Appendix B

2019 Fish Operations Plans

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2019 Fish Operations Plan

1. INTRODUCTION

The 2019 Fish Operations Plan (2019 FOP) describes the U.S. Army Corps of Engineers' (Corps) planned operations for juvenile fish passage at its four lower Snake River and four lower Columbia River dams during the 2019 spring and summer fish migration seasons, generally April 3 through August 31. The 2019 FOP is consistent with spill operations for juvenile fish passage and the regional forum process for adaptive management and in-season management provisions outlined in the 2019 NOAA Fisheries Columbia River System Biological Opinion (2019 BiOp)[1], the Extensions of the 2008 Columbia Basin Fish Accords (Accord Extensions), the 2019-2021 Spill Operation Agreement, the Corps' requirements under the Endangered Species Act, and is the subject of ongoing consultation and communications with the relevant wildlife agencies to ensure consistency with the Act. Other project operations and water management actions not specifically addressed in this document will be consistent with the 2019 BiOp and other guiding operative documents, including the 2019 Water Management Plan (WMP), seasonal WMP updates, and the 2019 Fish Passage Plan (FPP).

In addition to discussing project-specific fish passage spill operations, the 2019 FOP identifies factors that the Corps, the U.S. Bureau of Reclamation, and the Bonneville Power Administration (BPA) (collectively referred to as the "Action Agencies") must address in the context of operating this complex system of fourteen multiple purpose projects. The 2019 FOP includes a discussion of how the Corps manages fish passage spill and total dissolved gas (TDG), identifies Planned and Routine Operational Adjustments (Section 4) that influence fish passage spill, addresses adaptive management and in-season management processes for fish passage spill and other fish operations including the juvenile fish transportation program, and describes the Corps' monthly implementation reports.

[1] The Corps, in coordination with the other Action Agencies, and National Marine Fisheries Service (NMFS), employs the Regional Implementation Oversight Group (RIOG) and technical teams including the Technical Management Team (TMT) and Fish Passage Operations & Maintenance (FPOM), to coordinate with state, tribal and other federal experts for recommendations for implementing operations consistent with NMFS' Columbia River System Biological Opinions.

2. MANAGEMENT OF SPILL FOR FISH PASSAGE AND TDG

2.1. State Water Quality Standards for TDG

The Corps will manage spill for fish passage in 2019 consistent with the State of Washington and the State of Oregon total dissolved gas (TDG) water quality standards (WQS).[2] [3] Both states have accommodated levels of TDG above 110% for fish passage spill operations for ESA-listed juvenile salmonids at Corps projects on the lower Snake and lower Columbia rivers as follows:

Washington Short-Term Criteria Modification (Spring) and Criteria Adjustment (Summer):

- Spring: April 3 – June 20 (for lower Snake River dams); April 10 – June 15 (for lower Columbia River dams)
    - TDG must not exceed an average of one hundred twenty percent as measured in the tailraces fixed-monitoring sites in the tailrace of each dam. These averages shall be measured as an average of the twelve highest hourly readings in a calendar day; and
    - TDG must not exceed a two-hour instantaneous level of one hundred twenty-five percent of saturation for any two hours during the twelve highest hourly measurements per calendar day as measured in the fixed-monitoring sites in the tailrace of each dam.
- Summer: June 21 – August 31 (for lower Snake River dams); June 16 – August 31 (for lower Columbia River dams)
    - TDG must not exceed an average of 115% as measured in the forebays of the next downstream dams and must not exceed an average of 120% as measured in the tailraces of each dam (these averages are measured as an average of the 12 highest consecutive hourly readings in any one day, relative to atmospheric pressure); and
    - A maximum TDG one hour average of 125% must not be exceeded during spillage for fish passage.

Oregon Standard Modification (Spring and Summer):

- Spill must be reduced when the average TDG concentration of the 12 highest hourly measurements per calendar day exceeds 120% of saturation in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations.
- Spill must be reduced when instantaneous TDG levels exceed 125% of saturation for any 2 hours during the 12 highest hourly measurements per calendar day in the tailraces of McNary, John Day, The Dalles, and Bonneville dams' monitoring stations.

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[2] WASH. ADMIN. CODE §173-201A-200(l)(f)) provides the maximum TDG criteria for each of the aquatic life use categories and displays Table 200 (I)(f) that states: "Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection." The code also addresses exceptions and adjustments, including a provision allowing for an adjustment of the TDG criteria to aid fish passage over hydroelectric dams when consistent with an approved gas abatement plan.

[3] OR. ADMIN. R. 340-041-0031 provides in part: "the concentration of TDG relative to atmospheric pressure at the point of sample collection may not exceed 110 percent of saturation." OR. ADMIN. R. 340-041-104(3) identifies findings the Environmental Quality Commission must make for the purpose of allowing increased spill for salmon migration. *See* http://pweb.crohms.org/tmt/wqnew/state_tdg_waivers/or/2015_5yr.pdf

The terminology that has been adopted to refer to the State TDG WQS is the "gas cap." Gas cap spill is spill to the maximum level that meets, but does not exceed, the TDG criteria allowed under state law. In its implementation of spill for fish passage, the Corps will operate its fish passage projects in 2019 in accordance with the State TDG standards described above, including applying the different state calculation methodologies. When the standards vary or conflict, the Corps will apply the more stringent standard.

2.2. Spill Caps

The Corps' Reservoir Control Center (RCC) is responsible for daily management of spill operations responsive to changing conditions to manage TDG within all applicable State standards. To accomplish this, the RCC sets "spill caps" for each of the Corps' lower Columbia and lower Snake River projects on a daily basis throughout the fish passage spill season. Spill caps are the maximum spill level at each project that is estimated to meet, but not exceed, the gas cap. In spring 2019, the spill cap will be the hourly target spill level for a portion of the day as described below in Section 6, Table 3.

To calculate spill caps, the Corps evaluates observed and forecasted variables that influence TDG levels, including: (1) environmental conditions (e.g., total flow, wind, ambient temperature, barometric pressure, and incoming TDG from upstream); and (2) project operations (e.g., spill level, spill pattern, tailwater elevation, proportion of flow through the turbines, and project configuration). These data are used as input variables into the System TDG (SYSTDG) model in order to estimate TDG levels several days into the future. The Corps runs SYSTDG as a real-time operations tool, when appropriate, to forecast TDG levels at the Corps' projects. As warranted, the Corps will cross-check projected spill caps with SYSTDG results and consider observed data to make appropriate spill cap adjustments.

During spill for fish passage, the Corps reviews spill caps on a daily basis and adjusts as necessary to define the maximum spill level that maintains TDG within applicable State standards. Additional information about how the Corps will manage TDG is described in the "Current Procedures for Setting Spill Caps" available at:
https://pweb.crohms.org/tmt/documents/wmp/2019/

The fish passage projects may spill more than the target spill levels identified in Tables 3 and 4 due to high river flow that exceeds powerhouse hydraulic capacity or due to a lack of power demand (load). During periods when spill is above the spill cap due to lack of load conditions, the Corps will attempt to manage excess TDG on a system-wide basis by incrementally increasing spill at projects throughout the system in the order of priority defined in the Spill Priority List. For this purpose, the RCC also defines spill levels to target TDG in project tailraces of 122%, 125%, 127%, 130%, and 135%. The order of priority is coordinated with regional sovereigns in the TMT to allocate spill to projects to best manage system TDG while also considering how best to protect fish and other aquatic biota.

3. SPILLWAY OPERATIONS AND SPILL LEVEL PRECISION

The Corps plans to achieve the target spill levels defined in Tables 3 and 4 to the extent feasible; however, actual hourly spill levels at each dam may vary slightly depending on the precision of

the spillbay gate settings, real-time fluctuations in flow and/or project head, or automatic load following. At each project, spill is distributed across the spillway according to patterns defined in the project-specific chapters of the FPP[4] to provide favorable fish passage conditions.

Spillbay gates are opened to the settings identified in the FPP spill pattern table that correspond to the spill level that is closest to, but may be slightly higher or lower than, the target spill level. Due to these limitations in spill level precision, the observed hourly average spill level may range up to ±2 kcfs from the target spill level (or ±3 kcfs at The Dalles and Bonneville dams, as described in Section 8). When target spill is a percentage of total outflow, the hourly spill level is calculated to be within +/-1% of the target percentage (or ±4% at Little Goose as described in Section 8). Snake River projects will make spillbay gate setting changes as soon as feasible in response to target spill changes; however, there may be instances when spill level changes are delayed by up to 1 hour due to operation of the navigation locks.

4. MODIFICATIONS TO PLANNED OPERATIONS AND IN-SEASON MANAGEMENT

For planning purposes, the operations described in the 2019 FOP assume average runoff conditions. Actual runoff varies in magnitude and timing, and observed river flow may be higher or lower than average at any time such that modifications to the planned operations may be required. To accommodate these varying runoff conditions and other routinely observed conditions as they arise, the Corps, in conjunction with the other Action Agencies and NOAA Fisheries, coordinates with regional sovereigns on these conditions and other planned operations through the review of the 2019 FOP prior to spring spill operations (see section 4.1). The Corps responds in real-time to these routine conditions and planned operations by implementing adjustments as conditions require without additional coordination.

For unanticipated and unplanned conditions that are not pre-coordinated, the Corps will respond as necessary to adjust to the condition, and when possible, will use the existing regional coordination process[5] to adaptively manage and make necessary in-season adjustments in spill and other fish operations (e.g., spill levels, spill caps, spill patterns, juvenile fish transportation, and pool operating ranges).

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[4] The FPP is coordinated annually with regional sovereigns through the FPOM.

[5] In-season adaptive management changes in spill levels could include adjustments that address unintended biological consequences caused by spill (e.g., adult passage delays), for the juvenile fish transportation program, for research activities for studies to evaluate fish passage facilities, survival, or other fish-related issues. Spill patterns and biological testing protocols that have not been coordinated to-date will be considered through the regional coordination process using the Corps' Anadromous Fish Evaluation Program (AFEP) subcommittees, which include the TMT, the Studies Review Workgroup (SRWG), Fish Facility Design Review Work Group (FFDRWG), and FPOM.

4.1. Conditions that May Require Adjustments to Planned Operations

Under certain conditions or circumstances, the Corps may be required to adjust spill higher or lower than the target spill level at one or more projects.

Planned and Routine Operational Adjustments:[6]

1. High flow conditions that exceed powerhouse hydraulic capacity and require spilling more than the target spill level.
2. Low flow conditions that require adjustments in spill level while maintaining project minimum generation requirements (see section 4.3.1. below).
3. Lack of power demand (load) resulting in increased spill.
4. Scheduled turbine unit and/or transmission outages that reduce powerhouse hydraulic capacity and require spilling more than the target spill level.*
5. Standard operations for transmission reliability (see section 4.4.1. below)*
6. Navigation safety concerns (see section 4.6. below).*
7. Transition periods between Gas Cap spill and Performance Standard spill hours may result in actual hourly spill levels that are slightly higher or lower than targeted spill levels.

Non-routine or Unplanned Operational Adjustments:[7]

1. Contingency operations for transmission reliability (see section 4.4.2 below).
2. Fish emergencies (e.g., high river temperatures that exceed levels safe for fish, adult fish passage blockages, etc.).
3. Conditions related to project safety (e.g., erosion), health and human safety, navigation, or other unforeseen events that require spilling more or less than the target spill level.[8]
4. Other circumstances including human or programming error, unscheduled maintenance or outage, operational limitations (e.g., physical limitations of gate settings and spill

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[6] Planned and Routine Operational Adjustments are spill adjustments due to (1) conditions that occur routinely every year (e.g., high or low flow), or (2) planned operations (e.g., scheduled maintenance, transit of fish transport barge in the tailrace). These are considered pre-coordinated through regional sovereign review of the FOP and the FPP, and are implemented by the Action Agencies as conditions require and without additional coordination through the regional forum processes. Spill adjustments due to routine or planned operations are included in the monthly FOP Implementation Report in the hourly spill and flow charts (plots), and conditions with an (*) are reported in the "Pre-Coordinated Operations" Table. The FPP (Appendix A) identifies actions with pre-coordinated dates.

[7] Spill adjustments that occur due to non-routine or unplanned conditions or operations are implemented by the Action Agencies as conditions require and/or as coordinated with regional sovereigns through the in-season adaptive management process. Non-routine or Unplanned Operational Adjustments that affect spill levels are reported in the FOP Implementation Report Variance Table (and when warranted, a description may also be included in the Operational Adjustments section). When a Non-routine or Unplanned Operational Adjustment does not affect spill levels, information about this is provided in the Operational Adjustments section. If an adjustment continues into the next month, the adjustment is reported in the Pre-Coordinated Operations Table.

[8] When a generator requires repair, ongoing operations may require modification in order to prepare a turbine unit for the necessary maintenance without further damaging infrastructure or jeopardizing personnel safety. In order to safely install taillogs in a unit adjacent to the spillway, it may be necessary to cease spill through some spillbays for up to 6 hours during the installation of the physical barriers to isolate the area and subsequently dewater the draft tube environment. An alternate spill pattern for use during the maintenance period using the remaining spillbays will be coordinated through FPOM.

patterns outside of the level of precision defined in section 3 above, forebay elevations), and other unanticipated events or emergencies.
5. In-season adjustments following adaptive management coordination through the existing regional coordination process (see section 4).

4.2. TMT Emergency Protocols

The Corps and the other Action Agencies will operate the fourteen Columbia River System (or CRS) projects in emergency situations in accordance with the 2019 WMP Emergency Protocol (WMP Appendix 1). This protocol identifies the process the Action Agencies, in coordination with NOAA Fisheries, will use in the event of an emergency concerning project operations that impact planned fish protection measures. The emergency protocols also address the process for coordination with regional sovereigns. The most recent version of the Emergency Protocols is located at: http://pweb.crohms.org/tmt/documents/wmp/2019/Final/emerproto/

4.3. Low Flow Operations

4.3.1. Minimum Generation

All lower Snake and lower Columbia River dams have a minimum generation requirement that has been established to support power system reliability (see section 4.4.). The Corps has identified minimum generation powerhouse outflow values derived from the lower limit of the ±1% peak efficiency operating range defined in the project-specific chapters of the FPP and from actual generation records (see Table 1). Values stated in Table 1 are approximate ranges that account for varying head or other small adjustments in turbine unit operation that may result in variations from the reported minimum generation flow and spill amount. Conditions that may result in minor variations include:

1. Varying pool elevation: as reservoirs fluctuate within the operating range, flow rates through the generating unit change.
2. Generating unit governor "dead band": the governor controls the number of megawatts the unit should generate, but cannot precisely control a unit flow; variations may be 1-2% of unit flow. These variations can affect minimum generation ranges in Table 1.
3. System disturbances: once a generator is online and connected to the grid, it responds to changes in system voltage and frequency. These changes may cause the unit to increase or decrease flow and generation slightly within an hour. Individual units operate differently from each other and often have unit specific constraints.
4. Generation control systems regulate megawatt (MW) generation only, not flow through individual turbine units.

All of the lower Snake River powerhouses may be required to keep one generating unit online at all times for power system reliability under low river flow conditions, which may result in a reduction of spill at that project if there is insufficient flow in the river. Generally, units 1–3 are the first priority units for operation during the fish passage season for adult fish attraction flow to the fish ladders, but unit priority is also based on availability. During low river flow conditions, the Corps will operate the lower Snake River and lower Columbia River projects to the unit priority order specified in the FPP and minimum generation ranges identified in Table 1.

Table 1.– Minimum generation flow ranges (kcfs) for turbine units at Corps hydropower projects on the lower Snake and lower Columbia rivers.[9]

Project	Turbine Unit	Minimum Generation Flow Range[1] (kcfs)
Lower Granite	1, 3	11.8 – 12.9
	2[2]	17.5 – 18.5
	4, 5, 6	13.7 – 14.8
Little Goose	1, 2, 3	11.3 – 11.8
	4, 5, 6	13.8 – 14.4
Lower Monumental	1, 3	11.1 – 12.3
	2[2]	11.8 – 13.9
	4, 5, 6	14.1 – 14.9
Ice Harbor	1	8.4 – 10.1
	2[3]	TBD
	3[3]	TBD
	4	9.4 – 10.6
	5, 6[2]	13.1 – 14.1
McNary	N/A	50 – 60
John Day	N/A	50 – 60
The Dalles	N/A	50 – 60
Bonneville	N/A	30 – 40

1. "Minimum Generation" is the minimum number of megawatts (MW) that must be generated at each project in order to support power system reliability. This table defines the resulting flow range (kcfs) through turbines, which is a function of power output (MW), turbine efficiency, and project head.
2. Lower Granite Unit 2, Lower Monumental Unit 2, and Ice Harbor Units 5 and 6 are restricted due to runner blades that are fixed at a set angle (non-adjustable).
3. Ice Harbor Unit 3 is being rebuilt with a runner design that reduces impacts to fish, scheduled for completion in 2020. At that time, testing will be performed to determine the operating range. Also, Ice Harbor Unit 2 operating range has yet to be defined at the time this document was prepared.

There may be situations when river flows are insufficient to maintain minimum generation in Table 1 and the target spill level identified in Table 3 and Table 4 every hour. Under these conditions, the lower Snake River projects will operate one turbine unit at minimum generation and spill the remainder of outflow. The lower Columbia River projects will also operate at minimum generation and pass the remaining outflow as spill down to minimum spill levels. Under low river flow conditions during spring spill operations, the Corps will attempt to remain as close as possible to spill target levels for either gas cap spill or performance standard spill, depending on which operation is targeted for a given hour. The inability to meet the target gas cap spill level due to low river flow does not preclude the ability of the Corps to target performance standard spill levels for up to 8 hours a day as specified in Table 3. Additionally, inflow provided by non-Federal projects upstream is often variable and uncertain, and in combination with low flow conditions, may result in instances where forebay elevations go

[9] The table is accurate as of February 2019, but may change in-season as coordinated through FPOM (see the FPP).

outside of the restricted operating ranges for Snake River and Columbia projects described in Section 4.6.[10]

4.3.2. Navigation Lock Operation During Low Flows

At projects that have a target spill level that is a percentage of total outflow, emptying the navigation lock during low flow conditions may temporarily result in a reduced percentage of outflow that is reported as spill. During this time, the spill rate remains constant, but the spill reported as a percent of total outflow may be temporarily reduced below the target percentage. This occurs because the volume of water needed to empty the navigation lock during periods of low flow is a greater percentage of the total project outflow than during periods of higher flow.

4.3.3. Low Flow Operation at Little Goose

At Little Goose Dam, when daily average flow in the lower Snake River is ≤ 32 kcfs, achieving 30% spill would require switching powerhouse operations between operating two units at the low end of the ±1% of peak efficiency range to operating one unit at the high end of the ±1% of peak efficiency range. This operation, in combination with constant inflow from Lower Granite Dam, often makes it difficult to achieve the FOP prescribed spill level downstream at Lower Monumental Dam and to also maintain minimum operating pool (MOP) operations. During low flow periods (≤ 32 kcfs), Little Goose spill operations will transition from 30% to a constant spill level of approximately 7-11 kcfs to help stabilize Little Goose outflow, meet Lower Monumental target spill levels, and maintain MOP elevation at Little Goose. The constant spill level will be based on the previous day's average total project outflow, as follows: 11 kcfs when total outflow is 28.0 to 32.0 kcfs, 9 kcfs when total outflow is 24.0 to 27.9 kcfs, and 7 kcfs when total outflow is ≤ 23.9 kcfs.

4.4. Operations for Transmission System Reliability

In managing the fish passage spill operations, the Corps and BPA plan to allocate generation and spill at the eight Corps projects on the lower Columbia and Snake rivers in accordance with the 2019 FOP. Periodically, to ensure the reliability of the transmission system when system conditions warrant, it is necessary to increase or decrease the amount of water flowing through a project's turbines and spillbays at one or more of these projects.

Consistent with past practice, if any of the transmission system conditions listed below are present and can be alleviated by temporarily modifying generation levels at one or more federal projects, the Action Agencies will adjust generation and spill levels to avoid the transmission system impact. These events could result in actual spill being temporarily higher or lower than the target fish passage spill level. Such events may occur coincident with the transmission system event or in subsequent hour(s) should the event impact water balance at a specific hydro project or river reach. The Corps and BPA will work to restore conditions to support target spill operations as soon as practicable. These actions are taken to minimize the risk and/or scope of a

[10] Lower Snake River projects operate within the minimum operating pool (MOP) range during fish passage season (Table 2).

transmission system emergency and will be reported in the monthly FOP Implementation Report (see section 8 below).

4.4.1. Standard Operations for Transmission Reliability

Consistent with past practice, the Action Agencies manage the fourteen Columbia River System projects to be prepared to provide electric reliability support as follows:

1. Ensuring sufficient range of generation capability is available to provide the BPA balancing authority[11] area with contingency reserves required by North American Electric Reliability Corporation (NERC) and Western Electricity Coordination Council (WECC) reliability standards.[12]
2. Ensuring generation is available to increase or decrease in order to balance load and generation within the BPA balancing authority area to support reliability.
3. Ensuring enough generating units are online and have sufficient capability to increase or decrease generation to meet the BPA balancing authority area frequency response obligations, consistent with reliability standard requirements.
4. Ensuring that there is generation operating at projects in specific locations sufficient for arming for Remedial Action Schemes (RAS).[13] RAS schemes allow the transmission system to automatically respond to unplanned events on the power system by immediately dropping or reducing generation at those specified locations.
5. Maintaining minimum generation levels (see Table 1) at generators in specific locations to maintain correct voltage levels on the power system to ensure reliability.
6. Maintaining enough generation units online in diverse locations on the electrical grid to ensure system stability through rotating inertia.

4.4.2. Contingency Operations for Transmission Reliability

If the routine reliability tools described above are insufficient to resolve the transmission condition, the Action Agencies will implement the preemptive actions detailed in the Power System Emergency Action Plan (Attachment 1 to the TMT Emergency Protocols referenced in section 4.2 above) if time permits. Where necessary, the fourteen Columbia River System projects will be called upon to relieve the following conditions:

1. Increasing or decreasing generation at projects (redispatch) in specific geographic locations to relieve heavily loaded transmission lines if required by system conditions.

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[11] A balancing authority is the responsible entity that maintains load-interchange-generation balance within a Balancing Authority Area, and supports interconnection frequency in real time. Balancing authority area is the collection of generation, transmission, and loads within the metered boundaries of the designated balancing authority. The balancing authority maintains load-resource balance within this area.

[12] The Federal Energy Regulatory Commission has certified the NERC as the Electric Reliability Organization responsible for establishing and enforcing national reliability standards. NERC has delegated some of its authority to the WECC as the regional entity responsible for monitoring reliability standards compliance and enforcement in the Western Interconnection.

[13] Remedial Action Schemes are sets of automatic control circuits that switch various types of power system components on or off in response to disturbances on the interconnected transmission system.

This includes adjusting generation that flows over specific transmission facilities in order to keep flows over those paths within the requirements of NERC and WECC reliability standards.

2. Increasing or decreasing generation to ensure transmission system stability and/or reliable load service in local areas under specific system conditions. For example, increasing generation at Ice Harbor Dam to support transmission stability, including providing load service to the Tri-Cities area of Washington, when system conditions require.
3. Responding to unanticipated significant events, including NERC Energy Emergency Alerts or other system emergencies, consistent with the Power System Emergency Action Plan included as Attachment 1 to the TMT Emergency Protocols.
4. Other unanticipated significant events (e.g. fires, earthquakes, etc.).

These actions will be implemented consistent with the TMT Emergency Protocols (see section 4.2 above).

4.5. Turbine Unit Testing for Maintenance

Turbine units may be operationally tested prior to maintenance and prior to return to service for up to 60 minutes by running the unit at speed no load, various loads within the ±1% of peak efficiency range, and, if necessary, up to full load, to allow for measurements and testing. Testing of a unit under maintenance is in addition to a unit operating at minimum generation required for power system reliability. Testing may deviate from unit operating priorities specified in FPP Chapters 2-9 and may use water that would otherwise be used for spill if the unit operating for reliability is at the bottom of the ±1% of peak efficiency range. Water will be used from the powerhouse outflow allocation if possible, and water diverted from spill for operational testing will be minimized. The Corps coordinates this testing with the region through FPOM. Unit outages for required maintenance are described in FPP Appendix A. Maintenance dates are subject to change.

4.6. Navigation Safety

Short-term adjustments in spill or MOP may be required at any of the fish passage projects to address navigation safety concerns.[14] This may include changes in spill patterns, reductions in spill, short-term spill curtailment, or operating above MOP.

The 2019-2021 Spill Operation Agreement and the 2019 BiOp describe MOP at the lower Snake River projects as a 1.5-foot range above the minimum forebay elevation (Table 2). The term "MOP+1.5" was previously used to describe this operation that is intended to provide 1.0 foot of actual operational range with a 0.5 foot buffer. In order to clearly communicate the implementation of this operation, the term "MOP" will refer to the 1.5-foot operating range above the minimum forebay elevation at the lower Snake River projects (i.e., "MOP" is a 1.5-foot operating range).

[14] The Corps conducts annual surveys to assess sedimentation in the reservoirs and under certain conditions. To ensure safe navigation, there may be a need to operate the pools above the MOP range.

Table 2.– Normal and minimum operating pool (MOP) elevation ranges for lower Snake River projects[1].

Project	Normal Operating Elevation Range (ft)[2]		MOP Elevation Range (ft)[3]	
	Minimum	Maximum	Minimum	Maximum
Lower Granite	733.0	738.0	733.0	734.5
Little Goose	633.0	638.0	633.0	634.5
Lower Monumental	537.0	540.0	537.0	538.5
Ice Harbor	437.0	440.0	437.0	438.5

1. MOP elevations provided in feet above mean sea level (NGVD29).
2. September 1 – April 2.
3. April 3 – August 31.

Potential in-season adjustments to MOP, if necessary, will be an expanded forebay operating range (Expanded MOP), raised minimum forebay elevation (Raised MOP), or a variable forebay operating range (Variable MOP), as described below.

Expanded MOP: If the 1.5-foot MOP range is insufficient to maintain navigation safety, the range will be expanded (e.g., to 2 feet). For instance, some flow conditions may require a 2-foot forebay operating range at Ice Harbor in order to provide safe conditions for barge traffic at the Ice Harbor forebay navigation lock exit. These adjustments may be necessary for both commercial traffic and fish transport barges. Using Ice Harbor as an example, this type of adjustment would be described as "2-foot expanded MOP (437.0-439.0 feet)".

Raised MOP: If the minimum forebay elevation is insufficient to maintain navigation safety, the 1.5-foot MOP range will be raised as necessary. Adjustments in MOP operations have been necessary at several fish passage projects, typically during low flow conditions. For instance, unsteady or low flow at Little Goose and Ice Harbor dams (approximately 50 kcfs or less) may impact reservoir elevations and cause inadequate navigation depths at the downstream entrances to the Lower Granite and Lower Monumental navigation locks, respectively. Adjustments up to 1.5 feet above the minimum pool elevations at Little Goose and Ice Harbor may be necessary to accommodate safe entrance to the upstream navigation locks at Lower Granite and Lower Monumental dams. Using Little Goose as an example, this type of adjustment would be described as "1.5-foot raised MOP (634.5-636.0 feet)".

Variable MOP: Due to sediment deposition in the confluence area of the lower Snake and Clearwater rivers near Lewiston, Idaho, the Corps began implementing a "variable MOP" operation at Lower Granite Dam in April 2018 to provide the required federal navigation channel depth of 14 feet. This operation will continue during the 2019 fish passage season (and/or until maintenance dredging occurs) with a 1.5-foot range above the minimum forebay elevation based on inflow to Lower Granite. At high flows (≥ 120 kcfs), the required navigation channel depth is able to be maintained with Lower Granite operating in the MOP range of 733.0-734.5 feet. However, at flows below 120 kcfs, the Lower Granite forebay must be operated progressively higher in order to maintain the navigation channel depth, as follows:

- Inflow 80-119 kcfs = Lower Granite forebay operating range 734.0-735.5 feet (1-foot raised MOP);
- Inflow 50-79 kcfs = Lower Granite forebay operating range 734.5-736.0 feet (1.5-foot raised MOP);
- Inflow below 50 kcfs = Lower Granite forebay operating range 735.0-736.5 feet (2-foot raised MOP).

Spill Adjustments: High spill levels may create unsafe hydraulic conditions for commercial, non-commercial, and fish transportation barges entering and exiting the tailrace and/or while moored at the fish transport loading facility. Under these conditions, spill may be reduced temporarily as necessary to maintain safe navigation conditions for commercial, non-commercial, or fish transportation barges, which may result in temporarily filling the pool above the MOP range, depending on river flow.

5. JUVENILE FISH TRANSPORTATION PROGRAM

The best available information will be considered in the Corps' implementation of the juvenile fish transportation program operations at the Snake River collector projects in 2019. Should regional sovereigns recommend adjustments in transportation start dates that differ from those stated herein, the Corps will use the existing regional adaptive management process to make a determination on recommended operational adjustments.

The following describes the proposed transportation operations for the lower Snake River projects. Detailed descriptions of project and transport facility operations to implement the juvenile fish transportation program are contained in the FPP Appendix B.

5.1. Lower Snake River Dams – Transport Operation and Timing

Transportation will be initiated at Lower Granite, Little Goose, and Lower Monumental dams on April 24 (collection starting on April 23) or as coordinated through the Technical Management Team (TMT), FPOM, and the Regional Implementation Oversight Group (RIOG), but begin no later than May 1. Barging of fish will begin the following day after fish collection and collected juvenile fish will be transported from each facility on a daily or every-other-day basis (depending on the number of fish) throughout the migration season. Transportation operations will be carried out at each project in accordance with all relevant FPP operating criteria. Transportation and spill operations may be adjusted due to research, conditions at fish collection facilities (e.g., overcrowding or temperature extremes), or through the adaptive management process with FPOM and/or TMT (e.g., to respond to expected environmental conditions, to respond to recent transport vs in-river research results, to better match juvenile outmigration, or to achieve/maintain performance standards).

5.2. Transport Research – Seasonal Effects of Transport

An ongoing annual study will be conducted again in 2019 to determine seasonal effects of transporting fish from the Snake River to optimize a transportation strategy. At Lower Granite, fish will be collected for this study starting on April 2, with marking beginning on April 3.

Depending on the number of fish available, fish will be collected 1-2 days each week with tagging occurring on the day following collection. A barge will leave each Thursday morning with all fish collected during the previous 1-3 days. By barging all fish (minus the in-river group) during 1 to 3 days of collection, barge densities will be maintained at a level similar to what would occur under normal transport operations that time of year. This pattern will occur in the weeks preceding general transportation and will be incorporated into general transportation once that operation begins. The desired transported sample size is 6,000 wild Chinook, 4,000-6,000 wild steelhead, and 4,000-6,000 hatchery steelhead weekly for approximately eight weeks.

6. 2019 SPRING FISH PASSAGE SPILL OPERATIONS

Spring spill operations will occur April 3–June 20 at the four lower Snake River projects, and April 10–June 15 at the four lower Columbia River projects. The Corps will initiate spill at 0001 hours, or shortly after midnight, at each of the projects on the start date. Target spill levels for spring 2019 at each project are defined in Table 3.

Table 3.– Summary of 2019 spring target spill levels at lower Snake River and lower Columbia River projects.

PROJECT	GAS CAP SPILL (16 hours per day)[1, 2, 3, 5]	PERFORMANCE STANDARD SPILL (8 hours per day)[2, 4, 5]
Lower Granite	120% Gas Cap	20 kcfs
Little Goose	120% Gas Cap	30%
Lower Monumental	120% Gas Cap (uniform spill pattern)	30 kcfs (bulk spill pattern)
Ice Harbor	120% Gas Cap	30%
McNary	120% Gas Cap	48%
John Day	120% Gas Cap	32%
The Dalles	120% Gas Cap[6]	40%
Bonneville	120% Gas Cap[7]	100 kcfs

1. Uncertainty remains about how the system will respond to these new operations, therefore existing adaptive management processes will be employed to help address any unintended consequences that may arise in-season as a result of implementing these proposed spill operations.
2. Spill may be temporarily reduced at any project if necessary to ensure navigation safety or transmission reliability.
3. 120% Gas Cap spill is spill to the maximum level that meets, but does not exceed, the TDG criteria allowed under state laws.
4. The 8 hours of Performance Standard spill will occur in up to two blocks per calendar day, an am block and a pm block. An am block is defined as beginning in the am (but may end in the pm) and a pm block is defined as beginning in the pm (but may end in the am). Only Little Goose would be set to at least 4 hours in the am (beginning near dawn and not to exceed 5 hours in the am) and no more than 4 hours in the pm (generally near dusk) to help with adult passage issues. All other projects could spill up to 5 hours of performance standard spill either in the am or pm time period with the remaining hours occurring in the alternate time period (not to exceed 8 hours in a day).
5. No ponding above current Snake River MOP/John Day MIP assumptions (to provide a 1-ft. useable range and a 1.5-ft. useable range, respectively).
6. Spill to the 120% Gas Cap restricted to spillbays 1-8 (within the spillwall) when river flow is ≤ 350 kcfs.
7. Spill to the 120% Gas Cap, not to exceed 150 kcfs.

7. 2019 SUMMER FISH PASSAGE SPILL OPERATIONS

Summer spill operations will occur June 21–August 31 at the four lower Snake River projects, and June 16–August 31 at the four lower Columbia River projects. The Corps will initiate spill at 0001 hours, or shortly after midnight, at each of the projects on the start date. Target spill levels for summer 2019 at each project are defined in Table 4.

Table 4.– Summary of 2019 summer target spill levels at lower Snake River and lower Columbia River projects.

PROJECT	2019 SUMMER SPILL[1] (24 hrs/day)
Lower Granite	18 kcfs
Little Goose	30%
Lower Monumental	17 kcfs
Ice Harbor	30%
McNary	57%
John Day	35%
The Dalles	40%
Bonneville	95 kcfs

1. Spill may be temporarily reduced below the FOP target summer spill level at any project if necessary to ensure navigation safety or transmission reliability, or to avoid exceeding State TDG standards.

8. PROJECT-SPECIFIC OPERATIONS

The following sections describe 2019 spill operations for each project. The Corps will implement established spill patterns for all projects as described in the FPP.

8.1. Lower Granite Dam

8.1.1. Spring Spill April 3–June 20 (Table 3): Gas Cap (see section 2.1), 16 hours/day, and 20 kcfs for up to 8 hours/day.

8.1.2. Summer Spill June 21–August 31 (Table 4): 18 kcfs, 24 hours/day.

8.1.3. Operational Considerations: None for 2019.

8.2. Little Goose Dam

8.2.1. Spring Spill April 3–June 20 (Table 3): Gas Cap (see section 2.1), 16 hours/day, and 30%, 8 hours/day.

8.2.2. Summer Spill June 21–August 31 (Table 4): 30% (unless adjusted to a constant spill level during low flows per section 4.3.3), 24 hours/day.

8.2.3. Operational Considerations:

- When river flow is ≤ 32 kcfs, the project cannot maintain 30% spill. Therefore, the project will transition to constant spill of 7-11 kcfs, as described in section 4.3.3.

- During summer spill when the spillway weir is closed and project outflow is less than or equal to 38 kcfs, actual hourly average spill levels at Little Goose may range up to ±4% according to the spill pattern Table LGS-10 in FPP Chapter 8.

8.3. Lower Monumental Dam

8.3.1. Spring Spill April 3–June 20 (Table 3): Gas Cap (see section 2.1) using the uniform spill pattern, 16 hours/day, and 30 kcfs using the bulk spill pattern for up to 8 hours/day.

8.3.2. Summer Spill June 21–August 31 (Table 4): 17 kcfs, 24 hours/day.

8.3.3. Operational Considerations: Transit of the juvenile fish barge across the Lower Monumental tailrace, docking, and departure from the collection facility, may require a reduction in spill below the target spill level for safety concerns. The towboat captain may request spill be reduced or eliminated during transit. During juvenile fish loading operations, spill is typically reduced to 15 kcfs, but can be reduced further if necessary for safety reasons. Barge loading duration can be up to 3.5 hours. Reducing spill may cause the Lower Monumental pool to briefly operate outside of MOP elevations.[15]

8.4. Ice Harbor Dam

8.4.1. Spring Spill April 3–June 20 (Table 3): Gas Cap (see section 2.1), 16 hours/day, and 30% for up to 8 hours/day.

8.4.2. Summer Spill June 21–August 31 (Table 4): 30%, 24 hours/day

8.4.3. Operational Considerations: None for 2019.

8.5. McNary Dam

8.5.1. Spring Spill April 10–June 15 (Table 3): Gas Cap (see section 2.1), 16 hours/day, and 48% for up to 8 hours/day. A spillway weir will be operated in both spillbay 19 and spillbay 20 for the period April 10 through June 7. As in past years, both spillway weirs will be removed from service on June 8 (or next business day as coordinated through the FPOM) for the benefit of subyearling Chinook. This operational change will be coordinated through the FPOM. Temporary spill pattern changes to allow removal of the spillway weirs will occur; however spill will continue at the target level defined in Table 3 during removal of the spillway weirs using the spill pattern in FPP Table MCN-10. Following removal of the spillway weirs, the spill pattern in Table MCN-9 in FPP Chapter 5 will be used for the remainder of the spring and summer.

[15] With spill levels in spring 2019 targeting the gas cap for at least 16 hours/day, reducing spill at Lower Monumental for long durations could pose problems for staying within MOP at Ice Harbor Dam, the next downstream project.

8.5.2. Summer Spill June 16–August 31 (Table 4): 57%, 24 hours/day, without spillway weirs (removed in early June).

8.5.3. Operational Considerations: None for 2019.

8.6. John Day Dam

8.6.1. Spring Spill April 10–June 15 (Table 3): Gas Cap (see section 2.1), 16 hours/day, and 32% for up to 8 hours/day.

8.6.2. Summer Spill June 16–August 31 (Table 4): 35%, 24 hours/day.

8.6.3. Operational Considerations: None for 2019.

8.7. The Dalles

8.7.1. Spring Spill April 10–June 15 (Table 3): Gas Cap (see section 2.1), 16 hours/day, and 40% for up to 8 hours/day.

8.7.2. Summer Spill June 16–August 31 (Table 4): 40%, 24 hours/day.

8.7.3. Operational Considerations:

- Actual hourly average spill levels at The Dalles may range up to ±3 kcfs according to the spill pattern tables in FPP Chapter 3.
- Gas cap spill will be contained within spillbays 1-8 (within the spillwall) at river flow ≤350 kcfs.
- Spill bays 9, 10, 11, 13, 16, 18, 19, and 23 are operationally restricted due to wire rope, structural and concrete erosion concerns.

8.8. Bonneville Dam

8.8.1. Spring Spill April 10–June 15 (Table 3): Gas Cap (see section 2.1), 16 hours/day, and 100 kcfs for up to 8 hours/day.

8.8.2. Summer Spill June 16–August 31 (Table 4): 95 kcfs, 24 hours/day.

8.8.3. Operational Considerations:

- Maximum fish passage spill level is 150 kcfs. This constraint is based on physical model observations indicating an increased incidence of rock deposition into the spillway stilling basin at spill ≥ 150 kcfs, which has caused erosion to the structure in the past.
- Minimum spill level is 50 kcfs; however, as observed in past years, to provide acceptable juvenile fish egress conditions in the tailrace under extreme low flow conditions, lower spill levels may be considered and coordinated through the TMT and/or FPOM.
- Actual hourly average spill levels at Bonneville Dam may range up to ±3 kcfs according to spill pattern tables in FPP Chapter 2.

9. FOP IMPLEMENTATION REPORTING

The Corps posts monthly FOP Implementation Reports on the following website: http://pweb.crohms.org/tmt/documents/FOP_Implementation_Reports/. The updates will include monthly project plots containing the following information:

- total flow: the total hourly river flow rate;
- generation flow: the hourly flow through the powerhouse units;
- target spill: the spill target for that hour (Tables 3, 4);
- adjusted spill: the hourly spill level that can be achieved taking into consideration that spill may vary as a function of total river flow, forebay elevation, and generator capacity, and is subject to routine operational adjustments that limit the ability to spill to the target spill (see section 4.1);
- actual spill: the hourly flow over the spillway; and,
- resultant 12-hour average TDG for the tailwater at each project.

The reports will also provide information on operational adjustments that arise as a result of the spill program (e.g., Little Goose adult passage issues), and will address any emergency situations, including spill adjustments for contingency operations for transmission reliability.

The Corps will continue to provide the following data to the public regarding project flow, spill rate, TDG level, and water temperature.

- Hourly flow, generation, and spill quantity data for the lower Snake and Columbia River dams are posted to the following website:
    - http://www.nwd-wc.usace.army.mil/report/projdata.htm (web reports with the most recent 8 days of hourly project data and the current month of daily project data)
    - http://pweb.crohms.org/tmt/wq/historical/ (links to historic hourly project data files in .csv format organized by month back to 2004 including temperature and TDG information)
- Water quality data are received via satellite from FMS in the Columbia and Snake rivers every hour, and placed on a Corps public website upon receipt. Hourly TDG and water temperature data are posted to the following websites:
    - http://pweb.crohms.org/report/total.html (web reports with hourly TDG, project outflow and spill for the previous 3 days)
    - http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/ (links to historic hourly water quality data files for each FMS including barometric and total gas pressure, TDG and project outflow and spill in csv-format organized by month back to 2005)
    - Using the hourly TDG readings for each station in the lower Snake and Columbia rivers, the Corps will calculate both the highest 12-hour average TDG levels (Oregon and Washington spring method) and the highest consecutive 12-hour average TDG levels (Washington summer method) on a daily basis. These averages are reported at: http://www.nwd-wc.usace.army.mil/ftppub/water_quality/12hr/

- Spill cap information will be posted to the following site each day: http://pweb.crohms.org/tmt/documents/ops/spill/caps/.

In addition to the monthly FOP Implementation Reports, the Corps will continue to provide status updates at the regularly scheduled TMT meetings about the 2019 fish passage spill operations, including reasonably detailed information that is relevant to the Corps' process for implementing fish passage spill.