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

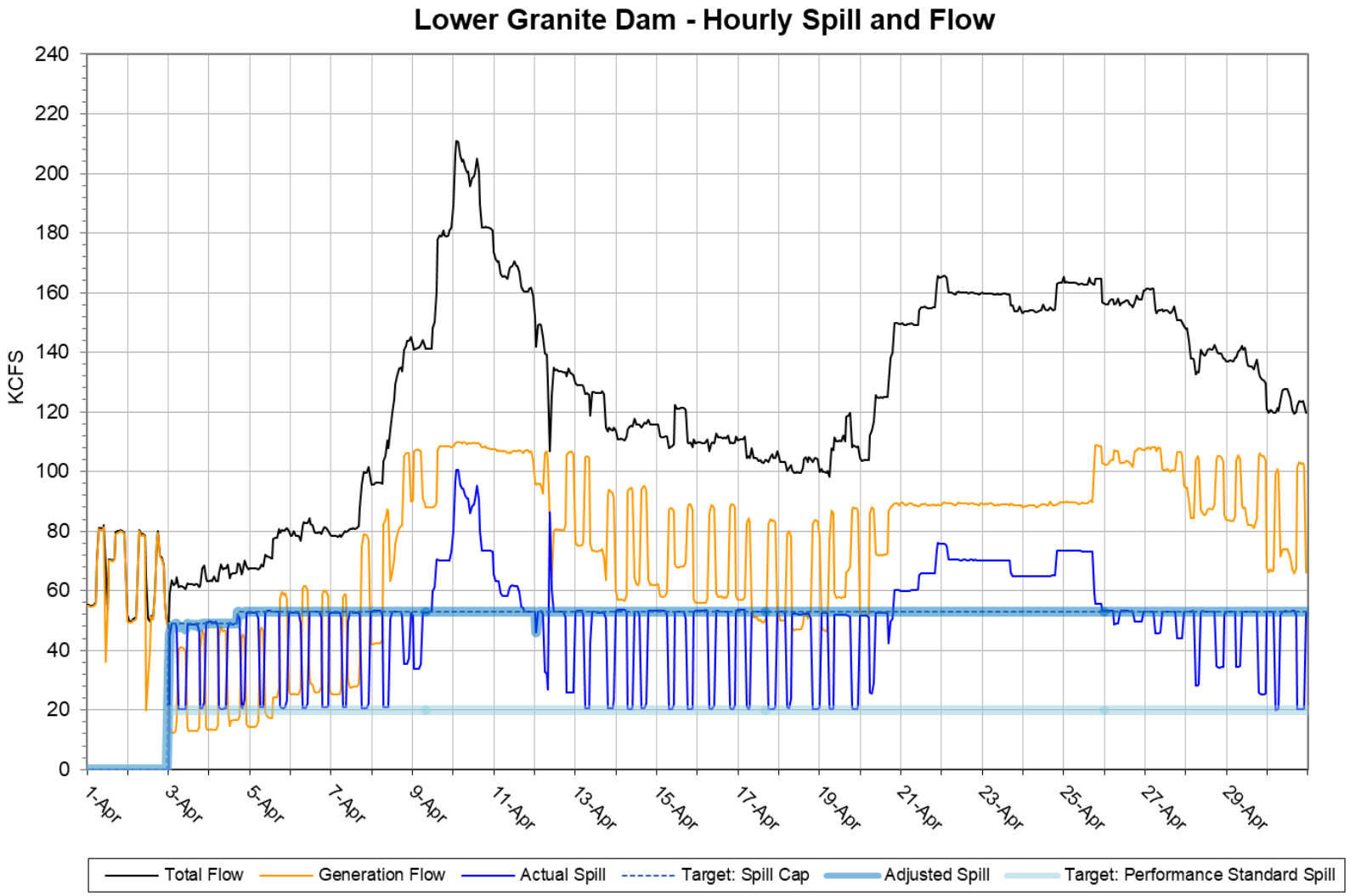

Lower Granite Dam - Hourly Spill and Flow
KCFS
240
220
200
180
160
140
120
100
80
60
40
20
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

Figure 2

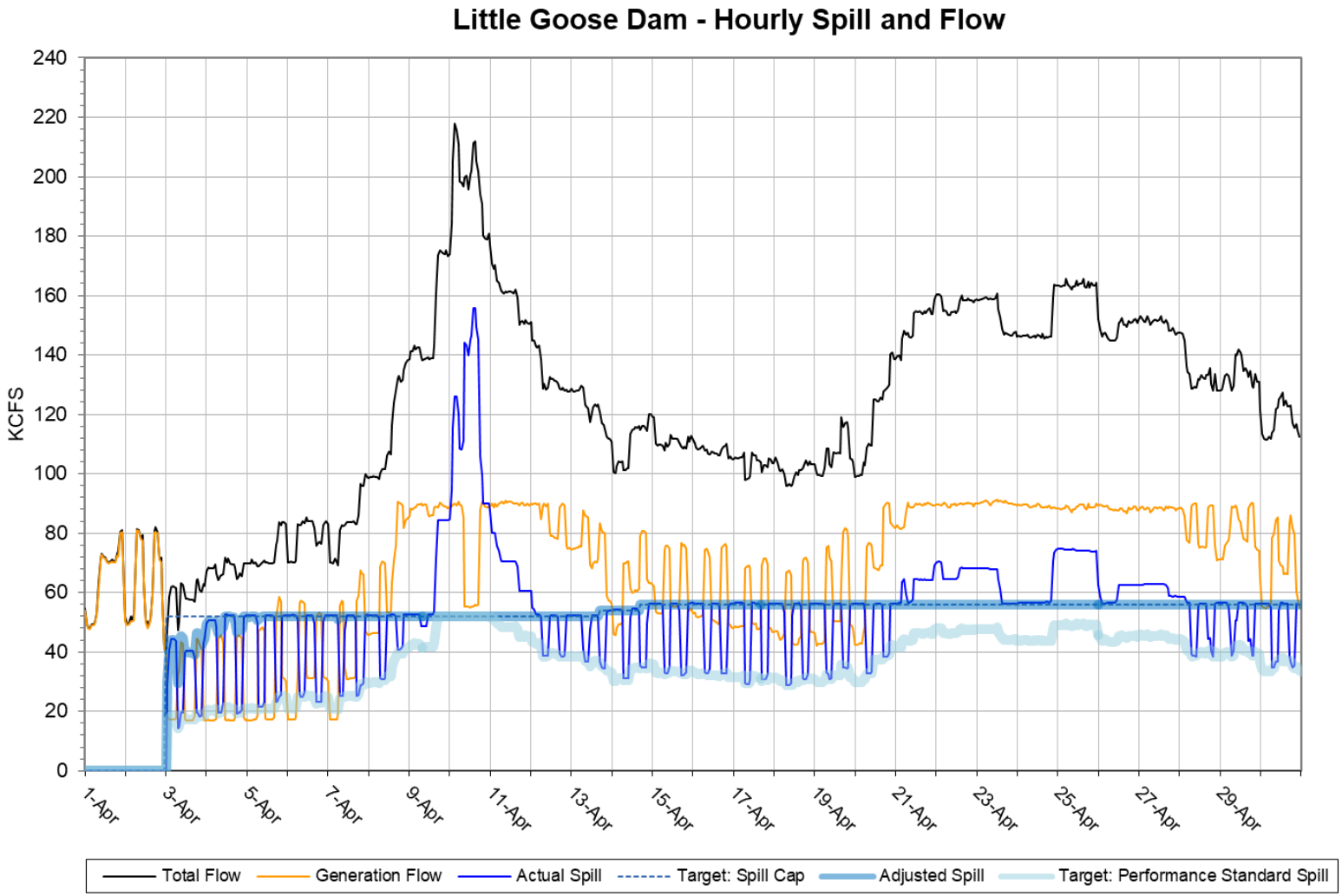

Little Goose Dam - Hourly Spill and Flow
KCFS
240
220
200
180
160
140
120
100
80
60
40
20
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

Figure 3

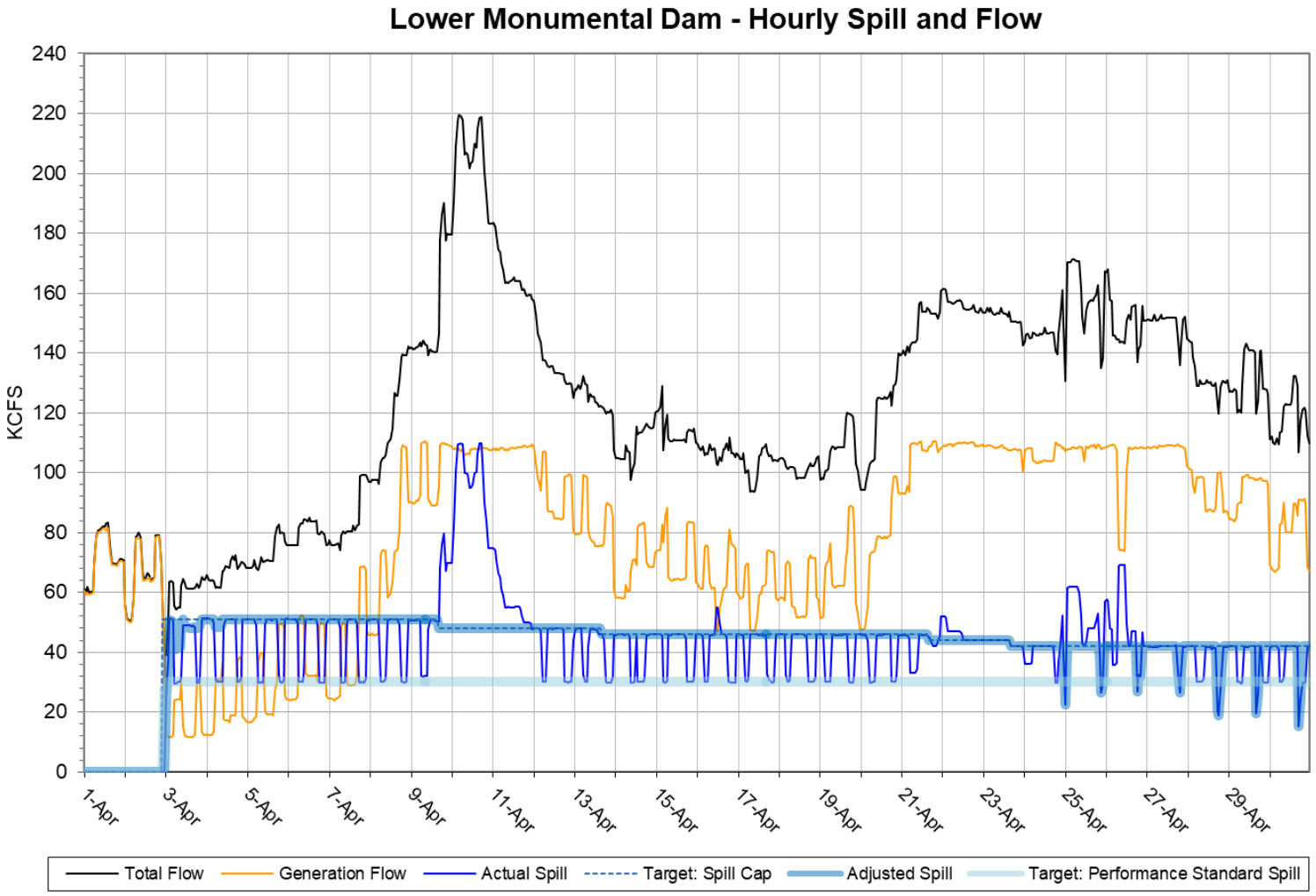


Figure 4

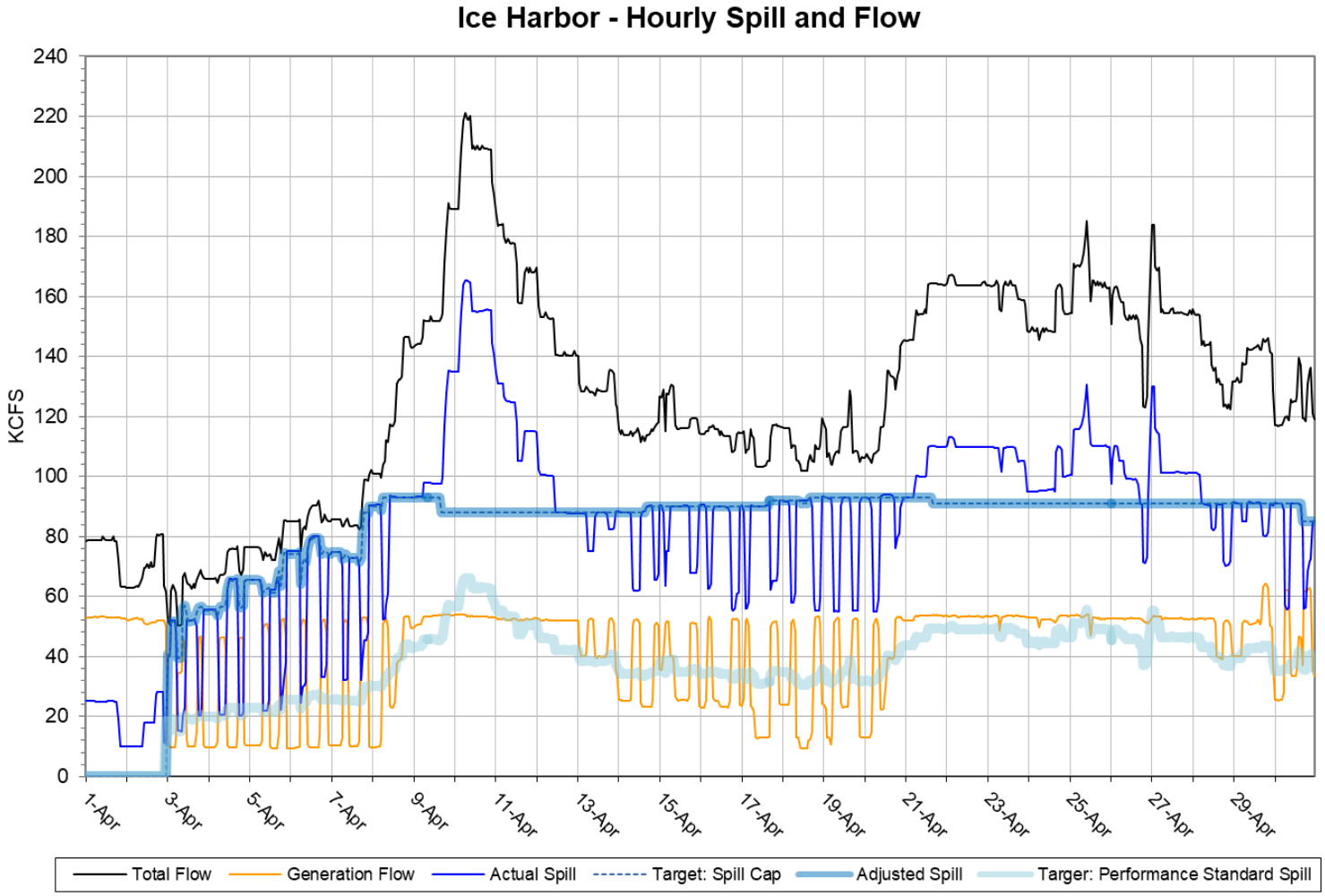

Ice Harbor - Hourly Spill and Flow
KCFS
240
220
200
180
160
140
120
100
80
60
40
20
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Targer: Performance Standard Spill

Figure 5

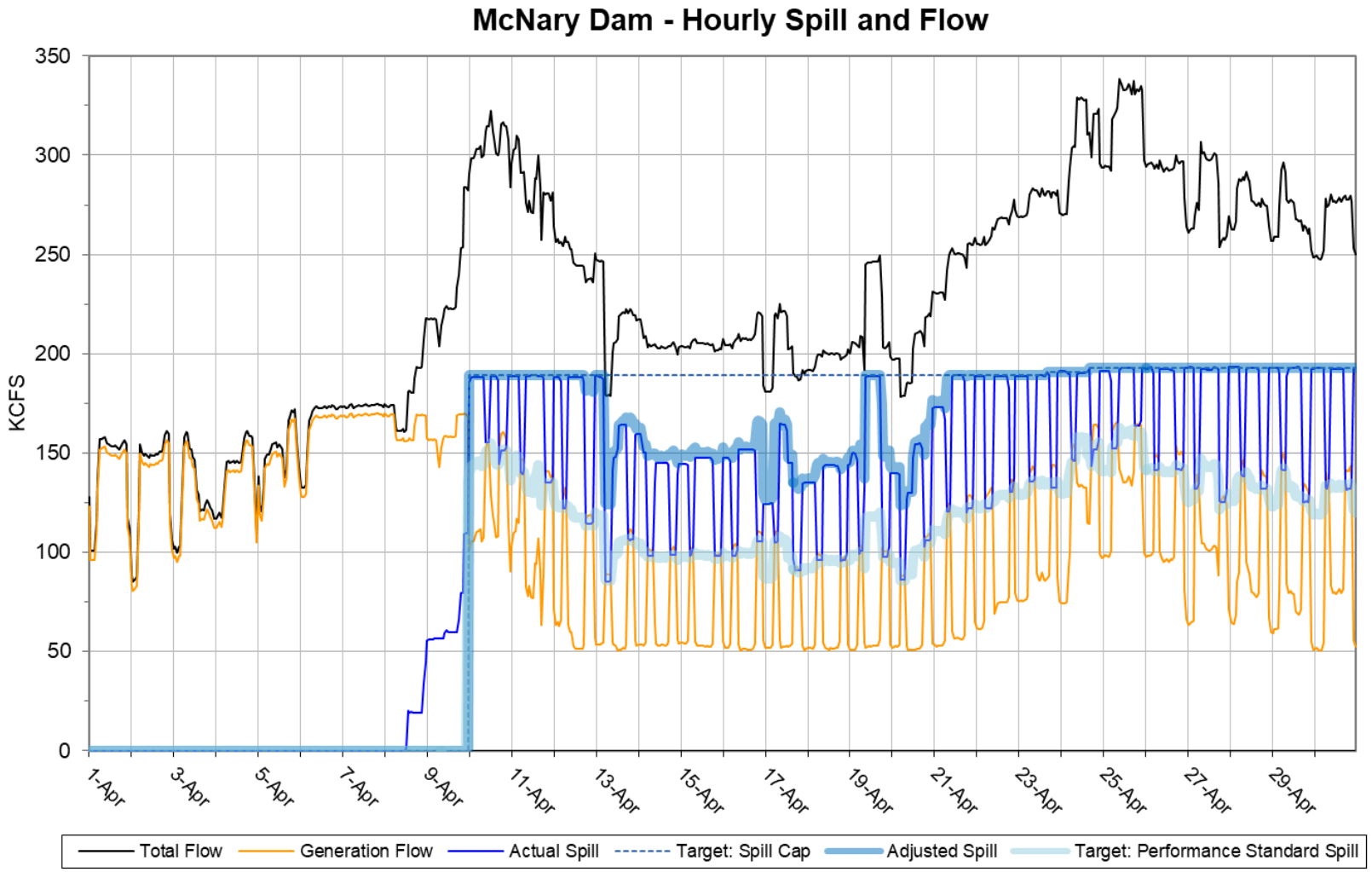

McNary Dam - Hourly Spill and Flow
KCFS
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

Figure 6

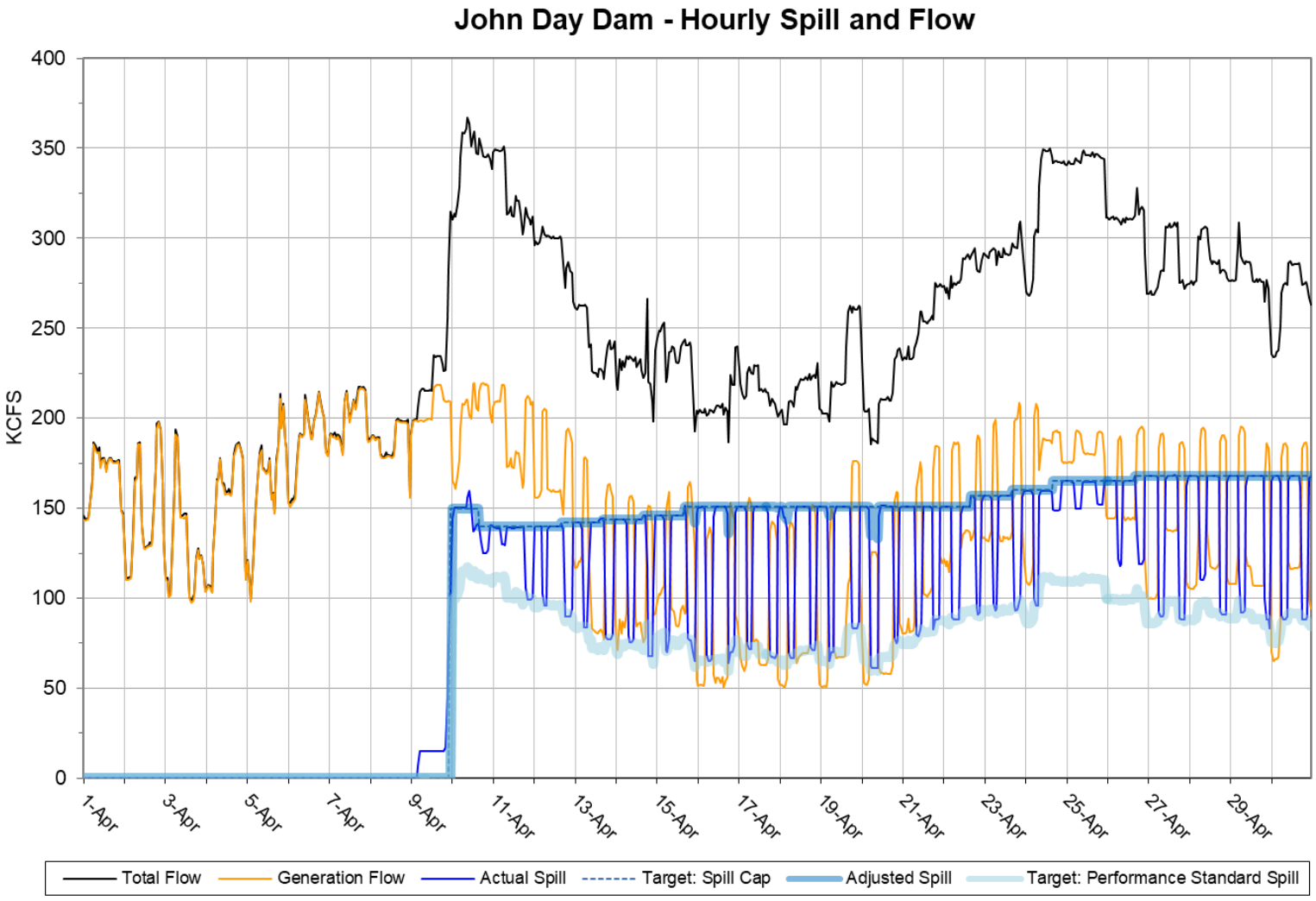

John Day Dam - Hourly Spill and Flow
KCFS
400
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

Figure 7

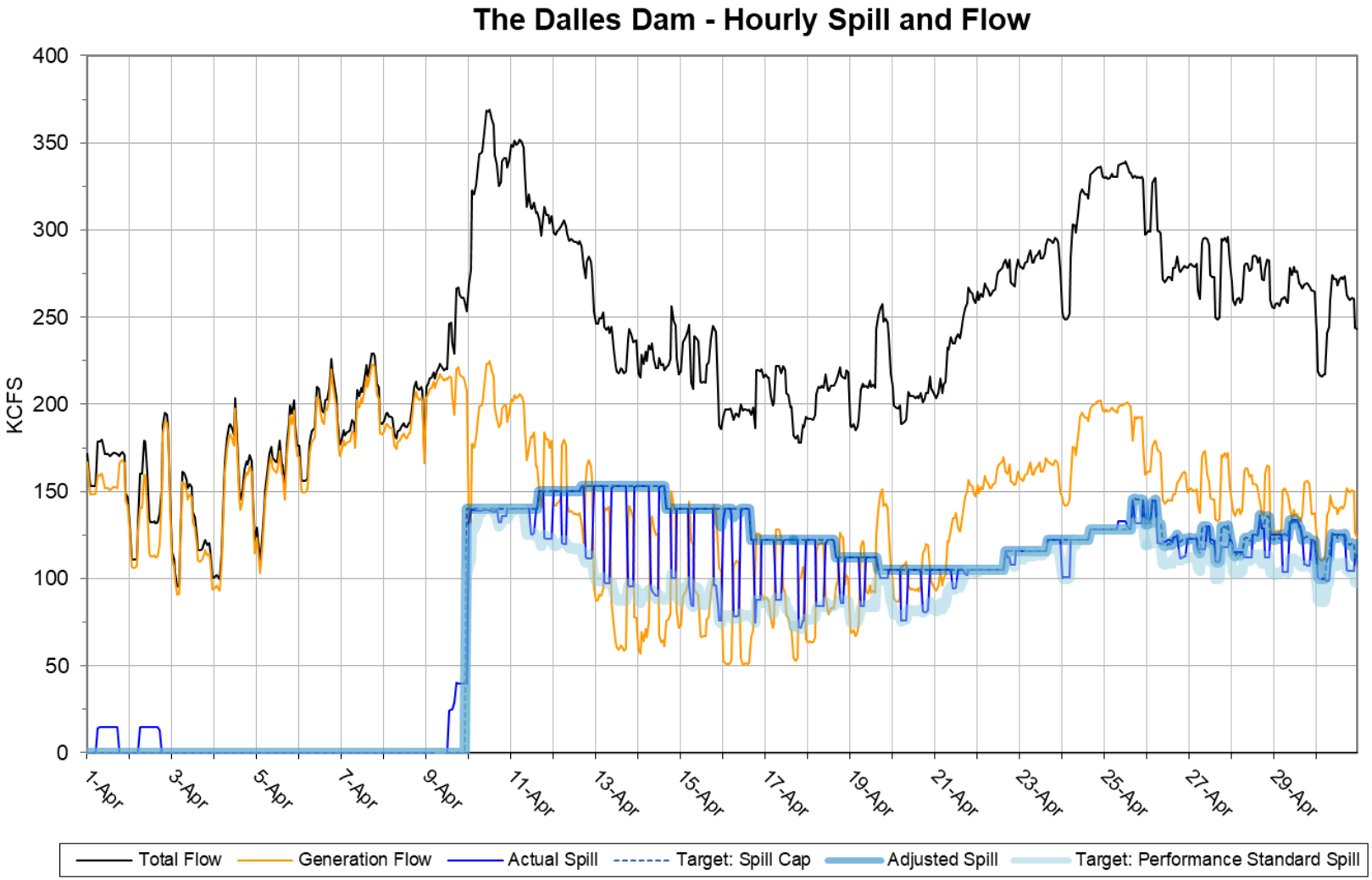
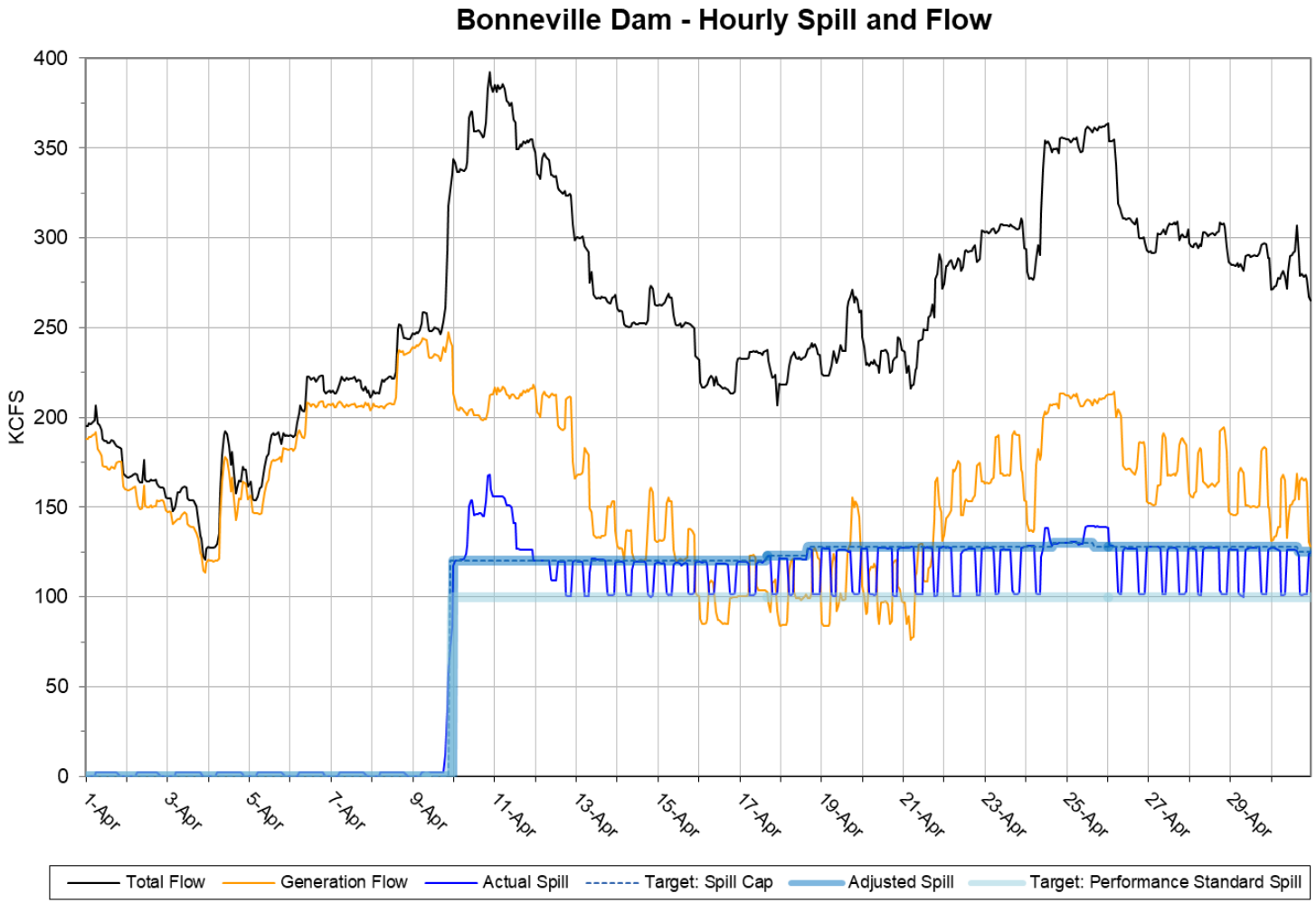

The Dalles Dam - Hourly Spill and Flow
KCFS
400
350
300
250
200
150
100
50
0
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
Total Flow
Generation Flow
Actual Spill
Target: Spill Cap
Adjusted Spill
Target: Performance Standard Spill

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