Appendix C

2019 FOP Implementation Reports

With Hourly Spill, Flow and Generation Graphs

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FISH OPERATIONS PLAN IMPLEMENTATION REPORT

April 2019

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 2019 Fish Operations Plan[1] (2019 FOP). The 2019 FOP describes the 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)[2], the 2018 Extensions of the 2008 Columbia Basin Fish Accords (Accord Extensions), the 2019-2021 Spill Operation Agreement (Agreement), the Corps' requirements under the Endangered Species Act (ESA), and is the subject of ongoing consultation and communications with the relevant wildlife agencies to ensure consistency with the ESA. 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).

This report describes the Corps' implementation of the 2019 FOP during the month of April 2019. In particular, 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 2019 FOP, section 4.1);
- actual spill: the hourly flow over the spillway; and,
- resultant 12-hour average TDG for the tailwater at each project.

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[1] The 2019 FOP was posted to the Technical Management Team (TMT) website on April 1, 2019 (http://pweb.crohms.org/tmt/documents/fpp/2019/).

[2] 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.

This report also provides information on issues and unanticipated or emergency situations that arose during implementation of the 2019 FOP in April 2019.

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 April, with hourly spill, target spill, adjusted spill, generation, and total flows. The monthly graphs begin on April 1 and end on April 30 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.
- 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 (2019 FOP section 4.1).

II. The average daily %TDG for the 12 highest hours for all projects is shown in the April 2019 Average Percent TDG Values Table (Table 4). The numbers in red indicate the project exceeded the %TDG cap - i.e. 120% (tailwater) for each project.

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 April 2019 Spill Variance Table (Table 2).[3] 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

[3] Involuntary spill conditions shown in the graphs are not considered variances and are not reported in the Spill Variance Table. Involuntary 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.

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 2019 FOP for Bonneville and The Dalles dams,[4] 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.

April Operations

The month of April was characterized by above average flows for the lower Snake and lower Columbia rivers with near average air temperatures and above average precipitation in the Columbia Basin. Observed precipitation in April was 123% of average on the Snake River above Ice Harbor and 113% of average on the Columbia River above The Dalles. The NOAA Northwest River Forecast Center runoff summary for April indicated that the adjusted runoff for the Snake River at Lower Granite was 178% of the 30-year average (1981-2010) with a volume of 8.1 MAF (Million acre-feet)[5]. The adjusted runoff for the Columbia River at The Dalles was 138% of the 30-year average (1981-2010) with a volume of 19.0 MAF[6].

The 2019 spring fish passage spill operation at the Corps' eight lower Snake and lower Columbia River projects differs from previous years' operations as a result of the Agreement signed in December 2018. 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. Target spill levels for

[4] As specified in the 2019 FOP section 3.

[5] Retrieved 1 May 2019: https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?tab=5

[6] Retrieved 1 May 2019: https://www.nwrfc.noaa.gov/runoff/runoff_summary.php?date=05/01/2019

April 2019 at each project are defined in Table 1.

Table 1: Summary of 2019 spring target spill levels at lower Snake River and lower Columbia River projects.

PROJECT	GAS CAP SPILL (at least 16 hours per day)[1, 2, 3, 5]	PERFORMANCE STANDARD SPILL (up to 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
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/water quality standards.
4. The 8 hours of Performance Standard spill can 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 flows is ≤ 350 kcfs).
7. Spill to the 120% Gas Cap, not to exceed 150 kcfs.

In its implementation of the 2019 FOP in April, the Corps evaluated conditions every day to establish spill caps at a level that was estimated to meet, but not exceed, the gas cap in the tailrace (see Table 4).[7] 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). For the month of April 2019, conditions constraining the spill cap at Bonneville and The Dalles dams did not occur (see Table 1 fn 6,7).

Operational Adjustments

[7] See 2019 FOP section 2.2

1. Lower Monumental

Beginning Sunday, April 7 at 0900 hrs, the uniform spill pattern[8] was applied to performance standard spill. The performance standard spill level remained at 30 kcfs. This action was in response to TDG exceeding state standards at the tailwater gauge due to the performance standard spill using the bulk spill pattern[9]. This change was coordinated with TMT on April 4 via email and at the April 10 TMT meeting. TMT members were in support of this operational adjustment.

2. The Dalles

Beginning Thursday, April 25 at 1600 hrs, the spill cap was changed from a fixed hourly level (kcfs) to a percentage of total project outflow on an hourly basis. The spill cap remains the maximum spill level that is estimated to meet, but not exceed, the gas cap (i.e., 120% TDG at the tailwater gauge). Analysis by the Corps determined that a spill cap set as a percent spill in terms of a proportion of project outflow meets the gas cap at The Dalles more often than spill at a fixed level. The Dalles tailwater gauge represents a mix of TDG from the spillway and the powerhouse and is highly influenced by the forebay TDG under all flows. The Dalles mixed tailwater condition is different from other fish passage projects where the tailwater gauge represents spillway TDG only under certain flow ranges. This change was coordinated with TMT on April 23 via email and at the April 24 TMT meeting. TMT members either supported or did not object to this operation.

[8] See FPP, Table LMN-8, Lower Monumental Dam Uniform Spill Patterns with RSW – as temporarily modified for Bay 7 Out of Service (created 3/20/2019), available online at: http://pweb.crohms.org/tmt/documents/FPOM/2010/2019_FPOM_MEET/2019_APR/Spill%20Table%20No%208.pdf

[9] See FPP, Table LMN-7, Lower Monumental Dam Bulk Spill Patterns with RSW.

Table 2: Spill Variance Table – April 2019 (4/1 to 4/30)

Project	Parameter	Date	Time[10]	# of Hours	Type	Reason
Little Goose	Additional Spill	4/7/19	1000	1	Human Error	Hourly spill increased to the spill cap. The performance standard spill AM block was 3 hours, 1 hour, less than the 4 hour minimum called for in FOP Section 6.
Little Goose	Reduced Spill	4/7/19	2100	1	Human Error	Hourly spill decreased to the performance standard spill. The performance standard spill PM block was 5 hours, 1 hour longer than the 4 hour maximum called for in FOP Section 6.
Lower Monumental	Additional Spill	4/16/19	1200-1400	3	Maintenance	Hourly spill increased to 50 and 55 kcfs (above the adjusted spill of 46 kcfs) due to a unit outage.
Ice Harbor	Reduced Spill	4/5/19 4/7/19	0200, 0500, 0600 0400	3 1	Operational Limitation	Hourly spill below adjusted spill while minimum generation exceeded the range for Unit 1 (8.4-10.1)[11] to 10.4 kcfs. Normal system operations and river conditions can result in operations outside the minimum generation flow range.
John Day	Reduced Spill	4/10/19	1500-1600	2	Human Error	Hourly spill decreased to 140 and 141 kcfs (below the adjusted spill of 150 kcfs) due to implementing spill cap change earlier than scheduled.
John Day	Additional Spill	4/10/19	1000-1100 1300	3	Maintenance	Hourly spill increased to 156 and 160 kcfs (above the adjusted spill of 150 kcfs) due to outage of unit 12 to investigate a leak. The AM block of performance standard spill started at 1200 hrs, 1 hour later than intended (1100-1300) and called for in the FOP Section 6.

[10] Data collected for reporting spill variances are reported as hourly averages. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented as an hour. The hourly average data is reported at the end of the hour (i.e. hour ending).

[11] Range does not include ±2% due to generating unit governor "dead band". When +/-2% is applied to the minimum generation flow range for Ice Harbor Unit 1, the range is 8.2–10.3 kcfs. See 2019 FOP section 4.3.1.

Table 3: Pre-Coordinated Operations – April 2019 (4/1 to 4/30)

Project	Parameter	Date	Time[14]	# of Hours	Type	Reason
Lower Granite	Reduced Spill	4/12/19	0100	1	Navigation	Hourly spill decreased to 46 kcfs, (below the adjusted spill of 53 kcfs) for safe navigation. Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6.
Lower Granite	Additional Spill	4/12/19	0900-1000	2	Maintenance	Hourly spill was increased to 60 and 86 kcfs (above the target spill of 53 kcfs) due to spill to pass debris. Regionally coordinated via 2019 FPP, page LGS-32, Section 5.
Lower Monumental	Reduced Spill	4/25/19 “ 4/26/19 4/27/19 4/28/19 4/29/19 4/30/19	0100 2100-2300 1900-2100 1900-2100 1800-1900 1700-1800 1800-1900	1 3 3 3 2 2 2	Navigation	Hourly spill reduced below adjusted spill for safe navigation. Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6.

Table 4: April 2019 Average Percent TDG Values Table (4/1 to 4/30)

Date	FIXED MONITORING STATIONS															
	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW	JDY	JHAW	TDA	TDDO	BON	CCIW
	Lower Granite FB	Lower Granite TW	Little Goose FB	Little Goose TW	Lower Monumental FB	Lower Monumental TW	Ice Harbor FB	Ice Harbor TW	McNary FB	McNary TW	John Day FB	John Day TW	The Dalles FB	The Dalles TW	Bonneville FB	Bonneville TW
Gas Cap %:	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
4/1/2019	103	103	102	102	102	103	104	113	110	109	108	107	107	107	108	110
4/2/2019	104	105	102	103	103	104	104	110	110	110	109	107	107	108	109	111
4/3/2019	104	118	103	118	103	119	103	115	110	109	108	107	107	106	108	112
4/4/2019	103	118	103	119	103	120	103	116	109	109	108	108	107	106	108	113
4/5/2019	103	119	104	119	112	120	112	116	109	109	109	108	108	107	107	113
4/6/2019	102	119	109	119	116	121	116	117	108	107	108	108	107	106	106	111
4/7/2019	102	119	113	119	116	120	116	117	108	107	108	107	107	106	106	110
4/8/2019	101	119	114	119	117	121	117	121	108	110	107	107	106	105	106	111
4/9/2019	102	124	114	124	118	124	117	125	108	115	107	113	105	105	105	112
4/10/2019	101	128	112	129	125	128	119	133	108	120	104	121	112	116	105	122
4/11/2019	104	121	117	124	129	124	124	128	117	120	104	119	111	116	116	121
4/12/2019	105	121	117	119	124	122	123	122	118	120	104	118	111	118	116	120
4/13/2019	105	120	116	119	121	121	121	120	117	118	106	118	111	123	116	120
4/14/2019	105	120	114	119	118	120	117	119	113	117	108	118	113	123	117	120
4/15/2019	104	120	113	120	119	120	116	120	110	117	111	118	115	124	121	120
4/16/2019	104	120	112	120	120	120	116	119	108	117	111	118	115	124	120	119
4/17/2019	103	120	113	119	118	119	116	119	109	117	110	118	114	123	119	119
4/18/2019	103	120	113	120	120	120	117	120	109	117	109	118	117	122	120	119
4/19/2019	105	120	115	120	122	120	119	120	113	119	110	118	118	121	122	120
4/20/2019	105	121	116	120	121	121	118	121	114	117	110	118	116	119	118	120
4/21/2019	104	124	115	122	120	121	117	124	112	119	110	118	114	118	114	120
4/22/2019	104	124	116	123	123	121	118	124	113	119	112	119	114	117	115	120
4/23/2019	106	124	118	123	124	121	119	124	114	119	113	119	116	119	116	120
4/24/2019	105	123	118	121	123	121	119	122	114	120	112	120	116	118	116	122
4/25/2019	106	124	119	124	124	124	120	125	116	120	114	120	117	120	119	123
4/26/2019	106	121	120	122	126	123	121	124	117	120	113	119	116	120	118	120
4/27/2019	105	120	118	122	122	120	121	124	116	120	113	120	114	118	115	120
4/28/2019	104	120	112	120	120	120	117	121	112	120	111	119	116	120	116	120
4/29/2019	105	120	114	120	121	120	118	121	113	120	111	120	117	121	119	121
4/30/2019	106	120	114	120	121	119	118	120	113	119	111	120	117	121	121	120
Exceedances:	0	11	0	10	14	14	5	15	0	0	0	1	0	9	3	5

Figure 1

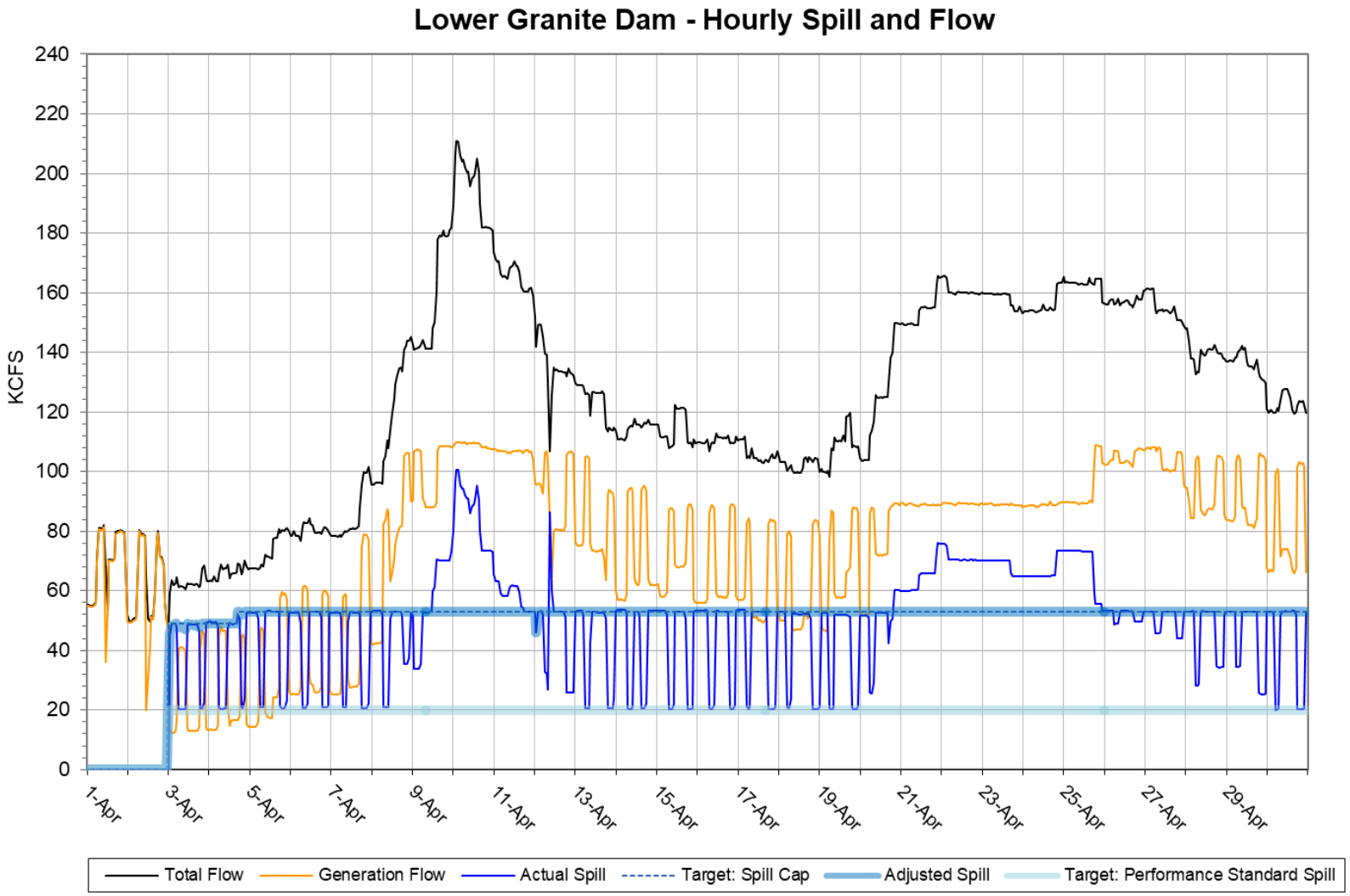

Lower Granite Dam - Hourly Spill and Flow
KCFS
240
220
200
180
160
140
120
100
80
60
40
20
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

Figure 2

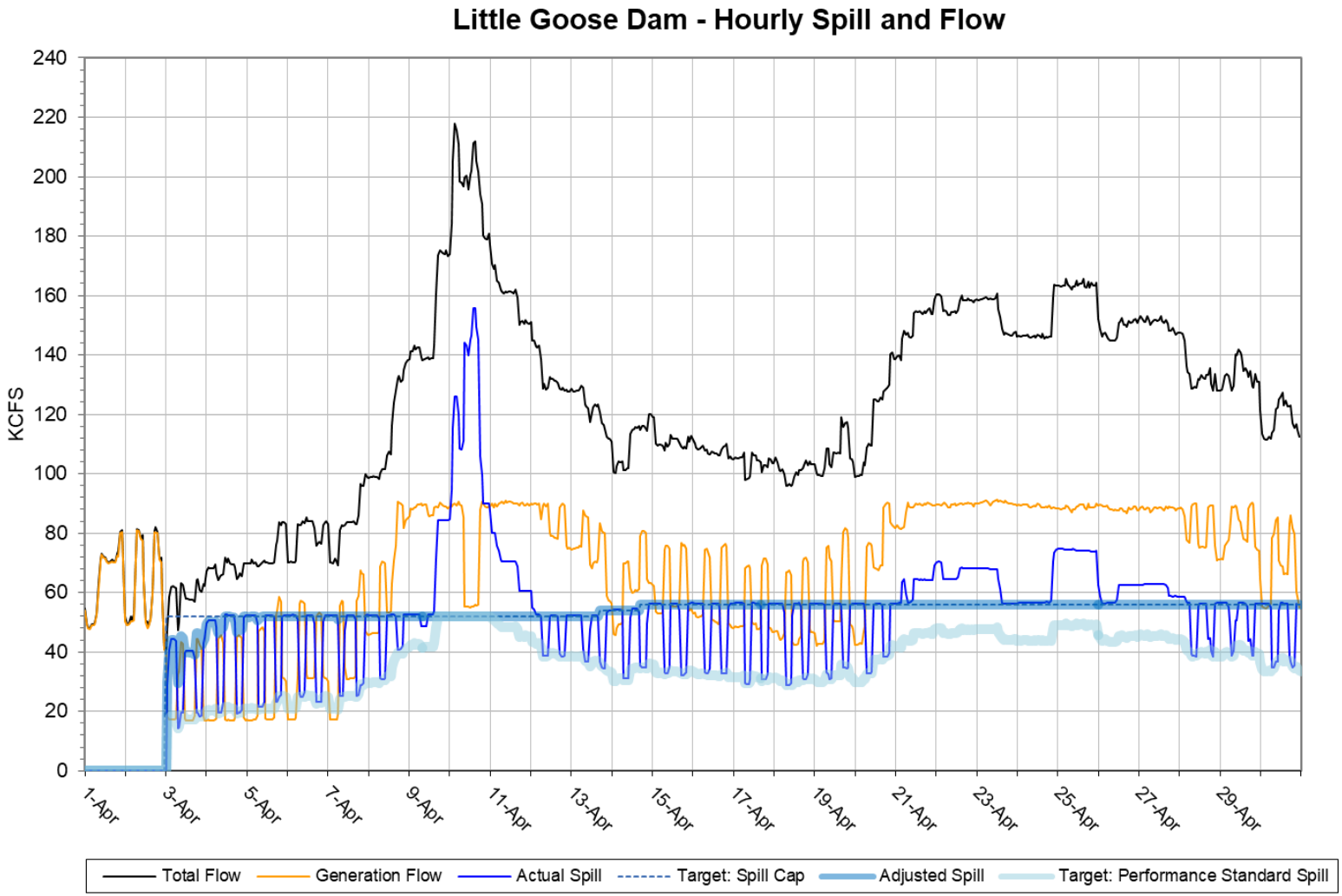

Little Goose Dam - Hourly Spill and Flow
KCFS
240
220
200
180
160
140
120
100
80
60
40
20
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

Figure 3

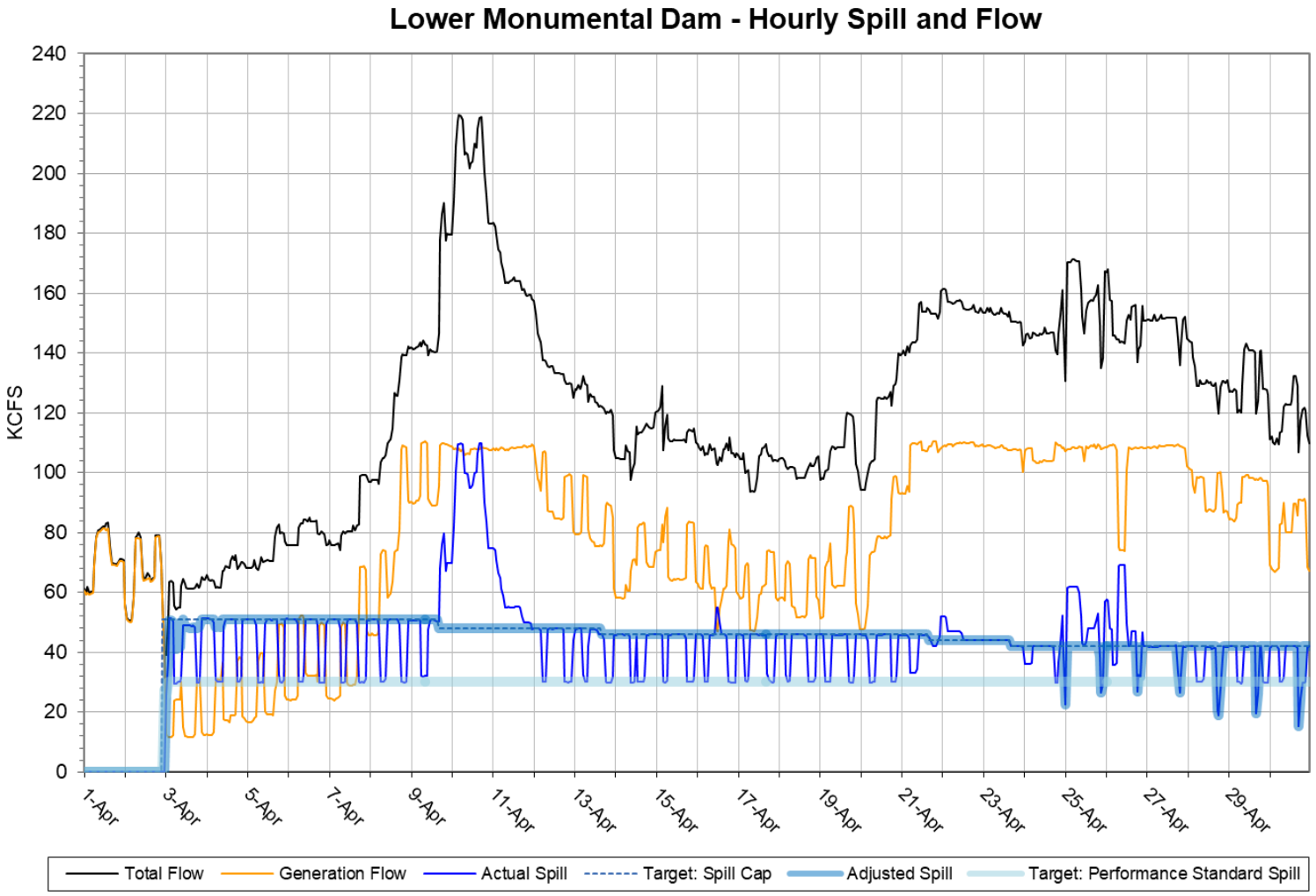


Figure 4

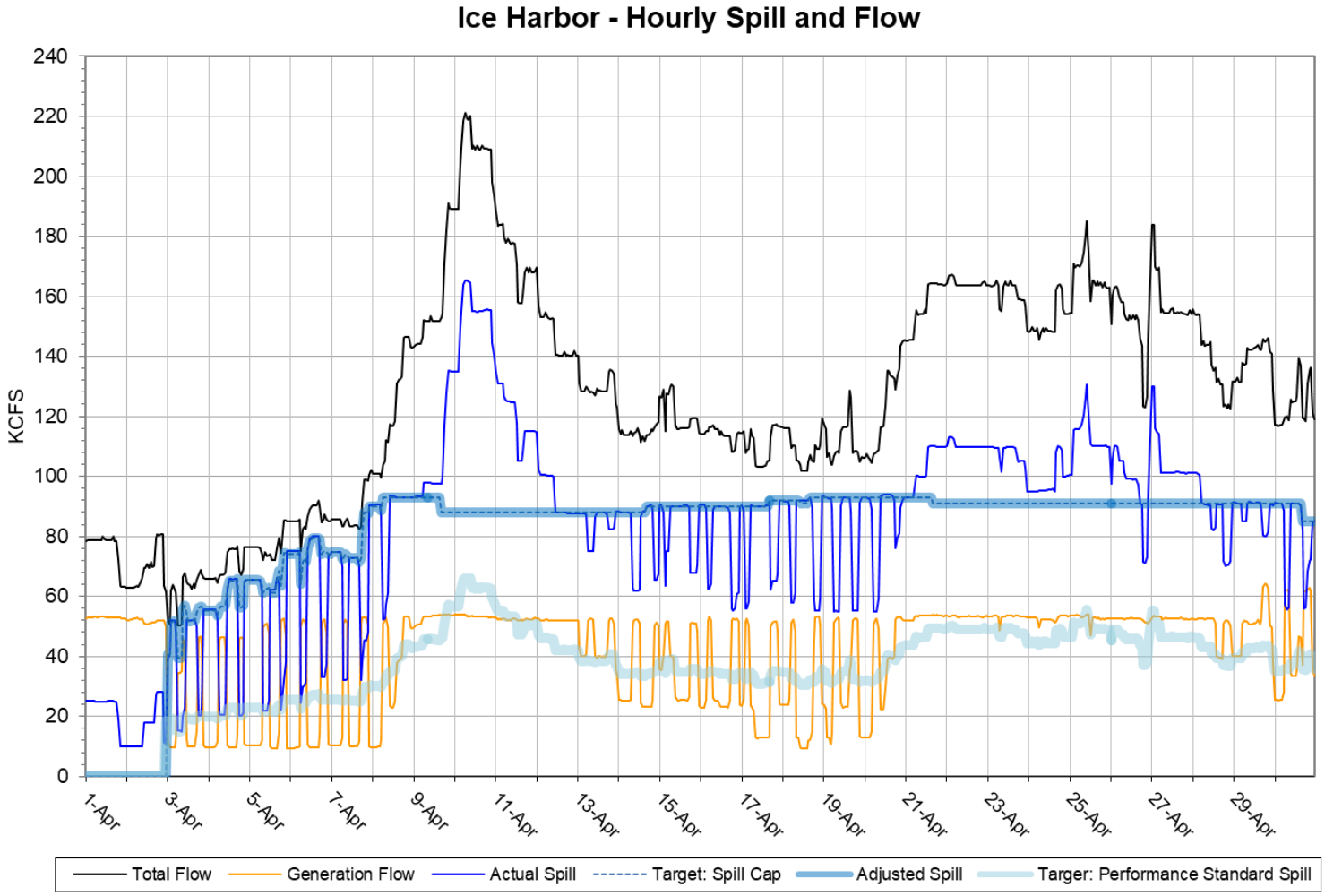

Ice Harbor - Hourly Spill and Flow
KCFS
240
220
200
180
160
140
120
100
80
60
40
20
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Targer: Performance Standard Spill

Figure 5

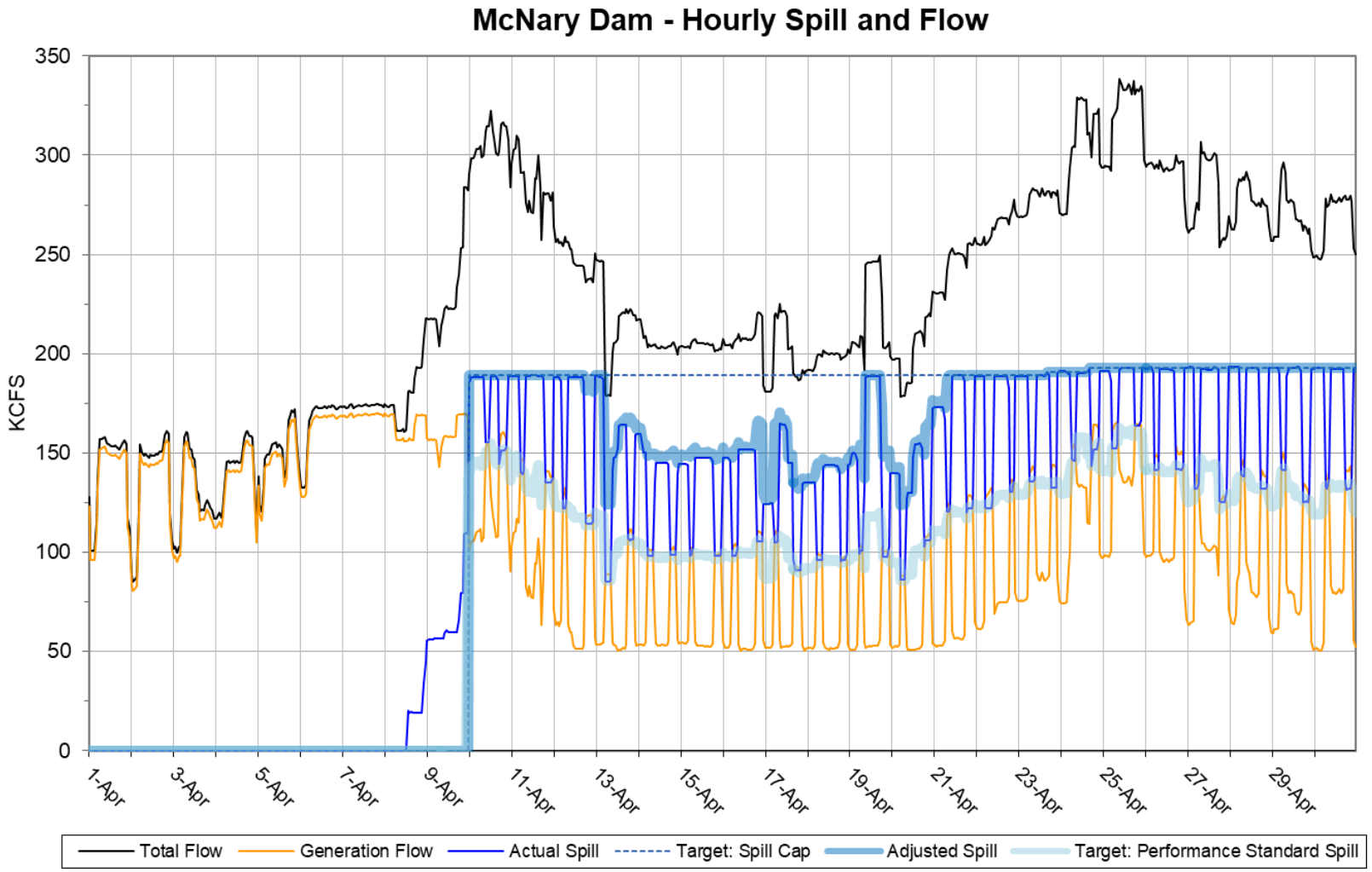

McNary Dam - Hourly Spill and Flow
KCFS
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

Figure 6

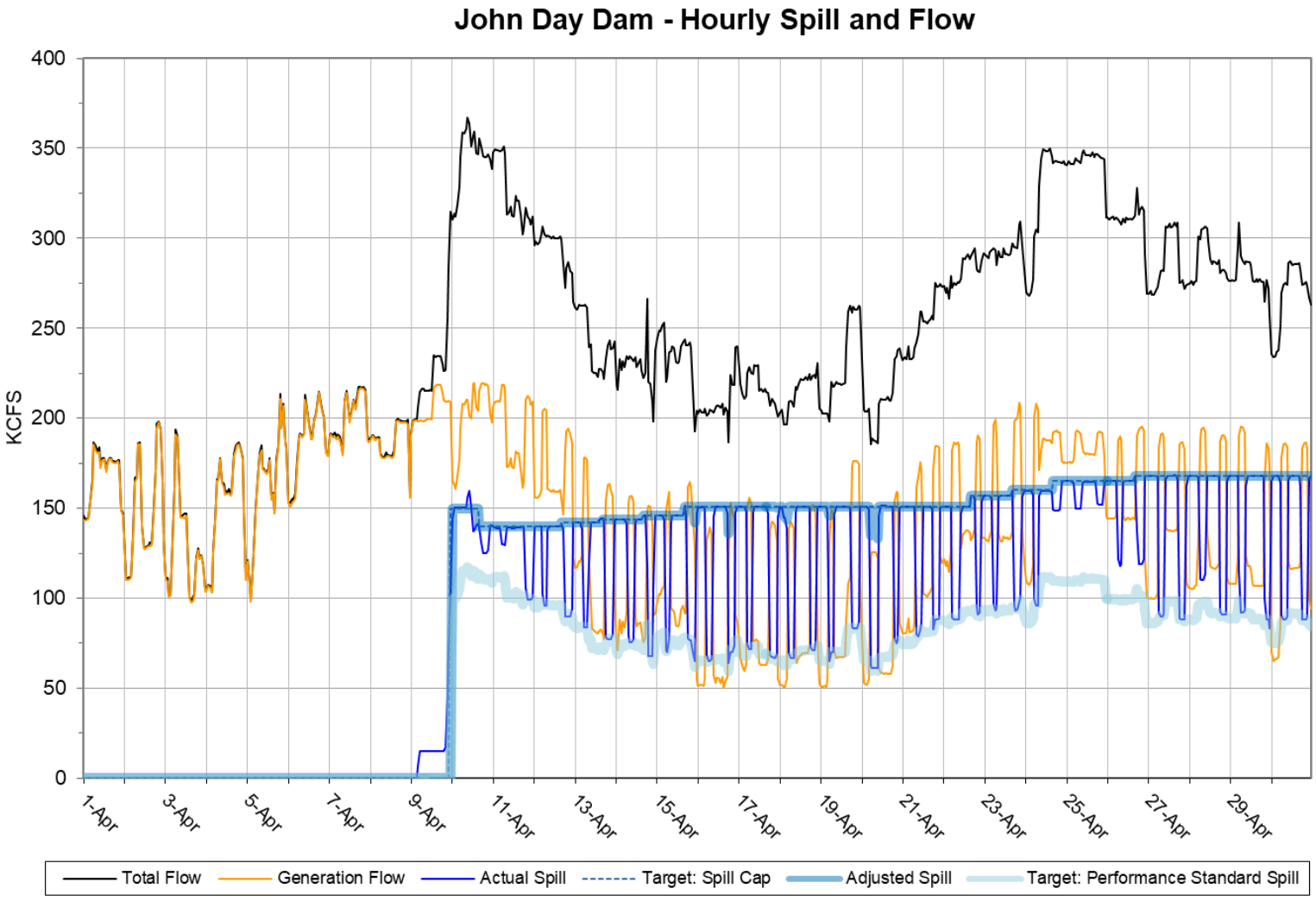

John Day Dam - Hourly Spill and Flow
KCFS
400
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

Figure 7

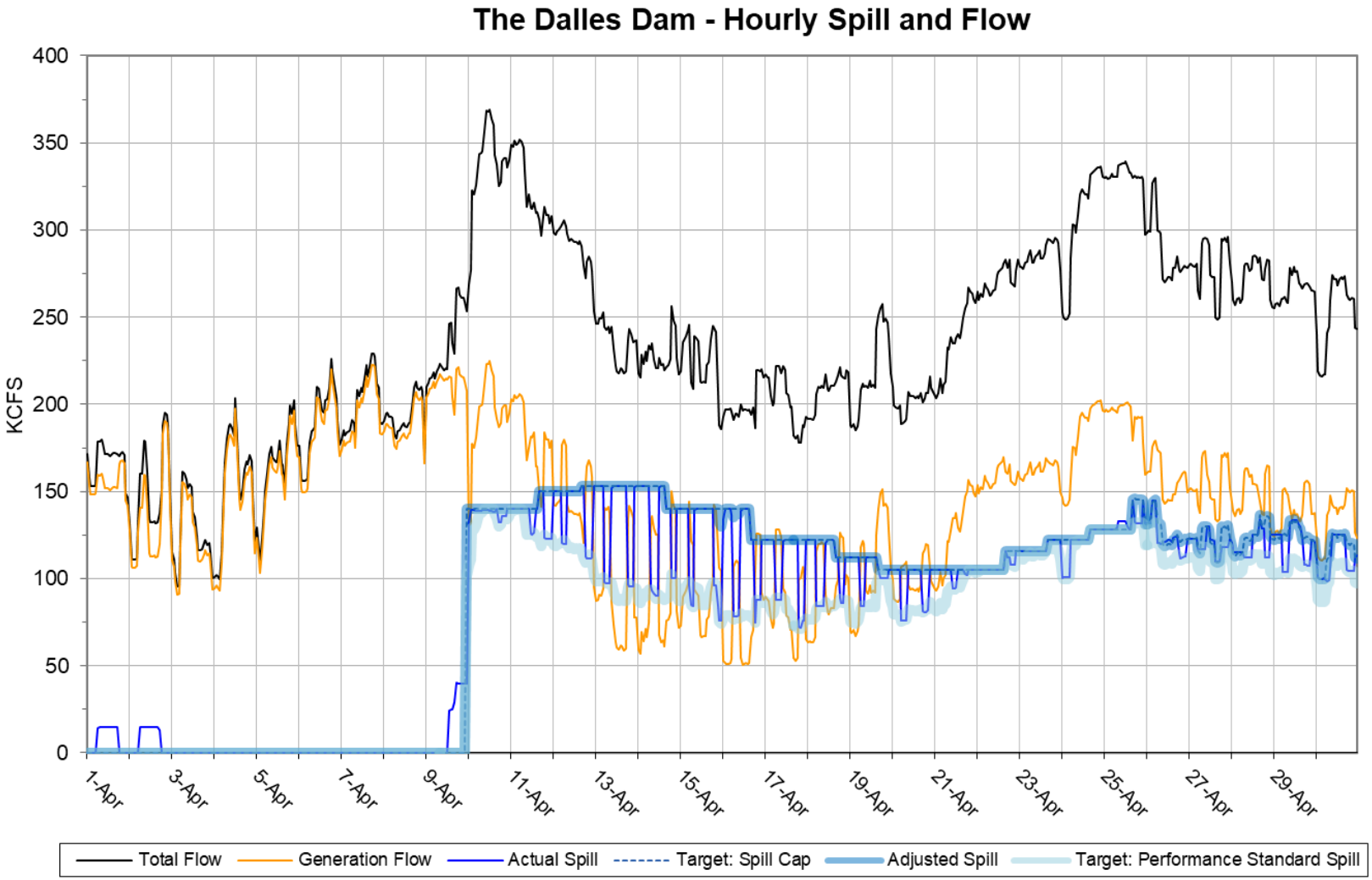
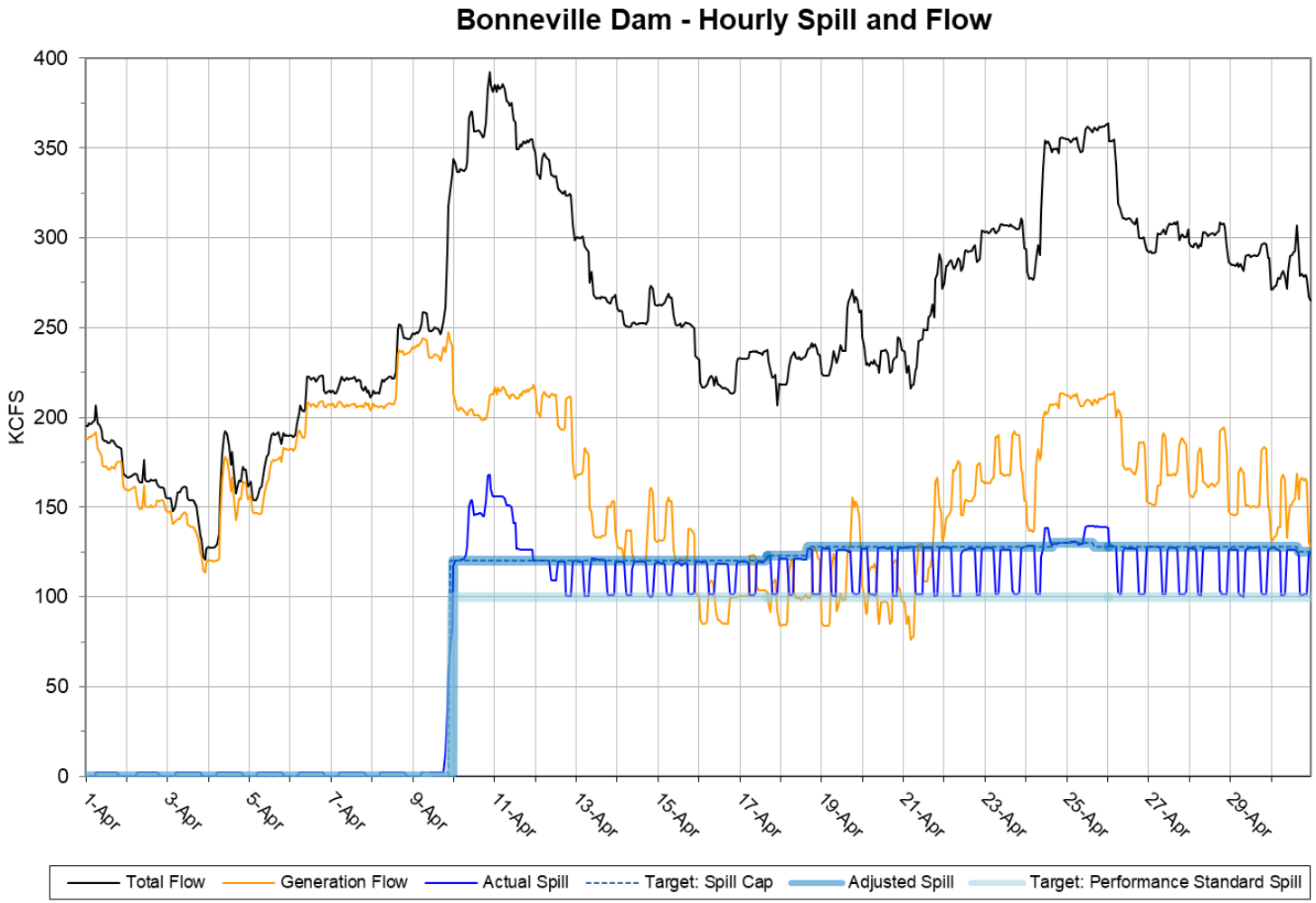

The Dalles Dam - Hourly Spill and Flow
KCFS
400
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

Figure 8


Bonneville Dam - Hourly Spill and Flow
KCFS
400
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

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[1] The 2019 FOP was posted to the Technical Management Team (TMT) website on April 1, 2019 (http://pweb.crohms.org/tmt/documents/fpp/2019/).

[2] 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.

This report also provides information on issues and unanticipated or emergency situations that arose during implementation of the 2019 FOP in May 2019.

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.
- 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 (2019 FOP section 4.1).

II. The average daily %TDG for the 12 highest hours for all projects is shown in the May 2019 Average Percent TDG Values Table (Table 4). The numbers in red indicate the project exceeded the %TDG cap - i.e. 120% (tailwater) for each project.

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 2019 Spill Variance Table (Table 2).[3] 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

[3] Involuntary spill conditions shown in the graphs are not considered variances and are not reported in the Spill Variance Table. Involuntary 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.

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 2019 FOP for Bonneville and The Dalles dams,[4] 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.

May Operations

The month of May was characterized by above average flows for the lower Snake River and average flows for the lower Columbia River with above average air temperatures and varied precipitation in the Columbia Basin. Observed precipitation in May was 105% of average on the Snake River above Ice Harbor and 83% of average on the Columbia River above The Dalles[5]. The NOAA Northwest River Forecast Center runoff summary for May indicated that the adjusted runoff for the Snake River at Lower Granite was 118% of the 30-year average (1981-2010) with a volume of 8.1 MAF (Million acre-feet). The adjusted runoff for the Columbia River at The Dalles was 100% of the 30-year average (1981-2010) with a volume of 25.3 MAF.[6]

The 2019 spring fish passage spill operation at the Corps' eight lower Snake and lower Columbia River projects differs from previous years' operations as a result of the Agreement signed in December 2018. Spring spill operations occur April 3–June 20 at the four lower Snake River

[4] As specified in the 2019 FOP section 3.
[5] Retrieved 1 May 2019: https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?tab=5
[6] Retrieved 1 May 2019: https://www.nwrfc.noaa.gov/runoff/runoff_summary.php?date=05/01/2019

projects, and April 10–June 15 at the four lower Columbia River projects. Target spill levels for April 2019 at each project are defined in Table 1.

Table 1: Summary of 2019 spring target spill levels at lower Snake River and lower Columbia River projects.

PROJECT	GAS CAP SPILL (at least 16 hours per day)[1, 2, 3, 5]	PERFORMANCE STANDARD SPILL (up to 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
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/water quality standards.
4. The 8 hours of Performance Standard spill can 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 flows is ≤ 350 kcfs).
7. Spill to the 120% Gas Cap, not to exceed 150 kcfs.

In its implementation of the 2019 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 in the tailrace (see Table 4).[7] 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). For the month of May 2019, conditions constraining the spill cap at Bonneville and The Dalles dams did not occur (see Table 1 fn 6,7).

[7] See 2019 FOP section 2.2

Operational Adjustments

1. Little Goose

Beginning on May 21, the Corps adjusted the hours of the 30% Performance Standard spill operation at Little Goose Dam to address upstream passage delay of adult spring Chinook at the project.

From May 21 through May 24, the Corps and BPA implemented the 30% spill operation for 5 hours in the morning (0600-1100) and 3 hours in the afternoon (1600-1900), per a recommendation from Idaho received on May 20 and consensus (no objections) from TMT on May 22.

From May 25 through May 28, the Corps and BPA implemented a modified 30% spill operation for 6 hours in the morning (0600-1200) and 2 hours in the afternoon (1700-1900). This operation was coordinated with TMT at the meeting on May 24 and regional sovereigns either supported or did not object.

Starting on May 29 and continuing into June[8], the Corps and BPA implemented a modified 30% spill operation for 8 consecutive hours in the morning (0400-1200). This operation was requested by FPAC on May 28 and coordinated with TMT at the meeting on May 29. Regional sovereigns either supported or did not object to this operation.

2. Lower Monumental

The uniform spill pattern continued to be applied to performance standard spill during May 2019 (see April 2019 FOP Implementation Report for details).

3. The Dalles

3.a. The spill cap as a percentage of total project outflow on an hourly basis continued during May 2019 (see April 2019 FOP Implementation Report for details).

3.b. Beginning May 10, the Corps began a combined spill operation at The Dalles and John Day Dams with two primary objectives: meet, but not exceed, 120% TDG in The Dalles tailrace while maintaining at least 40% spill at The Dalles Dam[9] for the benefit of juvenile fish passage. If necessary to achieve both of these objectives, the John Day Dam spill cap would be reduced below the estimated spill cap to meet, but not exceed, 120% TDG in the tailrace at John Day Dam. The Dalles tailrace gauge represents a mix of powerhouse and spillway TDG. The TDG associated with the powerhouse flow is at the same percentage as the upstream forebay TDG. The Dalles forebay TDG is a result of TDG generated upstream at John Day Dam and environmental conditions (e.g., wind speed, barometric pressure and water temperature). This combined spill approach at The Dalles and John Day Dams was coordinated with TMT at the May 10 TMT meeting. Regional sovereigns either supported or did not object to this operation.

[8] Operational adjustments that occur in June will be included in the June FOP Implementation Report.
[9] The Dalles spill cap remains a percentage of total project outflow on an hourly basis rather than a fixed daily level (kcfs).

3.c. On May 15, an error was discovered in the reported air pressure data at The Dalles tailwater gauge (TDDO). A 1.01 multiplier was being applied to the data transmitted from the gauge. This error caused an approximately one percent increase in the calculated percent saturation metrics at TDDO and resulted in 12-hr average TDG exceedances that were not previously reported. Therefore, spill caps for The Dalles spill may have been greater than they would have otherwise been. The error applies to data back to June 2015. The multiplier is no longer being applied and erroneous data has been corrected for 2015 through 2019. TMT members were made aware of this issue via email on May 16 and at the May 22 TMT meeting.

4. Bonneville

Beginning May 17, the Bonneville tailwater telemetered water quality sensor was removed to prevent damage during the forecasted high flows. In past years, total flow between 450 and 500 kcfs damaged the gauge. Access to the gauge is limited above a tailwater stage of 28.0 feet, which correlates with a flow of approximately 400 kcfs. The forecast on May 16 indicated flows in excess of 420 kcfs the week of May 20, with flows exceeding 380 kcfs on May 18. The Corps and USGS agreed that the real-time instrument should be replaced on May 17 while the gauge was still accessible. When the 10-day flow forecast predicted flows less than 380 kcfs, the USGS replaced the telemetered sensor (May 21). Although real-time data were not available for daily spill review, recorded data are available in the database from May 17 through May 22. TMT members were made aware of this issue via email on May 17 and at the May 22 TMT meeting.

Table 2: Spill Variance Table – May 2019 (5/1 to 5/31)

Project	Parameter	Date	Time[10]	# of Hours	Type	Reason
Ice Harbor	Additional Spill	5/30/19	1200	1	Human Error	Hourly spill increased to 95 kcfs (above adjusted spill of 89 kcfs) due to delay in shifting flow to generation when Unit 2 was returned to service.
John Day	Additional Spill	5/20/19	0700-1600	10	Maintenance	Hourly spill increased to 180 kcfs (above adjusted spill of 168 kcfs). Units 9-12 were taken out of service for unscheduled maintenance to replace the master power panel.
The Dalles	Reduced Spill	5/9/19	0900	1	Emergency	Hourly spill decreased to 90 kcfs (below adjusted spill of 96 kcfs) due to an emergency recovery of commercial barge from the spillway.

[10] Data collected for reporting spill variances are reported as hourly averages. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented as an hour. The hourly average data is reported at the end of the hour (i.e., hour ending).

Table 3: Pre-Coordinated Operations – May 2019 (5/1 to 5/31)

Project	Parameter	Date	Time[10]	# of Hours	Type	Reason
Lower Granite	Additional Spill	5/19/19	1000-1200	3	Maintenance	Hourly spill increased to 60 kcfs (above the adjusted spill of 51 kcfs) while performing VBS screen inspection. Regionally coordinated via 2019 FPP, page LWG-14.
Little Goose	Additional Spill	5/14/19	1000-1200	3	Maintenance	Hourly spill increased to 62 and 70 kcfs (above the adjusted spill of 54 kcfs) while removing debris from trash racks which necessitated a generation flow decrease. Regionally coordinated via 2019 FPP, page LGS-29.
Little Goose	Additional Spill	5/15/19	1000-1600	7	Maintenance	Hourly spill increased to 62 (above the adjusted spill of 54 kcfs) while removing debris from trash racks which necessitated a generation flow decrease. Regionally coordinated via 2019 FPP, page LGS-29.
Little Goose	Modified Performance Standard Hours	5/25/19 5/26/19 5/27/19 5/28/19	1200 1200 1200 1200	1 1 1 1	Adaptive Management	Extended the AM block of performance standard spill by 1 hour and shortened the PM block by 1 hour. Regionally coordinated at the 5/24/19 TMT meeting.
Little Goose	Modified Performance Standard Hours	5/29/19 5/30/19 5/31/19	1000-1200 1000-1200 1000-1200	3 3 3	Adaptive Management	Extended the AM block of performance standard spill by 3 hours and removed the 3-hour PM block. Regionally coordinated at the 5/28/19 TMT meeting.
Lower Monumental	Reduced Spill	5/1/19 5/2/19 5/3/19 5/4/19 5/5/19 5/6/19 5/7/19 5/8/19 5/9/19 5/10/19 5/11/19 5/12/19 5/13/19 5/14/19 5/15/19 5/17/19 5/19/19 5/21/19 5/23/19 5/25/19 5/27/19 5/29/19 5/31/19	1700-1800 1700-1900 1700-1800 1700-1900 1800-1900 1700-1900 1800-1900 1700-1800 1700-1900 1700-1800 1800-1900 1800-1900 1800-1900 1900 1800-1900 1800 1800 1900-2000 1800-2000 1800-1900 1800-1900 1800-1900 1800	2 3 2 3 2 3 2 2 3 2 2 2 2 1 2 1 1 2 3 2 2 2 1	Navigation	Hourly spill reduced below target spill for safe navigation. Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6

Project	Parameter	Date	Time[10]	# of Hours	Type	Reason
Lower Monumental	Additional Spill	5/17/19	0800-1200	5	Research Related	Hourly spill increased to 55 kcfs (above adjusted spill of 40 kcfs). Units 2 and 3 were taken out of service to change head gate cylinders as part of a Fish Guidance Efficiency research study. Regionally coordinated via 2019 FPP, Appendix A, page A-13.
Lower Monumental	Additional Spill	5/20/19	1000-1500	6	Maintenance	Hourly spill increased to 48 and 55 kcfs (above adjusted spill of 41 kcfs) while removing debris from trash racks which necessitated a generation flow decrease. Regionally coordinated via 2019 FPP, page LMN-28.
The Dalles	Additional Spill	5/20/19	1900	1	Transmission Reliability	Hourly spill increased to 42% (above adjusted spill of 40% ± 1%) due to providing balancing reserves. 24-hr average was 40.2%. Regionally coordinated via 2019 FPP, Appendix E, Section 4.1.

Table 4: May 2019 Average Percent TDG Values Table (5/1 to 5/31)

Date	FIXED MONITORING STATIONS															
	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW	JDY	JHAW	TDA	TDDO	BON	CCIW
	Lower Granite FB	Lower Granite TW	Little Goose FB	Little Goose TW	Lower Monumental FB	Lower Monumental TW	Ice Harbor FB	Ice Harbor TW	McNary FB	McNary TW	John Day FB	John Day TW	The Dalles FB	The Dalles TW	Bonneville FB	Bonneville TW
Gas Cap %:	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**
5/1/2019	106	120	115	**121**	121	119	118	119	113	120	112	120	117	**121**	120	120
5/2/2019	105	120	114	120	120	119	117	119	112	119	112	120	115	119	116	119
5/3/2019	105	120	114	120	120	120	117	119	112	119	113	120	116	120	113	119
5/4/2019	106	120	116	120	122	120	119	**121**	113	119	114	120	119	**123**	116	120
5/5/2019	107	120	117	120	122	120	119	120	115	118	114	120	119	**122**	117	120
5/6/2019	106	120	117	120	121	120	119	120	115	119	115	120	120	**122**	119	120
5/7/2019	105	119	117	120	122	120	119	120	115	119	117	119	119	**122**	118	120
5/8/2019	105	120	117	120	121	120	118	**121**	115	120	118	120	119	**121**	117	120
5/9/2019	104	120	116	120	122	120	118	**122**	115	119	118	120	121	**123**	119	120
5/10/2019	105	120	117	120	122	120	118	120	115	119	118	120	122	**123**	120	120
5/11/2019	105	120	118	120	122	120	119	120	116	119	120	119	121	**123**	121	120
5/12/2019	106	120	117	120	122	**121**	119	120	116	119	119	119	118	**121**	118	120
5/13/2019	105	120	116	120	121	120	118	120	115	119	117	119	117	120	115	120
5/14/2019	105	120	115	120	120	**121**	117	120	113	119	116	119	117	120	116	120
5/15/2019	105	120	115	**121**	121	**121**	118	**122**	113	119	115	120	118	**122**	118	**121**
5/16/2019	106	120	115	120	123	**121**	119	**124**	115	120	115	120	118	**121**	121	**121**
5/17/2019	105	120	114	120	121	**121**	118	**122**	114	120	113	119	114	119	116	119
5/18/2019	104	**123**	112	**125**	121	**124**	117	**129**	113	120	113	**121**	117	**122**	117	**121**
5/19/2019	106	**121**	115	**122**	126	**121**	119	**125**	117	120	112	**121**	116	**121**	120	**121**
5/20/2019	106	120	116	120	123	**121**	120	**121**	117	120	111	**122**	114	119	117	120
5/21/2019	105	120	115	120	121	120	119	**121**	115	120	114	120	117	**121**	118	120
5/22/2019	104	119	114	119	120	119	117	120	114	120	114	120	116	**121**	117	120
5/23/2019	104	119	114	120	121	120	118	120	116	120	115	120	118	**122**	117	120
5/24/2019	105	120	114	120	122	119	118	120	115	120	114	119	116	120	115	119
5/25/2019	105	120	113	120	120	120	117	120	113	120	112	119	116	120	114	119
5/26/2019	105	120	116	120	121	119	118	120	112	120	112	119	117	**121**	117	120
5/27/2019	105	120	116	120	121	120	118	120	114	120	112	119	117	120	117	119
5/28/2019	105	120	115	120	122	120	119	120	114	120	111	119	115	120	114	119
5/29/2019	105	120	116	120	122	120	119	120	114	120	114	120	116	120	114	120
5/30/2019	106	120	115	120	122	120	119	120	116	120	115	119	117	**121**	116	120
5/31/2019	106	120	116	120	121	**122**	119	**121**	115	120	116	119	118	**122**	118	**121**
Exceedances:		**2**		**4**		**9**		**11**		**0**		**3**		**20**		**5**

Figure 1

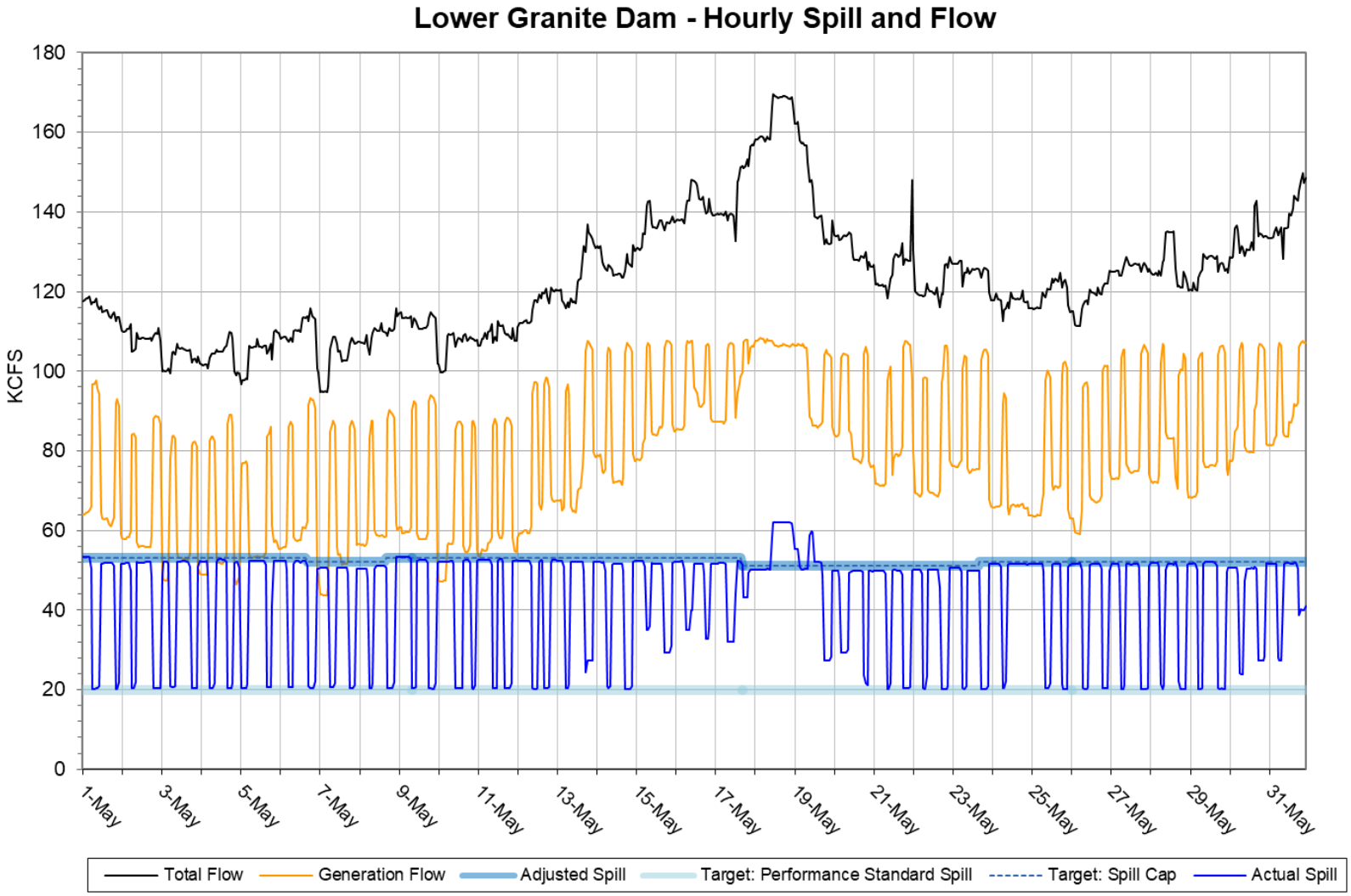

Lower Granite Dam - Hourly Spill and Flow
KCFS
180
160
140
120
100
80
60
40
20
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Actual Spill

Figure 2

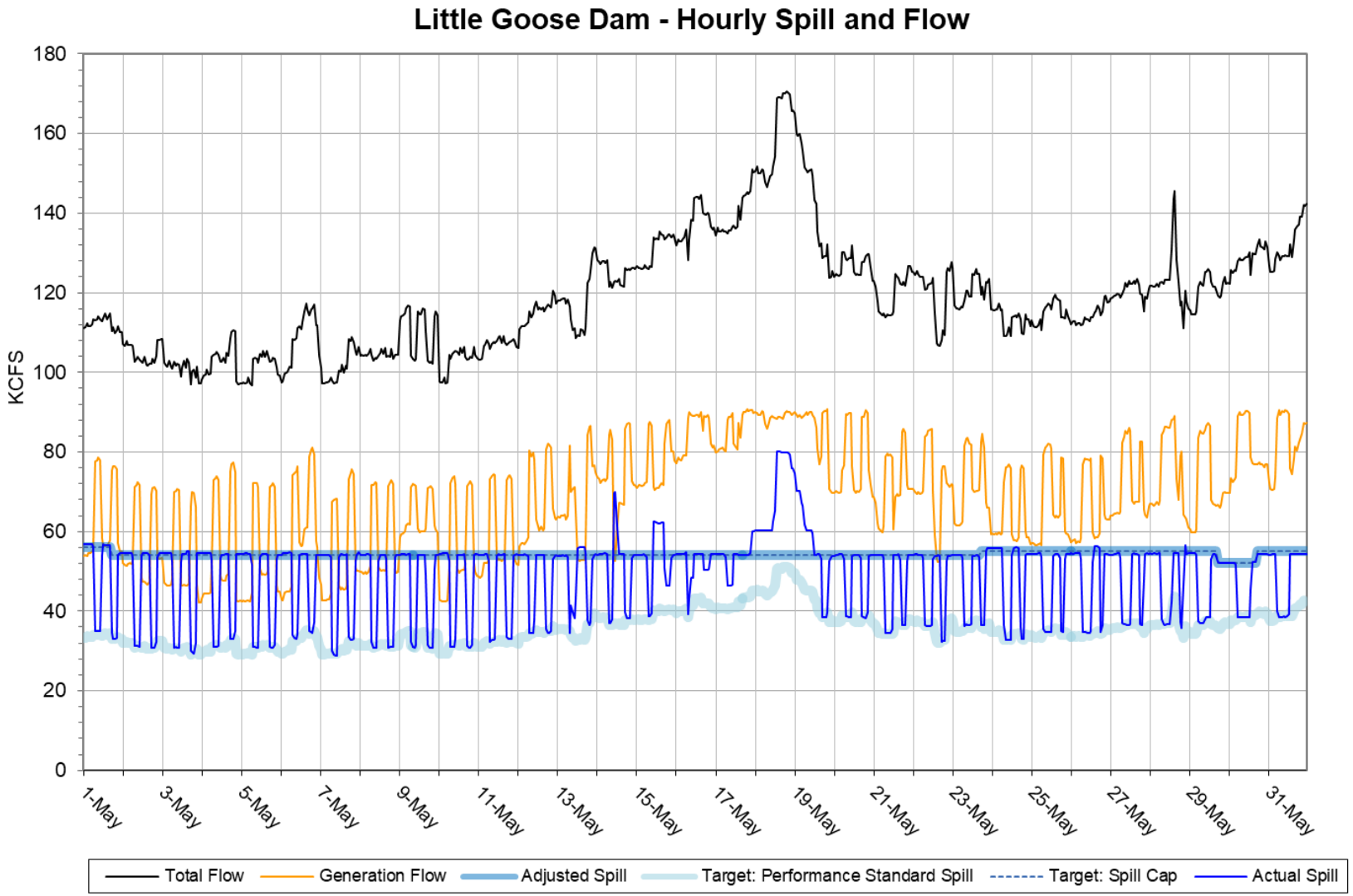

Little Goose Dam - Hourly Spill and Flow
KCFS
180
160
140
120
100
80
60
40
20
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Actual Spill

Figure 3

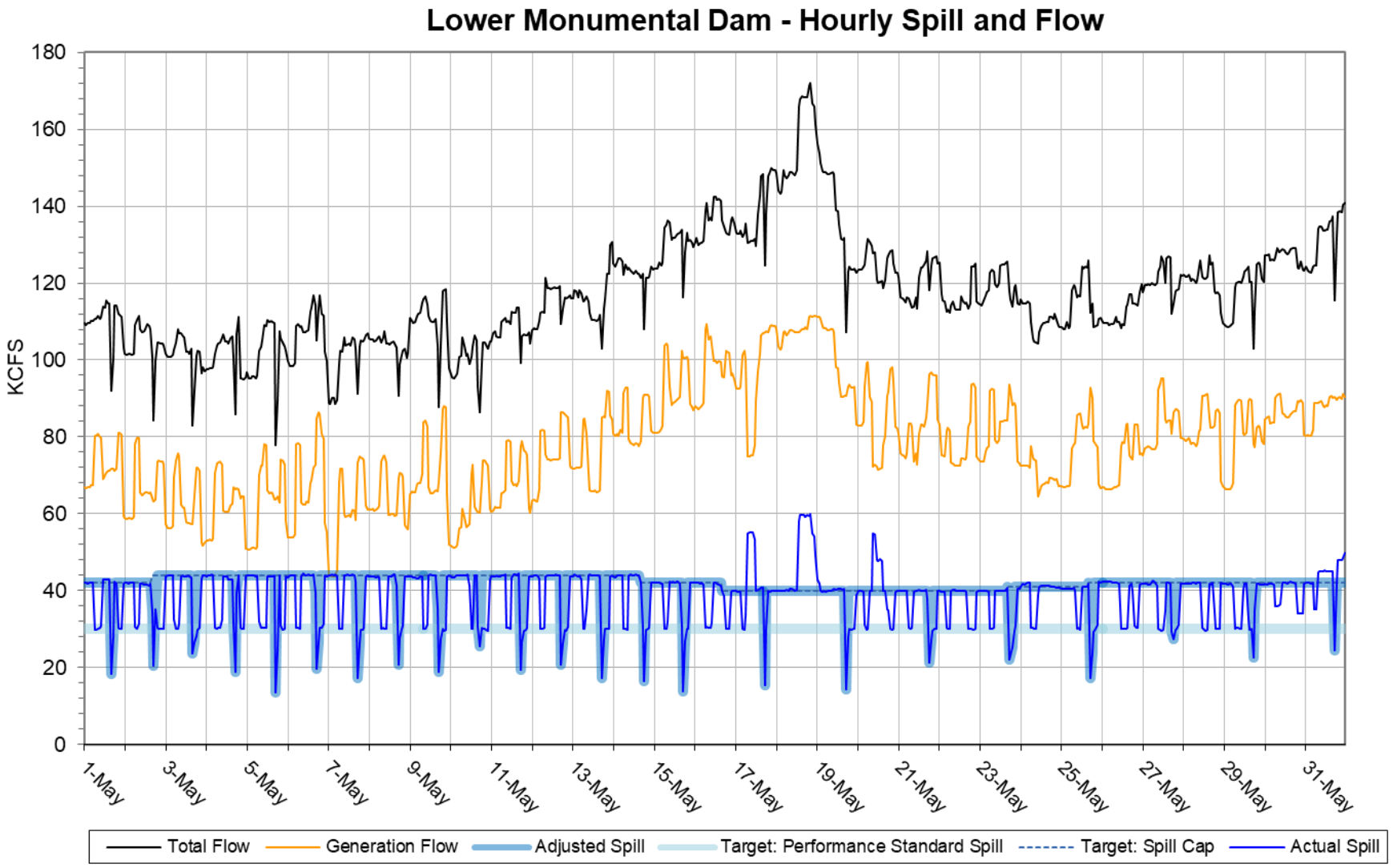

Lower Monumental Dam - Hourly Spill and Flow
KCFS
180
160
140
120
100
80
60
40
20
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Actual Spill

Figure 4

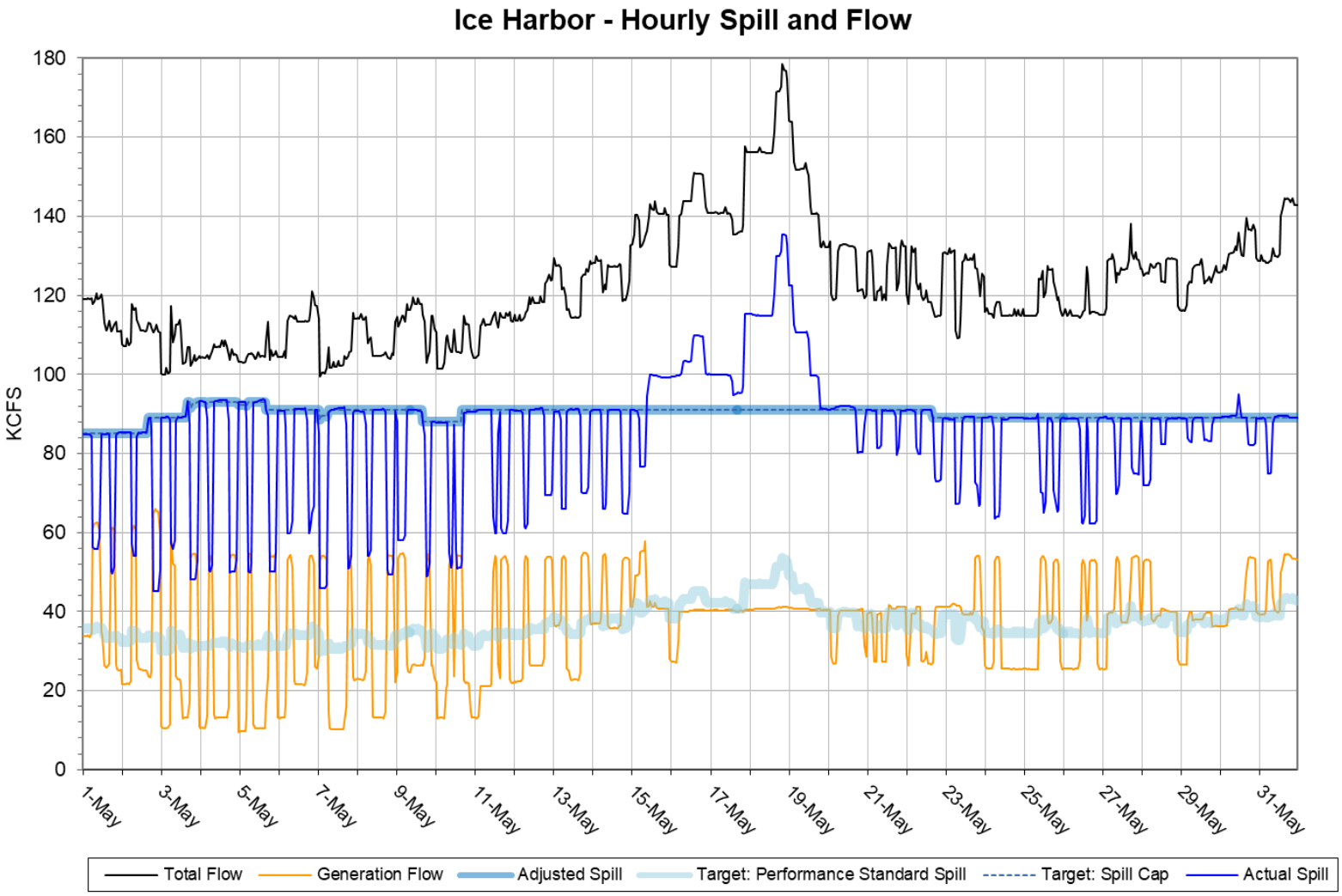

Ice Harbor - Hourly Spill and Flow
KCFS
180
160
140
120
100
80
60
40
20
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Actual Spill

Figure 5

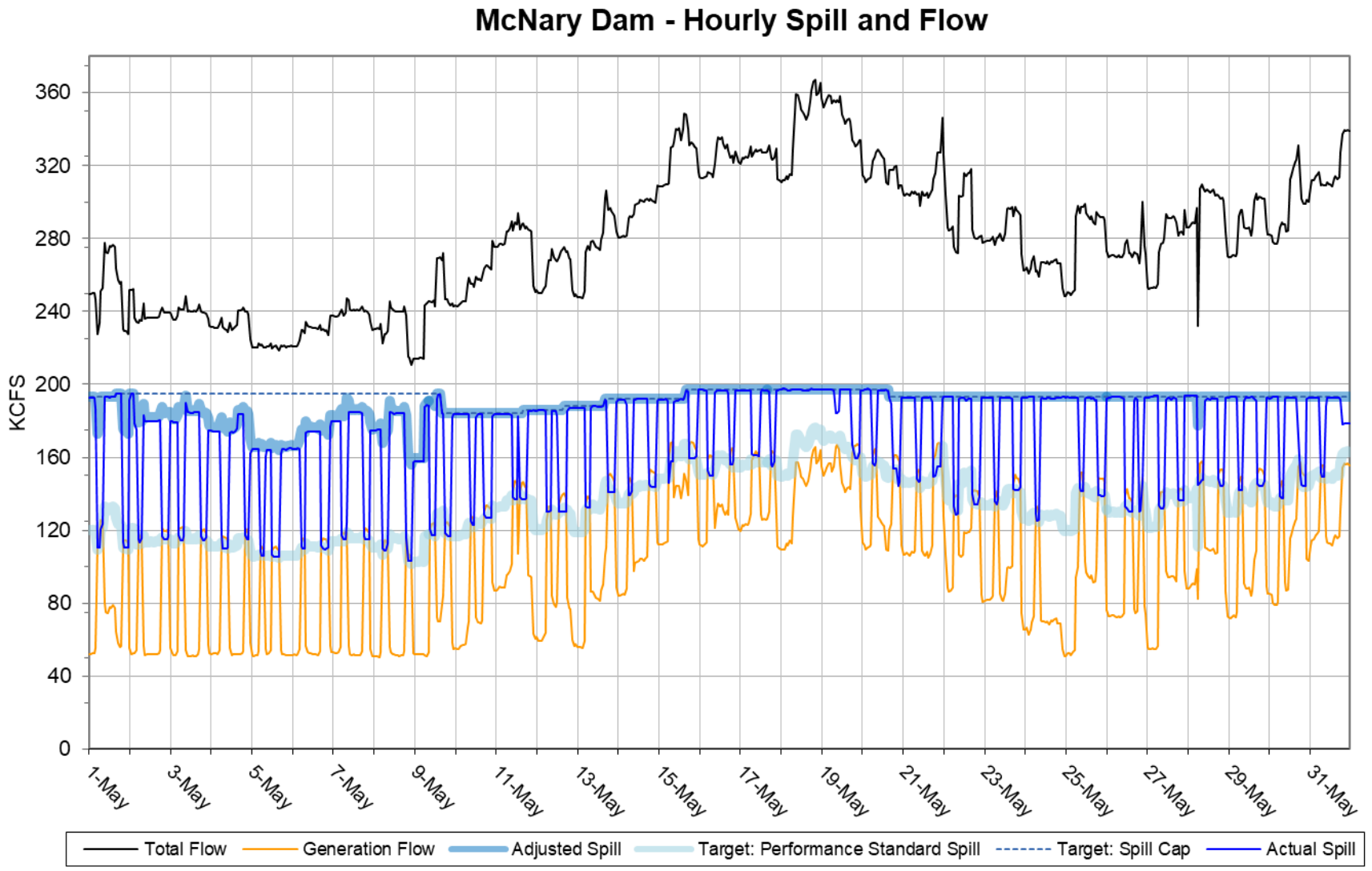

McNary Dam - Hourly Spill and Flow
KCFS
360
320
280
240
200
160
120
80
40
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Actual Spill

Figure 6

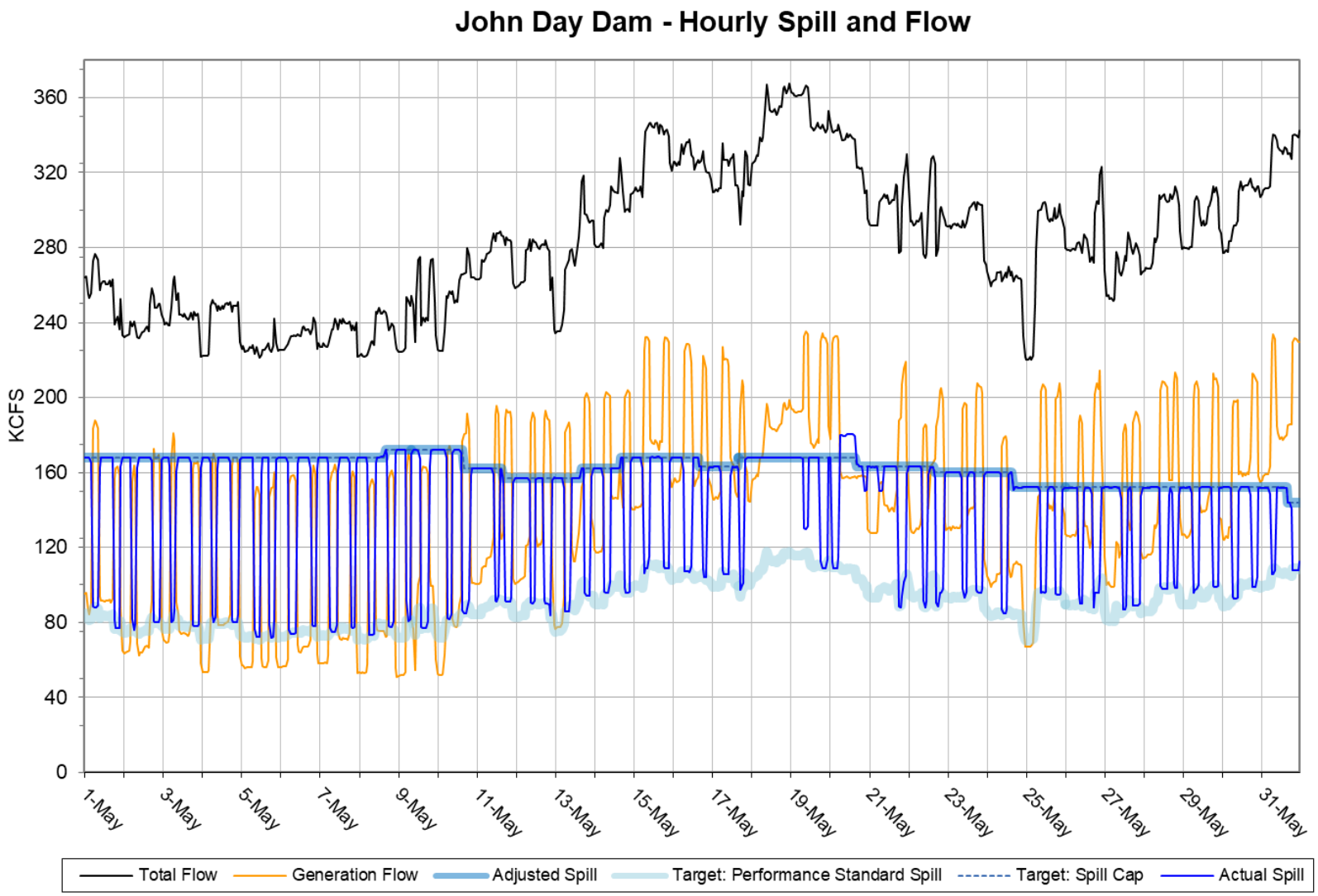

John Day Dam - Hourly Spill and Flow
KCFS
360
320
280
240
200
160
120
80
40
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Actual Spill

Figure 7

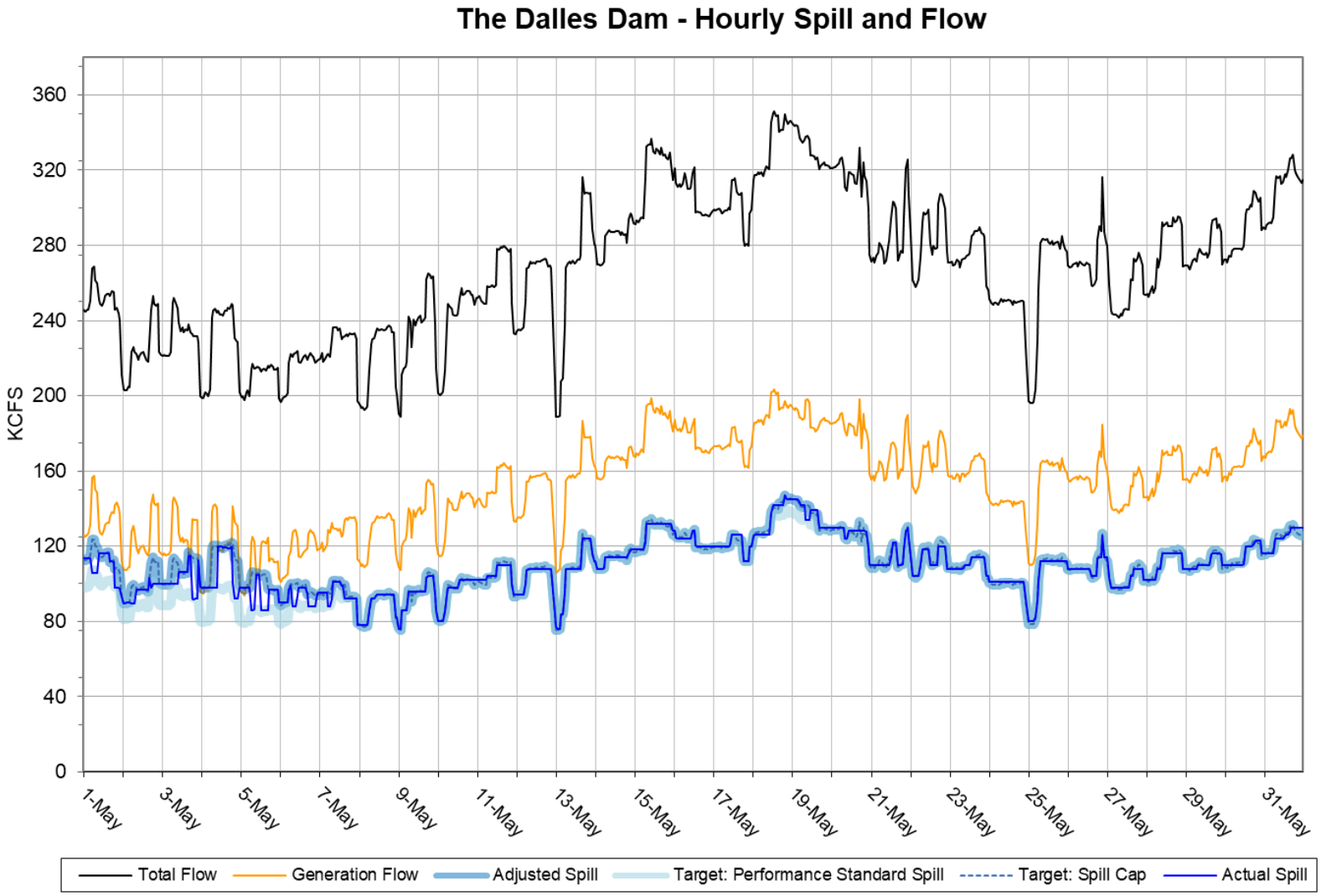
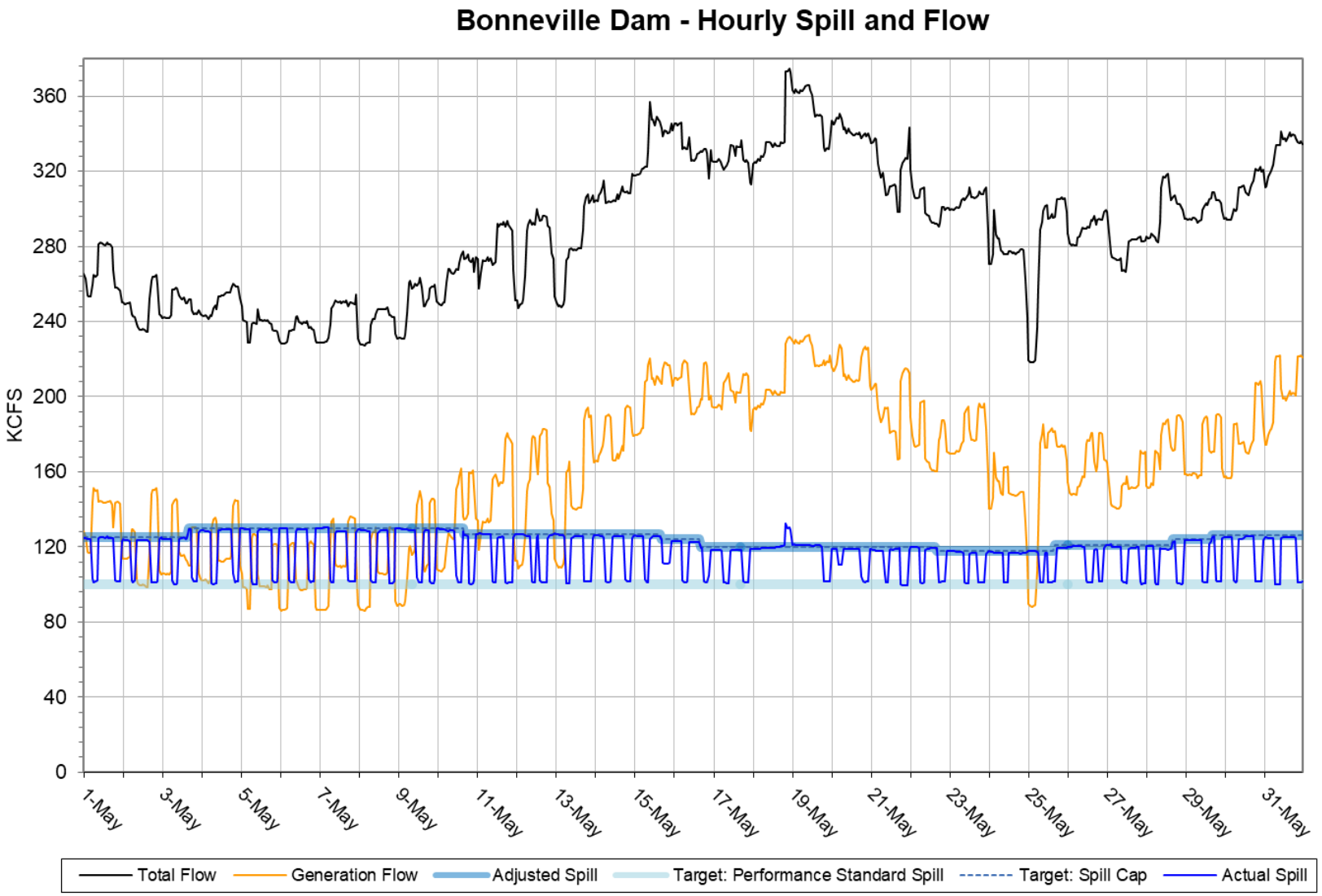

The Dalles Dam - Hourly Spill and Flow
KCFS
360
320
280
240
200
160
120
80
40
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Actual Spill

Figure 8


Bonneville Dam - Hourly Spill and Flow
KCFS
360
320
280
240
200
160
120
80
40
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Actual Spill

FISH OPERATIONS PLAN IMPLEMENTATION REPORT

June 2019

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 2019 Fish Operations Plan[1] (2019 FOP). The 2019 FOP describes the 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)[2], the 2018 Extensions of the 2008 Columbia Basin Fish Accords (Accord Extensions), the 2019-2021 Spill Operation Agreement (Agreement), the Corps' requirements under the Endangered Species Act (ESA), and is the subject of ongoing consultation and communications with the relevant wildlife agencies to ensure consistency with the ESA. 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).

This report describes the Corps' implementation of the 2019 FOP during the month of June 2019. In particular, 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 and 2);
- 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 2019 FOP, section 4.1);
- actual spill: the hourly flow over the spillway; and,

[1] The 2019 FOP was posted to the Technical Management Team (TMT) website on April 1, 2019 (http://pweb.crohms.org/tmt/documents/fpp/2019/).
[2] 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.

- resultant 12-hour average TDG for the tailwater at each project and for the next project's forebay downstream[3].

This report also provides information on issues and unanticipated or emergency situations that arose during implementation of the 2019 FOP in June 2019.

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 June, with hourly spill, target spill, adjusted spill, generation, and total flows. The monthly graphs begin on June 1 and end on June 30 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 thin dashed blue line represents the spill cap portion of the target spill estimated to reach the gas cap (spring only).
- The thick light blue line represents the performance standard spill level portion of the target spill (spring only).
- The dotted blue line represents the hourly target summer spill in kcfs (summer only).
- 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 (2019 FOP section 4.1).

II. The average daily %TDG for the 12 highest hours for all projects is shown in the June 2019 Average Percent TDG Values Table (Table 4). The numbers in red indicate the project exceeded the %TDG cap - i.e. 120% (tailwater) for each project and 115% (forebay of the next downstream dam, summer only).

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 June 2019

[3] Averages reported are consistent with the current and applicable Oregon TDG standard modification (120% tailwater) and Washington TDG criteria adjustments (120% tailwater during spring spill and 120% tailwater/115% forebay during summer spill). The Oregon TDG standard modification and the Washington TDG criteria adjustments during summer spill have different methodologies for calculating TDG. When the standards vary or conflict, the Corps applies the more stringent standard. See 2019 FOP section 2.1.

Spill Variance Table (Table 3).[4] 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 4).

"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 2019 FOP for Bonneville and The Dalles dams,[5] 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.

June Operations

The month of June was characterized by below average flows for the lower Snake and lower Columbia Rivers with above average air temperatures and well below average precipitation in the Columbia Basin. Observed precipitation in June was 33% of average on the Snake River above Ice Harbor and 41% of average on the Columbia River above The Dalles[6]. The NOAA

[4] Involuntary spill conditions shown in the graphs are not considered variances and are not reported in the Spill Variance Table. Involuntary 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.
[5] As specified in the 2019 FOP section 3.
[6] Retrieved 1 July 2019: https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?tab=5

Northwest River Forecast Center runoff summary for June indicated that the adjusted runoff for the Snake River at Lower Granite was 90% of the 30-year average (1981-2010) with a volume of 5.4 MAF (Million acre-feet). The adjusted runoff for the Columbia River at The Dalles was 74% of the 30-year average (1981-2010) with a volume of 19.4 MAF[7].

The 2019 spring fish passage spill operation at the Corps' eight lower Snake and lower Columbia River projects differs from previous years' operations as a result of the Agreement signed in December 2018. 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. Spring target spill levels for June 2019 through the dates listed above at each project are defined in Table 1.

Table 1: Summary of 2019 spring target spill levels at lower Snake River and lower Columbia River projects.

PROJECT	GAS CAP SPILL (at least 16 hours per day)[1, 2, 3, 5]	PERFORMANCE STANDARD SPILL (up to 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
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/water quality standards.
4. The 8 hours of Performance Standard spill can 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 flows is ≤ 350 kcfs).
7. Spill to the 120% Gas Cap, not to exceed 150 kcfs.

[7] Retrieved 1 July 2019: https://www.nwrfc.noaa.gov/runoff/runoff_summary.php?date=07/01/2019

Summer spill operations occur June 21–August 31 at the four lower Snake River projects, and June 16–August 31 at the four lower Columbia River projects (Table 2).

Table 2: 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 2019 FOP summer target spill level at any project if necessary to ensure navigation safety or transmission reliability, or to avoid exceeding State TDG standards.

In its implementation of the 2019 FOP in June, the Corps evaluated conditions every day to establish spill caps at a level that was estimated to meet, but not exceed, the gas cap in the tailrace (see Table 5).[8] 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). For the month of June 2019, conditions constraining the spill cap at Bonneville and The Dalles dams did not occur (see Table 1 fn 6,7).

Operational Adjustments

1. Little Goose

From June 1 through June 20, BPA and the Corps continued the TMT-coordinated modified 30% spill operation that began May 31 to spill 30% for 8 consecutive hours per day (0400-1200) in order to minimize adult Chinook salmon delay at Little Goose.[9] Flows above hydraulic capacity were stored in the forebay above MOP (633.0 – 634.5 feet) if necessary to maintain spill at 30% for 8 consecutive hours; any volume of water stored above MOP was then drafted by 0400 the following day. This operation was coordinated with TMT at the meetings on June 5, 12, and 19, and regional sovereigns either supported or did not object.

From June 5 through June 12, the Corps and BPA also implemented a modified operation of the Adjustable Spillway Weir (ASW) to switch from low crest to high crest for 16 hours/day (0400-2000). The intent of this operation was to reduce the proportion of spill through the ASW to improve tailrace hydraulics for adult passage. Starting on June 12, the ASW was maintained in high crest 24 hours/day due to declining river flows that were approaching the trigger of 85 kcfs

[8] See 2019 FOP section 2.2

[9] Operational adjustments that occurred in May are included in the May FOP Implementation Report.

defined in the 2019 Fish Passage Plan (FPP). The FPP flow criteria were met on June 13. This operation was coordinated with TMT at the meetings on June 5 and June 12, and regional sovereigns either supported or did not object.

On June 19 and 20, the Corps and BPA implemented a modified spring unit priority order that moved Unit 6 to last priority (1, 2, 3, 4, 5, 6) instead of the order defined in the 2019 FPP that has Unit 6 as second priority during spring spill (1, 6, 2, 3, 4, 5). The intent of this operation was to prioritize units on the south side of the powerhouse and maintain attraction flow to the adult ladder entrance while Unit 1 was out of service. Starting on June 21, the FPP summer unit priority order went into effect that has Unit 6 as last priority (1, 2, 3, 4, 5, 6). This operation was coordinated with TMT at the meeting on June 19 and regional sovereigns either supported or did not object.

Table 3: Spill Variances - June 2019 (6/1 to 6/30)

Project	Parameter	Date	Time[10]	# of Hours	Type	Reason
The Dalles	Additional Spill	6/11/19	0200	1	Human Error	Hourly spill increased to 43% (greater than 40% ±1 %) due to delay in changing to the appropriate target.
Ice Harbor	Reduced Spill	6/17/19	0500-0600	2	Operational Limitation	Hourly spill was less than adjusted spill while minimum generation exceeded the range for Unit 1 (8.4-10.1 kcfs[11]) to 10.4 kcfs. Normal system operations and river conditions can result in operations outside the minimum generation flow range.

[10] Data collected for reporting spill variances are reported as hourly averages. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented as an hour. The hourly average data is reported at the end of the hour (i.e., hour ending).

[11] Range does not include ±2% due to generating unit governor "dead band." When ±2% is applied to the minimum generation flow ranges for Ice Harbor turbine unit 1, the range is 8.2-10.3 kcfs. See FOP section 4.3.1.

Table 4: Pre-Coordinated Operations - June 2019 (6/1 to 6/30)

Project	Parameter	Date	Time[12]	# of Hours	Type	Reason
Little Goose	Reduced Spill	6/1/19 6/2/19 6/3/19 6/4/19 6/5/19 6/6/19 6/7/19 6/8/19 6/9/19 6/10/19 6/11/19 6/12/19 6/13/19 6/14/19 6/15/19 6/16/19 6/17/19 6/18/19 6/19/19 6/20/19	1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200 1000-1200	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	Adaptive Management	Extended the AM block of performance standard spill by 3 hours and removed the 3-hour PM block. Regionally coordinated at the 5/28/19 TMT meeting
Lower Monumental	Reduced Spill	6/2/19 6/6/19 6/8/19 6/10/19 6/12/19 6/14/19 6/16/19 6/18/19 6/20/22 6/22/19 6/24/19 6/27/19 6/28/19 6/30/19	1700 1800-1900 1700-1800 1700-1800 1700-1800 1700-1800 1700-1800 1700-1800 1800-1900 1800 1700-1800 0800, 1300 1800 1700-1800	1 2 2 2 2 2 2 2 2 1 2 2 1 2	Navigation	Hourly spill reduced below target spill for safe navigation. Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6.
Lower Monumental	Additional Spill	6/4/19 6/5/19 6/6/19	1400-1700 1000-1900 1000-1500	4 10 6	Maintenance	Hourly spill increased to 50 to 100 kcfs (greater than 42 kcfs) while performing STS screen inspection. Regionally coordinated via 2019 FPP, page LMN-12.
Lower Monumental	Additional Spill	6/7/19	0800-1800	11	Research Related	Hourly spill increased to 60-75 kcfs (greater than 42 kcfs). Units 2 and 3 were taken out of service to change head gate cylinders as part of a Fish Guidance Efficiency research study. Regionally coordinated via 2019 FPP, Appendix A, page A-13.
John Day	Reduced Spill	6/30/19	0100	1	Transmission Reliability	Hourly spill decreased to 33% (less than 35% ±1 %) due to providing balancing reserves. 24-hr average was 34.9%. Regionally coordinated via 2019 FOP, Section 4.1.

[12] Data collected for reporting pre-coordinated operations are reported as hourly averages. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented as an hour. The hourly average data are reported at the end of the hour (i.e., hour ending).

Project	Parameter	Date	Time[12]	# of Hours	Type	Reason
The Dalles	Reduced Spill	6/30/19	0100	1	Transmission Reliability	Hourly spill decreased to 38% (less than 40% ±1 %) due to providing balancing reserves. 24-hr average was 39.8%. Regionally coordinated via 2019 FOP, Section 4.1.

Table 5: June 2019 Average Percent TDG Values Table (6/1 to 6/30)

Date	FIXED MONITORING STATIONS															
	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW	JDY	JHAW	TDA	TDDO	BON	CCIW
	Lower Granite FB	Lower Granite TW	Little Goose FB	Little Goose TW	Lower Monumental FB	Lower Monumental TW	Ice Harbor FB	Ice Harbor TW	McNary FB	McNary TW	John Day FB	John Day TW	The Dalles FB	The Dalles TW	Bonneville FB	Bonneville TW
Gas Cap %:	120 115[13]	120	120 115	120	120 115	120	120 115	120	120 115	120	120 115	120	120 115	120	120 115	120
6/1/2019	106	120	116	123	122	124	120	123	116	120	118	120	118	122	118	121
6/2/2019	107	120	117	124	124	125	121	124	117	120	119	119	117	121	117	120
6/3/2019	107	120	116	124	123	124	121	124	116	120	116	119	114	119	114	121
6/4/2019	106	120	114	126	123	126	120	125	114	120	114	119	114	119	114	121
6/5/2019	107	120	115	124	125	125	123	123	115	120	113	119	115	120	115	120
6/6/2019	107	120	115	121	123	123	121	121	115	120	112	119	114	119	115	120
6/7/2019	106	120	113	119	119	122	119	120	110	119	110	118	113	117	113	119
6/8/2019	104	119	111	120	117	120	115	119	108	119	108	118	112	117	111	119
6/9/2019	104	119	111	120	118	119	116	119	110	119	108	118	117	120	114	119
6/10/2019	106	119	114	120	122	119	118	118	113	124	108	118	117	121	118	119
6/11/2019	106	120	116	120	122	119	118	118	114	124	110	118	117	120	118	120
6/12/2019	107	120	118	120	122	119	120	117	116	123	115	118	119	121	119	120
6/13/2019	107	119	119	121	123	119	121	118	116	119	118	118	118	121	119	120
6/14/2019	106	119	117	120	121	119	119	118	114	119	116	118	113	118	113	119
6/15/2019	105	120	117	120	120	120	118	118	113	118	117	118	116	118	110	119
6/16/2019	104	120	116	120	121	120	118	117	113	117	117	117	117	119	110	118
6/17/2019	104	120	117	120	121	119	118	117	113	117	117	116	115	118	110	117
6/18/2019	104	120	117	120	120	119	118	117	112	117	114	115	112	116	110	117
6/19/2019	104	119	115	120	118	118	116	116	112	117	109	115	109	115	108	117
6/20/2019	103	119	112	120	116	119	115	115	110	116	107	114	106	113	106	117
6/21/2019	103	116	111	119	115	117	113	114	108	117	106	114	107	114	106	117
6/22/2019	101	114	111	111	114	114	113	115	107	116	105	114	108	114	107	117
6/23/2019	101	113	111	111	115	112	113	115	106	116	104	113	108	114	107	117
6/24/2019	102	114	111	111	113	113	112	114	108	116	104	114	106	114	108	117
6/25/2019	103	115	111	111	111	113	112	114	109	117	104	114	108	115	109	117
6/26/2019	103	116	111	111	111	113	113	114	109	•[14]	104	114	108	115	110	117
6/27/2019	103	116	110	111	111	113	113	113	109	•	105	114	107	115	110	117
6/28/2019	103	116	111	112	110	114	111	113	108	•	105	114	108	•	111	117
6/29/2019	103	116	112	111	110	117	111	112	108	•	105	114	108	•	111	117
6/30/2019	102	116	112	111	111	117	111	112	109	•	107	115	109	•	112	117
Exceedances:				7		7		6		3	2		1	5		3

[13] The Washington Criteria Adjustment for the summer states that 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.

[14] Red shaded cells indicate no data due to malfunctioning gauge.

Figure 1

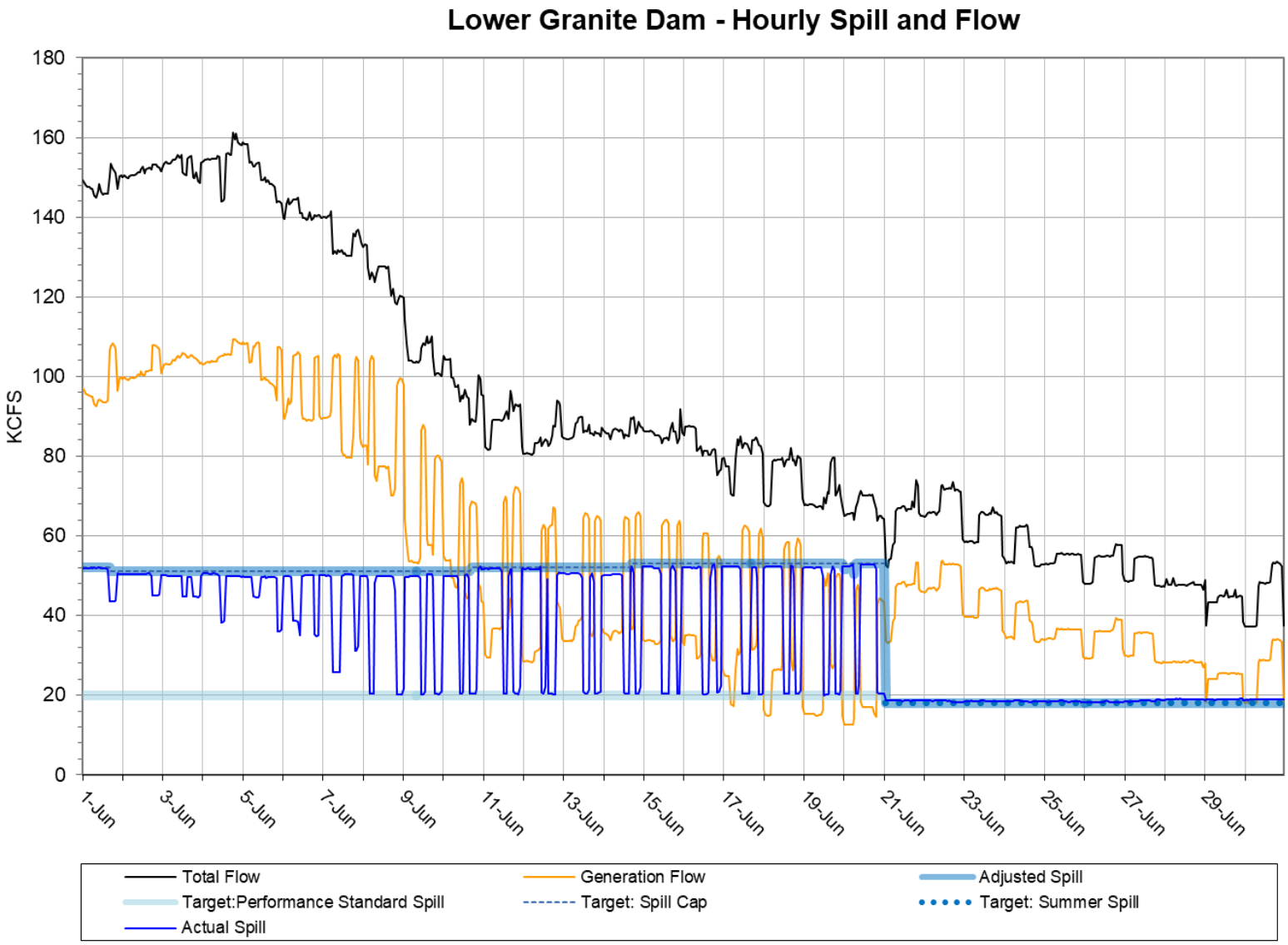
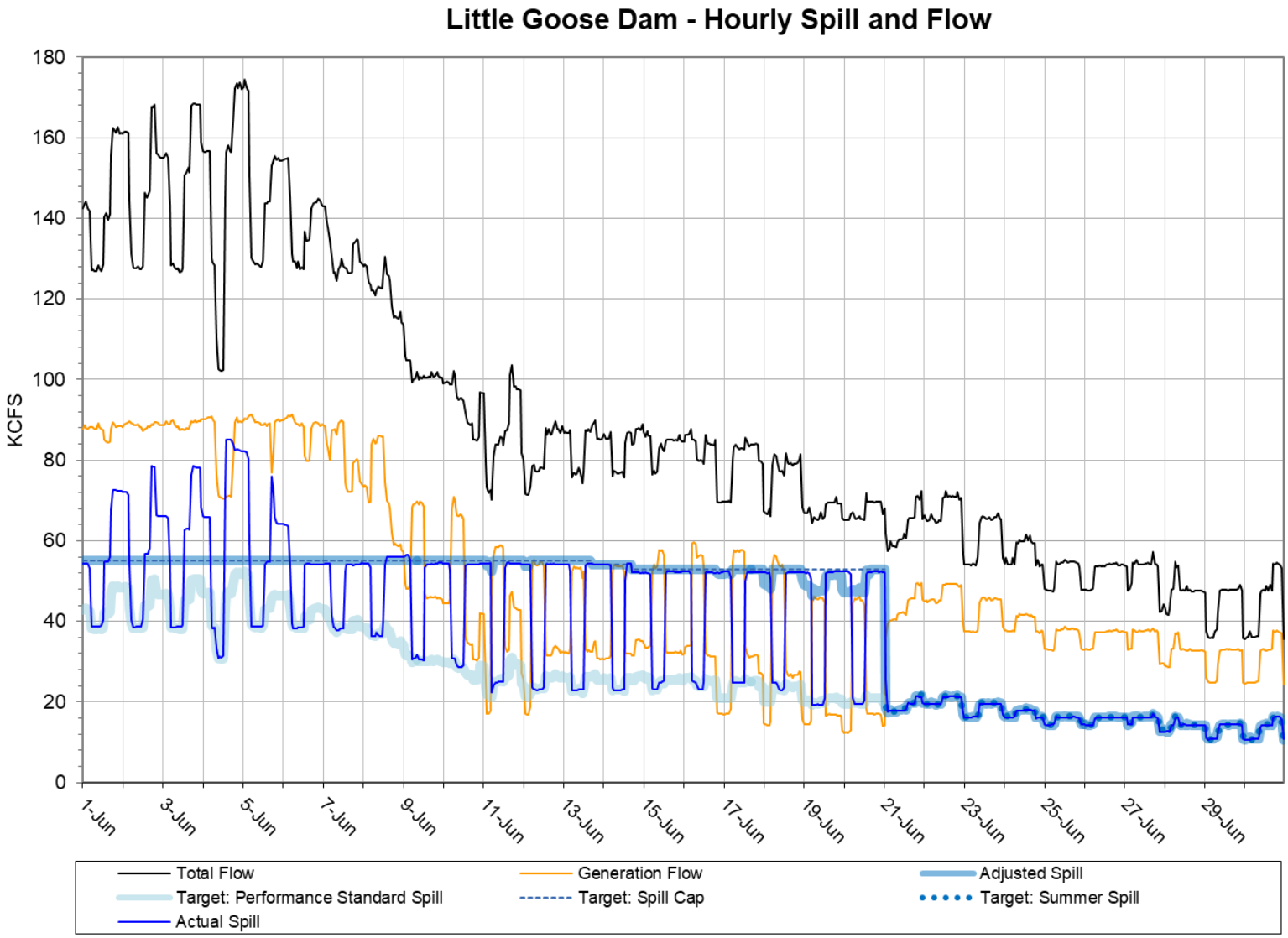

Lower Granite Dam - Hourly Spill and Flow
KCFS
180
160
140
120
100
80
60
40
20
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted Spill
Target:Performance Standard Spill
Target: Spill Cap
Target: Summer Spill
Actual Spill

Figure 2


Little Goose Dam - Hourly Spill and Flow
KCFS
180
160
140
120
100
80
60
40
20
0
1-Jun
3-Jun
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7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Target: Summer Spill
Actual Spill

Figure 3

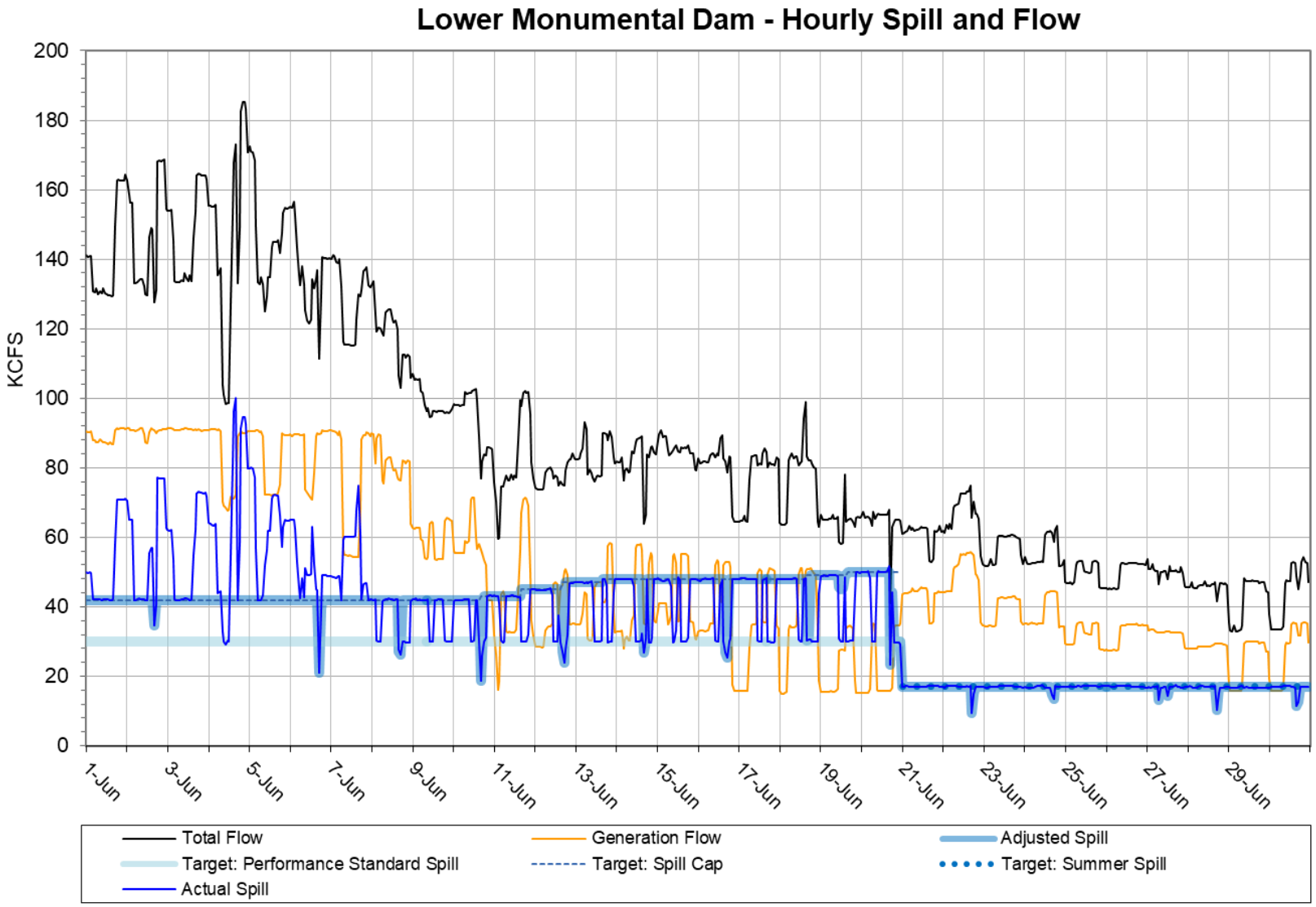

Lower Monumental Dam - Hourly Spill and Flow
KCFS
200
180
160
140
120
100
80
60
40
20
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Target: Summer Spill
Actual Spill

Figure 4

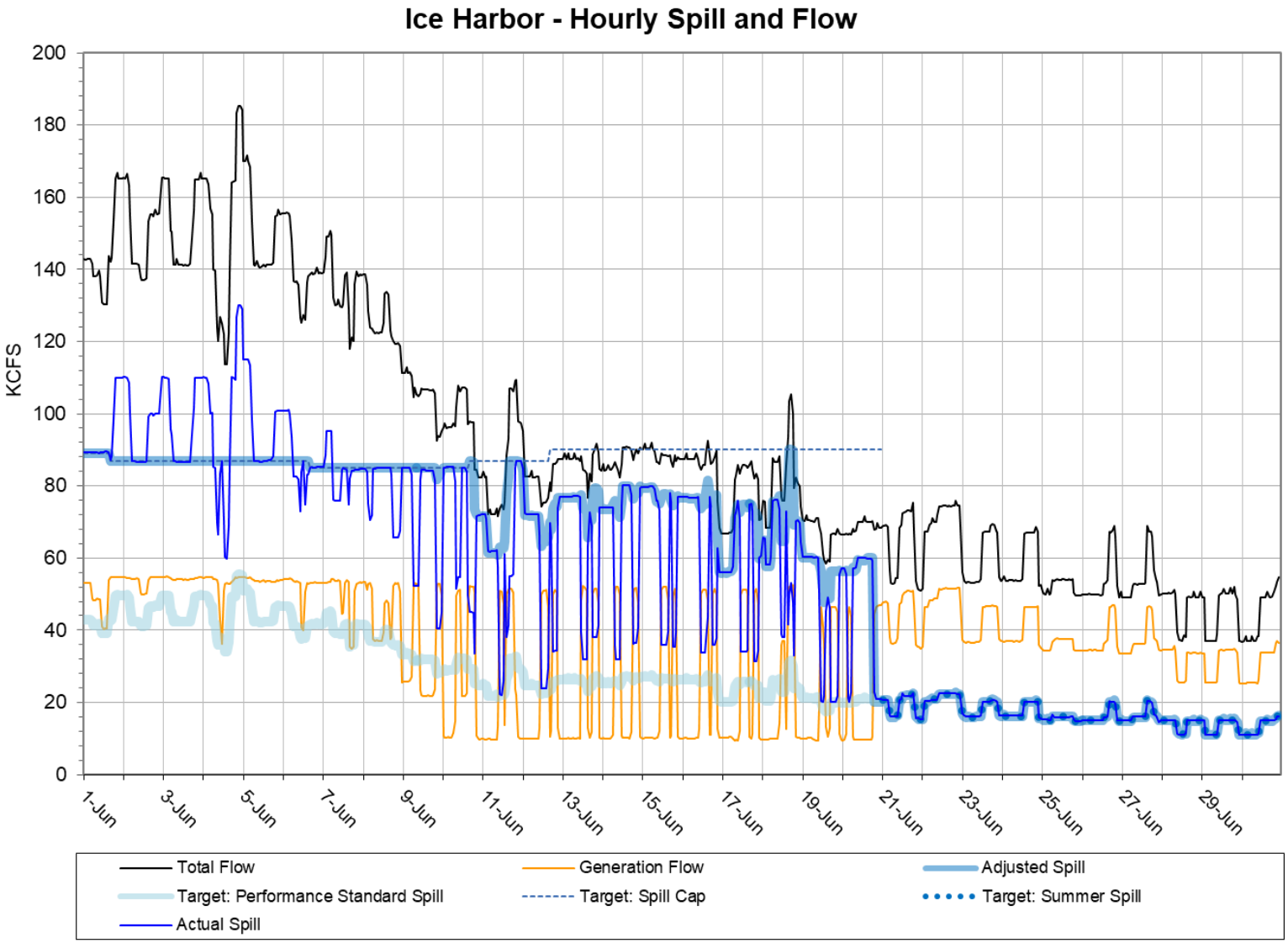

Ice Harbor - Hourly Spill and Flow
KCFS
200
180
160
140
120
100
80
60
40
20
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Target: Summer Spill
Actual Spill

Figure 5

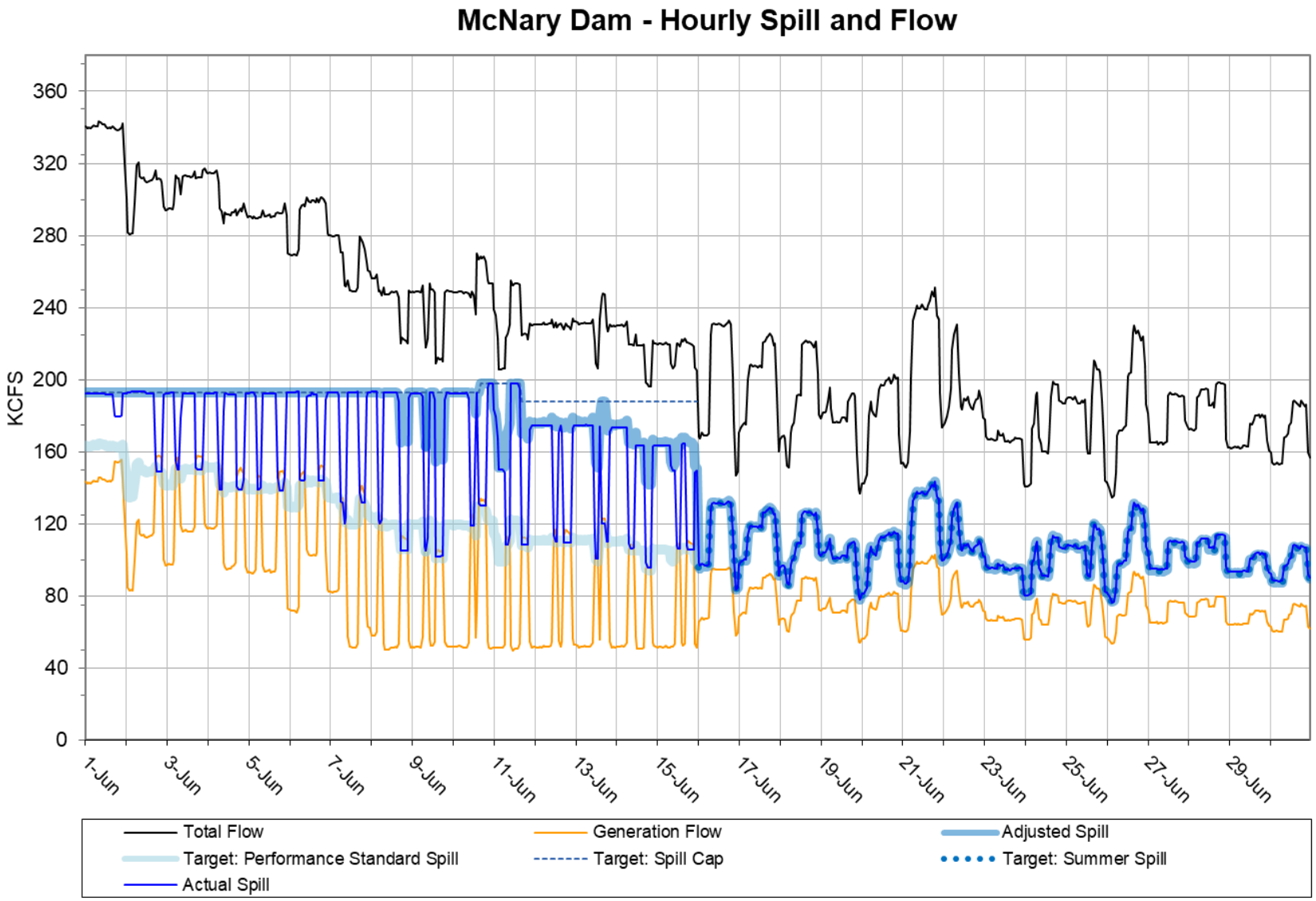

McNary Dam - Hourly Spill and Flow
KCFS
360
320
280
240
200
160
120
80
40
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Target: Summer Spill
Actual Spill

Figure 6

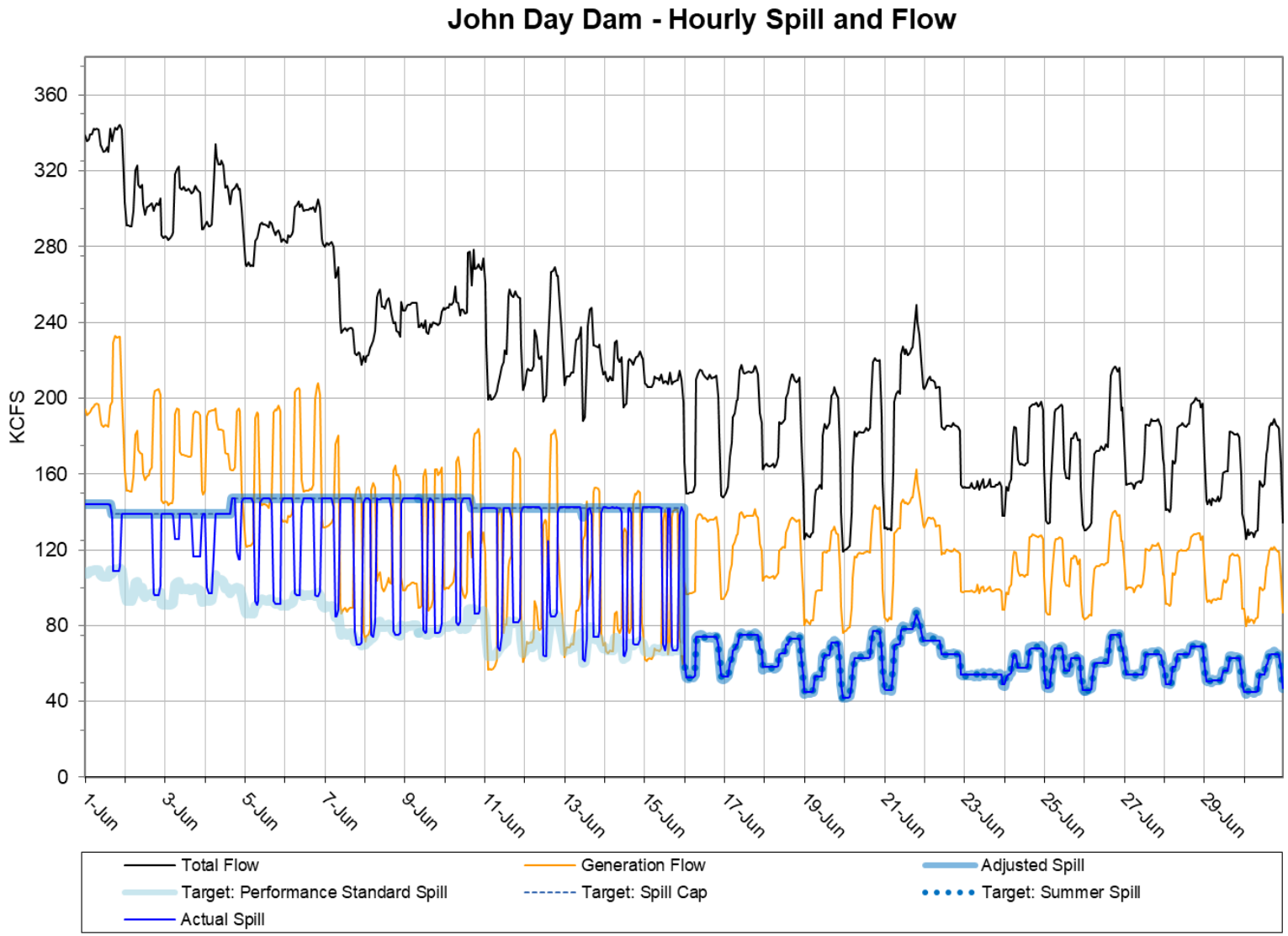


Figure 7

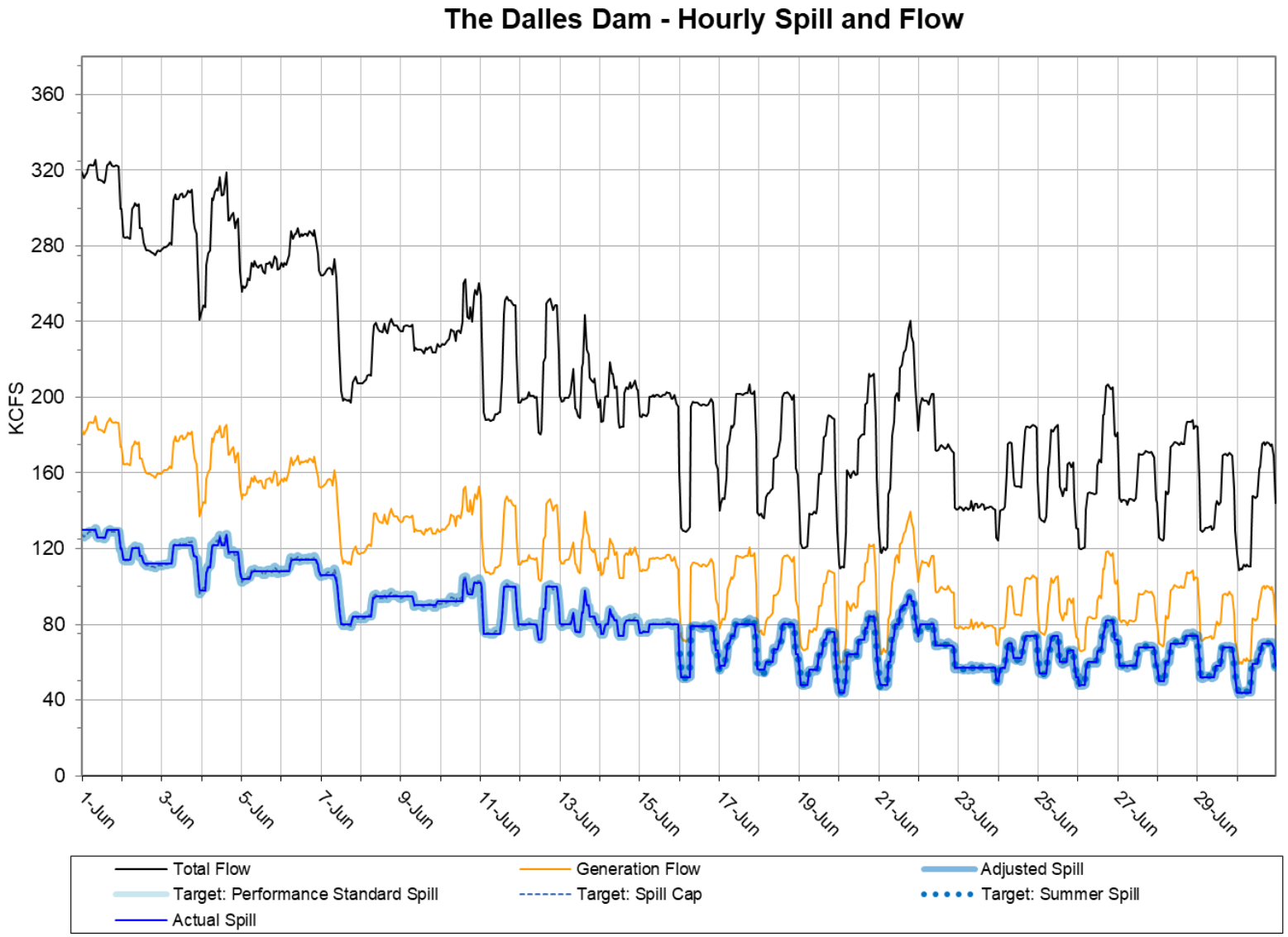
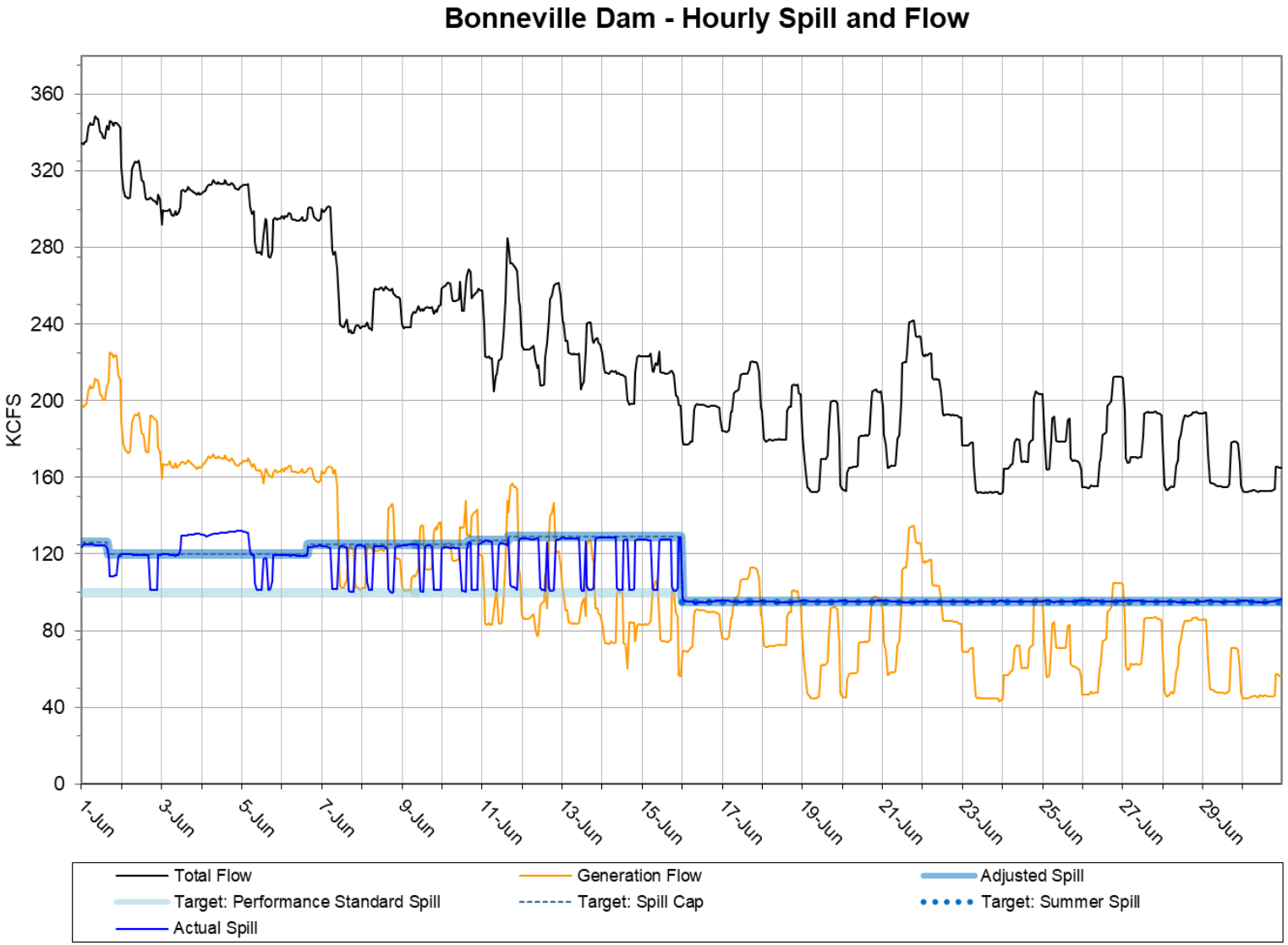

The Dalles Dam - Hourly Spill and Flow
KCFS
360
320
280
240
200
160
120
80
40
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Target: Summer Spill
Actual Spill

Figure 8


Bonneville Dam - Hourly Spill and Flow
KCFS
360
320
280
240
200
160
120
80
40
0
1-Jun
3-Jun
5-Jun
7-Jun
9-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
Total Flow
Generation Flow
Adjusted Spill
Target: Performance Standard Spill
Target: Spill Cap
Target: Summer Spill
Actual Spill

FISH OPERATIONS PLAN IMPLEMENTATION REPORT

July 2019

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 2019 Fish Operations Plan[1] (2019 FOP). The 2019 FOP describes the 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)[2], the 2018 Extensions of the 2008 Columbia Basin Fish Accords (Accord Extensions), the 2019-2021 Spill Operation Agreement (Agreement), the Corps' requirements under the Endangered Species Act (ESA), and is the subject of ongoing consultation and communications with the relevant wildlife agencies to ensure consistency with the ESA. 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).

This report describes the Corps' implementation of the 2019 FOP during the month of July 2019. In particular, information in this report includes the following:

- total flow: the total hourly river outflow 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 2019 FOP, section 4.1);
- actual spill: the hourly flow over the spillway; and,

[1] The 2019 FOP was posted to the Technical Management Team (TMT) website on April 1, 2019 (http://pweb.crohms.org/tmt/documents/fpp/2019/).

[2] 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.

- resultant 12-hour average TDG for the tailwater at each project and for the next project's forebay downstream[3].

This report also provides information on issues and unanticipated or emergency situations that arose during implementation of the 2019 FOP in July 2019.

Data Reporting

I. For each project providing fish passage operations, this report contains a graph displaying the performance of the summer fish passage spill program for the month of July, with hourly spill, target spill, adjusted spill, generation, and total flows. The monthly graphs begin on July 1 and end on July 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 dotted blue line represents the hourly target summer spill in kcfs.
- 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 (2019 FOP section 4.1).

II. The average daily %TDG for the 12 highest hours for all projects is shown in the July 2019 Average Percent TDG Values Table (Table 4). The numbers in red indicate the project exceeded the %TDG cap - i.e. 120% (tailwater) for each project and 115% (forebay of the next downstream dam).

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 July 2019 Spill Variance Table (Table 2).[4] The Spill Variance Table includes average hourly data; but

[3] Averages reported are consistent with the current and applicable Oregon TDG standard modification (120% tailwater) and Washington TDG criteria adjustments (120% tailwater/115% forebay during summer spill). The Oregon TDG standard modification and the Washington TDG criteria adjustments during summer spill have different methodologies for calculating TDG. When the standards vary or conflict, the Corps applies the more stringent standard. See 2019 FOP section 2.1.

[4] Involuntary spill conditions shown in the graphs are not considered variances and are not reported in the Spill Variance Table. Involuntary 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.

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 2019 FOP for Bonneville and The Dalles dams,[5] which may range up to ±3 kcfs) as compared to a target spill rate. 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 during low flows as described in Section 8 of the 2019 FOP). 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.

July Operations

The month of July was characterized by below average flows for the lower Snake and lower Columbia Rivers with near average air temperatures and well below average precipitation in the Columbia Basin. Observed precipitation in July was 26% of average on the Snake River above Ice Harbor and 64% of average on the Columbia River above The Dalles[6]. The NOAA Northwest River Forecast Center runoff summary for July indicated that the adjusted runoff for the Snake River at Lower Granite was 75% of the 30-year average (1981-2010) with a volume of

[5] As specified in the 2019 FOP section 3.
[6] Retrieved 1 August 2019: https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?tab=5

1.7 MAF (Million acre-feet). The adjusted runoff for the Columbia River at The Dalles was 74% of the 30-year average (1981-2010) with a volume of 10.7 MAF[7].

Summer spill operations occur June 21–August 31 at the four lower Snake River projects, and June 16–August 31 at the four lower Columbia River projects (Table 1).

Table 1: 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%[2]
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 2019 FOP summer target spill level at any project if necessary to ensure navigation safety or transmission reliability, or to avoid exceeding State TDG standards.
2. When river flow is ≤ 32 kcfs at Little Goose, 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 of the FOP.

In its implementation of the 2019 FOP in July, the Corps evaluated conditions every day to establish spill caps at a level that was estimated to meet, but not exceed, the gas cap in the tailrace (see Table 4).[8] 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).

Operational Adjustments

No operational adjustments to report during this period.

[7] Retrieved 1 August 2019: https://www.nwrfc.noaa.gov/runoff/runoff_summary.php?date=08/01/2019
[8] See 2019 FOP section 2.2

Table 2: Spill Variances - July 2019 (7/1 to 7/31)

Project	Parameter	Date	Time[9]	# of Hours	Type	Reason
Little Goose	Reduced Spill	7/31/19	2200	1	Human Error	Hourly spill decreased to 9 kcfs (less than the spill target 11 kcfs) due to a miscalculation. Daily average spill was 11 kcfs.
Ice Harbor	Additional spill	7/24/19 7/25/19 7/26/19 7/27/19 7/28/19 7/29/19 7/30/19 7/31/19	1400-1600 0400-1400 0700-1700 1300-1800 1100-1400 1500-1800 1300-1700 1500-1700	3 11 11 6 4 4 5 3	Operational Limitation	Hourly spill increased to between 33% and 40% of total flow (greater than the spill target of 30% ±1% range) due to the removable spillway weir (RSW) in bay 1 that physically limits the minimum spill rate to 8 kcfs.
Ice Harbor	Reduced Spill	7/31/19	1000-1200, 1400	4	Human Error	Hourly spill decreased to 5 and 6 kcfs (below minimum 8 kcfs spill with the RSW open) due to implementing the incorrect spill pattern.

[9] Data collected for reporting spill variances are reported as hourly averages. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented as an hour. The hourly average data is reported at the end of the hour (i.e., hour ending).

Table 3: Pre-Coordinated Operations - July 2019 (7/1 to 7/31)

Project	Parameter	Date	Time[10]	# of Hours	Type	Reason
Little Goose	Reduced Spill	7/11/19 7/22/19	1600 1300	1 1	Navigation	Hourly spill decreased to 28% of total flow (less than the spill target of 30% ± 1% range) due to volume of water needed to empty the navigation lock. Daily average spill was 30%. Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6.
Lower Monumental	Reduced Spill	7/2/19 7/4/19 7/6/19 7/8/19 7/10/19 7/12/19 7/14/19 7/16/19 7/18/19 7/20/19 7/22/19 7/24/19 7/26/19 7/28/19 7/30/19	1800-1900 1800-1900 1700-1800 1800 1800 1800 1700-1800 1700-1800 1700-1800 1700-1800 1800 1900 1700 1800 1900	2 2 2 1 1 1 2 2 2 2 1 1 1 1 1	Navigation	Hourly spill decreased to between 8 kcfs and 14 kcfs (less than the spill target of 17 kcfs ± 2 kcfs) for safe navigation. Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6.
Lower Monumental	Additional Spill	7/25/19 7/26/19 7/27/19 7/28/19 7/29/19 7/30/19 7/31/19	0600-1700 0600-1700 0700-1700 0600-1600 0600-1700 0600-1700 0600-1700	12 12 11 11 12 12 12	Maintenance	Hourly spill increased while generation was reduced to speed no load (5 kcfs) for station service due to units taken offline to perform Doble testing. Regionally coordinated via the 2019 FPP LMN Section 4.3.5.
Ice Harbor	Reduced Spill	7/7/19 7/11/19 7/12/19 7/31/19	1000 0400 1000 1300	1 1 1 1	Navigation	Hourly spill decreased to 28% of the total flow (less than the spill target of 30% ± 1% range) for safe navigation. Daily average spill was 30%. Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6.
Ice Harbor	Additional Spill	7/10/19	0000	1	Transmission Reliability	Hourly spill increased to 34% of the total flow (greater than 30% ±1 % range) due to a generation decrease in order to balance load. Daily average spill was 30%. Regionally coordinated via 2019 FOP Section 4.4.1 Item 2.
Ice Harbor	Reduced Spill	7/22/19	0800	1	Maintenance	Hourly spill decreased to 28% of total flow (less than 30% ±1 % range) due to units taken offline in order to perform Doble testing. Daily average spill was 30%. Regionally coordinated via the 2019 FPP IHR Section 4.3.4.

[10] Data collected for reporting pre-coordinated operations are reported as hourly averages. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented as an hour. The hourly average data are reported at the end of the hour (i.e., hour ending).

Project	Parameter	Date	Time[10]	# of Hours	Type	Reason
John Day	Additional Spill	7/6/19	2200	1	Transmission Reliability	Hourly spill increased to 37% of total flow (greater than 35% ±1 % range) due to a generation decrease in order to balance load. Daily average spill was 30%. Regionally coordinated via 2019 FOP Section 4.4.1 Item 2.

Table 4: July 2019 Average Percent TDG Values Table (7/1 to 7/31)

Date	FIXED MONITORING STATIONS															
	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW	JDY	JHAW	TDA	TDDO	BON	CCIW
	Lower Granite FB	Lower Granite TW	Little Goose FB	Little Goose TW	Lower Monumental FB	Lower Monumental TW	Ice Harbor FB	Ice Harbor TW	McNary FB	McNary TW	John Day FB	John Day TW	The Dalles FB	The Dalles TW	Bonneville FB	Bonneville TW
Gas Cap %:	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**
7/1/2019	103	116	113	111	112	117	113	113	111	•[11]	107	115	109	116	112	117
7/2/2019	104	116	114	112	113	117	114	113	111	116	107	114	109	115	110	117
7/3/2019	104	116	113	111	113	118	114	113	110	116	106	115	106	114	108	117
7/4/2019	105	116	113	110	112	117	113	113	109	115	106	115	107	114	107	117
7/5/2019	105	116	112	111	112	117	113	113	108	115	106	115	108	114	107	117
7/6/2019	103	116	113	111	113	117	113	114	109	115	106	114	107	114	107	117
7/7/2019	102	116	114	111	113	117	114	113	109	115	105	114	107	113	107	117
7/8/2019	102	115	114	111	113	118	114	113	109	116	105	114	107	114	107	117
7/9/2019	102	115	113	111	112	117	114	113	109	116	104	115	108	114	108	117
7/10/2019	101	115	112	111	113	117	114	113	109	116	104	114	109	115	110	117
7/11/2019	101	116	112	111	113	118	114	114	110	116	104	114	109	115	110	117
7/12/2019	102	116	112	111	113	117	115	114	110	116	105	114	109	115	110	117
7/13/2019	102	116	113	111	113	117	**116**	114	110	117	105	114	109	115	110	117
7/14/2019	102	116	112	110	113	117	**116**	114	110	116	105	115	107	114	109	117
7/15/2019	103	116	112	110	112	117	115	113	110	116	106	115	108	114	108	117
7/16/2019	103	116	112	111	112	117	114	113	109	116	106	115	109	115	109	117
7/17/2019	103	116	112	114	112	117	114	113	109	116	106	114	108	114	109	117
7/18/2019	102	115	112	115	112	117	114	113	108	116	106	114	107	114	108	117
7/19/2019	102	116	111	114	111	117	112	112	106	116	105	115	106	113	106	117
7/20/2019	101	116	110	114	110	117	111	112	105	116	105	115	108	115	107	117
7/21/2019	101	116	109	114	109	117	111	112	107	115	105	115	110	116	110	118
7/22/2019	101	116	108	114	111	117	112	112	108	116	106	115	110	116	110	118
7/23/2019	103	116	108	113	112	117	112	113	108	117	105	114	109	115	110	117
7/24/2019	102	116	109	111	112	116	112	112	108	116	104	114	106	113	106	117
7/25/2019	103	116	110	110	111	118	112	112	107	117	105	114	109	115	108	117
7/26/2019	104	116	110	110	111	118	112	112	108	116	105	114	109	115	110	117
7/27/2019	104	116	110	110	110	118	112	112	107	116	105	114	109	115	110	117
7/28/2019	101	116	110	110	108	118	111	112	107	115	105	114	106	113	108	117
7/29/2019	102	117	111	111	109	118	113	113	108	117	105	114	109	115	108	117
7/30/2019	102	116	111	111	108	118	113	112	108	116	105	114	109	114	108	117
7/31/2019	102	116	111	111	107	118	112	112	108	117	105	114	106	113	106	117
Exceedances:	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

[11] Red shaded cells indicate no data due to malfunctioning gauge.

Figure 1

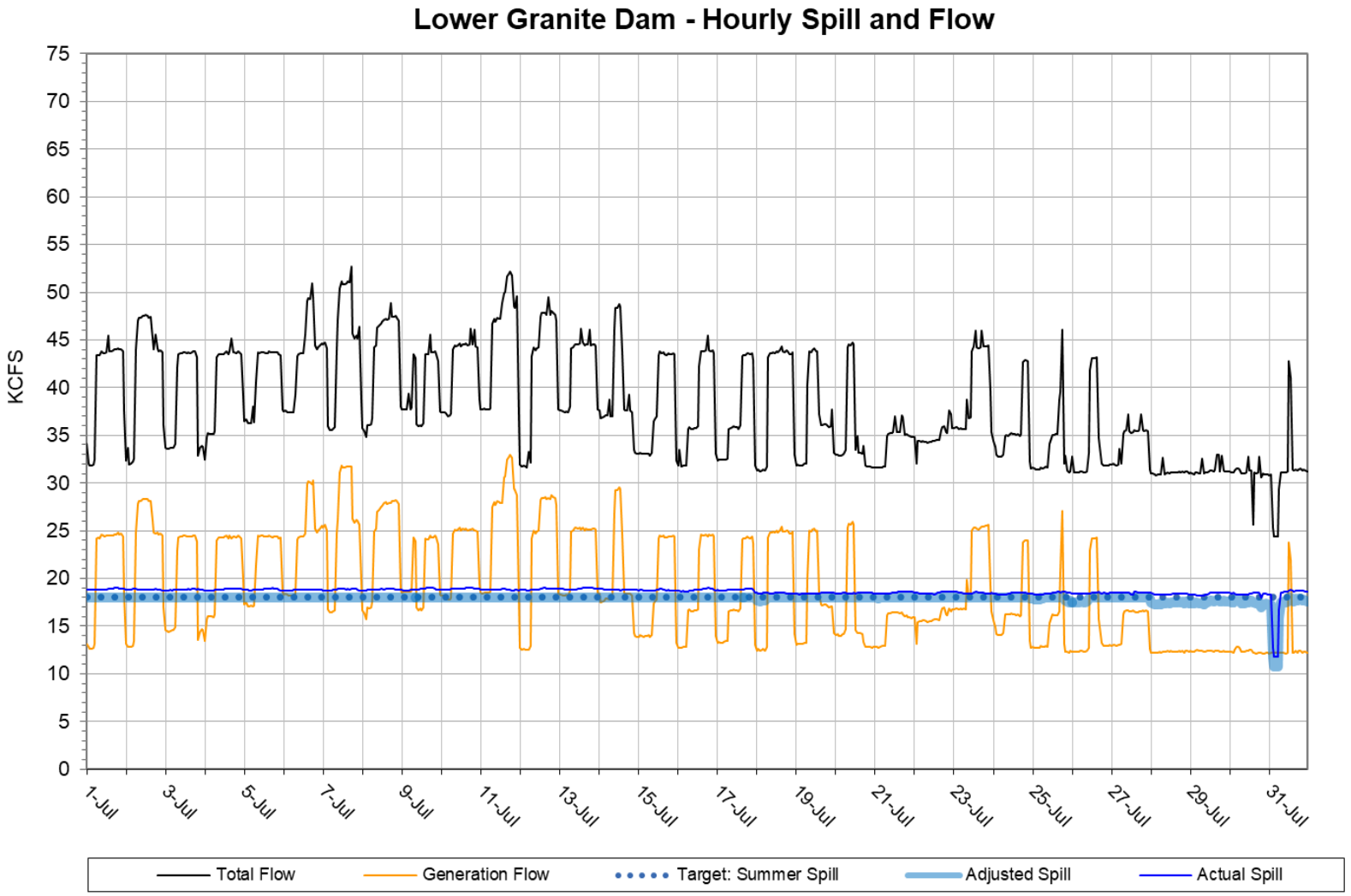

Lower Granite Dam - Hourly Spill and Flow
KCFS
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 2

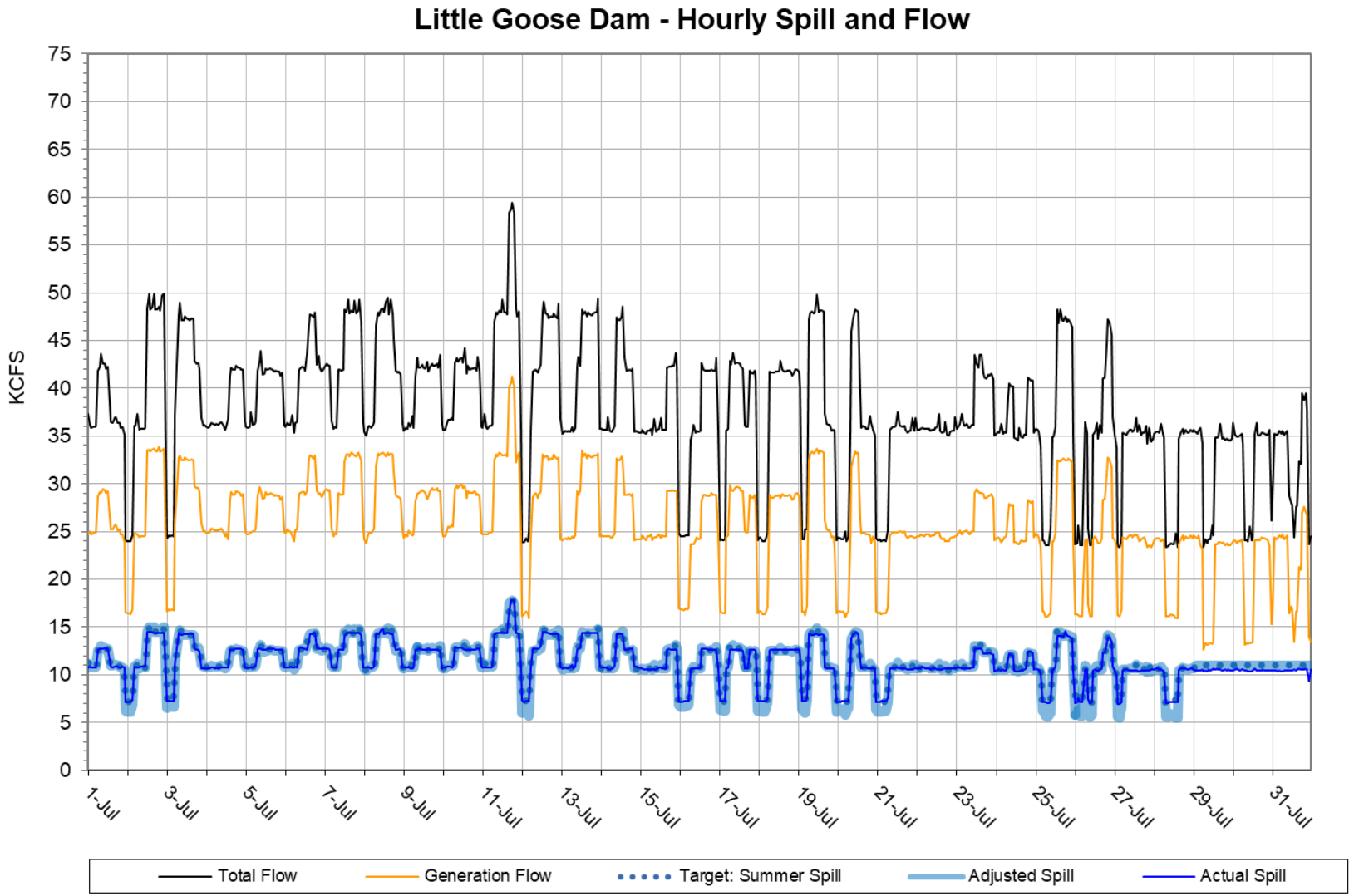
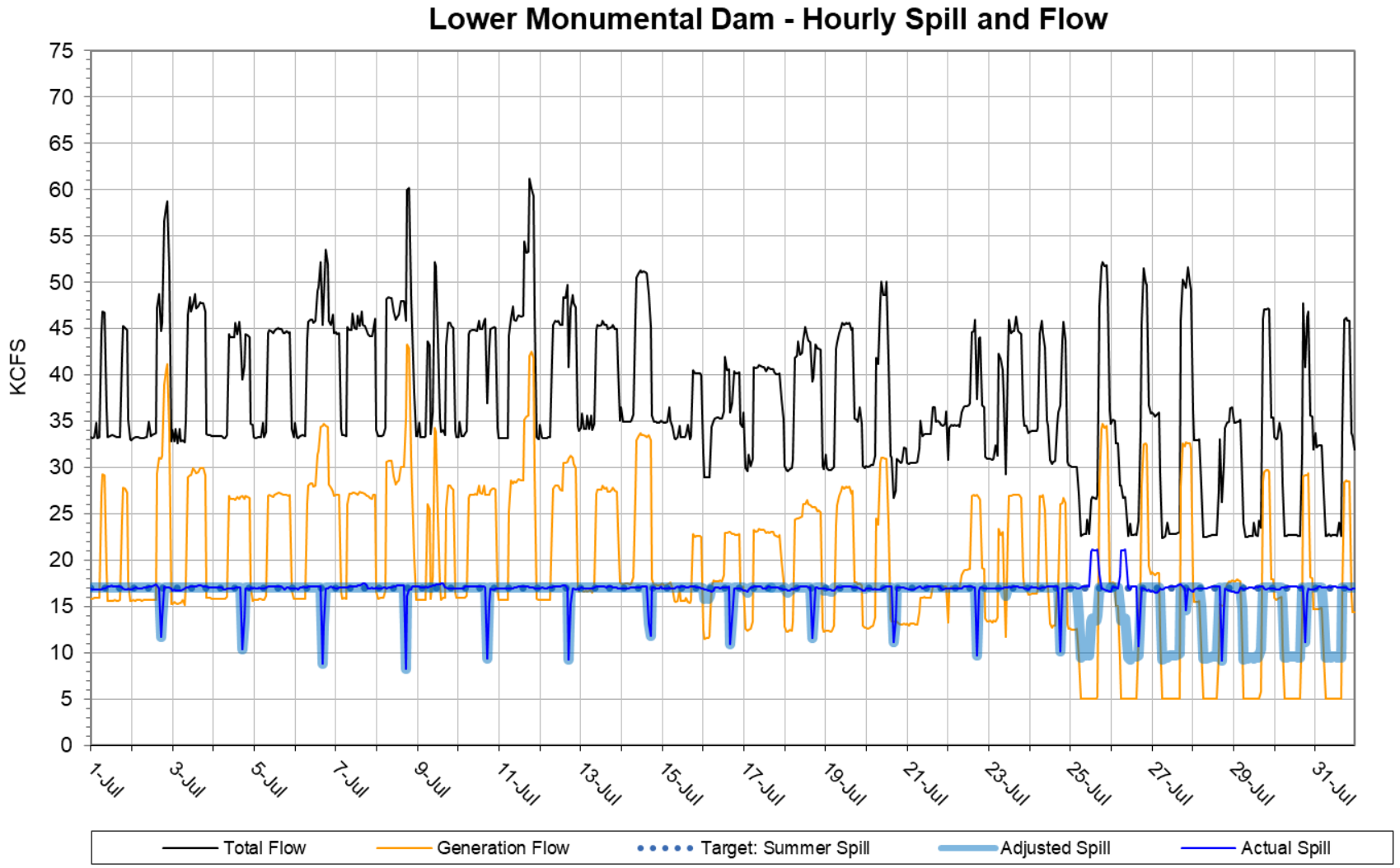

Little Goose Dam - Hourly Spill and Flow
KCFS
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 3


Lower Monumental Dam - Hourly Spill and Flow
KCFS
75
70
65
60
55
50
45
40
35
30
25
20
15
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5
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 4

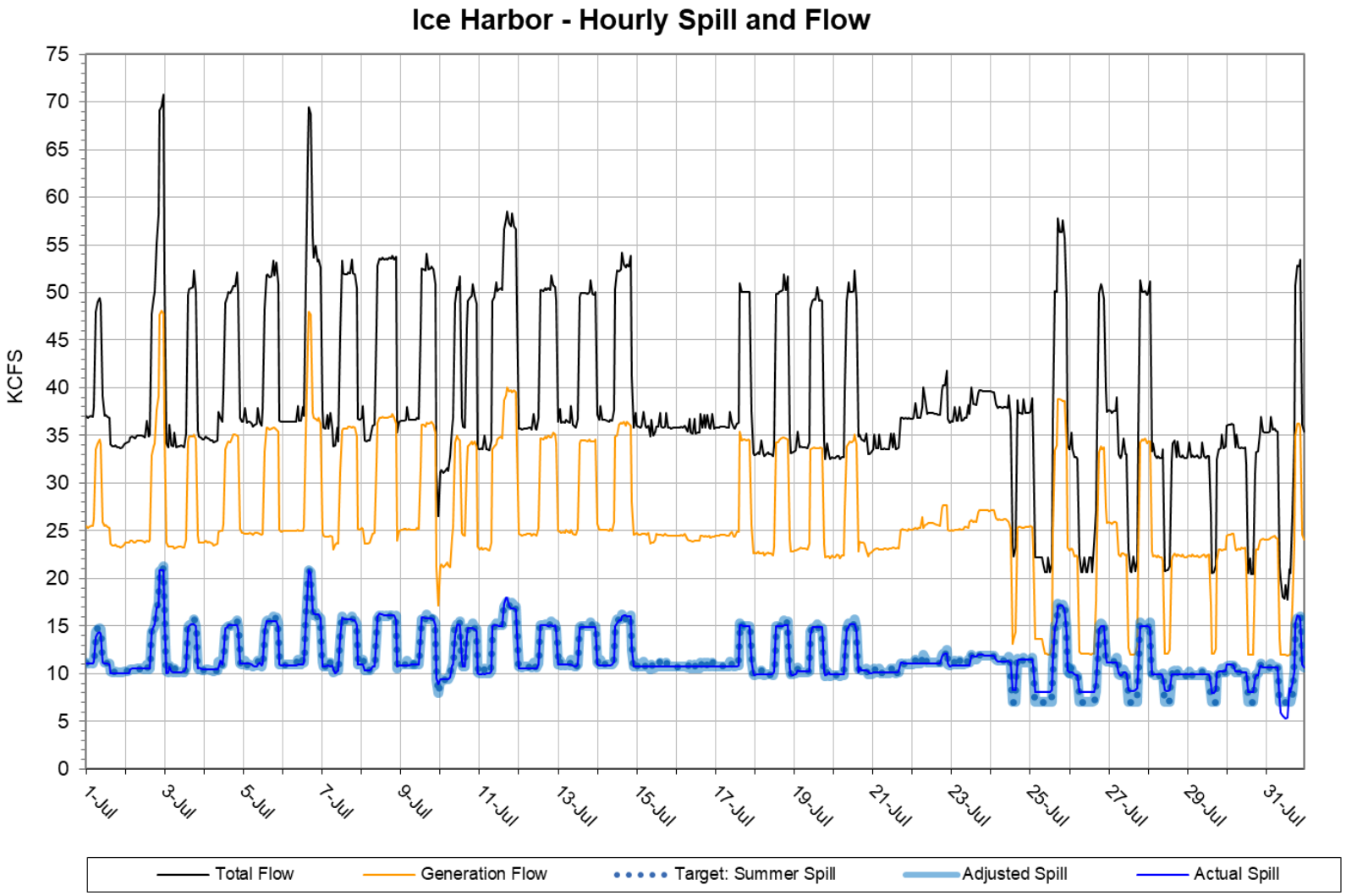

Ice Harbor - Hourly Spill and Flow
KCFS
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 5

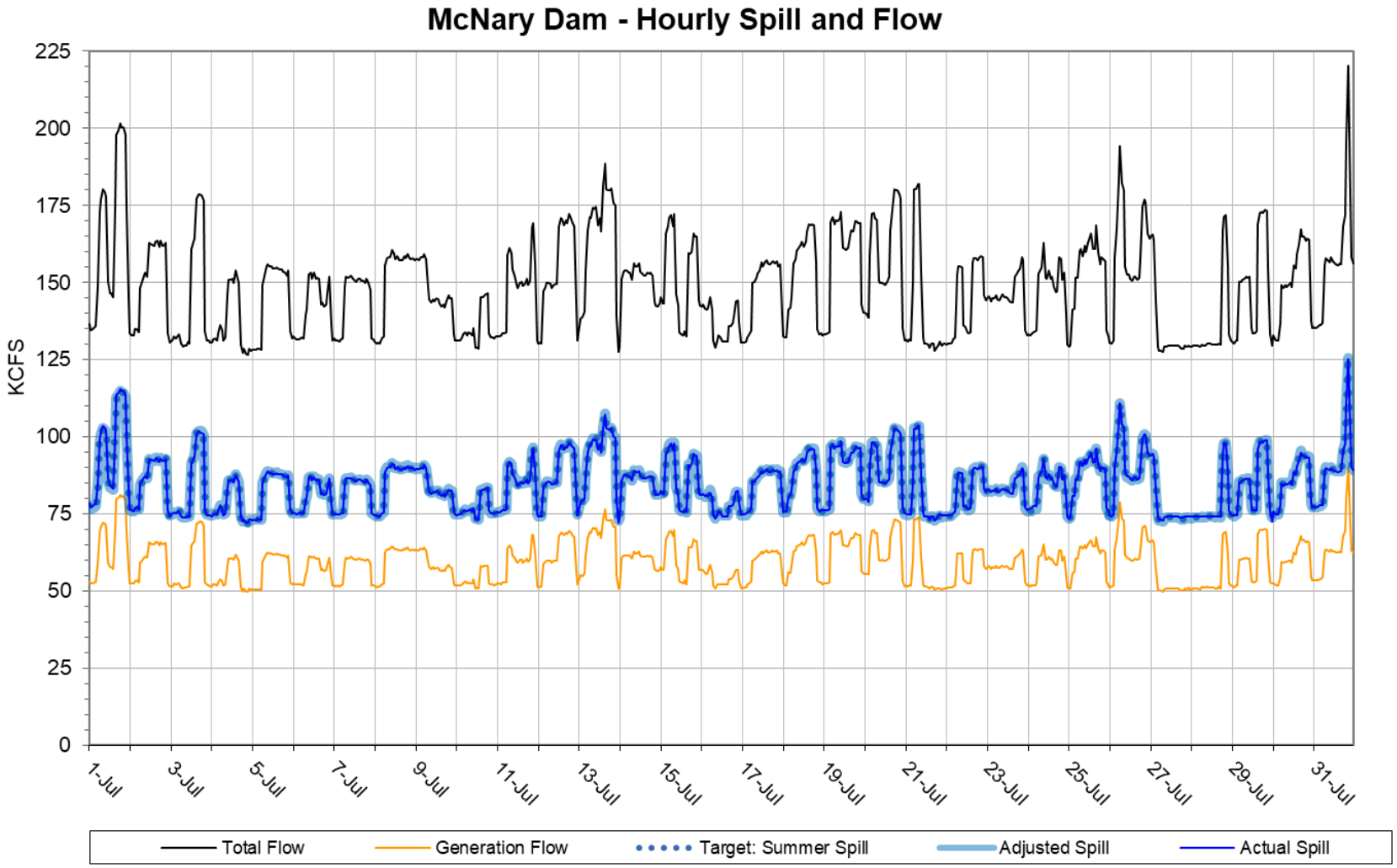

McNary Dam - Hourly Spill and Flow
KCFS
225
200
175
150
125
100
75
50
25
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 6

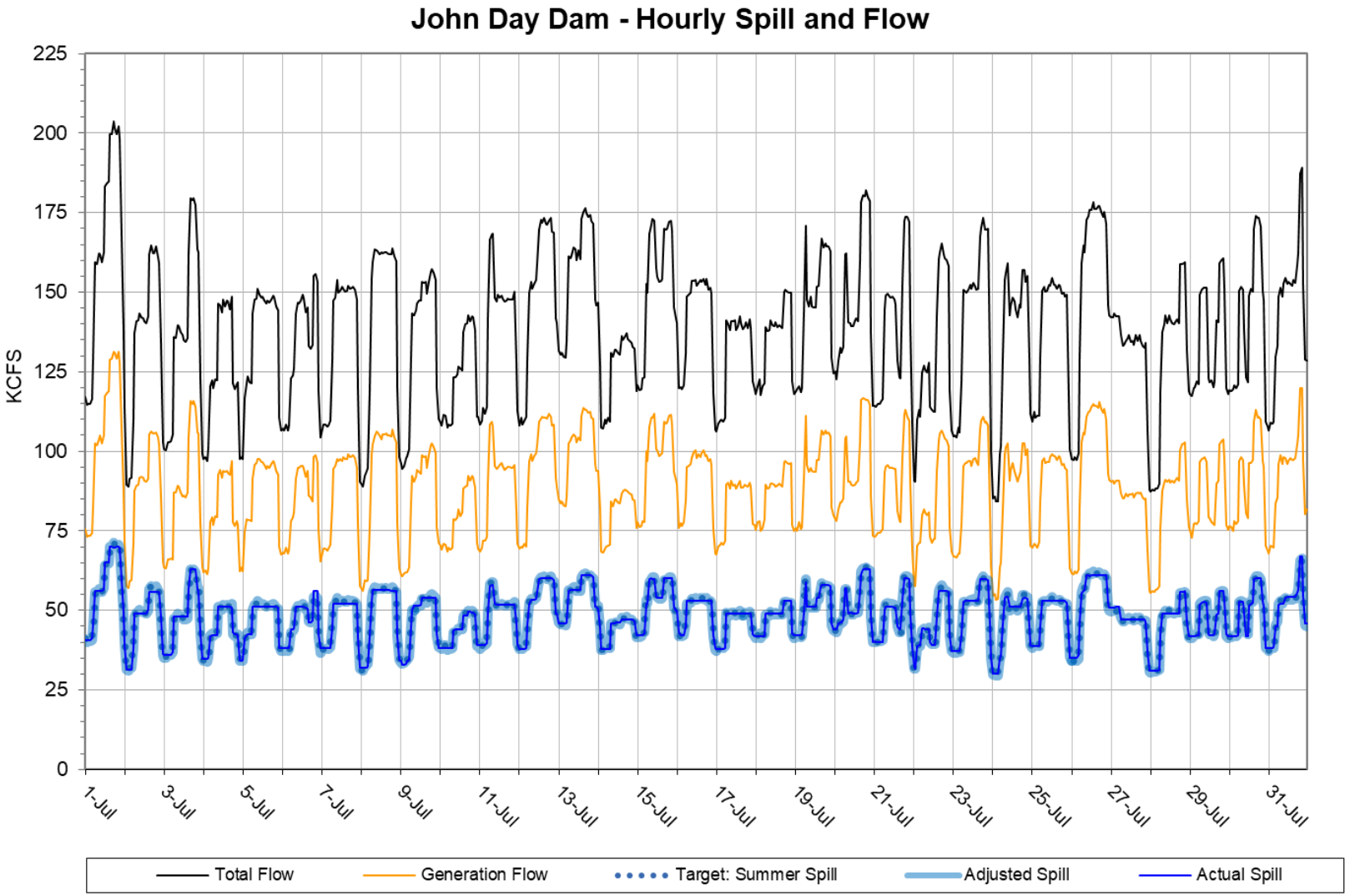

John Day Dam - Hourly Spill and Flow
KCFS
225
200
175
150
125
100
75
50
25
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 7

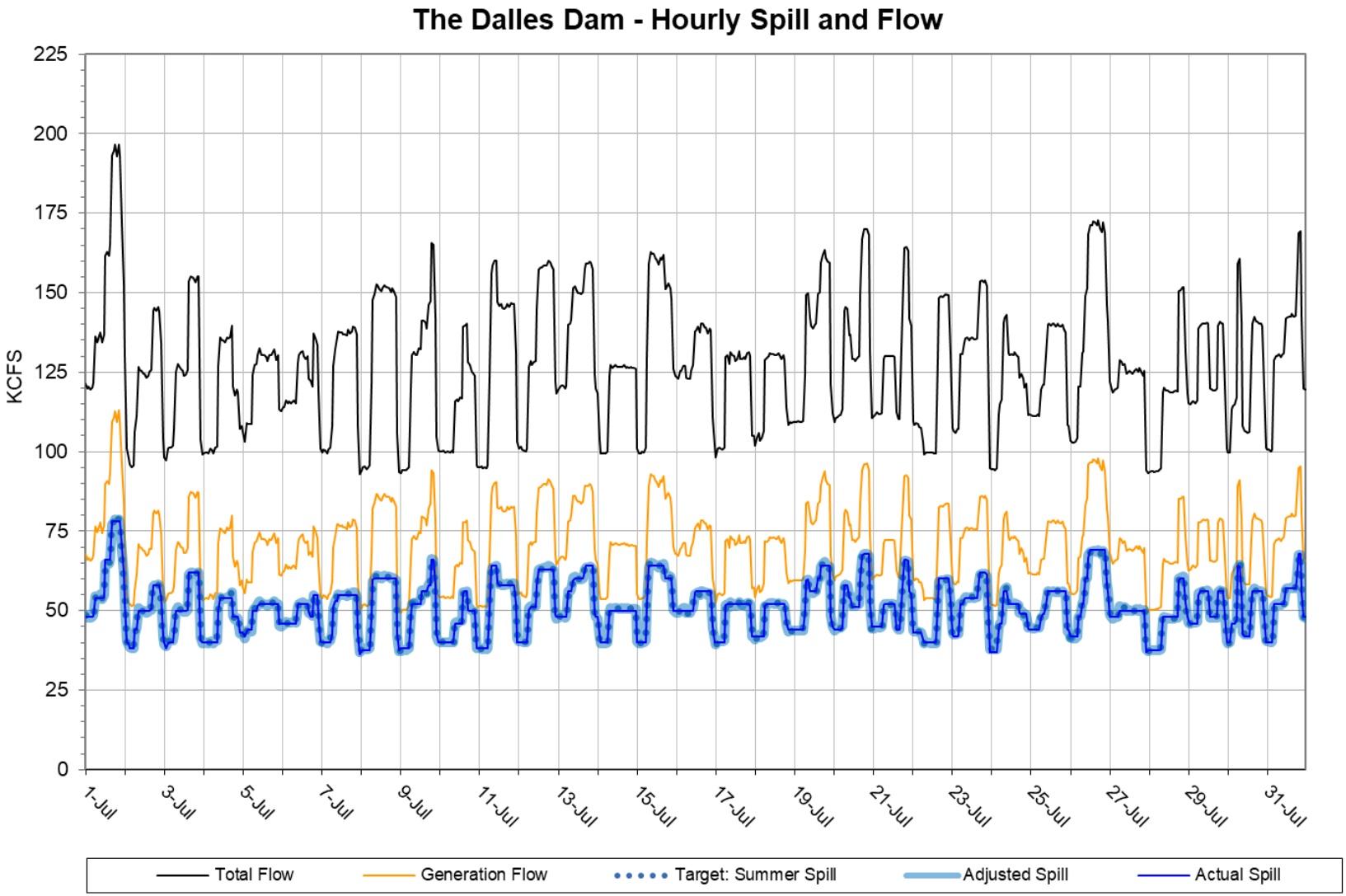
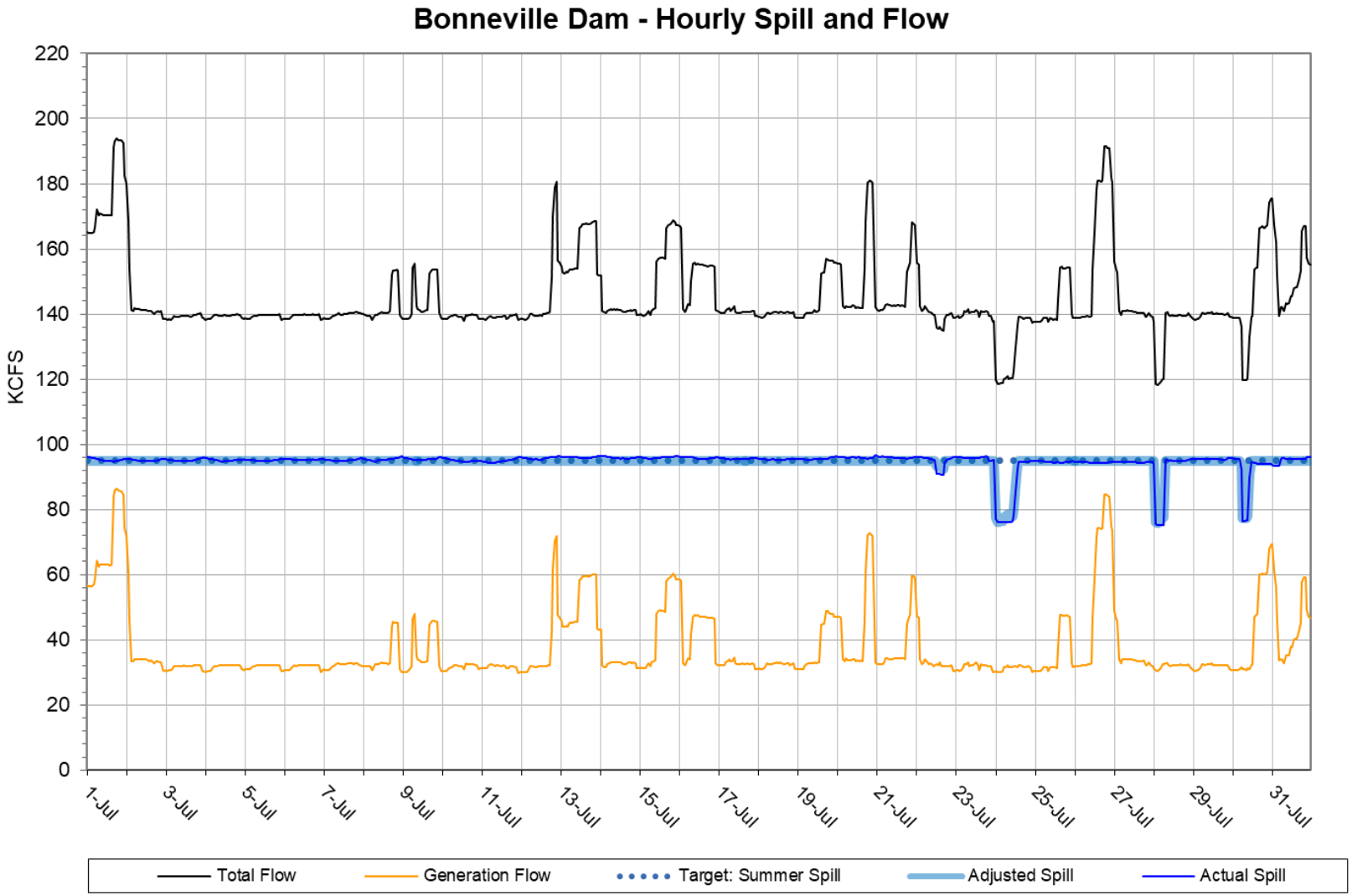

The Dalles Dam - Hourly Spill and Flow
KCFS
225
200
175
150
125
100
75
50
25
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 8


Bonneville Dam - Hourly Spill and Flow
KCFS
220
200
180
160
140
120
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27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

FISH OPERATIONS PLAN IMPLEMENTATION REPORT

August 2019

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 2019 Fish Operations Plan[1] (2019 FOP). The 2019 FOP describes the 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)[2], the 2018 Extensions of the 2008 Columbia Basin Fish Accords (Accord Extensions), the 2019-2021 Spill Operation Agreement (Agreement), the Corps' requirements under the Endangered Species Act (ESA), and is the subject of ongoing consultation and communications with the relevant wildlife agencies to ensure consistency with the ESA. 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).

This report describes the Corps' implementation of the 2019 FOP during the month of August 2019. In particular, information in this report includes the following:

- total flow: the total hourly river outflow 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 2019 FOP, section 4.1);
- actual spill: the hourly flow over the spillway; and,

[1] The 2019 FOP was posted to the Technical Management Team (TMT) website on April 1, 2019 (http://pweb.crohms.org/tmt/documents/fpp/2019/).
[2] 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.

- resultant 12-hour average TDG for the tailwater at each project and for the next project's forebay downstream[3].

This report also provides information on issues and unanticipated or emergency situations that arose during implementation of the 2019 FOP in August 2019.

Data Reporting

I. For each project providing fish passage operations, this report contains a graph displaying the performance of the summer fish passage spill program for the month of August, with hourly spill, target spill, adjusted spill, generation, and total flows. The monthly graphs begin on August 1 and end on August 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 dotted blue line represents the hourly target summer spill in kcfs.
- 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 (2019 FOP section 4.1).

II. The average daily %TDG for the 12 highest hours for all projects is shown in the August 2019 Average Percent TDG Values Table (Table 4). The numbers in red indicate the project exceeded the %TDG cap - i.e. 120% (tailwater) for each project and 115% (forebay of the next downstream dam).

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 August 2019 Spill Variance Table (Table 2).[4] The Spill Variance Table includes average hourly data; but

[3] Averages reported are consistent with the current and applicable Oregon TDG standard modification (120% tailwater) and Washington TDG criteria adjustments (120% tailwater/115% forebay during summer spill). The Oregon TDG standard modification and the Washington TDG criteria adjustments during summer spill have different methodologies for calculating TDG. When the standards vary or conflict, the Corps applies the more stringent standard. See 2019 FOP section 2.1.

[4] Involuntary spill conditions shown in the graphs are not considered variances and are not reported in the Spill Variance Table. Involuntary 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.

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 2019 FOP for Bonneville and The Dalles dams,[5] which may range up to ±3 kcfs) as compared to a target spill rate. 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 during low flows as described in Section 8 of the 2019 FOP). 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.

August Operations

The month of August was characterized by below average flows for the lower Snake and lower Columbia Rivers with above average air temperatures and below average precipitation in the Columbia Basin. Observed precipitation in August was 53% of average on the Snake River above Ice Harbor and 64% of average on the Columbia River above The Dalles[6]. The NOAA Northwest River Forecast Center runoff summary for August indicated that the adjusted runoff for the Snake River at Lower Granite was 95% of the 30-year average (1981-2010) with a

[5] As specified in the 2019 FOP section 3.
[6] Retrieved 3 September 2019: https://www.nwrfc.noaa.gov/water_supply/wy_summary/wy_summary.php?tab=5

volume of 1.2 MAF (Million acre-feet). The adjusted runoff for the Columbia River at The Dalles was 86% of the 30-year average (1981-2010) with a volume of 6.6 MAF[7].

Summer spill operations occur June 21–August 31 at the four lower Snake River projects, and June 16–August 31 at the four lower Columbia River projects (Table 1).

Table 1: 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%[2]
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 2019 FOP summer target spill level at any project if necessary to ensure navigation safety or transmission reliability, or to avoid exceeding State TDG standards.
2. When river flow is ≤ 32 kcfs at Little Goose, 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 of the FOP.

In its implementation of the 2019 FOP in August, the Corps evaluated conditions every day to establish spill caps at a level that was estimated to meet, but not exceed, the gas cap in the tailrace (see Table 4).[8] 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).

Operational Adjustments

1. Little Goose

From August 5 at 0500 hours through August 8 at 1700 hours, the Corps conducted testing and maintenance on Little Goose Transformer 1 (T1), which required T1 (Units 1–4) and T2 (Units 5, 6) to be out of service daily from 0500–1700. During these hours, Unit 6 was operated at speed no load (5 kcfs) for station service power and the remainder of project outflow was passed via the spillway. T2 was returned to service nightly from 1700–0500 but only Unit 6 was operated due to an ongoing Unit 5 outage.

This operation was a deviation from the operation coordinated in the 2019 FPP Appendix A that

[7] Retrieved 3 September 2019: https://www.nwrfc.noaa.gov/runoff/runoff_summary.php?date=09/01/2019
[8] See 2019 FOP section 2.2

called for Doble testing of T2, which would have had T1 (Units 1–4) returned to service nightly. Due to configuration issues associated with the ongoing Unit 5 outage, the project was unable to conduct T2 Doble testing and instead conducted maintenance on T1. This resulted in reduced powerhouse capacity at night due to only having Unit 6 available to operate instead of Units 1–4.

The Corps notified regional salmon managers of this modified outage schedule at the July 31 TMT meeting. Due to concerns with the impacts of reduced powerhouse capacity and high spill on adult sockeye passage, the salmon managers requested a special operation to maintain spill at 30% nightly between the hours of 1800 and 0100 to the extent possible given the maintenance and testing schedule, while operating the forebay within the 1-foot raised MOP range of 634.0–635.5 feet (raised one foot for navigation safety). While adult sockeye predominantly pass Little Goose Dam during the daytime hours, they are able to pass during evening hours. Therefore, in order to provide tailrace conditions to facilitate adult sockeye passage at Little Goose Dam, the Corps and BPA implemented the operation as requested and spilled 30% from 1800-0100 hours and maintained the forebay within MOP. During the remaining hours when maintenance and testing was underway, spill ranged from 43.5% to 85.6% (average 76.2%).

Table 2: Spill Variances - August 2019 (8/1 to 8/31)

Project	Parameter	Date	Time[9]	# of Hours	Type	Reason
Lower Granite	Additional Spill	8/13/19	2000-2200	3	Human Error	Hourly spill increased to between 21 and 22 kcfs (greater than the spill target of 18 ±2 kcfs range) due to a delay in changing to the appropriate target.
Lower Granite	Additional Spill	8/26/19	0700-1700	11	Maintenance	Hourly spill increased while generation was reduced to speed no load (5 kcfs) for station service in order to perform unscheduled repairs on transformer bank T1.
Lower Monumental	Reduced Spill	8/27/19 8/28/19	1900 1100	1 1	Operational Limitation	Hourly spill remained at 12 kcfs (less than the spill target of 17 kcfs ±2 kcfs), while generation drifted above minimum generation range for Unit 1 (11.1 - 12.3kcfs[10]) to 12.7 kcfs.
Ice Harbor	Additional spill	8/1/19 8/2/19 8/3/19 8/6/19- 8/7/19 8/8/19 8/8/19– 8/9/19 8/9/19- 8/10/19 8/10/19 8/10/19- 8/11/19 8/11/19	0700-1800 1100-1800 0100-0200 2300-0800 0200-0700 2200-0600 2000-0300 1300-1800 2300-0800 1700-2400	12 8 2 10 6 9 8 6 10 8	Operational Limitation	Hourly spill increased to between 32% and 40% of total flow (greater than the spill target of 30% ±1% range) due to the removable spillway weir (RSW) in bay 1 that physically limits the minimum spill rate to 8 kcfs. Daily average spill ranged from 32% to 36%.
Ice Harbor	Reduced Spill	8/9/19	1700	1	Maintenance	Hourly spill decreased to 28% (less than the target spill of 30% ±1% range). Unit 1 was taken out of service for unscheduled installation of a new transformer. Daily average spill was 34% due to multiple operations or spill variances.
Ice Harbor	Additional Spill	8/14/19 8/23/19 8/25/19	0700 1400 1900	1 1 1	Human Error	Hourly spill increased between 32 and 33% of the total flow (greater than the spill target of 30% ± 1% range) due to a miscalculation of spill. Daily average spill was 30%.

[9] Data collected for reporting spill variances are reported as hourly averages. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented as an hour. The hourly average data is reported at the end of the hour (i.e., hour ending).

[10] Range does not include ±2% due to generating unit governor "dead band." When 2% is applied to the minimum generation flow ranges for Lower Monumental turbine Unit 1, the range is 10.9-12.5 kcfs. See 2019 FOP section 4.3.1.

Project	Parameter	Date	Time[9]	# of Hours	Type	Reason
McNary	Additional Spill	8/5/19	1800-2100	4	Maintenance	Hourly spill increased to between 65% and 97% (greater than 57% ±1% range) due to an unscheduled transmission substation outage. Daily average spill was 61%.
The Dalles	Reduced Spill	8/6/19	1300	1	Human Error	Hourly spill decreased to 38% (less than the target spill of 40% ±1% range) due to a miscommunication of the planned spill operation. Daily average spill was 40%.
The Dalles	Additional Spill	8/14/19	2300	1	Human Error	Hourly spill increased to 44% (greater than the target spill of 40% ±1% range) due to a delay in changing to the appropriate target. Daily average spill was 40%.

Table 3: Pre-Coordinated Operations - August 2019 (8/1 to 8/31)

Project	Parameter	Date	Time[11]	# of Hours	Type	Reason
Lower Granite	Additional Spill	8/12/19 8/13/19 8/14/19 8/15/19 8/16/19	0700-1900 0700-1900 0700-1900 0700-1900 0700-1900	13 13 13 13 13	Maintenance	Hourly spill increased while generation was reduced to speed no load (5 kcfs) for station service due to units taken offline to perform Doble testing. Regionally coordinated via the 2019 FPP LWG Section 4.3.5 and Appendix A.
Lower Granite	Reduced Spill	8/27/19	0800	1	Maintenance	Spill remained at 14 kcfs (less than the spill target of 18 kcfs ±2 kcfs) while generation increased in order to perform pre-shutdown testing for annual maintenance of Unit 6. Regionally coordinated via the 2019 FOP Section 4.5.
Little Goose	Reduced Spill	8/1/19 8/8/19	1900 2300	1 1	Navigation	Hourly spill decreased to 28% of total flow (less than the spill target of 30% ±1% range) due to volume of water needed to empty the navigation lock. Daily average spill was between 28% and 33% due to multiple operations or spill variances Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6.
Little Goose	Reduced Spill	8/1/19	1100-1700	7	Maintenance	Hourly spill decreased to between 17% and 28% of total flow (less than 30% ±1% range) due to ramping rate testing of Unit 6. Daily average spill was 28%. Regionally coordinated via the 2019 FPP LGS Section 4.3.2.
Little Goose	Additional Spill	8/5/19 8/6/19 8/7/19 8/8/19	0600-1800 0600-1800 0600-1800 0600-1800	13 13 13 13	Maintenance	Hourly spill increased to between 42% and 85% of total flow (greater than 30% ±1 % range) due to units taken offline to perform Doble testing. Daily average spill ranged between 56% and 64%. Regionally coordinated via the 2019 FPP LGS Section 4.3.5 and Appendix A.
Little Goose	Additional Spill	8/6/19 8/7/19 8/8/19	0200-0600 0200-0600 0200-0600	4 4 4	Adaptive Management	Hourly spill increased to between 47% and 86% of total flow (greater than 30% ±1 % range). Daily average spill ranged between 60% and 64%. Regionally coordinated at the 7/31/19 TMT meeting. See the Operational Adjustments section for more details.

[11] Data collected for reporting pre-coordinated operations are reported as hourly averages. Therefore, while spill may be increased or decreased for only a portion of an hour, it is represented as an hour. The hourly average data are reported at the end of the hour (i.e., hour ending).

Project	Parameter	Date	Time[11]	# of Hours	Type	Reason
Little Goose	Reduced Spill	8/6/19	1900-2400	6	Adaptive Management	Hourly spill decreased to 7 kcfs (less than the spill target, 11 kcfs based on the previous day's average outflow). Regionally coordinated at the 7/31/19 TMT meeting. See the Operational Adjustments section for more details.
Lower Monumental	Additional Spill	8/1/19 8/2/19	0600-1700 0600-1800	12 13	Maintenance	Hourly spill increased while generation was reduced to speed no load (5 kcfs) for station service due to units taken offline to perform Doble testing. Regionally coordinated via the 2019 FPP LMN Section 4.3.5 and Appendix A.
Lower Monumental	Reduced Spill	8/28/19	1500-1600	2	Maintenance	Hourly spill remained at 12 kcfs (less than the spill target of 17 kcfs ±2 kcfs range) due to post-maintenance testing of Unit 4 after annual maintenance. Regionally coordinated via the 2019 FPP LMN Section 4.3.2.
Ice Harbor	Reduced Spill	8/4/19 8/5/19 8/11/19 8/12/19 8/13/19 8/15/19 8/16/19 8/17/19 8/18/19 8/19/19 8/20/19 8/22/19 8/23/19 8/24/19 8/26/19 8/27/19 8/28/19 8/29/19 8/30/19 8/31/19	0200-0300,0600 0600 1300 1300 1600 0700 0800-1000 0700 & 1100 0200, 0700, 1300, 1700 0300, 0700, 1600 0600 2100 1600 1700 & 2100 1300 0300, 0700, 1300 0200 0600 & 0900 1000 & 1300 0800	3 1 1 1 1 1 3 2 4 3 1 1 1 2 1 3 1 2 2 1	Navigation	Hourly spill decreased to between 27% and 28% of the total flow (less than the spill target of 30% ±1% range) for safe navigation. Daily average spill was between 29% and 36% due to multiple operations or spill variances. Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6.
Ice Harbor	Additional Spill	8/28/19	1800	1	Navigation	Hourly spill increased to 32% of the total flow (greater than the spill target of 30% ± 1% range) for safe navigation. Daily average spill was 30%. Regionally coordinated via 2019 FOP, Sections 4.1 and 4.6.
Ice Harbor	Reduced Spill	8/13/19	1100	1	Maintenance	Hourly spill decreased to 28% of the total flow (less than the spill target of 30% ±1% range). Project was switching units on and off for annual maintenance repair. Daily average spill was 30%. Regionally coordinated via the 2019 FOP Section 4.5.

Project	Parameter	Date	Time[11]	# of Hours	Type	Reason
Ice Harbor	Reduced Spill	8/14/19	0800	1	Maintenance	Hourly spill decreased to 28% of the total flow (less than the spill target of 30% ±1% range). Unit 6 was taken out of service for a scheduled 6-year overhaul. Daily average spill was 30%. Regionally coordinated via the 2019 FOP Section 4.5.
Ice Harbor	Reduced Spill	8/14/19	1500	1	Maintenance	Hourly spill decreased to 27% of the total flow (less than the spill target of 30% ±1% range) due to post-maintenance testing before Unit 4 was returned to service after an oil leak repair. Daily average spill was 30%. Regionally coordinated via the 2019 FPP IHR Section 4.3.2.
Ice Harbor	Additional Spill	8/14/19	1600	1	Maintenance	Hourly spill increased to 32% of the total flow (greater than the spill target of 30% ±1% range) due to post-maintenance testing of Unit 4 before it returned to service after an oil leak repair. Daily average spill was 30%. Regionally coordinated via the 2019 FPP IHR Section 4.3.2.
Ice Harbor	Reduced Spill	8/15/19	1000	1	Maintenance	Hourly spill decreased to 28% of the total flow (less than the spill target of 30% ±1% range) while performing STS screen inspection. Daily average spill was 29%. Regionally coordinated via 2019 FPP, page IHR-10.
Ice Harbor	Reduced Spill	8/15/19	1200	1	Maintenance	Hourly spill decreased to 28% of the total flow (less than the spill target of 30% ±1% range) while performing testing after gear box repair. Daily average spill was 29%. Regionally coordinated via 2019 FOP, section 4.5

Table 4: August 2019 Average Percent TDG Values Table (8/1 to 8/31)

Date	FIXED MONITORING STATIONS															
	LWG	LGNW	LGSA	LGSW	LMNA	LMNW	IHRA	IDSW	MCNA	MCPW	JDY	JHAW	TDA	TDDO	BON	CCIW
	Lower Granite FB	Lower Granite TW	Little Goose FB	Little Goose TW	Lower Monumental FB	Lower Monumental TW	Ice Harbor FB	Ice Harbor TW	McNary FB	McNary TW	John Day FB	John Day TW	The Dalles FB	The Dalles TW	Bonneville FB	Bonneville TW
Gas Cap %:	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**	**115**	**120**
8/1/2019	102	116	111	112	108	118	114	113	108	117	106	115	108	115	107	117
8/2/2019	101	116	111	111	108	118	114	113	108	117	106	114	108	115	108	117
8/3/2019	101	117	111	111	108	117	112	113	108	117	105	115	108	115	110	117
8/4/2019	102	116	111	111	108	117	113	112	109	117	107	115	110	116	112	117
8/5/2019	102	117	112	115	108	117	113	113	109	117	108	115	110	116	112	117
8/6/2019	102	117	113	116	108	116	114	113	110	117	109	115	111	116	112	117
8/7/2019	102	112	113	117	109	117	115	113	110	117	109	116	110	116	109	117
8/8/2019	103	112	113	116	109	117	115	113	110	117	109	116	109	115	106	117
8/9/2019	103	116	113	113	111	117	114	113	110	116	108	116	107	114	104	117
8/10/2019	103	116	113	111	112	116	114	112	109	116	108	116	108	114	104	114
8/11/2019	102	115	113	110	112	114	113	111	107	114	108	115	108	•[12]	104	114
8/12/2019	102	114	111	110	111	113	112	111	105	113	105	115	106	113	105	114
8/13/2019	102	115	109	110	110	113	111	107	106	115	106	115	110	115	106	117
8/14/2019	101	114	109	109	108	114	110	107	106	116	106	114	110	115	109	117
8/15/2019	101	114	109	109	107	113	110	107	107	116	105	114	109	115	108	117
8/16/2019	101	114	108	109	107	113	109	107	108	115	105	114	107	113	106	114
8/17/2019	100	112	108	109	107	113	110	107	108	115	104	114	105	112	105	114
8/18/2019	101	109	108	110	107	111	111	107	108	114	104	114	106	113	103	114
8/19/2019	101	108	108	109	107	112	111	107	108	114	104	114	106	113	103	113
8/20/2019	101	112	108	109	106	114	109	107	106	115	104	•	108	114	105	117
8/21/2019	101	112	108	109	106	114	109	107	107	116	104	115	108	114	105	117
8/22/2019	100	112	107	109	106	113	108	107	106	116	104	115	107	114	105	117
8/23/2019	101	110	108	109	106	113	108	107	106	115	104	115	108	115	107	117
8/24/2019	101	109	108	109	106	111	108	107	106	116	104	115	108	114	107	117
8/25/2019	101	110	106	108	106	110	108	107	105	114	103	113	107	113	106	112
8/26/2019	100	113	105	109	105	112	108	107	106	113	103	113	105	112	105	113
8/27/2019	99	111	105	109	107	113	109	108	107	114	105	114	110	115	105	114
8/28/2019	101	109	106	109	107	113	109	108	108	115	106	114	111	116	108	114
8/29/2019	101	109	107	109	106	111	109	108	106	115	105	114	111	116	109	117
8/30/2019	100	109	106	109	107	111	108	107	104	115	104	115	109	115	110	117
8/31/2019	101	109	105	109	107	110	109	108	104	115	105	114	107	114	108	115

[12] Red shaded cells indicate no data due to malfunctioning gauge.

Figure 1

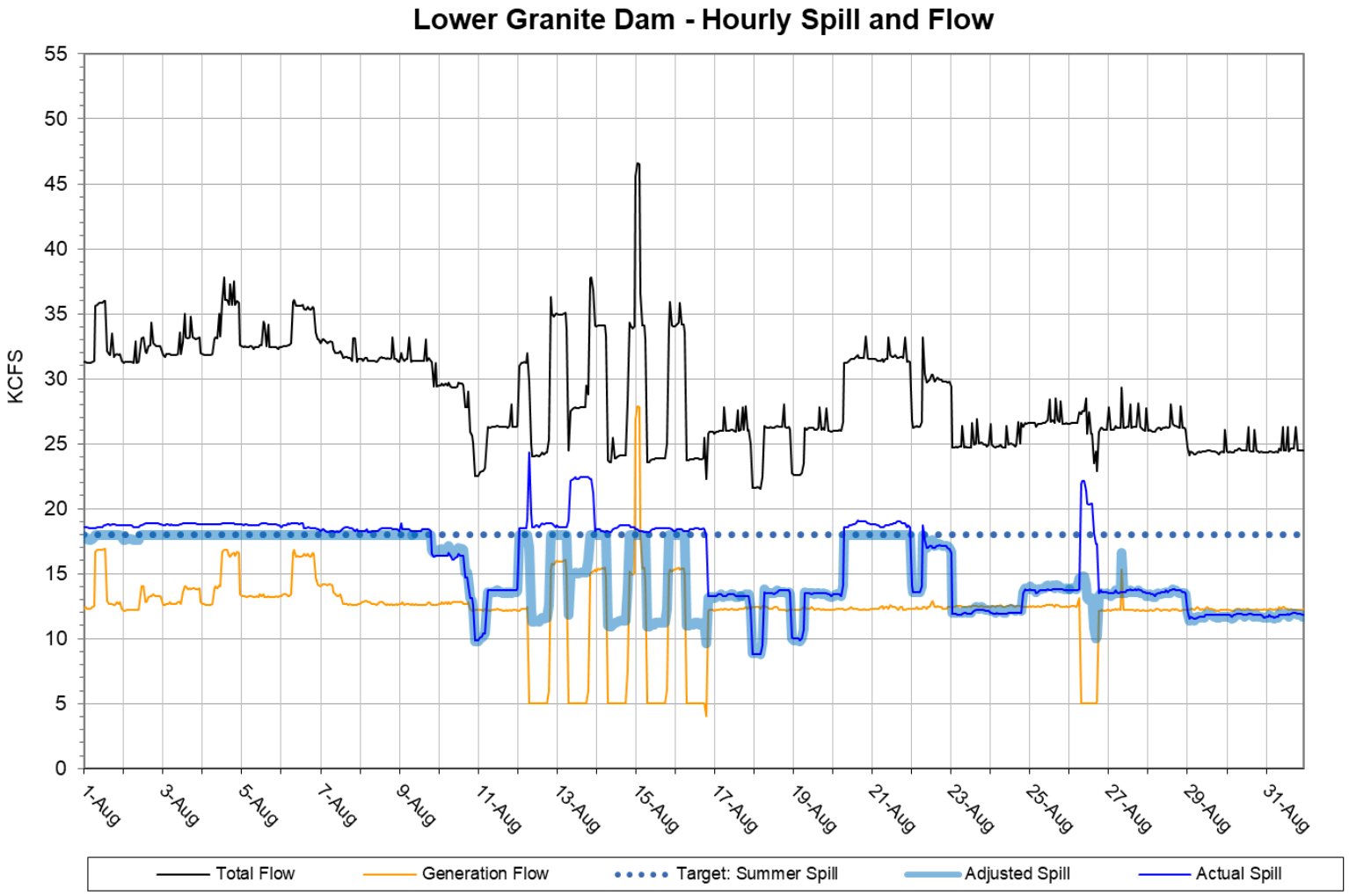
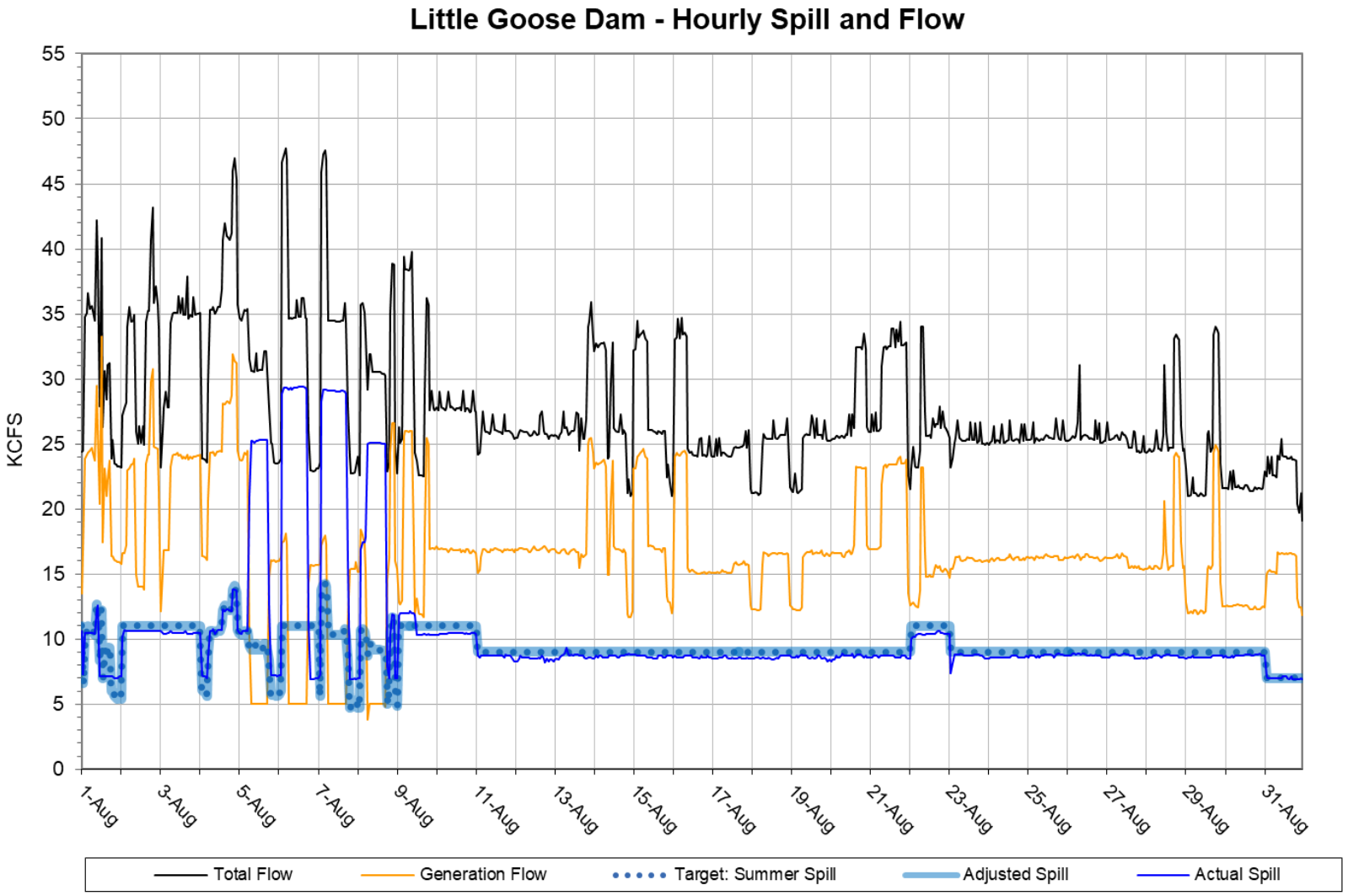

Lower Granite Dam - Hourly Spill and Flow
KCFS
55
50
45
40
35
30
25
20
15
10
5
0
1-Aug
3-Aug
5-Aug
7-Aug
9-Aug
11-Aug
13-Aug
15-Aug
17-Aug
19-Aug
21-Aug
23-Aug
25-Aug
27-Aug
29-Aug
31-Aug
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 2


Little Goose Dam - Hourly Spill and Flow
KCFS
55
50
45
40
35
30
25
20
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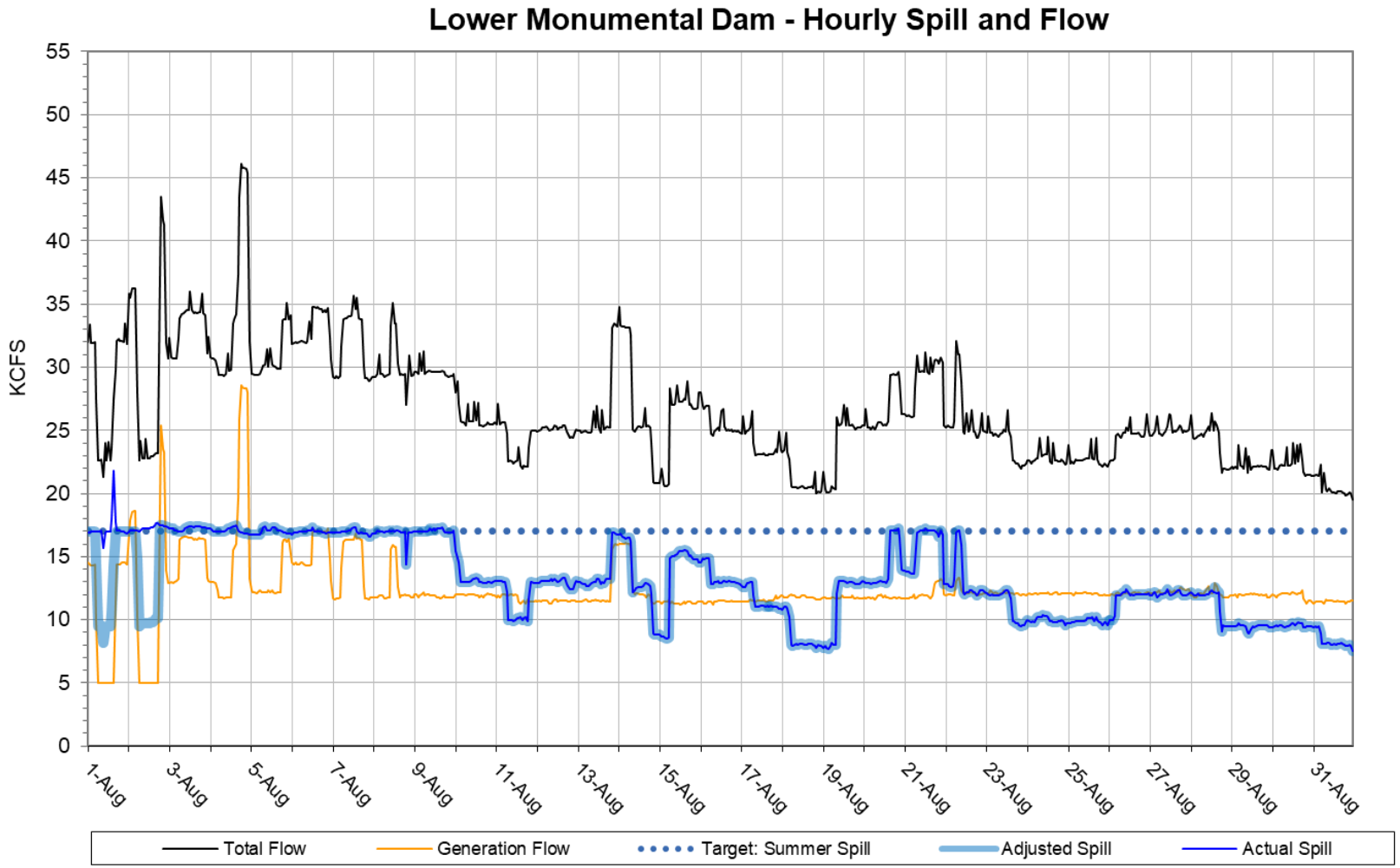
10
5
0
1-Aug
3-Aug
5-Aug
7-Aug
9-Aug
11-Aug
13-Aug
15-Aug
17-Aug
19-Aug
21-Aug
23-Aug
25-Aug
27-Aug
29-Aug
31-Aug
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 3


Lower Monumental Dam - Hourly Spill and Flow
KCFS
55
50
45
40
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10
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1-Aug
3-Aug
5-Aug
7-Aug
9-Aug
11-Aug
13-Aug
15-Aug
17-Aug
19-Aug
21-Aug
23-Aug
25-Aug
27-Aug
29-Aug
31-Aug
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 4

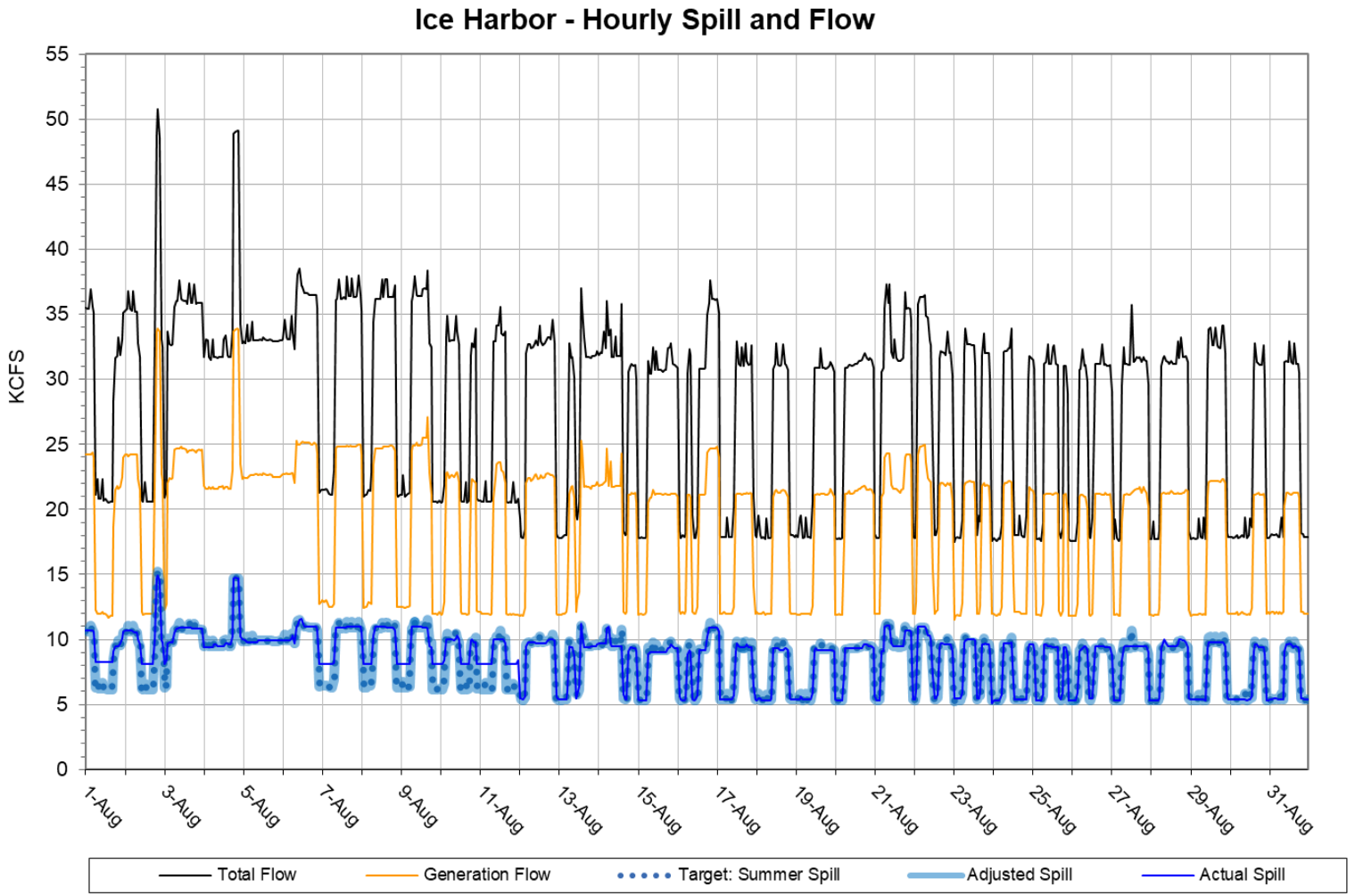

Ice Harbor - Hourly Spill and Flow
KCFS
55
50
45
40
35
30
25
20
15
10
5
0
1-Aug
3-Aug
5-Aug
7-Aug
9-Aug
11-Aug
13-Aug
15-Aug
17-Aug
19-Aug
21-Aug
23-Aug
25-Aug
27-Aug
29-Aug
31-Aug
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 5

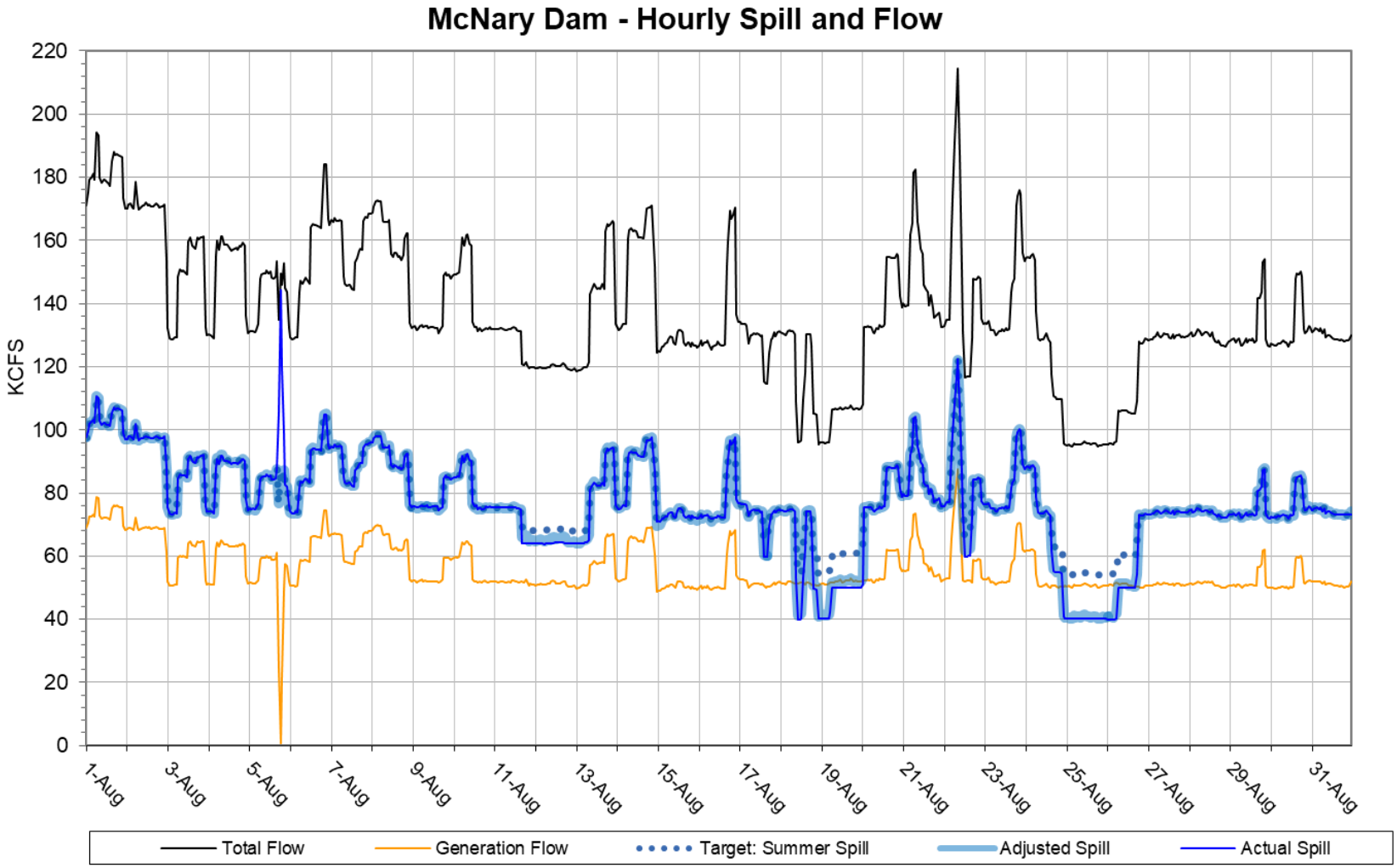

McNary Dam - Hourly Spill and Flow
KCFS
220
200
180
160
140
120
100
80
60
40
20
0
1-Aug
3-Aug
5-Aug
7-Aug
9-Aug
11-Aug
13-Aug
15-Aug
17-Aug
19-Aug
21-Aug
23-Aug
25-Aug
27-Aug
29-Aug
31-Aug
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 6

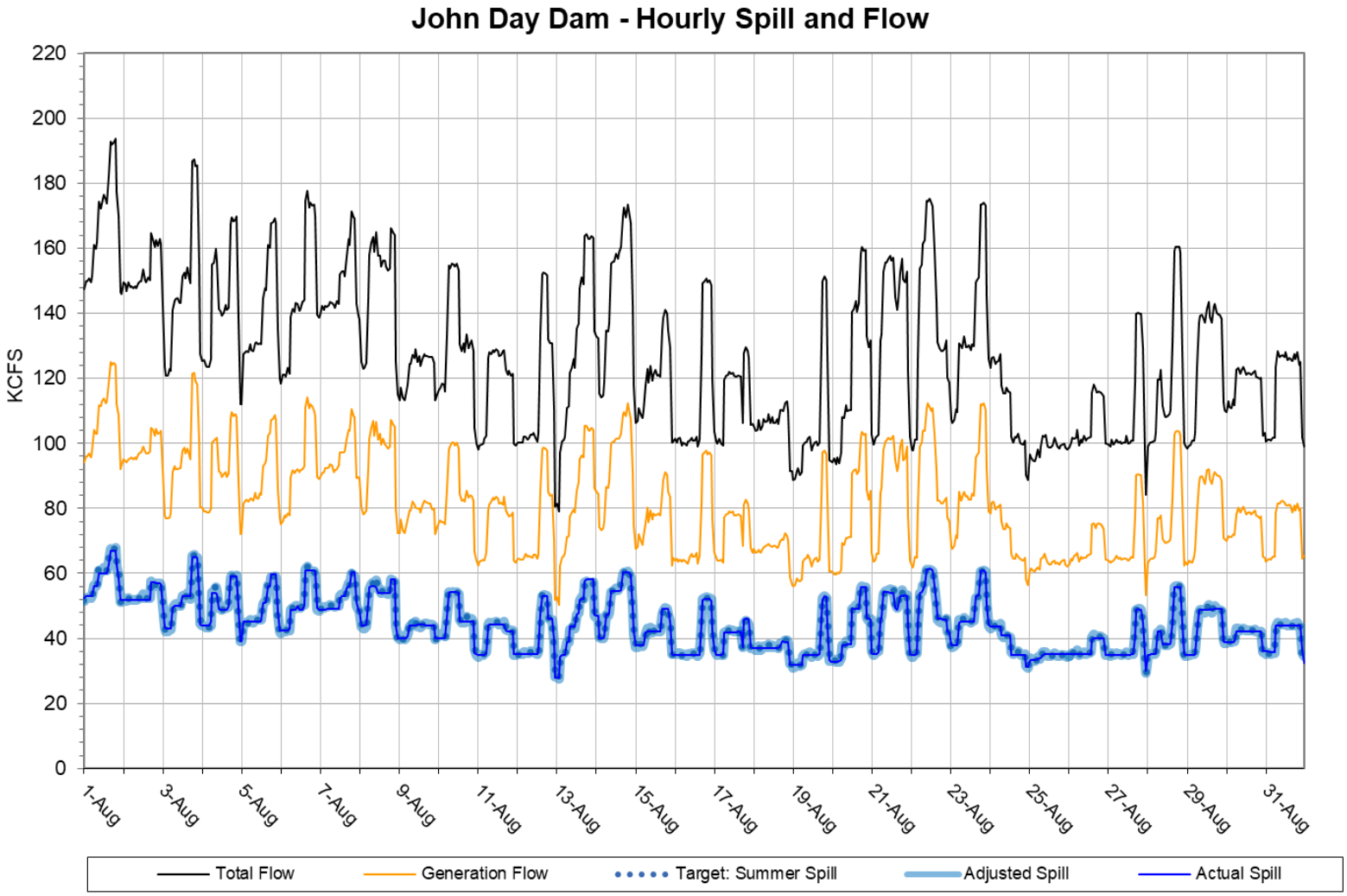

John Day Dam - Hourly Spill and Flow
KCFS
220
200
180
160
140
120
100
80
60
40
20
0
1-Aug
3-Aug
5-Aug
7-Aug
9-Aug
11-Aug
13-Aug
15-Aug
17-Aug
19-Aug
21-Aug
23-Aug
25-Aug
27-Aug
29-Aug
31-Aug
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 7

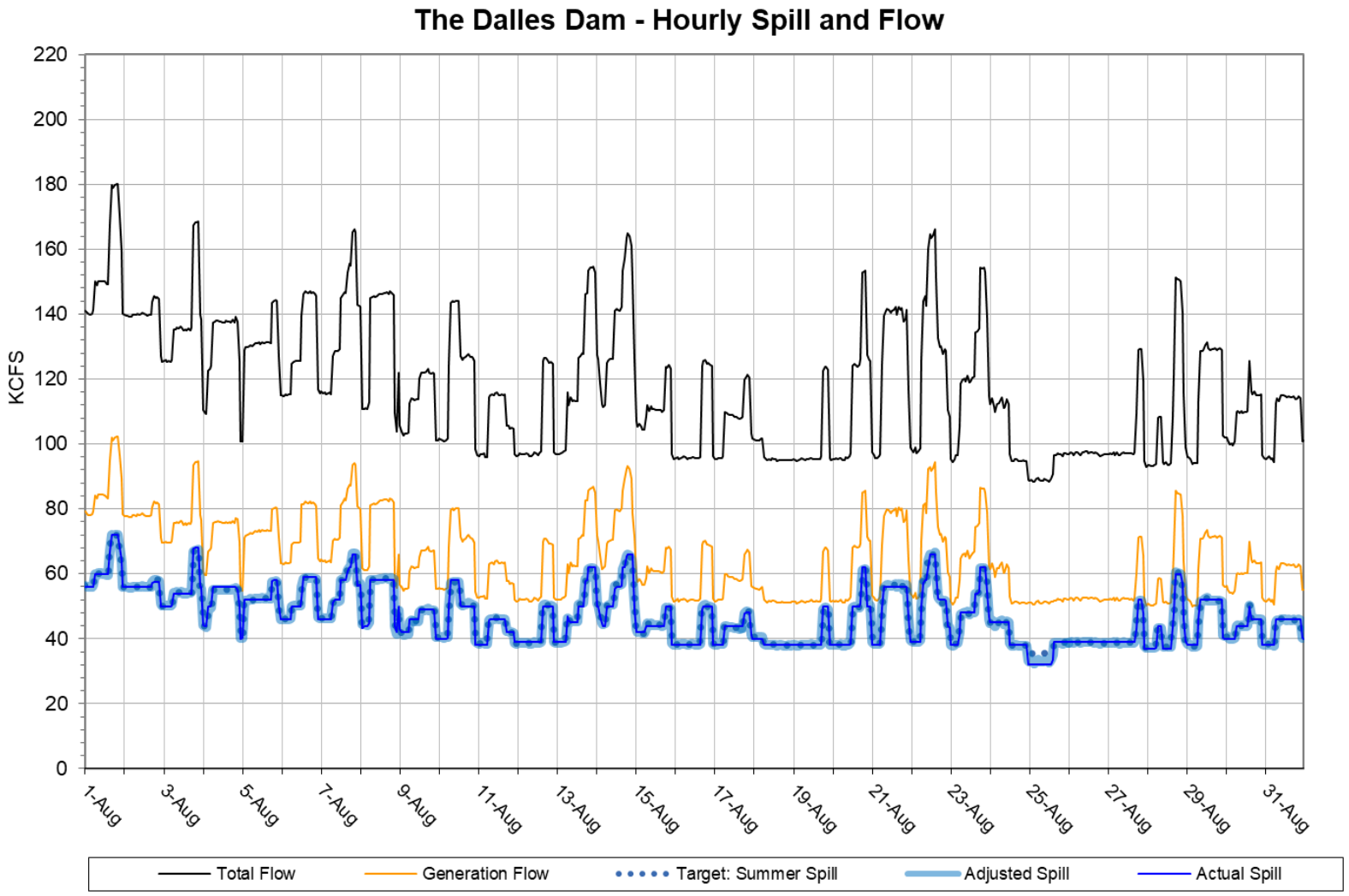
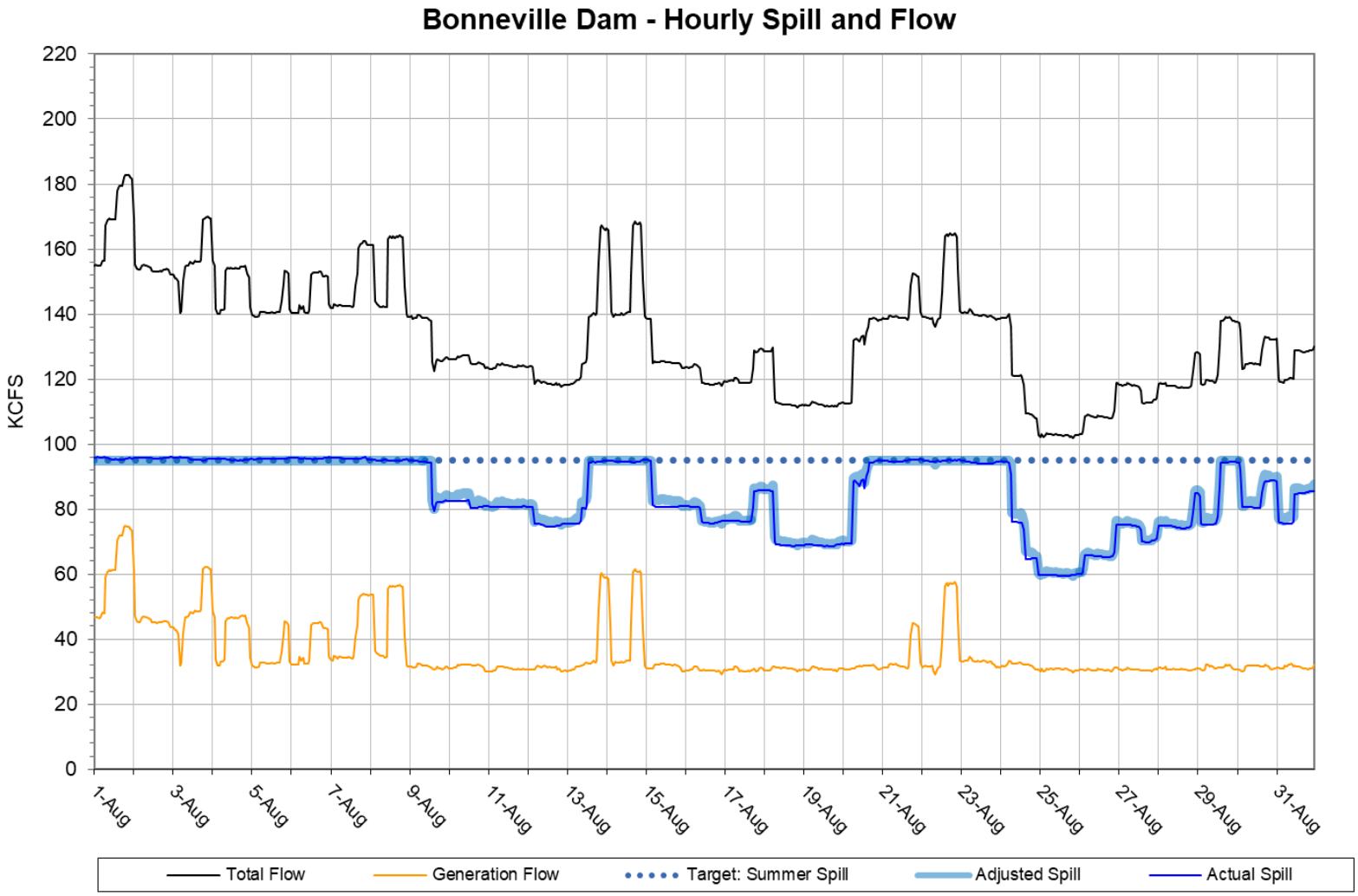

The Dalles Dam - Hourly Spill and Flow
KCFS
220
200
180
160
140
120
100
80
60
40
20
0
1-Aug
3-Aug
5-Aug
7-Aug
9-Aug
11-Aug
13-Aug
15-Aug
17-Aug
19-Aug
21-Aug
23-Aug
25-Aug
27-Aug
29-Aug
31-Aug
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill

Figure 8


Bonneville Dam - Hourly Spill and Flow
KCFS
220
200
180
160
140
120
100
80
60
40
20
0
1-Aug
3-Aug
5-Aug
7-Aug
9-Aug
11-Aug
13-Aug
15-Aug
17-Aug
19-Aug
21-Aug
23-Aug
25-Aug
27-Aug
29-Aug
31-Aug
Total Flow
Generation Flow
Target: Summer Spill
Adjusted Spill
Actual Spill