	0	5	2	2	2	2	18	38.9
0	RSW	0	5	0	5	2	2	2	3	19	40.6
0	**RSW**	**0**	**5**	**0**	**5**	**2**	**2**	**3**	**3**	**20**	**42.3**
0	RSW	0	5	0	5	5	2	2	2	21	44
0	RSW	0	6	0	5	5	2	2	2	22	45.6
0	RSW	0	6	0	6	5	2	2	2	23	47.3
0	RSW	0	6	0	6	6	2	2	2	24	48.9
0	**RSW**	**0**	**6**	**5**	**5**	**5**	**1**	**1**	**2**	**25**	**50.7**
0	RSW	0	6	5	5	5	1	2	2	26	52.4
0	RSW	0	6	5	5	5	2	2	2	27	54.1
0	RSW	0	6	6	5	5	2	2	2	28	55.7
0	RSW	0	6	6	5	5	2	3	2	29	57.4
0	**RSW**	**0**	**6**	**6**	**5**	**5**	**2**	**4**	**2**	**30**	**59.1**
0	RSW	0	6	6	5	5	2	5	2	31	60.7
0	RSW	0	6	6	5	5	3	5	2	32	62.4
0	RSW	0	6	6	5	5	4	5	2	33	64.1
0	RSW	0	6	6	5	5	5	5	2	34	65.8
0	**RSW**	**1**	**6**	**6**	**5**	**5**	**5**	**5**	**2**	**35**	**67.5**
0	RSW	2	6	6	5	5	5	5	2	36	69.2
0	RSW	3	6	6	5	5	5	5	2	37	70.9
0	RSW	4	6	6	5	5	5	5	2	38	72.6
0	RSW	5	6	6	5	5	5	5	2	39	74.2
0	**RSW**	**6**	**6**	**6**	**5**	**5**	**5**	**5**	**2**	**40**	**75.9**
0	RSW	6	6	6	6	5	5	5	2	41	77.5

Ice Harbor Dam Spill Pattern - RSW 45 kcfs/Spill Cap Number of Gate Stops per Spillbay										Total Stops	Total Spill (kcfs)
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	Bay 9	Bay 10		
0	RSW	6	6	6	6	6	5	5	2	42	79.2
0	RSW	6	6	6	6	6	6	5	2	43	80.9
0	RSW	6	6	6	6	6	6	6	2	44	82.5
0	**RSW**	**7**	**6**	**6**	**6**	**6**	**6**	**6**	**2**	**45**	**84.1**
0	RSW	7	7	6	6	6	6	6	2	46	85.7
0	RSW	7	7	7	6	6	6	6	2	47	87.3
0	RSW	7	7	7	7	6	6	6	2	48	88.9
0	RSW	7	7	7	7	7	6	6	2	49	90.5
0	**RSW**	**7**	**7**	**7**	**7**	**7**	**7**	**6**	**2**	**50**	**92.1**
0	RSW	7	7	7	7	7	7	7	2	51	93.7
0	RSW	8	7	7	7	7	7	7	2	52	95.3
0	RSW	8	8	7	7	7	7	7	2	53	96.9
0	RSW	8	8	8	7	7	7	7	2	54	98.5
0	**RSW**	**8**	**8**	**8**	**8**	**7**	**7**	**7**	**2**	**55**	**100.1**
0	RSW	8	8	8	8	8	7	7	2	56	101.7
0	RSW	8	8	8	8	8	8	7	2	57	103.3
0	RSW	8	8	8	8	8	8	8	2	58	104.9
0	RSW	9	8	8	8	8	8	8	2	59	106.6
0	**RSW**	**9**	**9**	**8**	**8**	**8**	**8**	**8**	**2**	**60**	**108.3**
0	RSW	9	9	9	8	8	8	8	2	61	110.0
0	RSW	9	9	9	9	8	8	8	2	62	111.7
0	RSW	9	9	9	9	9	8	8	2	63	113.4
0	RSW	9	9	9	9	9	9	8	2	64	115.2
0	**RSW**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**2**	**65**	**116.9**
0	RSW	10	9	9	9	9	9	9	2	66	118.4
0	RSW	10	10	9	9	9	9	9	2	67	119.9
0	RSW	10	10	10	9	9	9	9	2	68	121.4
0	RSW	10	10	10	10	9	9	9	2	69	122.9
0	**RSW**	**10**	**10**	**10**	**10**	**10**	**9**	**9**	**2**	**70**	**124.4**
0	RSW	10	10	10	10	10	10	9	2	71	125.9
0	RSW	10	10	10	10	10	10	10	2	72	127.4
0	RSW	11	10	10	10	10	10	10	2	73	129.1
0	RSW	11	11	10	10	10	10	10	2	74	130.8
0	**RSW**	**11**	**11**	**11**	**10**	**10**	**10**	**10**	**2**	**75**	**132.5**
0	RSW	11	11	11	11	10	10	10	2	76	134.2
0	RSW	11	11	11	11	11	10	10	2	77	135.9
0	RSW	11	11	11	11	11	11	10	2	78	137.6
0	RSW	11	11	11	11	11	11	11	2	79	139.3
0	**RSW**	**12**	**11**	**11**	**11**	**11**	**11**	**11**	**2**	**80**	**140.8**
0	RSW	12	12	12	11	11	11	11	2	82	143.8
0	RSW	12	12	12	12	11	11	11	2	83	145.3
0	RSW	12	12	12	12	12	11	11	2	84	146.8
0	**RSW**	**12**	**12**	**12**	**12**	**12**	**12**	**11**	**2**	**85**	**148.3**

Ice Harbor Dam Spill Pattern - RSW 45 kcfs/Spill Cap Number of Gate Stops per Spillbay										Total Stops	Total Spill (kcfs)
Bay 1	**Bay 2**	**Bay 3**	**Bay 4**	**Bay 5**	**Bay 6**	**Bay 7**	**Bay 8**	**Bay 9**	**Bay 10**		
0	RSW	12	12	12	12	12	12	12	2	86	149.8
0	RSW	13	12	12	12	12	12	12	2	87	151.4
0	RSW	13	13	12	12	12	12	12	2	88	153.0
0	RSW	13	13	13	12	12	12	12	2	89	154.6
0	**RSW**	**13**	**13**	**13**	**13**	**12**	**12**	**12**	**2**	**90**	**156.2**
0	RSW	13	13	13	13	13	12	12	2	91	157.8
0	RSW	13	13	13	13	13	13	12	2	92	159.4
0	RSW	13	13	13	13	13	13	13	2	93	161.0
0	RSW	14	13	13	13	13	13	13	2	94	162.6
0	**RSW**	**14**	**14**	**13**	**13**	**13**	**13**	**13**	**2**	**95**	**164.2**
0	RSW	14	14	14	13	13	13	13	2	96	165.8
0	RSW	14	14	14	14	13	13	13	2	97	167.4
0	RSW	14	14	14	14	14	13	13	2	98	169.0
0	RSW	14	14	14	14	14	14	13	2	99	170.6
0	**RSW**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**2**	**100**	**172.2**

* **Note**: The normal minimum spill rate is 15.2 kcfs. Table expanded for higher spill levels on 6/7/2010.