2022 Fish Passage Plan

Chapter 2 – Bonneville Dam

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Bonneville Dam *

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

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

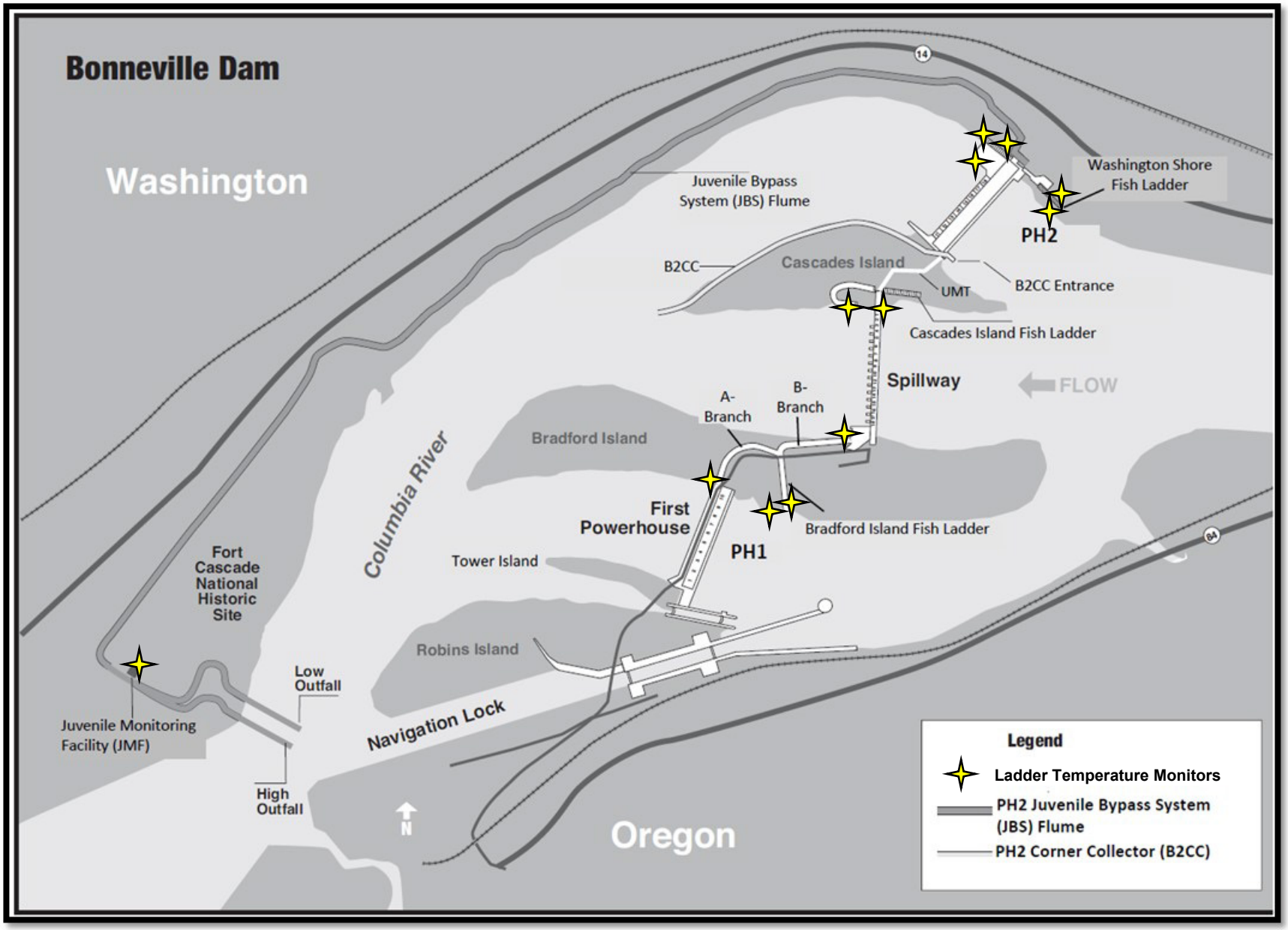


Figure BON-1. Bonneville Dam Overview, including Powerhouse 1 (PH1), Powerhouse 2 (PH2), Spillway, Adult Fish Ladders, PH2 Juvenile Bypass System (JBS), Corner Collector (B2CC), Juvenile Monitoring Facility (JMF) and JBS Outfall.

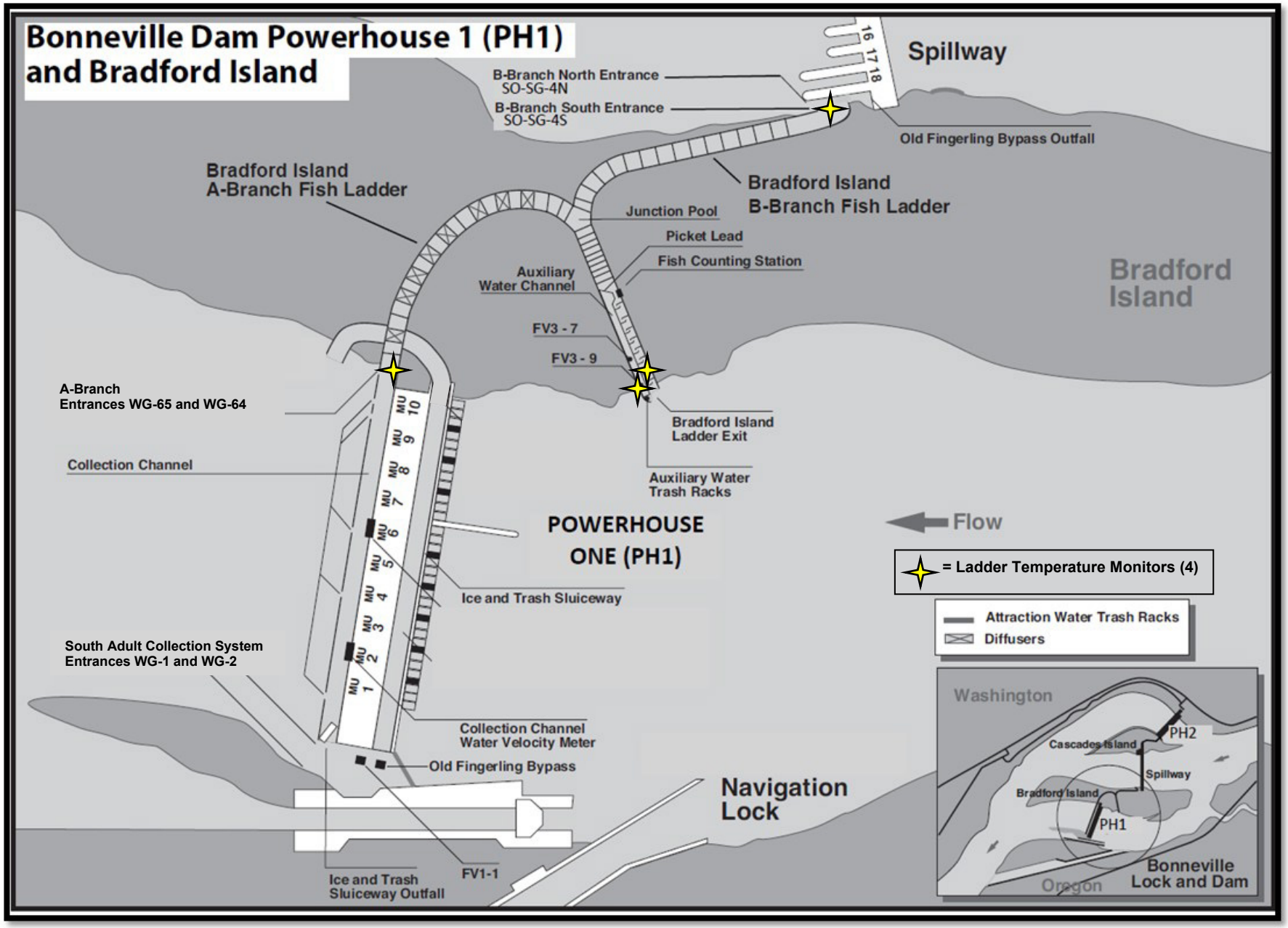


Figure BON-2. Bonneville Dam Powerhouse 1 (PH1) and Bradford Island Adult Fish Ladder A-Branch and B-Branch.

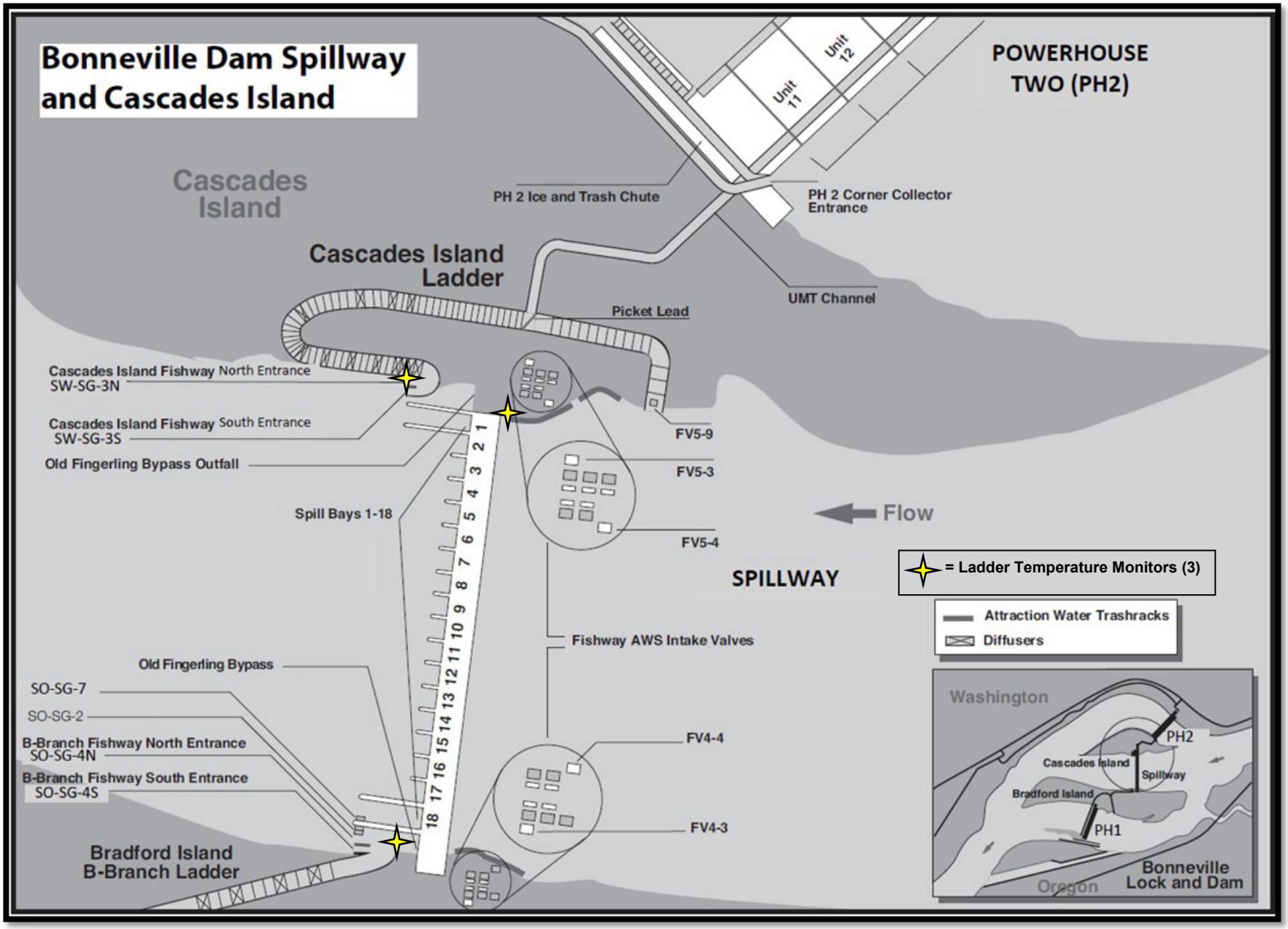


Figure BON-3. Bonneville Dam Spillway, Cascades Island Fish Ladder and Upstream Migrant Transportation (UMT) Channel.

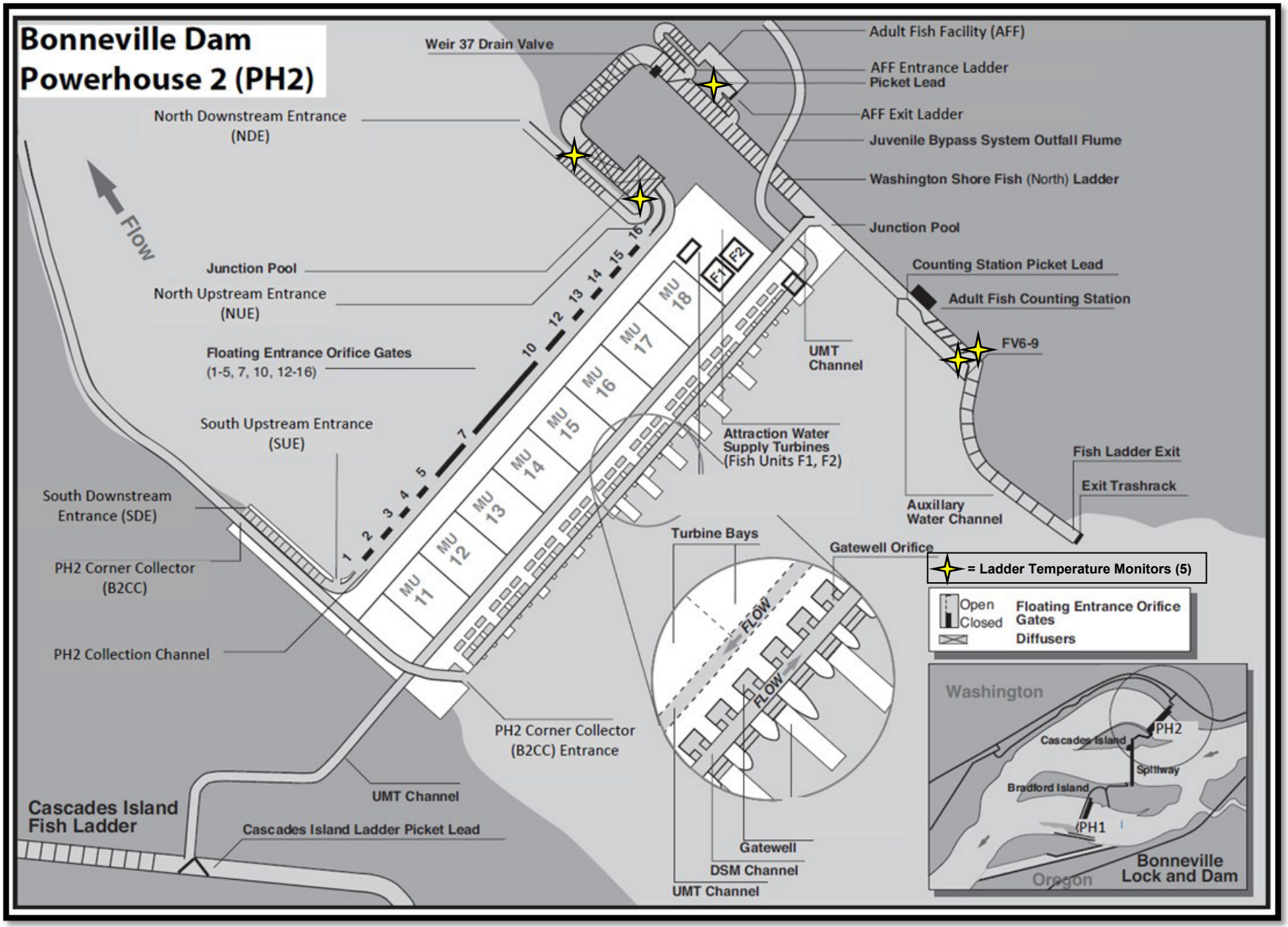


Figure BON-4. Bonneville Dam Powerhouse 2 (PH2) and Washington Shore (WS) North Fish Ladder.

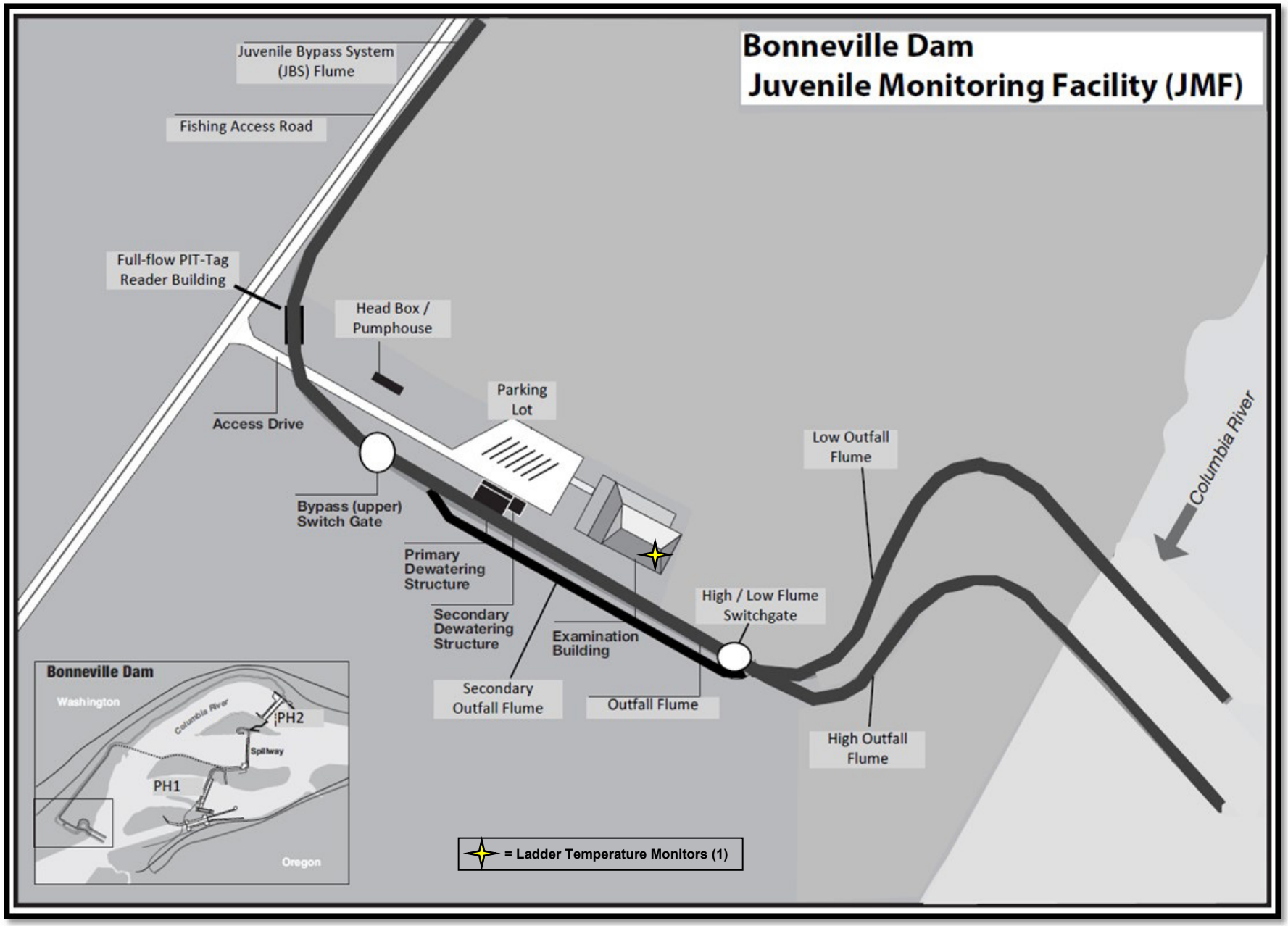
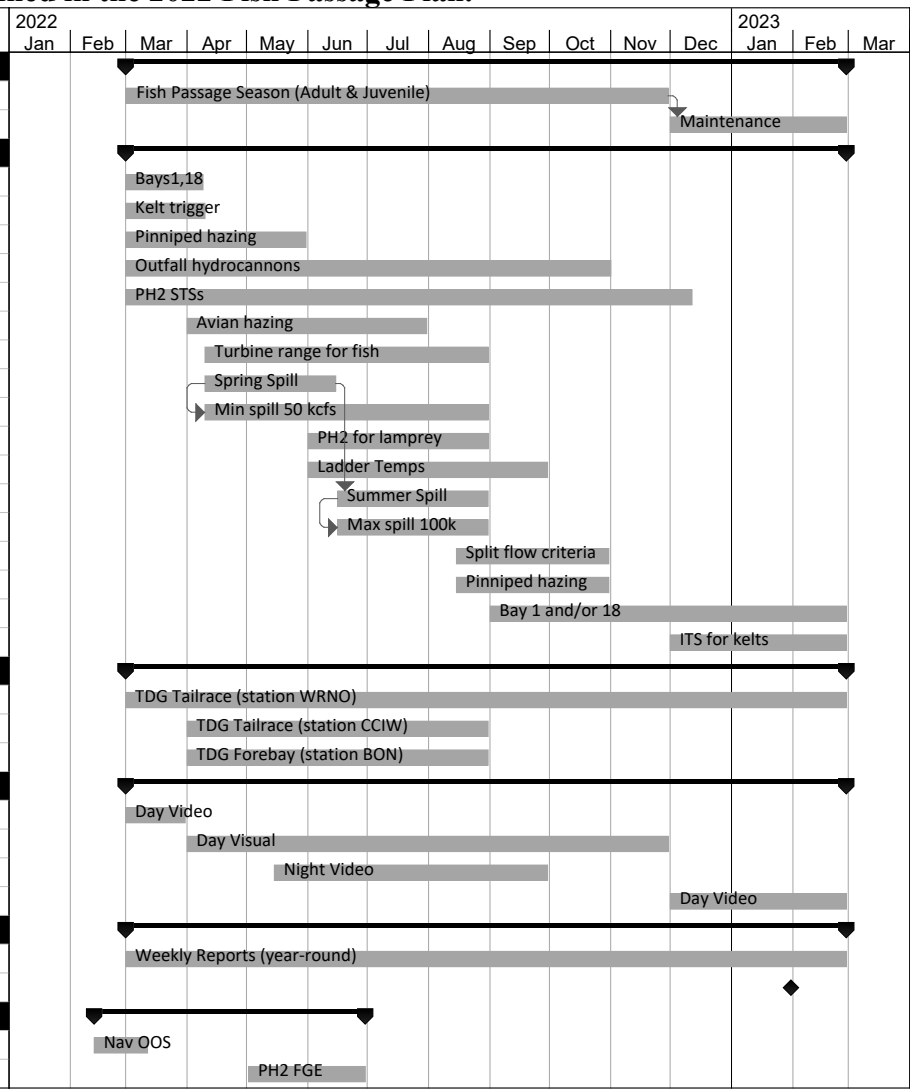


Figure BON-5. Bonneville Dam Juvenile (Smolt) Monitoring Facility (JMF) and Outfall Flumes.

Table BON-1. Bonneville Dam Schedule of Operations and Actions Defined in the 2022 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES (ADULT & JUVENILE)	**Tue 3/1/22**	**Tue 2/28/23**	
Fish Passage Season (Adult & Juvenile)	Tue 3/1/22	Wed 11/30/22	2.4
Winter Maintenance Period	Thu 12/1/22	Tue 2/28/23	2.3
PROJECT OPERATIONS FOR FISH PASSAGE	**Tue 3/1/22**	**Tue 2/28/23**	
Spillbays 1,18 for adult attraction	Tue 3/1/22	Sat 4/9/22	2.2.4
B2CC Kelt trigger	Tue 3/1/22	Sun 4/10/22	2.3.2.5.v
Pinniped hazing	Tue 3/1/22	Tue 5/31/22	Appendix L
Operate outfall hydrocannons	Tue 3/1/22	Tue 11/1/22	2.3.2.6
PH2 STS operation	Tue 3/1/22	Mon 12/12/22	2.3.2.5.a
Avian hazing	Fri 4/1/22	Sun 7/31/22	App L 3.2
Turbine operating range for fish passage	Sun 4/10/22	Wed 8/31/22	4.2
Spring Spill	Sun 4/10/22	Wed 6/15/22	App E (FOP)
Min spill 50 kcfs for juvenile egress	Sun 4/10/22	Wed 8/31/22	2.2.1
Reduced nighttime PH2 FU output for lamprey	Wed 6/1/22	Wed 8/31/22	2.4.2.13
Ladder Temperature Monitoring	Wed 6/1/22	Fri 9/30/22	2.4.2.11
Summer Spill	Thu 6/16/22	Wed 8/31/22	App E (FOP)
Day spill <=100 kcfs when PH1 operating	Thu 6/16/22	Wed 8/31/22	2.2.4
Split flow criteria	Mon 8/15/22	Mon 10/31/22	2.1.5
Pinniped Hazing	Mon 8/15/22	Mon 10/31/22	App L 3.5
Spillbays 1 and/or 18 for adult attraction	Thu 9/1/22	Tue 2/28/23	2.2.4
PH1 ITS gates for kelt passage	Thu 12/1/22	Tue 2/28/23	2.4.1.12
TDG MONITORING	**Tue 3/1/22**	**Tue 2/28/23**	
TDG Monitoring - Tailrace (WRNO)	Tue 3/1/22	Tue 2/28/23	2.2.3
TDG Monitoring - Tailrace (CCIW)	Fri 4/1/22	Wed 8/31/22	2.2.3
TDG Monitoring - Forebay (BON)	Fri 4/1/22	Wed 8/31/22	2.2.3
ADULT FISH COUNTING	**Tue 3/1/22**	**Tue 2/28/23**	
Day Video 0400-2000 PST	Tue 3/1/22	Thu 3/31/22	1.2.2
Day Visual 0500-2100 PDT	Fri 4/1/22	Wed 11/30/22	1.2.2
Night Video 2100-0500 PDT	Sun 5/15/22	Fri 9/30/22	1.2.2
Day Video 0400-2000 PST	Thu 12/1/22	Tue 2/28/23	1.2.2
REPORTS	**Tue 3/1/22**	**Tue 2/28/23**	
Weekly Reports (year-round)	Tue 3/1/22	Tue 2/28/23	2.5.2
Annual Report due NLT 31-Jan	Tue 1/31/23	Tue 1/31/23	2.5.2
SPECIAL OPS & STUDIES (APPENDIX A)	**Sun 2/13/22**	**Thu 6/30/22**	
Navigation Lock Outage	Sun 2/13/22	Sat 3/12/22	App A 1.4
PH2 FGE Study (Units 14, 15) - dates TBD	Mon 5/2/22	Thu 6/30/22	App A 2.2



1. FISH PASSAGE INFORMATION

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

1.1. Juvenile Fish Passage Facilities and Migration Timing

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

i. PH1 ice and trash sluiceway (ITS).

ii. PH1 minimum gap runner (MGR) turbines.

iii. PH2 juvenile bypass system (JBS), which consists of:

- streamlined trash racks
- submersible traveling screens (STS)
- vertical bar screens (VBS)
- two 12.5" orifices per gatewell in Main Units 11-14 and Fish Unit 2
- one 12.5" orifice in all other gatewells flowing into the bypass channel
- excess water elimination facility
- one 48" fish transport pipe that connects the bypass channel to the downstream Juvenile Monitoring Facility (JMF) and the tailrace via 48" and 42" transport pipes (high and low outfall, respectively).

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

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

1.1.2. Juvenile Fish Migration. The juvenile migration season is March 1–November 30. Yearling Chinook salmon and most other juvenile salmonids migrate downstream in the spring, whereas sub-yearling Chinook salmon predominantly migrate in the summer after mid-June. Studies specific to Bonneville Dam indicate that juvenile fish survival through various passage routes differ between spring and summer. The most recent 10 years of juvenile salmonid passage timing is summarized in **Table BON-2**. Bull trout, lamprey, juvenile sturgeon, and other listed salmonids are recorded as by-catch in the Juvenile Monitoring Facility (JMF) reports. To minimize impacts on downstream migrants, maintenance of juvenile fish facilities is scheduled between December 16 and the end of February and will be coordinated to avoid or minimize potential impacts on juvenile migrants that may be present during the work.

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

Year	10%	50%	90%	# Days	10%	50%	90%	# Days
	Yearling Chinook				Subyearling Chinook* (Brights only**)			
2012	24-Apr	12-May	23-May	30	23-Jun	9-Jul	26-Jul	34
2013	28-Apr	12-May	21-May	24	29-Jun	9-Jul	16-Jul	18
2014	22-Apr	9-May	24-May	33	28-Jun	9-Jul	25-Jul	28
2015	23-Apr	8-May	22-May	30	16-Jun	4-Jul	14-Jul	29
2016	18-Apr	2-May	13-May	26	24-Jun	7-Jul	24-Jul	31
2017	16-Apr	5-May	19-May	33	20-Jun	9-Jul	21-Jul	31
2018	14-Apr	4-May	17-May	33	7-Jun	8-Jul	22-Jul	45
2019	15-Apr	7-May	23-May	38	6-Jun	22-Jun	14-Jul	38
2020	20-Apr	7-May	21-May	31	8-Jun	4-Jul	27-Jul	49
2021	19-Apr	8-May	23-May	34	15-Apr	25-Apr	7-Jul	83
10-Yr MEDIAN	**20-Apr**	**9-May**	**23-May**	**34**	**15-Jun***	**29-Jun***	**19-Jul***	**35***
10-Yr MIN	**14-Apr**	**2-May**	**13-May**	**24**	**6-Jun***	**22-Jun***	**14-Jul***	**30***
10-Yr MAX	**28-Apr**	**18-May**	**6-Jun**	**44**	**21-Jun***	**9-Jul***	**15-Aug***	**70***
	Unclipped Steelhead				Clipped Steelhead			
2012	26-Apr	11-May	29-May	34	29-Apr	10-May	28-May	30
2013	22-Apr	12-May	3-Jun	43	28-Apr	9-May	28-May	31
2014	22-Apr	10-May	28-May	37	2-May	12-May	23-May	22
2015	30-Apr	18-May	29-May	30	4-May	11-May	25-May	22
2016	18-Apr	5-May	22-May	35	29-Apr	5-May	19-May	21
2017	24-Apr	10-May	30-May	36	22-Apr	5-May	20-May	28
2018	22-Apr	9-May	29-May	37	21-Apr	2-May	29-May	38
2019	23-Apr	8-May	29-May	36	22-Apr	4-May	19-May	27
2020	29-Apr	11-May	28-May	29	30-Apr	8-May	20-May	20
2021	30-Apr	15-May	3-Jun	34	28-Apr	6-May	20-May	22
10-Yr MEDIAN	**25-Apr**	**13-May**	**30-May**	**36**	**29-Apr**	**12-May**	**28-May**	**30**
10-Yr MIN	**17-Apr**	**5-May**	**22-May**	**26**	**21-Apr**	**2-May**	**19-May**	**19**
10-Yr MAX	**5-May**	**27-May**	**9-Jun**	**45**	**8-May**	**30-May**	**12-Jun**	**41**
	Coho				Sockeye (Wild & Hatchery)			
2012	26-Apr	18-May	7-Jun	43	9-May	14-May	23-May	15
2013	16-Apr	14-May	1-Jun	47	14-May	20-May	26-May	13
2014	25-Apr	12-May	28-May	34	15-May	22-May	30-May	16
2015	15-Apr	9-May	28-May	44	14-May	22-May	29-May	16
2016	13-Apr	2-May	19-May	37	5-May	11-May	20-May	16
2017	8-Apr	28-Apr	23-May	45	22-Apr	15-May	25-May	33
2018	16-Apr	6-May	24-May	38	7-May	14-May	23-May	16
2019	19-Apr	10-May	2-Jun	44	5-May	22-May	1-Jun	27
2020	27-Apr	7-May	30-May	33	14-May	23-May	31-May	17
2021	30-Apr	8-May	30-May	30	9-May	19-May	29-May	20
10-Yr MEDIAN	**25-Apr**	**13-May**	**30-May**	**36**	**13-May**	**22-May**	**1-Jun**	**20**
10-Yr MIN	**8-Apr**	**28-Apr**	**19-May**	**20**	**22-Apr**	**11-May**	**20-May**	**13**
10-Yr MAX	**15-May**	**24-May**	**9-Jun**	**47**	**3-Jun**	**10-Jun**	**4-Jun**	**34**

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

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

1.2. Adult Fish Passage Facilities and Migration Timing

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

i. Bradford Island (Figure BON-2) is formed by the PH1 collection channel and Bradford Island A-branch ladder that join the B-branch (south spillway) ladder at the Bradford Island junction pool. The Bradford Island fishway has a counting station and auxiliary water supplies for attraction flow.

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

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

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

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

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

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

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

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

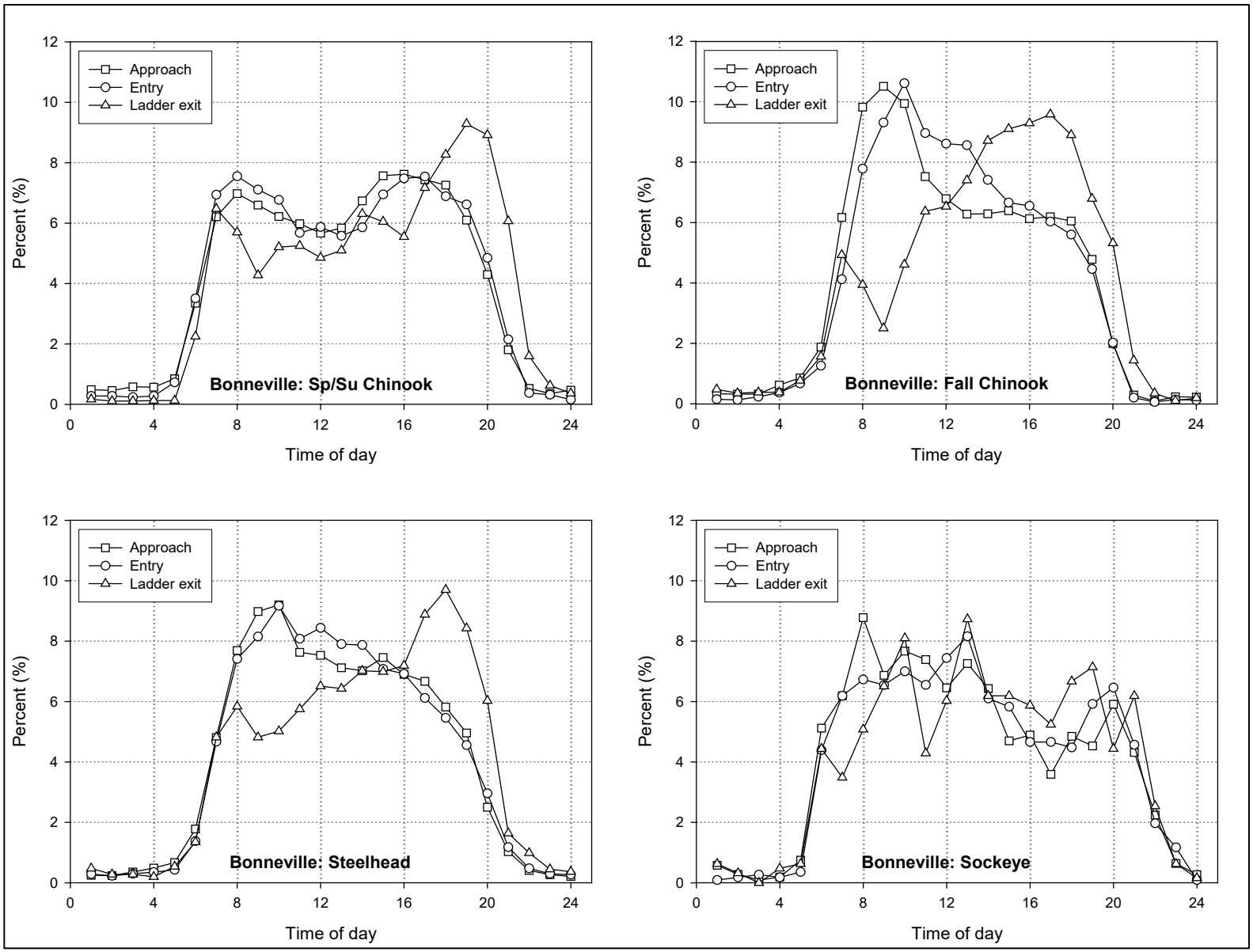


Figure BON-6. Diel Distribution of Adult Salmonids at Bonneville Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATION

2.1. General

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

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

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

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

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

> **2.1.5.1.a.** Before August 31, if adult and jack salmonid counts equal or exceed 30,000 fish/day, Project Fisheries will initiate coordination with FPOM to discuss options for splitting flow between powerhouses to balance attraction flow and adult passage among the project's fishways.
>
> **2.1.5.1.b.** After August 31, when adult and jack salmonid counts equal or exceed 25,000 fish/day, the Project will operate two or more priority turbines at PH1 in an attempt to balance adult passage between both powerhouses (assuming no PH1 units are already operating). While PH2 is still priority, Project Fisheries, at their discretion, may shift additional unit flow up to half the combined powerhouse flow, to PH1 as necessary to alleviate adult fishway crowding. This operation will continue until adult and jack salmonid counts fall below 20,000 fish/day.

2.2. Spill Management

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the FPP as **Appendix E**. Spill patterns are in **Table BON-16**. Spill changes will be made through regional coordination at TMT. From April 10–August 31, minimum spill is 50 kcfs to provide acceptable tailrace conditions for juvenile fish egress. However, during extreme low flow conditions, lower spill levels may be considered and coordinated through TMT. There is no minimum spill level September 1–April 9. See the FOP (**Appendix E**) for more information.

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

2.2.3. Excessive total dissolved gas (TDG) may harm fish and will be controlled to the extent possible, subject to river conditions. Management tools include system-wide spill distribution through the Spill Priority List issued by the Corps Northwestern Division Reservoir Control Center (RCC), night and/or day spill limits, and shaping of spill. Night spill is limited as necessary to control TDG, and adjustments may be granted on a case-by-case basis by the RCC, dependent upon TDG monitoring at stations downstream of the dam, biological monitoring, and fish movement. Monitoring of TDG at Bonneville Dam occurs during the periods defined in **Table BON-1**, pursuant to the Corps' annual *TDG Management Plan* and the current *Dissolved Gas Monitoring Plan of Action*.[2] Starting March 1, TDG at Cascades Island will be reported every 4 hours, as well as the spill rate and total project outflow.

2.2.4. Day/Night Spill.

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

2.2.4.2. The transition between Day and Night spill will normally take 15–20 minutes due to the time required to start, synchronize, and load multiple generators. Transition to Day spill will begin after the Night period is over. Frequently, a change in total river flow will occur concurrently with these transitions. The transition to Night spill should begin early enough to minimize the chance of violating the established Night spill maximum for TDG.

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

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

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

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

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

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

2.3. Operating Criteria - Juvenile Fish Facilities

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

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

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

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

2.3.1.4. Powerhouse Two (PH2).

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

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

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

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

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

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

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

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

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

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

2.3.1.5. Spillway.

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

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

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

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

2.3.2.1. Measure main unit gatewell drawdown at least once per week. Remove debris from forebay and trashracks as required to maintain less than 1.5' of total drawdown in gatewells.

2.3.2.2. A slight oily sheen is common in many gatewells from sources such as lubricated lifting beams, etc. Remove any unusual accumulations of oil (e.g., oil slick) in gate slots within 24 hours. Determine appropriate procedures to remove fish during this situation in coordination with FPOM. Promptly deal with oil accumulations, regardless of unit operating status.

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

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

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

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

2.3.2.5. Powerhouse Two (PH2).

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

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

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

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

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

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

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

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

2.3.2.5.i. Inspect VBSs immediately prior to peaks in juvenile fish migration, which begin about May 1, mid-July, and September 1.

2.3.2.5.j. More frequent inspections may be required by the Project Biologist if there are any indications of STS or VBS malfunction or failure (e.g., deteriorating fish condition) or during periods of increased debris in the bypass system.

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

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

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

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

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

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

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

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

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

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

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

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

2.3.2.5.r. Gatewell Cleaning.

i. Clean gatewells before the water surface becomes 50% covered with debris. If due to the volume of debris it is not possible to keep the gatewell surface at least 50% clear of debris, clean at least once daily.

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

iii. Close gatewell orifices during the cleaning operations.

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

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

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

2.3.2.5.s. Gatewell Orifice Systems.

i. Ensure all gatewell orifice systems are operational.

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

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

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

2.3.2.5.t. DSM2 Channel Screen Cleaners.

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

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

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

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

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

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

2.3.2.5.u. DSM2 Channel Elevation.

i. DSM channel elevation is maintained by a combination of add-in water, 30 non-regulating orifices, and 12 regulating orifices (Units 11-14). The add-in water provides a fixed input of 60 cfs and the non-regulating orifices are open at all forebay elevations.

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

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

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

i. March 1–April 10 (Kelt Trigger): Open the B2CC for downstream migrating steelhead kelt if 2 kelts per day are counted at the JMF adult/debris separator on 2 consecutive days and the total cumulative count since March 1 is at least 20 kelts. When the kelt trigger has been met, JMF personnel will notify Project Fisheries and the Control Room to open the B2CC within 1 hour.

ii. April 10–August 31 (FOP Spring & Summer Spill): Unless already open for kelt, open the B2CC within one hour of the start of spring spill on April 10 and operate continuously during spring and summer spill (**Appendix E**). Close the B2CC within one hour of the end of summer spill on August 31.

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

2.3.2.6. Juvenile Monitoring Facility (JMF).

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

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

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

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

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

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

2.4. Operating Criteria - Adult Fish Facilities

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

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

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

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

2.4.1.4. One of the two spillway ladders will always be in full operation unless otherwise coordinated.

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

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

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

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

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

2.4.1.10. Inspect ladder exits and clear of debris.

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

2.4.1.12. Except when closed to facilitate maintenance activities, operate the PH1 ITS gates 1A, 1B, 3B, 6C, and 10B from December 1 through the end of February for steelhead kelt passage. Set chain gate 1A and 1B at 70' msl. Operate gates 3B, 6C, and 10B according to **Table BON-6**. From December 15 through end of February, the Project may close the ITS end gate or ITS gates for winter maintenance (including researcher equipment O&M). Closures may not exceed six hours per day unless otherwise coordinated with FPOM.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2.4.2.7. Maintain water velocity between 1.5 feet per second (fps) and 4 fps (2 fps preferred) for the full length of the powerhouse collection channel and the lower ends of the fish ladders that are below tailwater. Measure water velocities once per week during fishway inspections to verify channels are operating between 1.5 and 4 fps. If the velocity reading is out of criteria, weekly readings will increase to three times a week until proper conditions are met.

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

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

2.4.2.10. Fish Counting.

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

ii. Crowder ranges at BON are:

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

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

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

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

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

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

2.4.2.11. Fishway Temperature Monitoring.

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

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

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

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

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

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

2.4.2.12. Powerhouse One (PH1).

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

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

ii. Fish Valve FV1-1.

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

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

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

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

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

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

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

Table BON-7. Bonneville Dam Powerhouse One (PH1) Weir Gate Requirements.

Weir Gate	Submergence Requirement (ft)	Differential Requirement (ft)	Sill Elevation (ft)
1	> 8	1 – 2	8.5
2	> 8	1 – 2	2.0
64	8.0 – 8.4	1 – 2	2.0
65	8.0 – 8.4	1 – 2	8.5

Table BON-8. Bradford Island A-branch Fish Ladder Diffuser Operating Ranges.

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

Table BON-9. Bradford Island B-Branch Fish Ladder Diffuser Operating Ranges.

Diffuser	Operating Range (ft)	Diffuser	Operating Range (ft)	Diffuser	Operating Range (ft)
FG3-18	> 34	FG3-23	> 19	FG3-28	< 25
FG3-19	> 31	FG3-24	> 16	FG3-29	Manual open
FG3-20	> 28	FG3-25	13–34	FG3-30	Manual open
FG3-21	> 25	FG3-26	12–31	FG3-31	> 25
FG3-22	> 22	FG3-27	10.5–28.0	FG3-32	> 26
				FG3-33	> 27

Table BON-10. Cascades Island Fish Ladder Diffuser Operating Ranges.

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

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

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

2.4.2.13. Powerhouse Two (PH2).

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

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

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

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

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

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

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

2.5.1. Monitoring.

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

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

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

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

2.5.1.5. Continue to implement the zebra mussel monitoring program. These organisms are a serious problem elsewhere in the country and may become introduced into the Columbia River basin. Inspections should also be made when dewatering project facilities.

2.5.2. Reporting.

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

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

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

iii. Adult fishway control calibrations.

iv. STS and VBS inspections.

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

vi. When trapping is occurring in the AFF.

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

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

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

3. FISH FACILITIES MAINTENANCE

3.1. Fish Facilities Routine Maintenance

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

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

3.1.3. Submersible Traveling Screens (STS).

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

ii. Whenever a generator malfunctions or is scheduled for maintenance, the three STSs in that turbine may be maintained, repaired, or exchanged for other STSs needing maintenance or repair.

iii. One third of the STSs at Bonneville are scheduled for complete overhaul each year resulting in a three-year maintenance cycle unless future developments indicate that longer life expectancy is possible.

3.1.4. Juvenile Bypass Systems (JBS).

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

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

iii. During the winter maintenance period, systems may be dewatered downstream of the gatewell orifices, then visually inspected in all accessible areas for damaged equipment and in areas that may cause problems to juvenile fish. Any problem areas identified will be repaired if the project is able. In extreme cases, the work will be contracted as soon as possible or repaired during the next winter maintenance period. Channel modifications and general maintenance also should be completed at this time.

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

3.1.5. Turbines and Spillbays.

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

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

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

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

3.1.6. Adult Fish Collection Systems.

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

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

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

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

v. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser

gratings are normally checked during the winter maintenance period to confirm they are in place, either by dewatering the fish passageway and physically inspecting the diffuser gratings, or by other methods.

vi. Diffuser gratings may come loose during fish passage season. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings. If a diffuser grating is known to or suspected of having moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway. If possible, a video inspection should be made ASAP to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and tribes through the established FPOM coordination procedure. Repairs will be made as quickly as possible unless coordinated differently.

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

3.1.7. Adult Fish Ladders & Counting Stations.

i. Also see *Adult Fish Trapping Protocols* in **Appendix G**. Adult ladders will be dewatered once each year during winter maintenance. During this time, ladders will be inspected for blocked orifices, projections into the fishway that may injure fish, weir stability, damaged picket leads, exit gate problems, loose diffusion gratings, unreadable or damaged staff gauges, defective diffusion valves, malfunctioning counting station equipment, as well as other potential problems. Problems identified throughout the passage year that do not affect fish passage, as well as those identified during the dewatered period, may then be repaired.

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

iii. Fish count station windows, light panels, and crowder panels will be cleaned as needed to achieve accurate counts and, when practicable, during the time of day when fish passage is least affected, usually late morning.

3.2. <u>Fish Facilities Non-Routine Maintenance.</u>

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

becomes apparent that non-routine maintenance or repairs are required. The Operations Project Manager has the authority to initiate work prior to notifying CENWP-OD when delay of work will result in unsafe situations for people, property, or fish.

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

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

3.2.4. Juvenile Bypass System (JBS).

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

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

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

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

v. All STS gatewells will be inspected daily and cleaned before they become 50% covered with debris. If due to the volume of debris it is not possible to keep the gatewell surfaces at least 50% clear, they will be cleaned at least once daily. Turbines with a gatewell fully covered with debris will not be operated, except on a last-on/first-off basis if required to comply with other coordinated fish measures. This is to maintain clean orifices and minimize fish injury. The gatewell orifices will be closed during the cleaning operation. Gatewell drawdown will be checked and trashracks cleaned if necessary.

vi. If the bypass system fails in the dewatering section or release pipe, fish may be released through the emergency relief conduit. This operation will continue until repairs are completed or until the end of fish passage season. Any decision on whether to shut the system down for dewatering and repairs will be made in coordination with the FPOM. During this emergency operating mode, power generation will be minimized at PH2. Repairs will receive high priority.

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

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

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

iii. Powerhouse Two (PH2).

- If either or both fishway auxiliary water turbines do not provide sufficient water to meet full criteria, the adult facilities will be operated according to *Emergency Operations* defined in **Table BON-12**, or until a fishway head of 1' is achieved.
- If one of the fish turbines fails or is taken out of service, emergency operating criteria for turbines, floating orifices, diffuser gates, and main gates defined in **Table BON-12** will be followed to the extent practicable, and shore entrance weirs should be raised in increments or closed as needed to maintain the proper fishway head.
- From September 1 through March 31, if both fish turbines fail and cannot be repaired within 8 hours, coordination with FPOM will occur to develop operational guidelines that may include modified powerhouse priority.
- PH2 adult fishway diffusion system valves A3, A4 have been removed due to damage. These valves were designed to be closed when tailwater drops below 11' and 9', respectively. Even though the valves cannot be closed, velocity in the channel has remained in criteria.

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

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

3.2.6. Adult Fish Ladders & Counting Stations.

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

ii. Picket leads with excessive spacing (greater than 1"), concrete erosion around the leads, or missing pickets can allow fish into areas where escape is difficult. In some instances of picket lead failure, spare leads and spare installation slots are available to replace damaged leads so they can be removed and repaired. In the remaining instances of picket lead failure or concrete erosion, the timing and method of repair will depend upon the severity of the problem. The decision of whether to dewater the fishway and repair any problems will be made in coordination with FPOM.

iii. Diffuser gratings may come loose during fish passage season. Daily inspections of fish ladders and collection systems should include looking for flow changes that may indicate problems with diffuser gratings. If a diffuser grating is known to or suspected of having moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize

impacts on adult fish in the fishway. If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with FPOM. Repairs shall be made as quickly as possible unless coordinated differently.

4. TURBINE UNIT OPERATION & MAINTENANCE

4.1. Turbine Unit Priority Order

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

4.1.2. When splitting flows (**section 2.1.5**), the top two available PH1 priority units will be operated first, followed by normal PH2 unit priority. If more units are needed after all available PH2 units are operating, proceed with normal PH1 unit priority.

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

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

PERIOD / OPERATION	UNIT PRIORITY ORDER
Year-Round: Fish Ladders in service; PH1 Ladder out of service	**PH2**: 11, 18, 12, 17, 13, 14, 15, 16, **Then PH1**: 1, 10, 3, 6, 9, 4, 5, 8, 7, 2
PH2 Fish Ladder out of service	**PH1**: 1, 10, 3, 6, 9, 4, 5, 8, 7, 2, **Then PH2**: 11, 18, 12, 17, 13, 14, 15, 16
Split Flows (see **section 2.1.5**)	**PH1**: 1, 10 (or top two available PH1 priority units), **Then PH2**: 11, 18, 12, 17, 13, 14, 15, 16, **Then PH1:** 3, 6, 9, 4, 5, 8, 7, 2
PH1 Unit Priority	1, 10, 3, 6, 9, 4, 5, 8, 7, 2
PH2 Unit Priority	11, 18, 12, 17, 13, 14, 15, 16

4.2. Turbine Unit Operating Range

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

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

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

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

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

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

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

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

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

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

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

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

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

2. Then, increase PH2 units above the mid-range to the 1% upper limit in order from south to north (Unit 11 to Unit 18). *NOTIFY FPOM ASAP (no later than 3 workdays) and include in the Weekly Report.*
3. Then, increase spill above 150 kcfs, up to 180 kcfs. *PH2 UNITS MAY ONLY BE OPERATED ABOVE THE MID-RANGE WHEN SPILL IS BETWEEN 150 KCFS AND 180 KCFS.*
4. Then, increase spill above 180 kcfs and resume operating PH2 units within the mid-range.

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

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

Table BON-14. Sequential Steps to Pass Increasing Flow per Temporary PH2 Operating Range Guidelines in section 4.2.2.2.b.

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

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

4.2.2.3. If in-season operation outside the 1% range or above BOP at PH1 is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. In-season operation outside the 1% range may be necessary to:

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

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

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

iv. Comply with other coordinated fish measures.

4.2.3. Off-Season: September 1–April 9. While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

4.3. Turbine Unit Maintenance

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

4.3.2. Priority unit maintenance will be scheduled for the winter maintenance period or when there are few fish passing the project, to the extent possible. Priority units 1, 10, 11, and 18 will be scheduled for any necessary extended outages between December 1 and April 30. In addition, Unit 10 maintenance outages may be scheduled from July 15 through August 31 when Powerhouse 1 units are not operating. Non-priority units should not be scheduled for routine or extended outages during this time if it will delay or conflict with priority unit maintenance. When PH1 is operating, Units 1 and 10 provide important attraction flow for adult fish and helps pass juvenile fish downstream. Therefore, long-term outages of Unit 1 and 10 will be avoided during the juvenile passage season until after adult fall Chinook and coho migration ends in late October.

4.3.3. Operational Testing. Operational testing may deviate from priority units and may require water that would otherwise be used for spill if units operating for reliability are at the 1% lower limit (minimum generation). Water for operational testing will be used from powerhouse allocation when possible and diverted from spill only to the extent necessary to maintain power system reliability. During testing, units may be operated outside of the 1% range for up to 20 minutes. Unit operations below the 1% range will be minimized to the extent practicable.

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

ii. Post-Maintenance: After maintenance or repair, units may be operationally tested while remaining in maintenance or forced outage status by running for up

to a cumulative time of 60 minutes within and outside of the 1% range before returning to operational status.

4.3.4. When a unit is idle, wicket gates will remain in closed position unless tail logs are installed and fish salvage has been done in the draft tube, or if the project is holding a safety pool below the level of the wicket gates. Turbines that have been idle/out-of-service will be started by slow rolling the unit after tipping turbine blades from flat to steep and back to flat.

4.3.5. In the event of long-term powerhouse outages, affected units will be operated for 4-8 hours every 2 weeks to exercise governor components and clean wetted surfaces of corrosion so that if the unit is needed, fish injury will be minimized and the units will be in good operating condition. Actual runtime will be the minimum necessary to keep the unit in good working condition and may be performed at night, day, or whenever unit cycling will have the minimum effect on fish as determined by the Project Biologist.

4.3.6. Head gates[6] at Units 11-18 have been dogged off and the system depressurized. Oil leaks develop frequently when the system operates with normal pressure. Further related instructions are described in a memo from the Project Chief of Operations "*Memorandum for All Operations, dated September 23, 1993. Subject: Powerhouse 2 Hydraulic Head Gate Operation*".

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

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

Project Head (feet)	PH1 Units 1–10							
	1% Lower Limit		1% Upper Limit		Best Operating Point (BOP)		Operating Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs
35	19.2	7,463	23.1	8,964	27.3	10,527	26.4	10,473
36	19.9	7,476	23.9	8,994	28.3	10,564	28.0	10,816
37	20.5	7,485	24.8	9,050	29.2	10,598	29.6	11,174
38	21.1	7,486	25.7	9,111	30.2	10,627	31.3	11,532
39	21.7	7,487	26.6	9,180	31.2	10,654	33.0	11,927
40	22.3	7,495	27.5	9,241	32.1	10,677	34.8	12,350
41	22.9	7,510	28.4	9,293	33.2	10,759	36.7	12,732
42	23.6	7,530	29.3	9,331	34.3	10,837	38.6	13,047
43	24.3	7,552	30.1	9,362	35.4	10,910	40.4	13,331
44	25.0	7,573	31.1	9,411	36.5	10,979	42.2	13,616
45	25.7	7,588	32.1	9,489	37.6	11,045	44.0	13,910
46	26.3	7,597	33.2	9,599	38.8	11,109	45.7	14,213
47	26.9	7,604	34.4	9,729	39.9	11,170	47.4	14,519
48	27.5	7,609	35.6	9,864	41.0	11,227	47.9	14,288
49	28.1	7,615	36.8	9,981	42.1	11,282	48.1	13,901
50	28.7	7,623	37.9	10,063	43.2	11,333	48.5	13,608
51	29.4	7,632	38.9	10,109	44.2	11,356	48.9	13,331
52	30.0	7,641	39.8	10,131	45.2	11,378	49.2	13,048
53	30.6	7,648	40.6	10,141	46.2	11,398	49.6	12,778
54	31.3	7,657	41.5	10,156	47.2	11,418	50.0	12,565
55	31.9	7,668	42.3	10,180	48.2	11,465	50.3	12,381
56	32.5	7,679	43.2	10,212	49.2	11,478	50.6	12,202
57	33.1	7,690	44.2	10,249	50.3	11,518	51.0	12,031
58	33.8	7,701	45.2	10,293	51.4	11,557	51.1	11,831
59	34.4	7,714	46.2	10,344	52.4	11,594	51.1	11,600
60	35.1	7,726	47.2	10,400	53.5	11,630	51.2	11,384
61	35.7	7,737	48.3	10,461	54.3	11,610	51.4	11,215
62	36.3	7,747	49.3	10,526	55.1	11,591	51.6	11,053
63	36.9	7,756	50.4	10,590	56.0	11,572	51.7	10,876
64	37.6	7,768	51.5	10,654	56.6	11,519	51.6	10,655
65	38.2	7,783	52.6	10,713	56.8	11,388	51.4	10,438
66	38.8	7,780	53.4	10,712	57.1	11,265	51.0	10,172
67	39.4	7,775	54.2	10,703	57.3	11,124	51.0	10,026
68	39.9	7,769	54.9	10,690	57.6	11,021	51.1	9,881
69	40.4	7,765	55.6	10,679	57.8	10,896	50.8	9,673
70	41.0	7,766	56.3	10,651	58.0	10,736	50.3	9,439

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

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

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

5. DEWATERING PLANS

5.1. General

5.1.1. *Guidelines for Dewatering and Fish Handling Plans* (**Appendix F**) and project *Dewatering Plans*[7] have been developed by the projects and approved by FPOM and are followed for most project facility dewaterings. The plans include consideration for fish safety and are consistent with the following general guidance. The appropriate plans are reviewed by participants before each salvage operation.

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

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

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

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

5.2. Dewatering – Juvenile Bypass Systems (JBS)

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

5.3. Dewatering – Adult Fish Ladder

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

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

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

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

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

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

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

5.4. Dewatering – Powerhouse Fish Collection System

5.4.1. During the pumping or draining operation to dewater a portion or the entire collection channel, the water level will not be allowed to drop to a level which strands fish. Personnel shall remain onsite during pumping operations to ensure stranding does not occur, or a water-level sensor that deactivates the dewatering process will be used. Project Fisheries will directly assist fish rescue operations, provide technical guidance, ensure fish safety, and ensure rescue equipment/personnel are available if needed.

5.5. Dewatering – Turbine Units

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

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

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

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

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

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

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

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

5.6. Dewatering – Navigation Lock

5.6.1. The navigation lock is frequently dewatered for routine maintenance in late February/early March, in conjunction with navigation lock outages at The Dalles and John Day dams. The area between the upstream bulkhead and the upstream gate is surveyed for fish as water levels allow. The lateral and pool areas on the floor of the lock are surveyed for fish from above. Most of these areas remain full of water, precluding the ability to implement successful fish salvage operations. Areas where water levels slowly decrease are accessed via crane when pool levels reach a depth of approximately 3 feet. The fill conduits are accessed and checked for fish only if needed and can be done safely. All salvaged fish are removed, transported via bag or tank, and released to the river.

6. FOREBAY DEBRIS REMOVAL

Debris can impact fish passage conditions in several ways. It can plug or block trash racks, VBSs, gatewell orifices, dewatering screens, and facility piping, resulting in impingement, injuries, and descaling of fish. Debris is removed by operating the PH1 ITS, B2CC, or passing it through the spillway with a special spill gate operation. Special spill operations that don't follow the normal spill schedule or rate limits will be coordinated prior to implementation. Normally the project will contact CENWP-OD at least two workdays before the special operation is required. Using information provided by the project, CENWP-OD will coordinate with FPOM and RCC, as necessary. Once the coordination is complete, RCC will issue a teletype to the project with the details.

7. RESPONSE TO HAZARDOUS MATERIALS SPILLS

Bonneville Project's guidance for responding to hazardous substance spills is contained in its *Emergency Spill Response Plan*. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure. Project Fisheries will be contacted as soon as possible after a hazardous material release and prior to any modification to fishway operations. Project Biologist(s) will in turn contact the CENWP-OD biologist and FPOM. Attempts should be made to first contact the Project Biologist on duty. During fish passage season, there is a Project Biologist on duty seven days a week. If a Project Biologist cannot be reached by radio or in the office, attempts to contact Project Fisheries will occur in the following order (contact information available in Control Room):
Andrew Derugin (Supervisor); Leif Halvorson; Brian Bissell; Tammy Mackey (Operations Chief).

Table BON-16. [*pg 1 of 10*] Bonneville Dam Spill Patterns in Vertical Gate Opening (ft) per Spillbay.[a]

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

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

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

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

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

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

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

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
5	8	8.5	9	9	10	10	11	12	12	11	10	9	9	9	8.5	8	5	**164**	**319.6**
5	8	8.5	9	9	10	10	11	12	12	11	10	10	9	9	8.5	8	5	**165**	**321.2**
5	8	8.5	9	9	10	11	11	12	12	11	10	10	9	9	8.5	8	5	**166**	**322.8**
5	8	8.5	9	9	10	11	11	12	12	11	11	10	9	9	8.5	8	5	**167**	**324.5**
5	8	8.5	9	9	10	11	12	12	12	11	11	10	9	9	8.5	8	5	**168**	**326.1**
5	8	8.5	9	9	10	11	12	12	12	12	11	10	9	9	8.5	8	5	**169**	**327.7**
5	8	8.5	9	9	10	11	12	13	12	12	11	10	9	9	8.5	8	5	**170**	**329.2**
5	8	8.5	9	9	10	11	12	13	13	12	11	10	9	9	8.5	8	5	**171**	**330.8**
5	8	8.5	9	10	10	11	12	13	13	12	11	10	9	9	8.5	8	5	**172**	**332.5**
5	8	8.5	9	10	10	11	12	13	13	12	11	10	10	9	8.5	8	5	**173**	**334.1**
5	8	8.5	9	10	11	11	12	13	13	12	11	10	10	9	8.5	8	5	**174**	**335.8**
5	8	8.5	9	10	11	11	12	13	13	12	11	11	10	9	8.5	8	5	**175**	**337.4**
5	8	8.5	9	10	11	12	12	13	13	12	11	11	10	9	8.5	8	5	**176**	**339.0**
5	8	8.5	9	10	11	12	12	13	13	12	12	11	10	9	8.5	8	5	**177**	**340.6**
5	8	8.5	9	10	11	12	13	13	13	12	12	11	10	9	8.5	8	5	**178**	**342.2**
5	8	8.5	9	10	11	12	13	13	13	13	12	11	10	9	8.5	8	5	**179**	**343.7**
5	8	8.5	9	10	11	12	13	14	13	13	12	11	10	9	8.5	8	5	**180**	**345.3**
5	8	8.5	9	10	11	12	13	14	14	13	12	11	10	9	8.5	8	5	**181**	**346.8**
5	8	8.5	9	10	11	12	13	15	14	13	12	11	10	9	8.5	8	5	**182**	**348.4**
5	8	8.5	9	10	11	12	14	15	15	13	12	11	10	9	8.5	8	5	**184**	**351.5**
5	8	8.5	9	10	11	12	14	15	15	14	12	11	10	9	8.5	8	5	**185**	**353.1**
5	8	8.5	9	10	11	13	14	15	15	14	12	11	10	9	8.5	8	5	**186**	**354.6**
5	8	8.5	9	10	11	13	14	15	15	14	13	11	10	9	8.5	8	5	**187**	**356.2**
5	8	8.5	9	10	12	13	14	15	15	14	13	11	10	9	8.5	8	5	**188**	**357.8**
5	8	8.5	9	10	12	13	14	15	15	14	13	12	10	9	8.5	8	5	**189**	**359.4**
5	8	8.5	9	10	12	13	14	16	15	14	13	12	10	9	8.5	8	5	**190**	**360.9**
5	8	8.5	9	10	12	13	14	16	16	14	13	12	10	9	8.5	8	5	**191**	**362.5**
5	8	8.5	9	10	12	13	15	16	16	14	13	12	10	9	8.5	8	5	**192**	**364.0**
5	8	8.5	9	10	12	13	15	16	16	15	13	12	10	9	8.5	8	5	**193**	**365.6**
5	8	8.5	9	10	12	14	15	16	16	15	13	12	10	9	8.5	8	5	**194**	**367.1**
5	8	8.5	9	10	12	14	15	16	16	15	14	12	10	9	8.5	8	5	**195**	**368.7**
5	8	8.5	9	10	12	14	15	17	16	15	14	12	10	9	8.5	8	5	**196**	**370.2**
5	8	8.5	9	10	12	14	15	17	17	15	14	12	10	9	8.5	8	5	**197**	**371.8**
5	8	8.5	9	10	12	14	16	17	17	15	14	12	10	9	8.5	8	5	**198**	**373.3**
5	8	8.5	9	10	12	14	16	17	17	16	14	12	10	9	8.5	8	5	**199**	**374.9**
5	8	8.5	9	10	12	14	16	18	17	16	14	12	10	9	8.5	8	5	**200**	**376.4**
5	8	8.5	9	10	12	14	16	18	18	16	14	12	10	9	8.5	8	5	**201**	**378.0**
5	8	8.5	9	11	12	14	16	18	18	16	14	12	10	9	8.5	8	5	**202**	**379.6**
5	8	8.5	9	11	12	14	16	18	18	16	14	12	11	9	8.5	8	5	**203**	**381.2**
5	8	8.5	9	11	13	14	16	18	18	16	14	12	11	9	8.5	8	5	**204**	**382.8**
5	8	8.5	9	11	13	14	16	18	18	16	14	13	11	9	8.5	8	5	**205**	**384.4**
5	8	8.5	9	11	13	15	16	18	18	16	14	13	11	9	8.5	8	5	**206**	**385.9**
5	8	8.5	9	11	13	15	16	18	18	16	15	13	11	9	8.5	8	5	**207**	**387.4**
5	8	8.5	9	11	13	15	17	18	18	16	15	13	11	9	8.5	8	5	**208**	**389.0**
5	8	8.5	9	11	13	15	17	18	18	17	15	13	11	9	8.5	8	5	**209**	**390.5**
5	8	8.5	9	11	13	15	17	19	18	17	15	13	11	9	8.5	8	5	**210**	**392.1**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
5	8	8.5	9	11	13	15	17	19	19	17	15	13	11	9	8.5	8	5	**211**	**393.7**
5	8	8.5	10	11	13	15	17	19	19	17	15	13	11	9	8.5	8	5	**212**	**395.3**
5	8	8.5	10	11	13	15	17	19	19	17	15	13	11	10	8.5	8	5	**213**	**397.0**
5	8	8.5	10	12	13	15	17	19	19	17	15	13	11	10	8.5	8	5	**214**	**398.6**
5	8	8.5	10	12	13	15	17	19	19	17	15	13	12	10	8.5	8	5	**215**	**400.2**
5	8	8.5	10	12	14	15	17	19	19	17	15	13	12	10	8.5	8	5	**216**	**401.7**
5	8	8.5	10	12	14	15	17	19	19	17	15	14	12	10	8.5	8	5	**217**	**403.3**
5	8	8.5	10	12	14	16	17	19	19	17	15	14	12	10	8.5	8	5	**218**	**404.8**
5	8	8.5	10	12	14	16	17	19	19	17	16	14	12	10	8.5	8	5	**219**	**406.4**
5	8	8.5	10	12	14	16	18	19	19	17	16	14	12	10	8.5	8	5	**220**	**407.9**
5	8	8.5	10	12	14	16	18	19	19	18	16	14	12	10	8.5	8	5	**221**	**409.5**
5	8	8.5	10	12	14	16	18	20	19	18	16	14	12	10	8.5	8	5	**222**	**411.1**
5	8	8.5	10	13	14	16	18	20	20	18	16	14	12	10	8.5	8	5	**224**	**414.2**
5	8	8.5	10	13	14	16	18	20	20	18	16	14	13	10	8.5	8	5	**225**	**415.8**
5	8	8.5	10	13	15	16	18	20	20	18	16	14	13	10	8.5	8	5	**226**	**417.4**
5	8	8.5	10	13	15	16	18	20	20	18	16	15	13	10	8.5	8	5	**227**	**418.9**
5	8	8.5	10	13	15	17	18	20	20	18	16	15	13	10	8.5	8	5	**228**	**420.4**
5	8	8.5	10	13	15	17	18	20	20	18	17	15	13	10	8.5	8	5	**229**	**422.0**
5	8	8.5	10	13	15	17	19	20	20	18	17	15	13	10	8.5	8	5	**230**	**423.6**
5	8	8.5	10	13	15	17	19	20	20	19	17	15	13	10	8.5	8	5	**231**	**425.1**
5	8	8.5	10	13	15	17	19	21	20	19	17	15	13	10	8.5	8	5	**232**	**426.7**
5	8	8.5	10	13	15	17	19	21	21	19	17	15	13	10	8.5	8	5	**233**	**428.3**
5	8	8.5	10	13	16	17	19	21	21	19	17	15	13	10	8.5	8	5	**234**	**429.9**
5	8	8.5	10	13	16	17	19	21	21	19	17	16	13	10	8.5	8	5	**235**	**431.4**
5	8	8.5	10	13	16	18	19	21	21	19	17	16	13	10	8.5	8	5	**236**	**433.0**
5	8	8.5	10	13	16	18	19	21	21	19	18	16	13	10	8.5	8	5	**237**	**434.5**
5	8	8.5	10	13	16	18	20	21	21	19	18	16	13	10	8.5	8	5	**238**	**436.1**
5	8	8.5	10	13	16	18	20	21	21	20	18	16	13	10	8.5	8	5	**239**	**437.7**
5	8	8.5	10	13	16	18	20	22	21	20	18	16	13	10	8.5	8	5	**240**	**439.4**
5	8	8.5	10	13	16	18	20	22	22	20	18	16	13	10	8.5	8	5	**241**	**441.0**
5	8	8.5	10	13	16	19	20	22	22	20	18	16	13	10	8.5	8	5	**242**	**442.6**
5	8	8.5	10	13	16	19	20	22	22	20	19	16	13	10	8.5	8	5	**243**	**444.1**
5	8	8.5	10	13	16	19	21	22	22	20	19	16	13	10	8.5	8	5	**244**	**445.8**
5	8	8.5	10	13	16	19	21	22	22	21	19	16	13	10	8.5	8	5	**245**	**447.4**
5	8	8.5	10	13	16	19	21	23	22	21	19	16	13	10	8.5	8	5	**246**	**449.1**
5	8	8.5	10	13	16	19	21	23	23	21	19	16	13	10	8.5	8	5	**247**	**450.7**
5	8	8.5	10	13	16	19	22	23	23	21	19	16	13	10	8.5	8	5	**248**	**452.4**
5	8	8.5	10	13	16	19	22	23	23	22	19	16	13	10	8.5	8	5	**249**	**454.0**
5	8	8.5	10	13	16	19	22	24	23	22	19	16	13	10	8.5	8	5	**250**	**455.8**
5	8	8.5	10	13	16	19	22	24	24	22	19	16	13	10	8.5	8	5	**251**	**457.5**
5	8	8.5	10	13	16	19	22	25	24	22	19	16	13	10	8.5	8	5	**252**	**459.3**
5	8	8.5	10	13	16	19	22	25	25	22	19	16	13	10	8.5	8	5	**253**	**461.1**
5	8	8.5	11	13	16	19	22	25	25	22	19	16	13	10	8.5	8	5	**254**	**462.7**
5	8	8.5	11	13	16	19	22	25	25	22	19	16	13	11	8.5	8	5	**255**	**464.3**
5	8	8.5	11	14	16	19	22	25	25	22	19	16	13	11	8.5	8	5	**256**	**465.9**
5	8	8.5	11	14	16	19	22	25	25	22	19	16	14	11	8.5	8	5	**257**	**467.5**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
5	8	8.5	11	14	17	19	22	25	25	22	19	16	14	11	8.5	8	5	**258**	**469.0**
5	8	8.5	11	14	17	19	22	25	25	22	19	17	14	11	8.5	8	5	**259**	**470.5**
5	8	8.5	11	14	17	20	22	25	25	22	19	17	14	11	8.5	8	5	**260**	**472.1**
5	8	8.5	11	14	17	20	22	25	25	22	20	17	14	11	8.5	8	5	**261**	**473.7**
5	8	8.5	11	14	17	20	23	25	25	22	20	17	14	11	8.5	8	5	**262**	**475.4**
5	8	8.5	11	14	17	20	23	25	25	23	20	17	14	11	8.5	8	5	**263**	**477.1**
5	8	8.5	11	14	17	20	23	26	25	23	20	17	14	11	8.5	8	5	**264**	**478.9**
5	8	8.5	11	14	17	20	23	26	26	23	20	17	14	11	8.5	8	5	**265**	**480.8**
5	8	10	11	14	17	20	23	26	26	23	20	17	14	11	8.5	8	5	**266.5**	**483.3**
5	8	10	11	14	17	20	23	26	26	23	20	17	14	11	10	8	5	**268**	**485.8**
5	8	10	12	14	17	20	23	26	26	23	20	17	14	11	10	8	5	**269**	**487.4**
5	8	10	12	14	17	20	23	26	26	23	20	17	14	12	10	8	5	**270**	**489.0**
5	8	10	12	15	17	20	23	26	26	23	20	17	14	12	10	8	5	**271**	**490.5**
5	8	10	12	15	17	20	23	26	26	23	20	17	15	12	10	8	5	**272**	**492.1**
5	8	10	12	15	18	20	23	26	26	23	20	17	15	12	10	8	5	**273**	**493.6**
5	8	10	12	15	18	20	23	26	26	23	20	18	15	12	10	8	5	**274**	**495.2**
5	8	10	12	15	18	21	23	26	26	23	20	18	15	12	10	8	5	**275**	**496.8**
5	8	10	12	15	18	21	23	26	26	23	21	18	15	12	10	8	5	**276**	**498.4**
5	8	10	12	15	18	21	24	26	26	23	21	18	15	12	10	8	5	**277**	**500.2**
5	8	10	12	15	18	21	24	26	26	24	21	18	15	12	10	8	5	**278**	**501.9**
5	8	11	12	15	18	21	24	26	26	24	21	18	15	12	10	8	5	**279**	**503.5**
5	8	11	12	15	18	21	24	26	26	24	21	18	15	12	11	8	5	**280**	**505.2**
5	8	11	13	15	18	21	24	26	26	24	21	18	15	12	11	8	5	**281**	**506.7**
5	8	11	13	15	18	21	24	26	26	24	21	18	15	13	11	8	5	**282**	**508.3**
5	8	11	13	16	18	21	24	26	26	24	21	18	15	13	11	8	5	**283**	**509.8**
5	8	11	13	16	18	21	24	26	26	24	21	18	16	13	11	8	5	**284**	**511.4**
5	8	11	13	16	19	21	24	26	26	24	21	18	16	13	11	8	5	**285**	**512.9**
5	8	11	13	16	19	21	24	26	26	24	21	19	16	13	11	8	5	**286**	**514.5**
5	8	11	13	16	19	22	24	26	26	24	21	19	16	13	11	8	5	**287**	**516.2**
5	8	11	13	16	19	22	24	26	26	24	22	19	16	13	11	8	5	**288**	**517.8**
5	8	11	13	16	19	22	25	26	26	24	22	19	16	13	11	8	5	**289**	**519.6**
5	8	11	13	16	19	22	25	26	26	25	22	19	16	13	11	8	5	**290**	**521.4**
5	8	11	13	16	20	22	25	26	26	25	22	19	16	13	11	8	5	**291**	**523.0**
5	8	11	13	16	20	22	25	26	26	25	22	20	16	13	11	8	5	**292**	**524.6**
5	8	11	13	16	20	23	25	26	26	25	22	20	16	13	11	8	5	**293**	**526.3**
5	8	11	13	16	20	23	25	26	26	25	23	20	16	13	11	8	5	**294**	**527.9**
5	8	11	13	16	20	23	26	26	26	25	23	20	16	13	11	8	5	**295**	**529.8**
5	8	11	13	16	20	23	26	26	26	26	23	20	16	13	11	8	5	**296**	**531.6**
6	8	11	13	16	20	23	26	26	26	26	23	20	16	13	11	8	5	**297**	**533.5**
6	8	11	13	16	20	23	26	26	26	26	23	20	16	13	11	8	6	**298**	**535.4**
6	9	11	13	16	20	23	26	26	26	26	23	20	16	13	11	8	6	**299**	**537.1**
6	9	11	13	16	20	23	26	26	26	26	23	20	16	13	11	9	6	**300**	**538.8**
6	9	12	13	16	20	23	26	26	26	26	23	20	16	13	11	9	6	**301**	**540.4**
6	9	12	13	16	20	23	26	26	26	26	23	20	16	13	12	9	6	**302**	**542.0**
6	9	12	14	16	20	23	26	26	26	26	23	20	16	13	12	9	6	**303**	**543.5**
6	9	12	14	16	20	23	26	26	26	26	23	20	16	14	12	9	6	**304**	**545.1**

BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay																		Total Open	Spill [a]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(ft)	(kcfs)
6	9	12	14	17	20	23	26	26	26	26	23	20	16	14	12	9	6	**305**	**546.6**
6	9	12	14	17	20	23	26	26	26	26	23	20	17	14	12	9	6	**306**	**548.2**
6	9	12	14	17	21	23	26	26	26	26	23	20	17	14	12	9	6	**307**	**549.8**
6	9	12	14	17	21	23	26	26	26	26	23	21	17	14	12	9	6	**308**	**551.4**
6	9	12	14	17	21	24	26	26	26	26	23	21	17	14	12	9	6	**309**	**553.1**
6	9	12	14	17	21	24	26	26	26	26	24	21	17	14	12	9	6	**310**	**554.9**
7	9	12	14	17	21	24	26	26	26	26	24	21	17	14	12	9	6	**311**	**556.7**
7	9	12	14	17	21	24	26	26	26	26	24	21	17	14	12	9	7	**312**	**558.5**
7	10	12	14	17	21	24	26	26	26	26	24	21	17	14	12	9	7	**313**	**560.2**
7	10	12	14	17	21	24	26	26	26	26	24	21	17	14	12	10	7	**314**	**561.8**
7	10	13	14	17	21	24	26	26	26	26	24	21	17	14	12	10	7	**315**	**563.4**
7	10	13	14	17	21	24	26	26	26	26	24	21	17	14	13	10	7	**316**	**565.0**
7	10	13	15	17	21	24	26	26	26	26	24	21	17	14	13	10	7	**317**	**566.5**
7	10	13	15	17	21	24	26	26	26	26	24	21	17	15	13	10	7	**318**	**568.1**
7	10	13	15	18	21	24	26	26	26	26	24	21	17	15	13	10	7	**319**	**569.6**
7	10	13	15	18	21	24	26	26	26	26	24	21	18	15	13	10	7	**320**	**571.2**
8	10	13	15	18	21	24	26	26	26	26	24	21	18	15	13	10	7	**321**	**572.9**
8	10	13	15	18	21	24	26	26	26	26	24	21	18	15	13	10	8	**322**	**574.7**
8	11	13	15	18	21	24	26	26	26	26	24	21	18	15	13	10	8	**323**	**576.3**
8	11	13	15	18	21	24	26	26	26	26	24	21	18	15	13	11	8	**324**	**577.9**
8	11	14	15	18	21	24	26	26	26	26	24	21	18	15	13	11	8	**325**	**579.5**
8	11	14	15	18	21	24	26	26	26	26	24	21	18	15	14	11	8	**326**	**581.0**
8	11	14	16	18	21	24	26	26	26	26	24	21	18	15	14	11	8	**327**	**582.6**
8	11	14	16	18	21	24	26	26	26	26	24	21	18	16	14	11	8	**328**	**584.1**
8	11	14	16	19	21	24	26	26	26	26	24	21	18	16	14	11	8	**329**	**585.7**
8	11	14	16	19	21	24	26	26	26	26	24	21	19	16	14	11	8	**330**	**587.3**
8	11	14	16	19	22	24	26	26	26	26	24	21	19	16	14	11	8	**331**	**588.9**
8	11	14	16	19	22	24	26	26	26	26	24	22	19	16	14	11	8	**332**	**590.6**
8	11	14	16	19	22	25	26	26	26	26	25	22	19	16	14	11	8	**334**	**594.1**
8	12	14	16	19	22	25	26	26	26	26	25	22	19	16	14	11	8	**335**	**595.7**
8	12	14	16	19	22	25	26	26	26	26	25	22	19	16	14	12	8	**336**	**597.3**
8	12	15	16	19	22	25	26	26	26	26	25	22	19	16	14	12	8	**337**	**598.9**
8	12	15	16	19	22	25	26	26	26	26	25	22	19	16	15	12	8	**338**	**600.4**
8	12	15	17	19	22	25	26	26	26	26	25	22	19	16	15	12	8	**339**	**602.0**
8	12	15	17	19	22	25	26	26	26	26	25	22	19	17	15	12	8	**340**	**603.5**
8	12	15	17	20	22	25	26	26	26	26	25	22	19	17	15	12	8	**341**	**605.1**
8	12	15	17	20	22	25	26	26	26	26	25	22	20	17	15	12	8	**342**	**606.7**