FISH OPERATIONS PLAN IMPLEMENTATION REPORT

May 2023

U.S. Army Corps of Engineers
Northwestern Division
Portland, OR.

Introduction

The U.S. Army Corps of Engineers (Corps) developed this report in accordance with the 2023 Fish Operations Plan[1] (2023 FOP). The 2023 FOP describes the Corps' planned operations for juvenile fish passage at its four lower Snake River and four lower Columbia River dams during the 2023 spring and summer fish migration seasons, generally April 3 through August 31. The 2023 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 Record of Decision for the Columbia River System Operations Environmental Impact Statement (CRSO EIS ROD) dated September 28, 2020, CRSO Final EIS, 2020 National Marine Fisheries Service (NMFS) Columbia River System and U.S. Fish and Wildlife Service Biological Opinions (2020 BiOps)[2], the Extensions of the 2008 Columbia Basin Fish Accords (Accord Extensions)[3], the Corps' requirements under the Endangered Species Act (ESA), and the ongoing consultation and communications with the relevant wildlife agencies to ensure consistency with the Act. The 2023 FOP also incorporates spill operations agreed to in the Term Sheet for Stay of Preliminary Injunction Motion and Summary Judgment Schedule[4] for the *NWF et al. v. NMFS et al.* (3:01-cv-00640-SI) litigation, as extended and modified through the Administration's Commitments in Exhibit 2 of the Joint Motion to Extend the Litigation Stay filed August 4, 2022 (referred to collectively as 2022 Agreement). Other project operations and water management actions not specifically addressed in this document will be consistent with other guiding operative documents, including the 2023 Water Management Plan (WMP), seasonal WMP updates, and the 2023 Fish Passage Plan (FPP).

[1] The 2023 FOP was posted to the Technical Management Team (TMT) website on March 27, 2023 (http://pweb.crohms.org/tmt/documents/fpp/2023/).

[2] The Corps, in coordination with the other Action Agencies, and NMFS, employs the Regional Implementation Oversight Group (RIOG) and technical teams including the Technical Management Team (TMT) and Fish Passage Operations & Maintenance (FPOM) coordination group, to coordinate with state, tribal and other federal experts for recommendations for implementing operations consistent with the 2020 BiOps.

[3] The 2020 Amendment to and 2018 Extension of the 2008 Columbia Basin Fish Accords are available at https://www.salmonrecovery.gov/Partners/FishAccords.aspx

[4] 2022 Agreement: https://pweb.crohms.org/tmt/JointMotion_TermSheet_CourtOrder_OCT2021.pdf

This report describes the Corps' implementation of the 2023 FOP during the month of May. Information in this report includes the following:

- 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 (Table 1);
- 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 2023 FOP, Section 4.1);
- actual spill: the hourly flow over the spillway; and,
- resultant 12-hour average TDG for the tailwater at each project.

This report also provides information on issues and unanticipated or emergency situations that arose during implementation of the 2023 FOP in May 2023.

Data Reporting

I. For each project providing fish passage operations, this report contains a graph displaying the performance of the spring fish passage spill program for the month of May, with hourly spill, target spill, adjusted spill, generation, and total flows. The monthly graphs begin on May 1 and end on May 31 and reflect the following operations for the lower Snake River and the lower Columbia River projects:

- The black line represents the average hourly total river flow through the project in thousand cubic feet per second (kcfs).
- The orange line represents the average hourly generation flow through the powerhouse each hour in kcfs.
- The thin solid blue line represents the actual average hourly spill level through the spillway in kcfs.
- The dashed blue line represents the spill cap portion of the target spill estimated to reach the gas cap or target TDG.
- The thick light blue line represents the performance standard spill level portion of the target spill.
- The thick dark blue line represents the adjusted spill cap spill: the hourly spill cap 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 (2023 FOP section 4.1).

II. The average daily %TDG for the 12 highest hours for all projects is shown in the May 2023 Average Percent TDG Values Table (Table 4). Red numbers indicate that the project exceeded the %TDG cap - i.e. 125% (tailwater) on that day.

General Implementation Remarks

For all projects that spill for fish passage, the actual spill may vary from the adjusted spill due to various conditions as described below. When actual spill varied from adjusted spill levels during periods of voluntary spill, the change in spill level is described below in the May 2023 Spill Variance Table (Table 2).[5] The Spill Variance Table includes average hourly data; but when spill varies from adjusted spill for a portion of an hour, it is characterized as a variance for a full hour. There are instances when the hourly adjusted spill levels are not achievable due to mechanical limitations in setting spill gates to implement the regionally coordinated spill pattern. The project operator sets the spill gate stops to most closely approximate the adjusted spill to the extent practicable. Other routine activities that changed spill levels, which were coordinated with regional partners, are identified in the monthly Pre-Coordinated Operations Table (Table 3).

"Low flow" operations at the lower Columbia and lower Snake projects are triggered when inflow is insufficient to provide both minimum generation and the target spill levels. For this report, the decrease in target spill is represented as adjusted spill. In these situations, the projects operate at minimum generation and pass the remainder of project inflow as spill and through other routes, such as fish ladders, sluiceways, and navigation locks. As flows transition from higher flows to low flows, there may be situations when flows recede at a higher rate than forecasted. In addition, inflows provided by nonfederal projects upstream are variable and uncertain.

The combination of these factors may result in instances when unanticipated changes to inflow result in forebay elevations dropping to the low end of the Minimum Operating Pool (MOP). Since these projects have limited operating flexibility, maintaining minimum generation, MOP elevation, and the target spill may not be possible throughout every hour.

Actual spill levels at Corps projects may vary up to ±2 kcfs within the hour (except as otherwise noted in the 2023 FOP for Bonneville and The Dalles dams,[6] which may range up to ±3 kcfs) as compared to a target spill. A number of factors influence actual spill, including hydraulic efficiency, exact gate opening calibration, spillway gate hoist cable stretch due to temperature changes, and forebay elevation (e.g. a higher forebay results in a greater level of spill since more water can pass under the spill gate). 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 target spill levels. Occurrences requiring an adjustment in operations and/or regional coordination are described in greater detail in the "Operational Adjustments" section below.

[5] Forced spill conditions shown in the graphs are not considered variances and are not reported in the Spill Variance Table. Forced spill conditions may result from lack of load, high river inflows that exceed available powerhouse capacity, scheduled or unscheduled turbine unit outages or transmission outages of various durations, passing debris, etc.

[6] As specified in the 2023 FOP Section 3.

May Operations

The month of May was characterized by above average precipitation and flows for the lower Snake and lower Columbia rivers. The May 2023 observed precipitation was 104% of average on the Snake River above Ice Harbor and 106% of average on the Columbia River above The Dalles.[7] The NOAA Northwest River Forecast Center runoff summary for May indicated that the adjusted runoff for the Snake River at Lower Granite was 130% of the 30-year average (1991-2020) with a volume of 9.6 MAF (Million acre-feet). The May 2023 adjusted runoff for the Columbia River at The Dalles was 133% of the 30-year average (1991-2020) with a volume of 36.4 MAF.[8]

Spring spill operations 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 initiates spill at 0001 hours, or shortly after midnight, at each of the projects on the start date. Target spill levels for spring 2023 at each project are defined in Table 1 (Table 3 in the 2023 FOP). If deleterious impacts of the proposed spill operations are observed in-season, existing adaptive management processes may be employed to address the cause of the impacts. Spill may be temporarily reduced at any project to ensure navigation safety or transmission reliability. In order to operate consistently with state water quality standards, spill may also be reduced if observed GBT levels exceed those identified in state water quality standards (*See* WASH. ADMIN. CODE § 173-201A-200(l)(f)(ii)(B)(III) and *Order Approving a Modification to the Oregon's Water Quality Standard for Total Dissolved Gas in the Columbia River Mainstem*, page 5).

Spill up to the 125% Gas Cap is spill to the maximum level that meets, but does not exceed, the TDG criteria allowed under state laws. This includes a criterion for not exceeding 126% TDG for the average of the two greatest hourly values within a day.

[7] Retrieved June 5, 2023: https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?tab=5
[8] Retrieved June 5, 2023: https://www.nwrfc.noaa.gov/runoff/runoff_summary.php

Table 1.– Summary of 2023 spring target spill levels at lower Snake River (April 3 – June 20) and lower Columbia River (April 10 – June 15) projects (Table 3 in the 2023 FOP).

PROJECT	SPRING SPILL DATES	SPRING SPILL OPERATION
Lower Granite [A, C]	April 3 until adult criteria met (no later than April 24)	24 hours/day: 125% Gas Cap
	Adult criteria met (no later than April 24) – June 20	16 hours/day: 125% Gas Cap 8 hours/day: 20 kcfs Performance Standard
Little Goose [B, C]	April 3 – June 20	16 hours/day: 125% Gas Cap 8 hours/day: 30% Performance Standard
Lower Monumental [A, C]	April 3 until adult criteria met (no later than April 24)	24 hours/day: 125% Gas Cap
	Adult criteria met (no later than April 24) – June 20	16 hours/day: 125% Gas Cap 8 hours/day: 40%
Ice Harbor	April 3 – June 20	24 hours/day: 125% Gas Cap
McNary	April 10 – June 15	24 hours/day: 125% Gas Cap
John Day [D]	April 10 – June 15	16 hours/day: 125% Gas Cap 8 hours/day: 32% Performance Standard
The Dalles [E]	April 10 – June 15	24 hours/day: 40% Performance Standard
Bonneville [F]	April 10 – June 15	24 hours/day: 125% Gas Cap

A. Lower Granite and Lower Monumental Adult Criteria – Within 1 business day of when the earliest of the following conditions occurs: (1) a cumulative total of 25 adult spring Chinook salmon (not including jacks) pass Lower Monumental Dam; or (2) a cumulative total of 50 adult spring Chinook salmon (not including jacks) pass Ice Harbor Dam; or (3) April 24, 2023, the Corps will implement 20 kcfs performance standard spill, up to 40% spill to manage high flows, at Lower Granite and 40% spill at Lower Monumental for 8 consecutive AM hours, 0400–1200, to target hours of peak adult passage. If lack of load conditions precludes the implementation of 20 kcfs performance standard spill at Lower Granite and 40% spill at Lower Monumental during the targeted AM period, those blocks will begin as soon as practicable during AM hours and continue for up to 8 consecutive hours. If a second block is needed, it will start as soon as load conditions allow, continue for at least two consecutive hours, and conclude no later than 2000. During periods of high river flow, the 8-hour Lower Granite performance standard spill may increase from 20 kcfs up to 40% of total river outflow if needed to improve conditions to meet performance standard blocks.

B. Little Goose – The 8 hours of performance standard spill will occur between the hours of 0300 and 2200 in one or two blocks per calendar day. Within 1 business day of a cumulative total of 25 adult spring Chinook salmon (not including jacks) passing Lower Monumental Dam, the Corps will implement performance standard spill at Little Goose Dam for 8 consecutive AM hours (April 3–15 starting at 0500 hours; April 16–June 20 starting at 0400 hours) to target hours of peak adult passage. If lack of load conditions preclude the implementation of performance standard spill during the targeted periods, performance standard spill will begin as soon as practicable during AM hours and continue for up to 8 consecutive

hours. If a second block is needed, it will start as soon as load conditions allow, continue for at least two consecutive hours, and conclude no later than 2000.

C. During periods of high river flow that exceeds powerhouse hydraulic capacity, implementing 8 consecutive hours of spill as described in Footnotes A and B may result in storing additional inflow in the forebay above MOP. If it is necessary to pond water to achieve the 8-hour block of spill during high inflow, water stored above MOP should be drafted out over the remaining hours by increasing spill to pass inflow from 1200-1600 hours, then increasing spill as necessary from 1600-0400 to draft the pool back to MOP. If it is forecasted that the drafting spill will result in exceeding 130% TDG in the tailrace, all 16 hours will be used to return the pool to MOP. In lack of load conditions performance standard spill blocks will be prioritized at Little Goose, Lower Monumental, and Lower Granite dams, in that order.

D. John Day Dam – The 8 hours/day of performance standard spill may occur with some flexibility, in either a single 8-hour block or two separate blocks per calendar day. Performance standard spill will not be implemented between 2200-0300 hours.

E. The Dalles Dam –TDG in The Dalles tailrace may fluctuate up to 125% prior to reducing spill at upstream projects or reducing spill at The Dalles below 40%. Maintain 40% spill for 24 hours at The Dalles and reduce John Day spill below the 125% TDG spill cap as needed for TDG management. Spill above 40%, up to 125% TDG, may occur for TDG management or for carrying reserves.

F. Bonneville Dam – Spill for fish passage should not exceed 150 kcfs due to erosion concerns.

In its implementation of the 2023 FOP in May, the Corps evaluated conditions every day to establish spill caps at a level that was estimated to meet, but not exceed, the gas cap or target TDG in the tailrace (see Table 4).[9] This evaluation considered: environmental conditions (e.g., river flow, wind, water temperature, barometric pressure, incoming TDG from upstream, and water travel time) and project operations (e.g., spill level, spill pattern, tailwater elevation, proportion of flow through the turbines, and project configuration).

[9] See 2022 FOP, Section 2.2

Operational Adjustments

1. Lower Snake River, GBT exceedance, May 9

On May 9, the incidence of gas bubble trauma (GBT) exceeded the State of Washington's action criterion threshold of 15 percent GBT in non-paired fins at over 26.4 percent for 106 native non-salmonids sampled below Ice Harbor. Since Washington's 125 percent TDG gas cap is conditional on low rates of GBT, the gas cap reverted to 120 percent TDG in the tailrace/115 percent TDG in the next downstream forebay. As outlined in the 2023 GBT Biological Monitoring Plan approved by Washington Department of Ecology (WDOE), if an action criterion is exceeded at a GBT monitoring location, Washington requires that the gas cap will be reduced within the geographic zone where the action criterion exceedance was detected. Because the sample was taken below Ice Harbor Dam, the Corps adhered to the 2023 GBT Biological Monitoring Plan approved by WDOE by managing spill at all four lower Snake River dams to target the 115/120 percent TDG level the following afternoon at 1600, May 10. Performance standard spill continued at Lower Granite, Little Goose, and Lower Monumental as described in the FOP.

After the notice of GBT exceedance, WDOE indicated that, despite the provisions in the 2023 GBT Biological Monitoring Plan approved by WDOE, the 125 percent gas cap could remain at Lower Granite Dam because dam-specific samples did not exceed the biological thresholds. Therefore, the Corps returned spill operations at Lower Granite to the 16 hours/day at 125 percent gas cap, 8 hours/day at 20 kcfs Performance Standard operation on May 11 at 1900.

A System Operational Request (SOR) was received on May 11 and coordinated with regional sovereigns during the May 11th Technical Management Team (TMT) meeting. The SOR requested the elimination of performance standard spill at Lower Monumental while the gas cap is 115/120 percent TDG[10]. Following discussion at TMT, the Action Agencies did not implement the SOR and continued with 8-hours of performance standard spill per the FOP. Additional information regarding the Corps disposition to the SOR may be found on the following website: https://pweb.crohms.org/tmt/sor/2023/.

At Little Goose, between May 15 and May 17, generation was reduced during performance standard hours to maintain both the 30 percent spill target and the spill cap which later led to spill greater than the spill cap to maintain MOP.

Similarly, at Lower Monumental, between May 16 and 17, generation was reduced during performance standard hours to maintain both the 40 percent spill target and the spill cap which later led to spill greater than the spill cap to maintain MOP.

As outlined in the 2023 GBT Biological Monitoring Plan, the following criteria were followed to guide reinstatement of spring spill operations up to 125 percent TDG:

a. If gas bubble trauma exceeds any of the action criteria, additional GBT monitoring must

[10] SOR 2023-1 https://pweb.crohms.org/tmt/agendas/2023/0517_SOR_2023-1_-_Spill_Reduction_for_GBT_FinalV2.pdf

demonstrate the incidence of GBT is below the applicable action criterion before spill up to 125 percent TDG can resume.

b. GBT must be below the applicable action criterion over the next 7-day period before spill up to 125 percent TDG can be applied again.

Sampling downstream of Ice Harbor occurred again on May 16 and indicated GBT was less than action criteria. The 125 percent TDG gas cap operations resumed on May 17 at 1600.

2. Lower Snake River, GBT exceedance, May 30

On May 30, a second exceedance of the 15 percent GBT threshold was observed below Ice Harbor when 15.4 percent of native non-salmonids and the gas cap was reduced to 115/120 percent TDG levels at Little Goose, Lower Monumental, and Ice Harbor in accordance with the in-season guidance from WDOE to operate differently than the 2023 GBT Biological Monitoring Plan approved by WDOE described in Operational Adjustment 1 above. Spill levels to meet 115/120 percent TDG were implemented on May 31 at 1600. Regional sovereigns were notified of this operational adjustment on May 31, via email coordination, and the Corps convened an unscheduled TMT meeting to coordinate these adjustments on June 2. The Corps received an SOR regarding this operation and additional information regarding the Corps disposition of this SOR may be found on the following website: https://pweb.crohms.org/tmt/sor/2023/. This operational adjustment will be discussed in more detail in the June FOP Implementation Report.

Table 2: Spill Variance Table – May 2023 (5/1 to 5/31)

Project	Parameter	Date	Time[11]	# of Hours	Type	Reason
Little Goose	Additional Spill	5/5	1700	1	Human Error	Hourly spill was 84 kcfs (greater than adjusted spill target 78 kcfs) due to a delay in changing to the new fish passage spill cap.
Little Goose	Additional Spill	5/18 5/19 5/20 5/21 5/22 5/23 5/24	2000-2400 0100-2400 0100-2400 0100-2400 0100-1200, 1800-2400 0100-2400 0100-1600	5 24 24 24 19 24 16	Maintenance	Hourly spill was between 78 and 130 kcfs (greater than adjusted spill target of 75 kcfs) when units were removed from service to monitor transformer T1C after high levels of flammable gas were detected.
Lower Monumental	Additional Spill	5/1	1100	1	Maintenance	Hourly spill was 45% (greater than the adjusted spill target of 40% +/- 1%) due to a tripped relay resulting in an unplanned powerhouse outage.
The Dalles	Reduced Spill	5/7	1900-2000	2	Human Error	Hourly spill decreased to 38% (less than adjusted spill target of 40% ± 1%) due to a miscalculated value.

[11] Note: Data collected for reporting spill variances is reported using hourly-averaged data. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented in the Spill Variance Table as an hour.

Table 3: Pre-Coordinated Operations – May 2023 (5/1 to 5/31)

Project	Parameter	Date	Time[12]	# of Hours	Type	Reason
Lower Monumental	Reduced Spill	5/2 5/4 5/5 5/8 5/10 5/12 5/14 5/16 5/18 5/20 5/22 5/24 5/26 5/28 5/30	1800-2000 2400 0100-0300 2000-2200 1700-1900 1900-2100 1800-2000 1800-2000 1700-2000 1800-1900 1800-2000 1800-2000 1800-1900 1700-1900 1700-1900	3 1 3 3 3 3 3 3 3 2 3 3 2 3 3	Navigation	Hourly spill decreased to between 13 and 77 kcfs (less than adjusted spill target of between 45 and 100 kcfs) for navigation. Regionally coordinated via 2023 FOP, Sections 4.1 and 4.6.
Ice Harbor	Reduced Spill	5/24	2000	1	Navigation	Hourly spill decreased to 107 kcfs (less than adjusted spill target of 110 kcfs) for navigation. Regionally coordinated via 2023 FOP, Sections 4.1 and 4.6.
John Day	Reduced Spill	5/19 5/20 5/21 5/22 5/23 5/25 5/28	2200 1000-1200 0700 0600 0200 0200 1400	1 3 1 1 1 1 1	Navigation	Hourly spill decreased to between 150 and 197 kcfs (less than adjusted spill target of between 190 and 205 kcfs) for navigation. Regionally coordinated via 2023 FOP, Sections 4.1 and 4.6.

[12] Note: Data collected for reporting spill variances is reported using hourly-averaged data. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented in the Pre-Coordinated Operations Table as an hour.

Table 4: May 2023 Average Percent TDG Values Table (5/1 to 5/31)

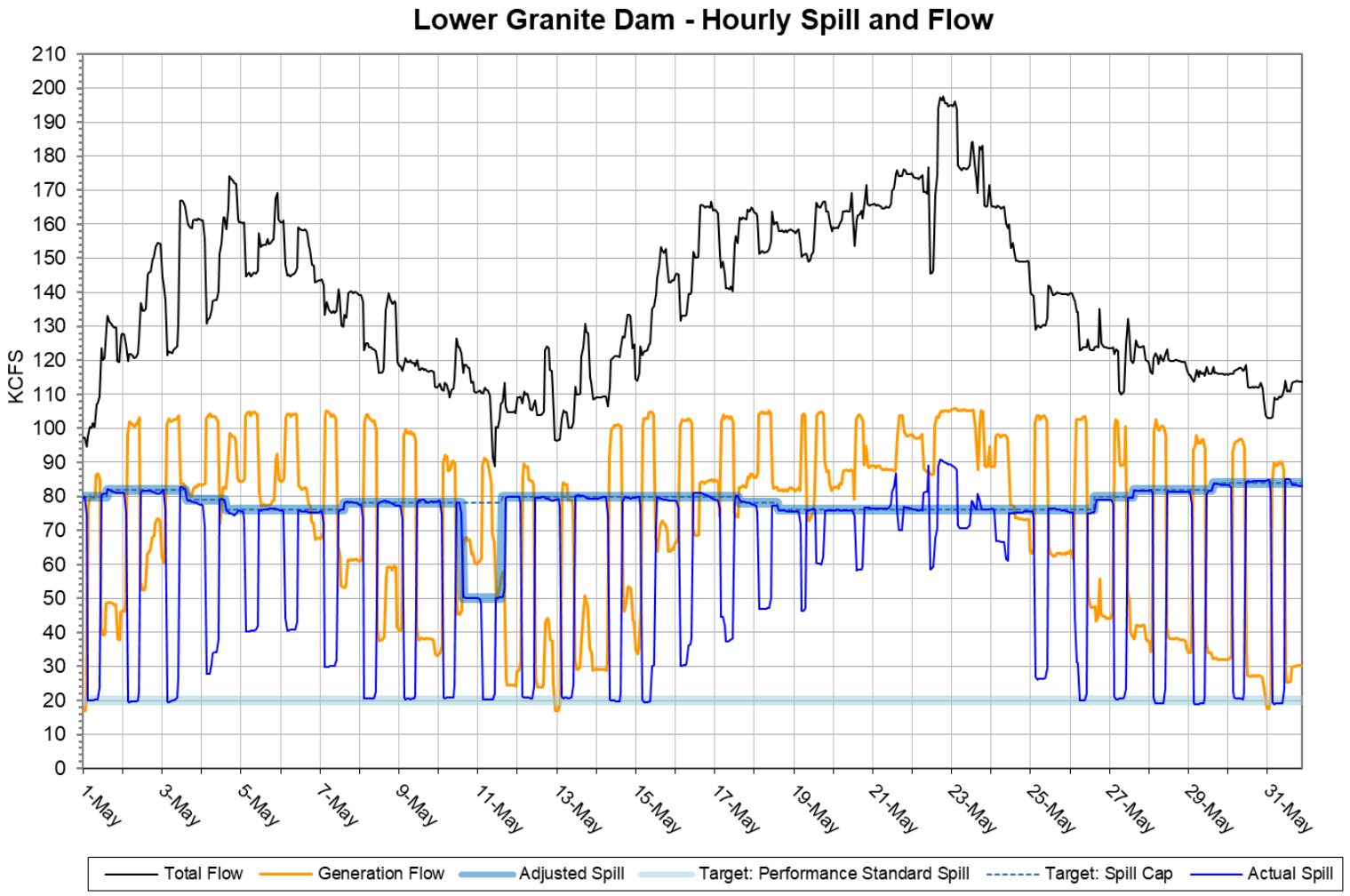
Station:	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW	JDY	JHAW	TDA	TDDO	BON	CCIW
Gas Cap %:	N/A	125	N/A	125 or 120	N/A or 115	125 or 120	N/A or 115	125 or 120	N/A or 115	125	N/A	125	N/A	125	N/A	125
5/1/2023	104	125	119	125	123	123	119	125	115	120	111	119	114	115	113	121
5/2/2023	103	**126**	118	125	124	124	121	124	113	123	113	121	119	120	113	121
5/3/2023	104	**126**	120	125	127	**126**	123	125	115	125	114	122	122	123	116	122
5/4/2023	106	125	121	**127**	127	**126**	124	125	115	125	112	124	119	122	117	123
5/5/2023	105	124	118	**126**	124	**127**	120	125	113	124	111	125	121	122	114	123
5/6/2023	104	124	116	125	124	**126**	121	125	111	124	113	124	122	124	119	124
5/7/2023	104	125	118	125	124	125	121	125	113	124	111	124	122	123	120	124
5/8/2023	105	125	118	124	124	124	121	125	115	**126**	113	123	123	124	121	124
5/9/2023	104	•[13]	118	124	125	123	121	125	115	125	115	124	122	123	120	124
5/10/2023	104	122	118	**122**[14]	**125**	**122**	**121**	**123**	115	125	118	124	124	125	122	124
5/11/2023	104	121	118	117	**125**	119	**122**	120	**116**	125	122	124	126	**126**	123	124
5/12/2023	104	124	118	117	**120**	119	**120**	120	**116**	124	123	125	126	**126**	124	123
5/13/2023	104	124	117	117	**119**	119	**119**	120	**117**	124	124	123	128	**127**	124	123
5/14/2023	105	125	119	118	**119**	119	**118**	120	**116**	125	124	124	128	**128**	126	123
5/15/2023	105	125	121	119	**119**	120	**118**	**121**	**117**	125	124	123	127	**127**	126	*124*[15]
5/16/2023	105	**126**	120	**122**	**120**	**121**	**118**	**124**	**117**	124	123	124	124	**126**	125	*124*
5/17/2023	105	**126**	120	125	122	124	119	125	119	125	126	125	125	**127**	127	*125*
5/18/2023	106	125	122	**126**	124	125	121	125	119	125	125	124	125	**127**	126	***128***
5/19/2023	106	124	120	**126**	127	124	122	125	120	125	125	124	124	**126**	124	*125*
5/20/2023	106	124	121	**127**	130	125	123	125	120	125	124	125	124	**126**	123	*124*
5/21/2023	107	125	121	**127**	130	125	124	124	119	124	122	125	120	123	120	*124*
5/22/2023	106	**127**	118	**127**	127	125	121	125	114	**127**	116	125	117	122	116	*124*
5/23/2023	107	**126**	117	**128**	130	125	122	**129**	114	**127**	113	125	119	124	119	*124*
5/24/2023	108	125	121	**126**	131	124	125	124	117	125	112	122	118	124	122	*123*
5/25/2023	107	123	121	124	130	124	126	125	119	125	118	122	122	125	123	125
5/26/2023	107	123	122	125	127	124	125	125	118	125	124	122	124	125	123	124
5/27/2023	106	124	121	125	126	123	124	125	119	125	123	122	121	123	121	122
5/28/2023	106	124	121	125	125	124	123	124	118	125	121	122	121	123	116	122
5/29/2023	105	124	121	125	126	122	123	125	117	125	121	122	122	123	115	122
5/30/2023	105	124	120	125	126	122	123	122	116	123	118	123	120	122	115	122
5/31/2023	105	125	118	**122**	**123**	**121**	**122**	**122**	114	122	115	123	117	120	112	121
Exceedances:		**6**		**12**	**8**	**7**	**8**	**5**	**6**	**3**				**10**		**1**

[13] Indicates missing data.

[14] Shading indicates that the WQS was reduced to 120% TDG in the project tailrace, 115% TDG in the next downstream forebay, due to GBT exceedance. Due to logistical constraints, spill cap changes occur once a day at 1600, which does not align with a daily metric calculation

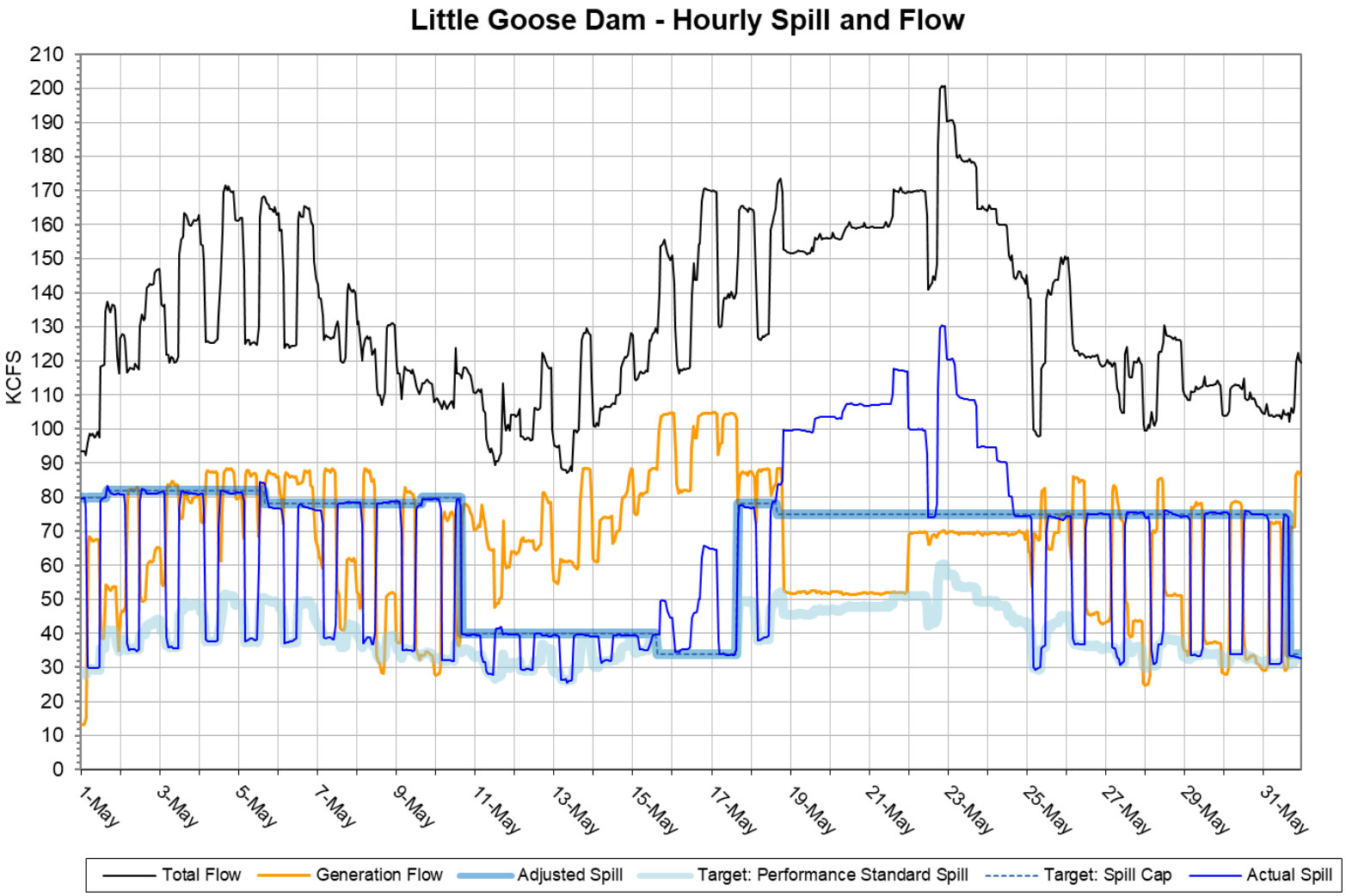
[15] The Bonneville tailwater (CCIW) real-time gauge was replaced with a data logger from May 15 through May 24 due to high flows (per the MFR dated 14 April 2019).

Figure 1[16]



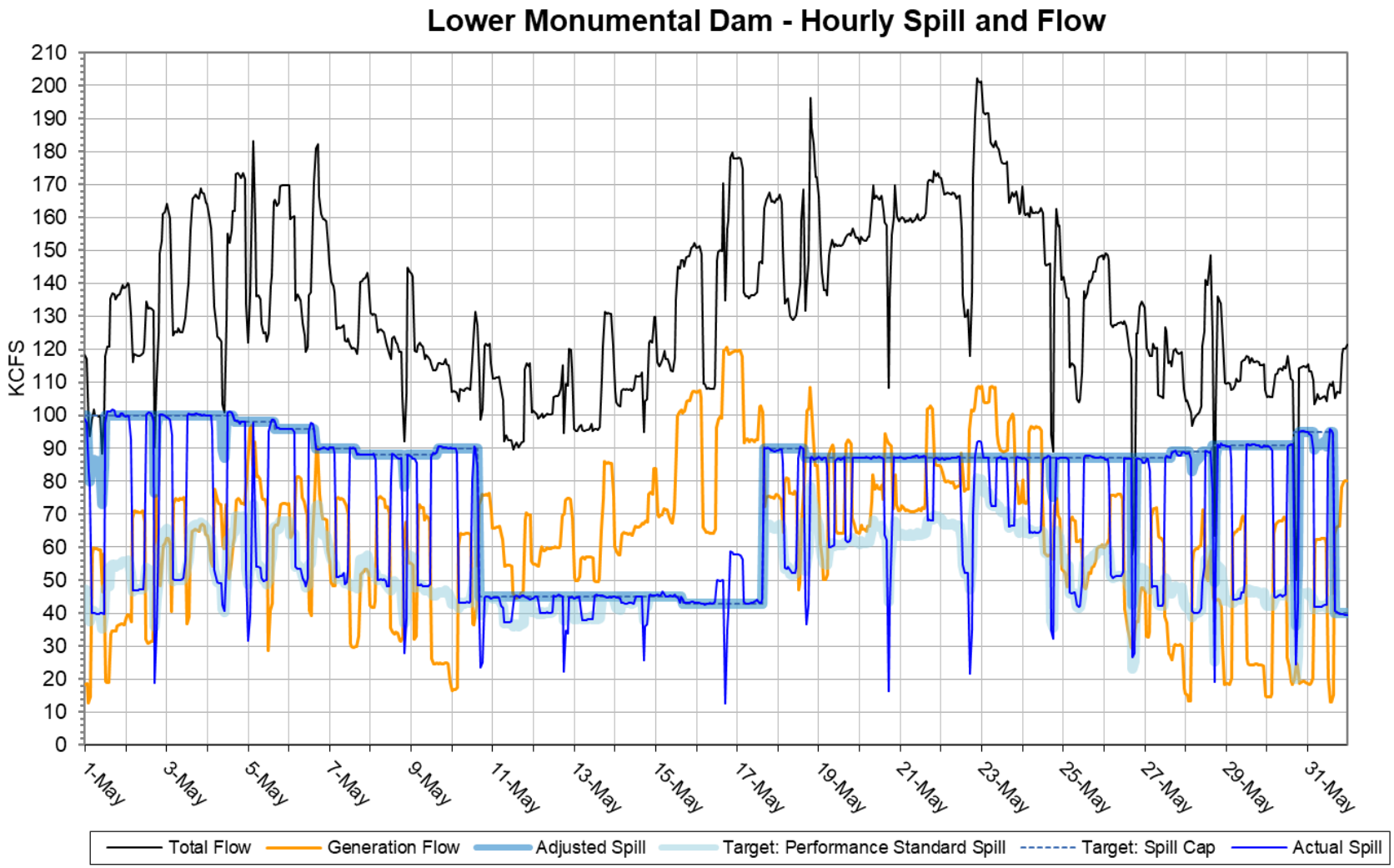
[16] The adjusted spill line is a simplified representation due to limitations of representing a range of minimum generation values. See Tables 2 and 3 for spill variances and pre-coordinated operations.

Figure 2[17]



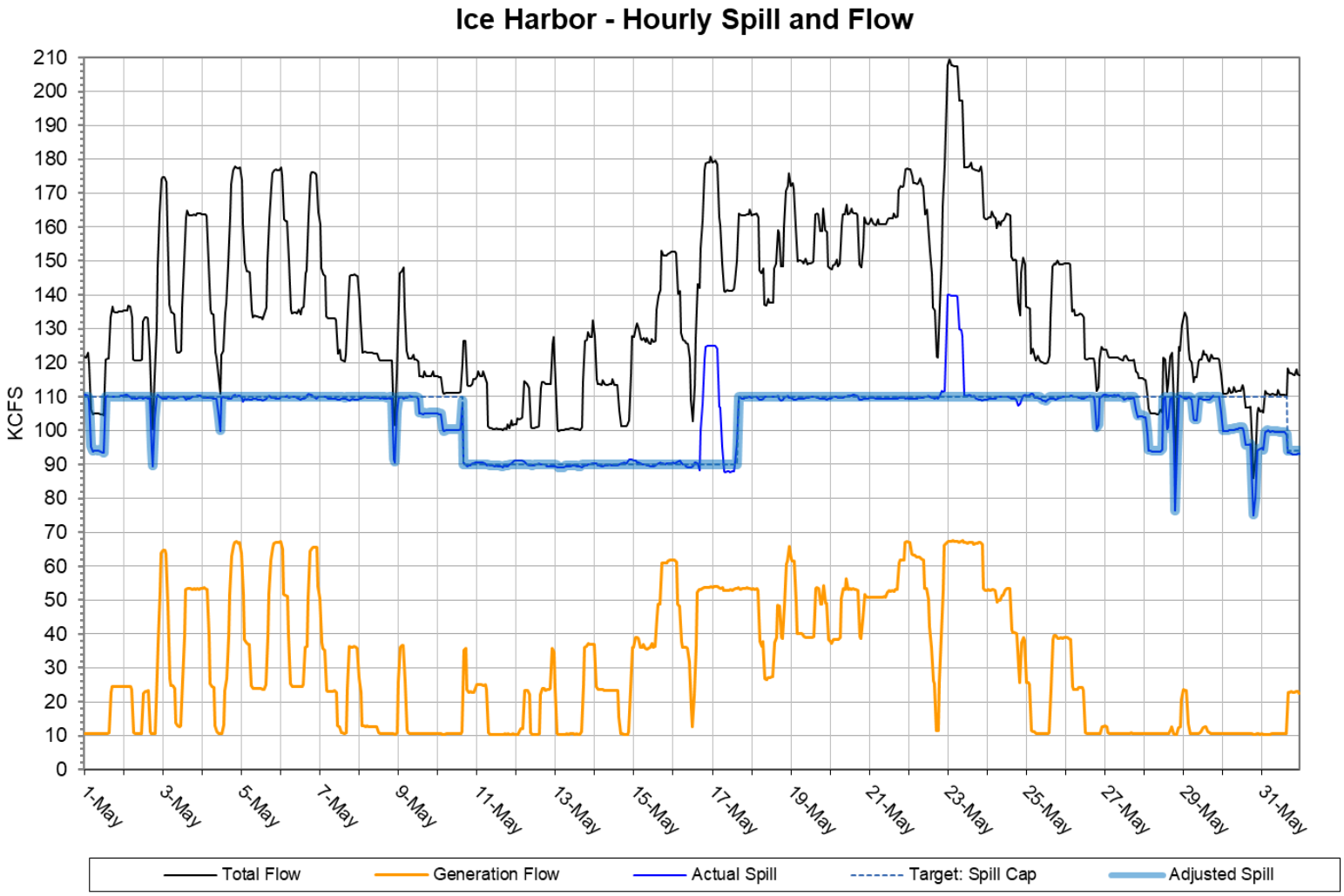
[17] The adjusted spill line is a simplified representation due to limitations of representing a range of minimum generation values. See Tables 2 and 3 for spill variances and pre-coordinated operations.

Figure 3[18]



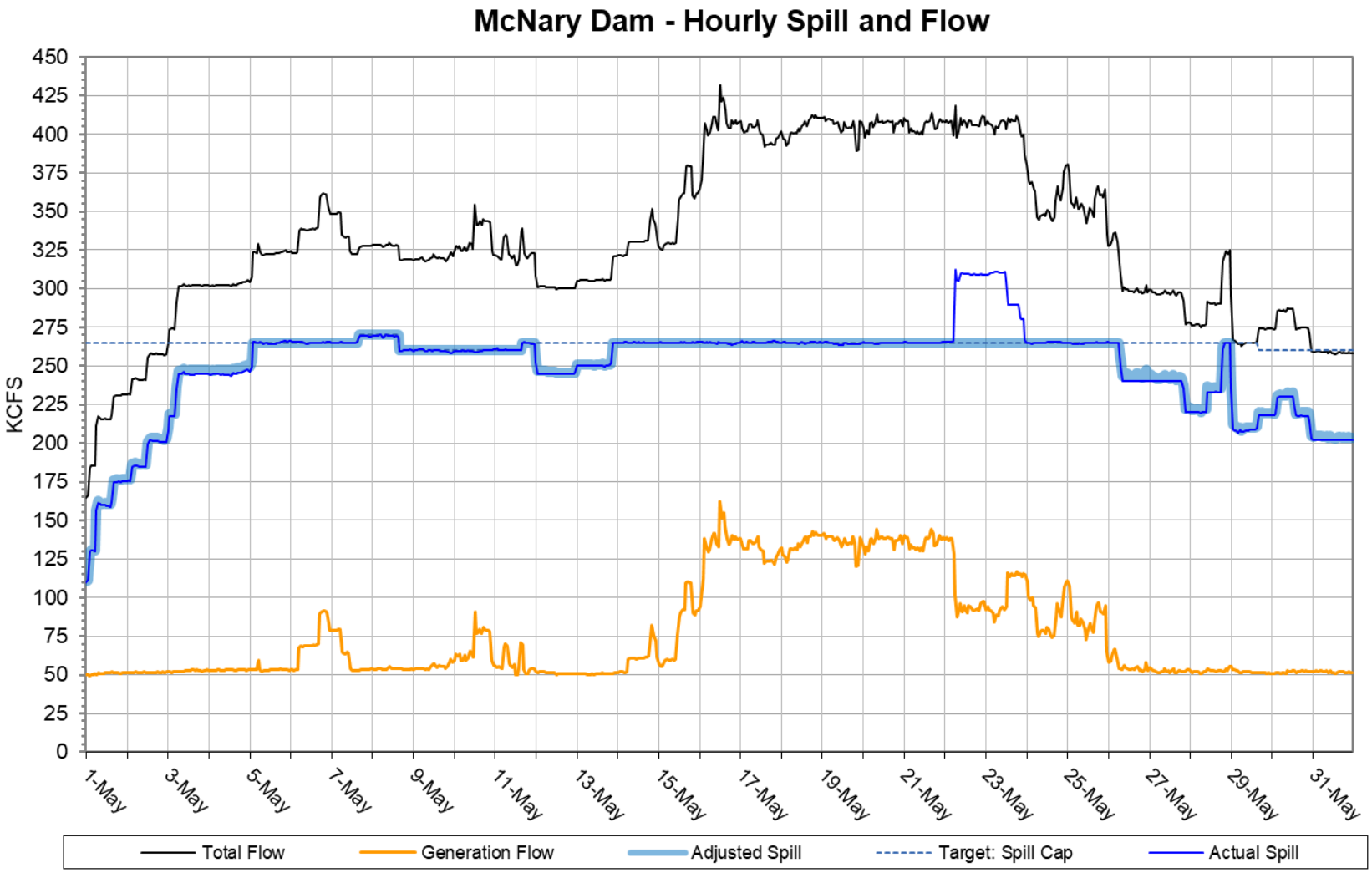
[18] The adjusted spill line is a simplified representation due to limitations of representing a range of minimum generation values. See Tables 2 and 3 for spill variances and pre-coordinated operations.

Figure 4[19]



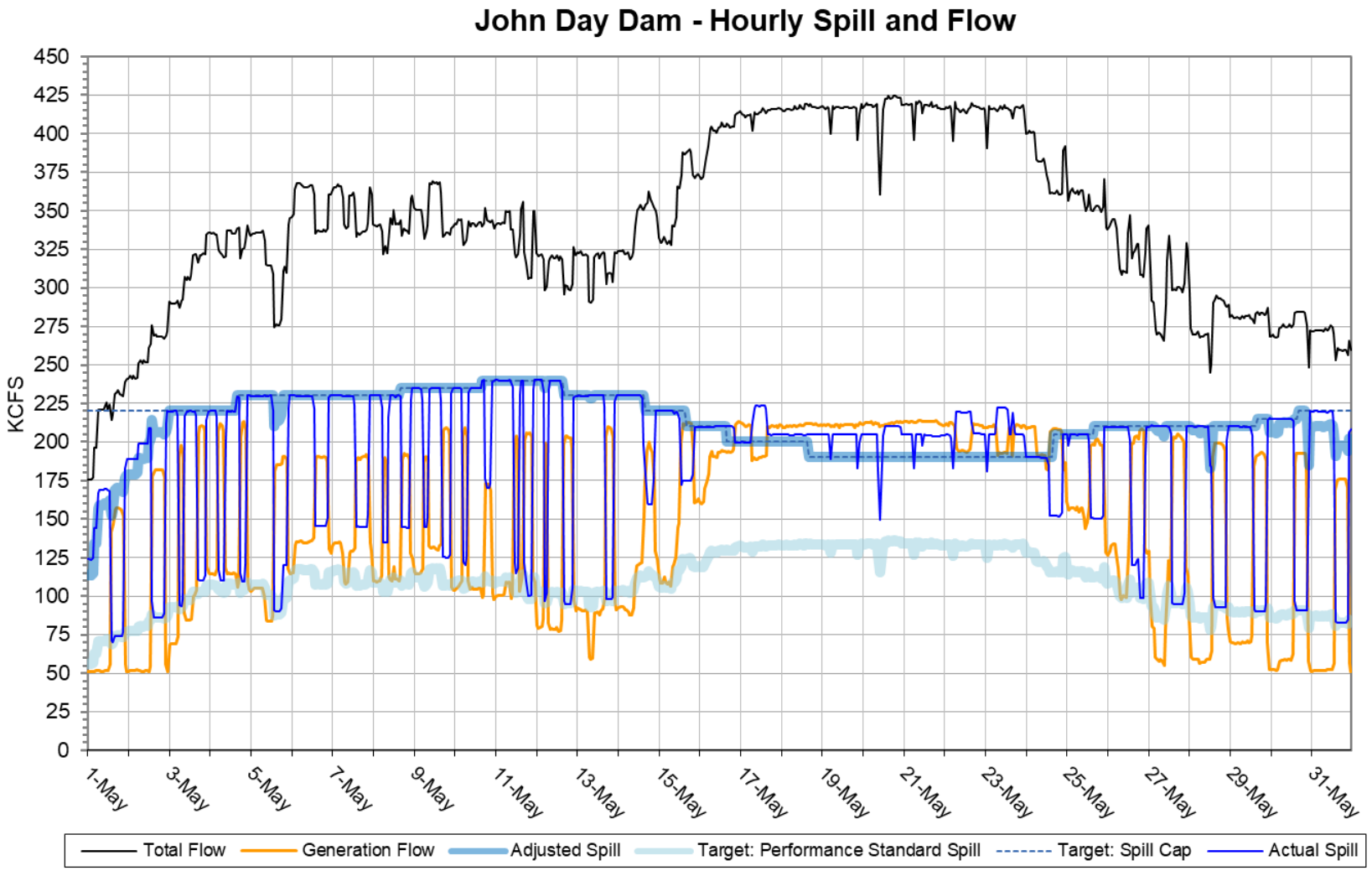
[19] The adjusted spill line is a simplified representation due to limitations of representing a range of minimum generation values. See Tables 2 and 3 for spill variances and pre-coordinated operations.

Figure 5[20]



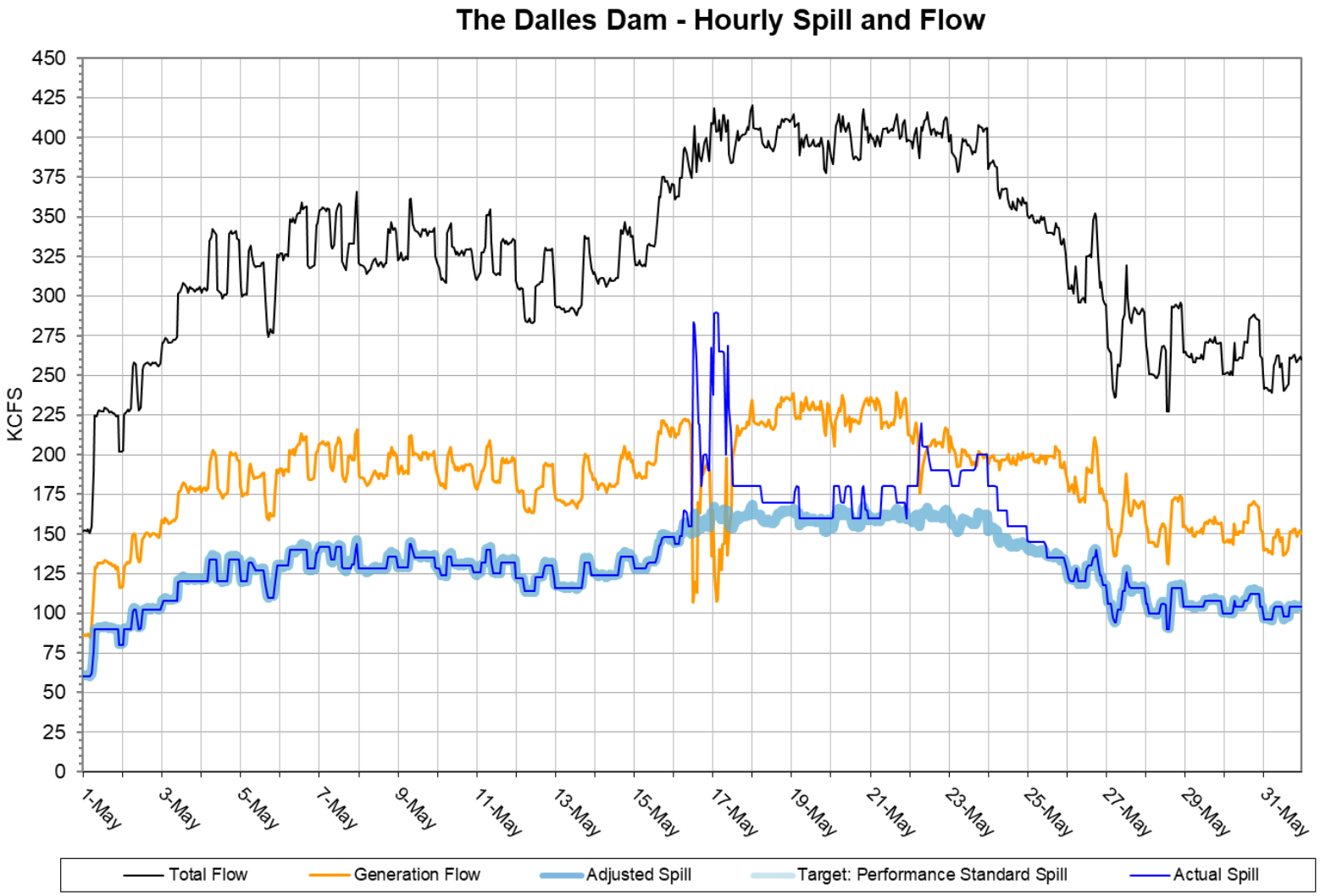
[20] The adjusted spill line is a simplified representation due to limitations of representing a range of minimum generation values. See Tables 2 and 3 for spill variances and pre-coordinated operations.

Figure 6[21]



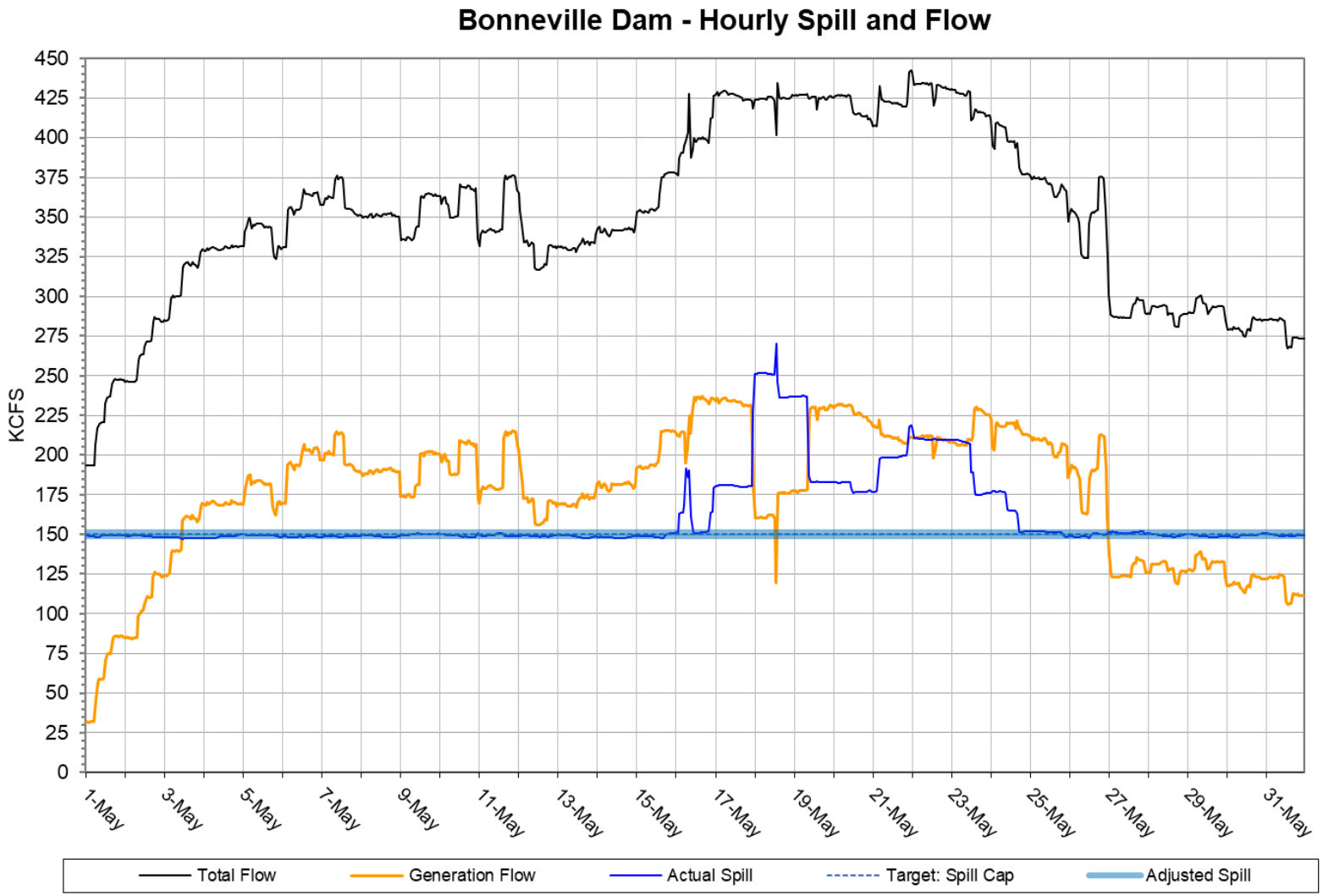
[21] The adjusted spill line is a simplified representation due to limitations of representing a range of minimum generation values. See Tables 2 and 3 for spill variances and pre-coordinated operations.

Figure 7[22]



[22] The adjusted spill line is a simplified representation due to limitations of representing a range of minimum generation values. See Tables 2 and 3 for spill variances and pre-coordinated operations.

Figure 8[23]



[23] The adjusted spill line is a simplified representation due to limitations of representing a range of minimum generation values. See Tables 2 and 3 for spill variances and pre-coordinated operations.