FISH OPERATIONS PLAN IMPLEMENTATION REPORT

July 2016

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

Introduction

The U.S. Army Corps of Engineers (Corps) is submitting this report in accordance with the 2016 Fish Operations Plan (2016 FOP) posted to the Technical Management Team (TMT) website on February 29, 2016. The 2016 FOP describes the Corps' project operations for fish passage at its Federal Columbia River Power System (FCRPS) dams during the spring and summer fish migration season, generally April through August. To the extent Corps project operations are not specified in the 2016 FOP, the FCRPS operations will be consistent with the 2014 NOAA Fisheries Supplemental Biological Opinion (2014 Supplemental BiOp), the USFWS 2000 and 2006 BiOps, and/or other operative documents, including the 2016 Water Management Plan (WMP), WMP seasonal updates, and the 2016 Fish Passage Plan (FPP).

The Corps' July 2016 lower Snake and Columbia River project and fish passage operations are contained in this report. In particular, information in this report includes the following:

- Hourly flow through the powerhouse at each dam;
- Hourly flow over the spillway compared to the spill target for that hour; and
- Daily average Total Dissolved Gas (TDG) levels (percent of saturation) in the tailwater at each project, and in the subsequent downstream project's forebay.[1]

This report also provides information on presented issues and unanticipated or emergency situations that arose during implementation of the 2016 FOP in July 2016.

Data Reporting

I. For each project providing fish passage operations, this report contains one graph per operational month (July) displaying the performance of the fish passage spill program, with hourly spill, FOP spill, generation, and total flows. The monthly graphs begin on July 1 and end on July 31 for the following lower Snake River and lower Columbia River projects: Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville.

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

Operations represented on the monthly graphs start at 0100 hours on July 1 for the lower Snake River and the lower Columbia River projects as follows:

- The dark tan line represents the average hourly total river flow through the project in thousand cubic feet per second (kcfs).
- The dotted blue line represents the average hourly flow through the powerhouse each hour in kcfs.
- The dotted pink line represents the actual average hourly spill level through the spillway in kcfs.
- The thin green line represents the hourly FOP spill level as defined in the 2016 FOP.
- The thick green line represents the adjusted FOP spill. This is the hourly maximum 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 the following conditions:

    - spill percentage or flow rate specified in the 2016 FOP;
    - spill caps as set daily for TDG management;
    - test spill levels for fish passage research;
    - minimum generation for power system needs;
    - minimum spill at Bonneville (50 kcfs) dam; and
    - minimum spill at John Day is 25 percent of project outflow.

II. The average daily %TDG for the 12 highest hours for all projects is shown in the July 2016 Average Percent TDG Values Table (Table 3). The numbers in red indicate the project exceeded the %TDG cap - i.e. 115% (forebay of the next downstream dam) or 120% (tailwater) for each project. For the lower Columbia projects, tailwater TDG values are presented by displaying the highest value %TDG (controlling limit), and the lower value is displayed with a strikethrough.

General Implementation Remarks

For all projects that spill for fish passage, the actual spill may vary from the target spill due to various conditions as described below. When spill levels briefly deviate below or above the level specified in the 2016 FOP, the dotted pink line will be below or above the heavy green line in the figures.[2] Actual deviations from the target operation during voluntary spill hours are described below in the July 2016 Spill Variance Table (Table 1).[3] The Spill Variance Table includes average hourly data; therefore, while spill may vary from target FOP spill for only a portion of an hour, the Spill Variance Table characterizes the variance as a full hour. There are instances when the hourly FOP 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

[2] The actual thickness of the heavy green line (Adjusted FOP Spill) is not intended to represent the full allowable tolerance; and if the dotted pink line is slightly outside it should not be construed to indicate a spill variance or involuntary spill.

[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, and passing debris.

stops to most closely approximate the 2016 FOP level of spill while also avoiding exceeding the %TDG spill cap to the extent practicable.

"Low flow" operations at the lower Columbia and Snake projects are triggered when inflow is insufficient to provide both minimum generation and the specified spill levels. 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. During low flow periods at Little Goose Dam, the overall project spill percentage appears to be reduced because the calculations do not account for the volume of water released during navigational lockages; however, the actual spill volume remains constant. When this occurs, it is recorded in the monthly Pre-Coordinated Operations Table (Table 2)[4] denoted as "Navigation" type.

Actual spill levels at Corps projects with set flow targets may vary up to ±2 kcfs within the hour (except as otherwise noted in the 2016 FOP for Bonneville and The Dalles dams[5], which may range up to ±3 kcfs) as compared to those specified in the 2016 FOP and the RCC spill priority list (defining the project %TDG spill caps). 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).

The 2016 FOP describes project "Operations during Rapid Load Changes" (p. 6). For reporting purposes, when hourly spill levels were not met as a result of load swing hours and other related within-hour load variability issues, the notation "Transmission Stability" will be used in the Spill Variance Table. "Transmission Stability" occurs because projects must be available to respond to within-hour load variability to satisfy North American Electric Reliability Corporation (NERC) reserve requirements ("on response") or other NERC mandatory reliability regulatory requirements. In addition to within-hour load variability, projects on response must be responsive to within hour changes resulting from intermittent generation (such as wind generation). During periods of rapidly changing loads and intermittent generation, projects on response may have significant changes in turbine discharge within the hour while spill quantity remains the same within the hour. Under normal conditions, within-hour load changes primarily occur immediately preceding and following the peak load hours; however, within-hour changes in intermittent generation can occur at any hour of the day. Occasionally, several hours after peak load hours, the project may be decreasing total outflow and generation faster than the

[4] Other routine activities that change spill levels and have been coordinated with regional partners will be identified in Table 2.

[5] As specified in the 2016 FOP (p. 14), this applies when the spill level is below 40% of total flow at The Dalles Dam.

corresponding spill decreases causing the percent spill to be slightly higher. Due to the high variability of within-hour load, reporting actual spill percentages that vary by more than the ±1 percent within hour requirement (or other ranges specified in the 2016 FOP) may occur with greater frequency with "Transmission Stability" hours than other hours.

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 well below average flows for the lower Snake River and lower Columbia River. The NOAA Northwest River Forecast Center's Runoff Processor indicated that the July 2016 adjusted volume runoff on the lower Snake River was well below the 30 year average (1981-2010): 1.4 MAF (Million Acre Feet) or 63% of average as measured at Lower Granite Dam. For the lower Columbia, the Runoff Processor indicated the July 2016 adjusted volume runoff was also well below the 30 year average (1981-2010): 9.4 MAF or 64% of average as measured at The Dalles. The monthly precipitation summary for July was well below average at 60% on the Snake River above Ice Harbor Dam and below average on the Columbia River above The Dalles Dam at 81%.

During the July 2016 reporting period, the planned 2016 FOP spill operations were carried out as follows:

- Lower Granite Dam - The hourly target spill level was 18 kcfs, 24 hours/day.
- Little Goose Dam - The hourly target spill level was 30% of total project outflow, 24 hours/day. Spill transitioned to a fixed rate of 7-11 kcfs, depending on the previous day's average project outflow: outflow 28-32 kcfs = spill 11 kcfs; outflow 24-28 kcfs = spill 9 kcfs; outflow below 24 kcfs = spill 7 kcfs.
- Lower Monumental Dam - The hourly target spill level was 17 kcfs, 24 hours/day.
- Ice Harbor Dam - The hourly target spill level alternated in 2-day blocks between 30% of total project outflow, 24 hours/day and 45 kcfs during the day and the %TDG cap during the night (%TDG cap range ~75 – 95 kcfs) through July 13 when the operation transitioned to 45 kcfs during the day and the %TDG cap during the night. Nighttime spill hours are 1800–0500.
- McNary Dam - The hourly target spill level was 50% of total project outflow, 24 hours/day.
- John Day Dam - The hourly target spill level alternated in 2-day blocks between 30% and 40% of total project outflow, 24 hours/day until July 20 when the operation transitioned to 30% of total project outflow, 24 hours/day. Spill level changes occurred at 2000 hours.
- The Dalles Dam - The hourly target spill level was 40% of total project outflow, 24 hours/day.
- Bonneville Dam - The hourly target spill level alternated in 2-day blocks between 95 kcfs, 24 hours/day and 85 kcfs during the day and 121 kcfs during the night until July 5 when the operation transitioned to 95 kcfs, 24 hours/day, in order to minimize erosion of the Bradford Branch-B fish ladder. Nighttime hours are 2130-0430 through July 5. See Operational Adjustments section for additional discussion of operations.

Operational Adjustments

1. Bonneville Dam

On Thursday, July 7, 2016, from 1200–1600 hours, Bonneville Dam spillbays 2–18 were closed to facilitate a sonar survey of developing erosion holes in the Bradford Island B-Branch fish ladder on the south shore of the spillway tailrace. Based on results from an emergency survey on June 17 (see the June 2016 FOP Implementation Report, page 5), the Corps determined a sonar survey of bathymetry in the area was necessary to inform repairs and to establish a baseline for monitoring until repairs are completed.

During the 4-hour operation, spill through bay 1 was maintained at 1 kcfs to provide attraction flow to the Cascades Island ladder entrance on the north shore of the spillway tailrace. Hourly average spill ranged from 1 to 15 kcfs, which was below the planned 2016 FOP summer spill operation of 95 kcfs (± 3 kcfs), 24 hours per day. All other fish passage routes were operated in accordance with criteria in the 2016 Fish Passage Plan (FPP).

The Corps coordinated this operation with regional sovereigns via a Memo of Coordination (MOC), sent to the Fish Passage Operations and Maintenance (FPOM) workgroup on June 28 and discussed at a FPOM conference call on July 5 and at the TMT meeting on July 6. The Corps provided updates to the MOC via email on July 6 and July 12, and at the FPOM meeting on July 14. Results from the sonar survey were emailed to FPOM on July 20. Regional sovereigns either supported or did not object to this operation.

In addition to the operation for the sonar survey, the summer spill treatment schedule was revised on July 5 to maintain spill at a constant 95 kcfs through August 31 when flow is available. This revision of the planned 2016 FOP summer spill operation (alternating 2-day blocks of 95 kcfs and 85 kcfs day/121 kcfs night) has been implemented to avoid frequent changes in tailrace hydraulics that could exacerbate the erosion. Additionally, on July 21, the Corps implemented a modified spill pattern to minimize energy dissipated at the area of erosion. The revised summer spill schedule and spill patterns were coordinated with FPOM via conference calls on July 5 and July 19, and during a site visit of Bonneville Dam to test spill patterns on July 20. All FPOM representatives were in support or did not object to these operations.

Table 1: Spill Variance Table – July 2016 (7/1 to 7/31)

Project	Parameter	Date	Time[6]	Hours	Type	Reason
Ice Harbor	Additional spill	7/11/16	0800-1500	8	Operational Limitations	Hourly spill ranged from 32% to 34% (above 30% ±1%). Hourly total project outflow ranged from 23 to 27 kcfs. Due to spillway weir (SW) operation, minimum spill is fixed at approx 8 kcfs, which results in spill >FOP target when total outflow is approx 17-27 kcfs. 24-hr avg spill was 39%.

Table 2: Pre-Coordinated Operations – July 2016 (7/1 to 7/31)

Project	Date[6]	Type	Description of Event	Regional Coordination
Little Goose	July 8	Navigation	The volume of water needed to empty the navigation lock reduces the spill percentage.	2016 FOP, page 6
Lower Monumental	Every other day from July 2 through July 30	Navigation	Spill was reduced for safe passage of fish barges crossing project tailwater.	2016 FOP, pages 2, 4 and 7
Lower Monumental	10 hours every day from July 29 through July 31	Maintenance	Spill increased due to units taken offline in order to perform doble testing.	2016 FPP, LMN section 4.3.5 and Appendix A sections 1.4 and 7.1.7.
Ice Harbor	July 8	Navigation	Spill percentage increased due to operation of the SW while attempting 30% spill, operating at min gen, and a lockage during the same hour.	2016 FOP, page 6
John Day	July 12	Maintenance	Spill was increased and then decreased as part of a WECC model validation testing on a unit at difference loads and voltages.	2016 FPP, JDA, section 4.2.1.3
Bonneville	July 5-July 31	Operational Limitations	Spill was switched to a constant 95 kcfs in order to minimize erosion of the Bradford Branch-B fish ladder.	The modified spill treatment schedule was coordinated with the region via FPOM memo of coordination (MOC) 16BON47.
Bonneville	July 7	Operational Limitations	Spill was reduced in order to perform a sonar survey of the erosion holes at the Bradford Branch-B fish ladder.	The survey was coordinated with the region via FPOM memo of coordination (MOC) 16BON47 and discussions at the 7/6/16 TMT.

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

Table 3: July 2016 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	
Method:	WA	WA	WA	WA	WA	WA	WA	WA	WA	OR	WA	WA	OR	WA	WA	OR	WA	WA	OR	WA
7/1/2016	103	111	115	110	113	118	115	114	111	117	~~117~~	109	~~115~~	115	107	113	~~113~~	106	116	~~116~~
7/2/2016	103	111	116	110	114	117	116	114	110	117	~~117~~	109	115	~~115~~	108	~~113~~	113	107	~~117~~	117
7/3/2016	103	111	116	110	113	117	115	114	110	~~116~~	117	109	~~113~~	114	108	~~112~~	113	107	117	~~117~~
7/4/2016	103	111	113	109	113	117	114	112	109	116	~~116~~	107	~~113~~	114	106	112	~~112~~	106	~~116~~	117
7/5/2016	103	111	112	109	112	116	114	112	108	116	~~116~~	106	114	~~114~~	107	112	~~112~~	105	~~116~~	116
7/6/2016	102	111	110	113	110	117	113	113	108	117	~~117~~	105	~~114~~	114	106	113	~~113~~	107	117	~~117~~
7/7/2016	102	111	108	112	110	117	112	112	108	116	~~116~~	105	114	~~113~~	108	113	~~113~~	109	117	~~117~~
7/8/2016	102	111	108	112	110	115	112	112	107	116	~~116~~	105	114	~~114~~	109	114	~~114~~	109	~~117~~	117
7/9/2016	102	111	108	112	109	117	111	113	108	~~116~~	116	105	~~114~~	114	109	~~114~~	114	109	117	~~117~~
7/10/2016	102	111	107	112	108	117	111	113	107	~~114~~	115	105	~~113~~	114	108	~~112~~	113	109	~~117~~	117
7/11/2016	102	111	107	111	108	116	110	112	106	115	~~115~~	105	114	~~114~~	106	112	~~112~~	109	~~117~~	117
7/12/2016	102	110	107	109	108	117	108	111	106	116	~~116~~	105	~~114~~	114	108	112	~~112~~	107	117	~~117~~
7/13/2016	101	110	106	109	106	117	108	114	105	116	~~116~~	104	114	~~114~~	107	~~113~~	113	107	117	~~117~~
7/14/2016	99	110	105	109	108	117	109	114	107	~~116~~	116	104	~~114~~	114	107	113	~~113~~	107	~~117~~	117
7/15/2016	102	110	107	109	108	116	110	114	107	116	~~116~~	103	~~113~~	114	106	~~112~~	113	107	117	~~117~~
7/16/2016	102	111	107	109	107	117	111	114	109	116	~~116~~	103	113	~~113~~	105	~~112~~	112	106	117	~~117~~
7/17/2016	103	111	108	109	107	116	113	113	109	~~116~~	116	104	~~114~~	114	107	113	~~113~~	106	117	~~117~~
7/18/2016	104	111	108	109	107	117	113	114	109	117	~~117~~	104	~~113~~	114	107	~~112~~	113	106	~~117~~	117
7/19/2016	103	110	108	109	106	116	113	114	108	~~116~~	116	105	~~113~~	113	106	112	~~112~~	108	117	~~117~~
7/20/2016	102	111	108	110	107	116	112	114	108	~~115~~	116	106	114	~~114~~	108	113	~~113~~	109	~~117~~	117
7/21/2016	102	112	108	110	107	116	112	114	108	116	~~116~~	107	~~114~~	114	110	115	~~115~~	109	117	~~117~~
7/22/2016	102	112	108	110	107	116	112	113	108	~~115~~	116	107	113	114	109	~~112~~	114	109	117	~~117~~
7/23/2016	102	112	108	109	106	115	112	114	108	115	~~115~~	105	114	~~114~~	105	111	~~111~~	106	117	~~117~~
7/24/2016	103	113	107	109	108	116	112	114	108	115	~~115~~	106	114	~~114~~	107	113	~~113~~	107	117	~~117~~
7/25/2016	103	112	107	109	108	116	112	114	109	116	~~116~~	106	114	~~114~~	109	114	~~114~~	108	117	~~117~~
7/26/2016	103	112	107	109	107	114	112	114	111	117	~~116~~	106	114	~~114~~	108	~~113~~	114	108	117	~~117~~
7/27/2016	102	112	107	109	108	114	112	114	111	117	~~117~~	106	114	~~114~~	107	113	~~113~~	106	~~117~~	117
7/28/2016	103	113	107	110	108	114	113	113	111	117	~~117~~	107	114	~~114~~	109	~~114~~	114	108	117	~~117~~
7/29/2016	103	113	108	110	108	116	114	113	112	117	~~117~~	108	114	~~114~~	109	115	~~115~~	110	~~117~~	117
7/30/2016	104	113	109	110	108	116	114	112	112	~~117~~	117	109	115	~~114~~	109	~~113~~	115	110	~~117~~	117
7/31/2016	104	112	109	109	108	116	114	111	111	117	~~117~~	107	115	~~115~~	106	~~111~~	112	107	117	~~117~~

Figure 1

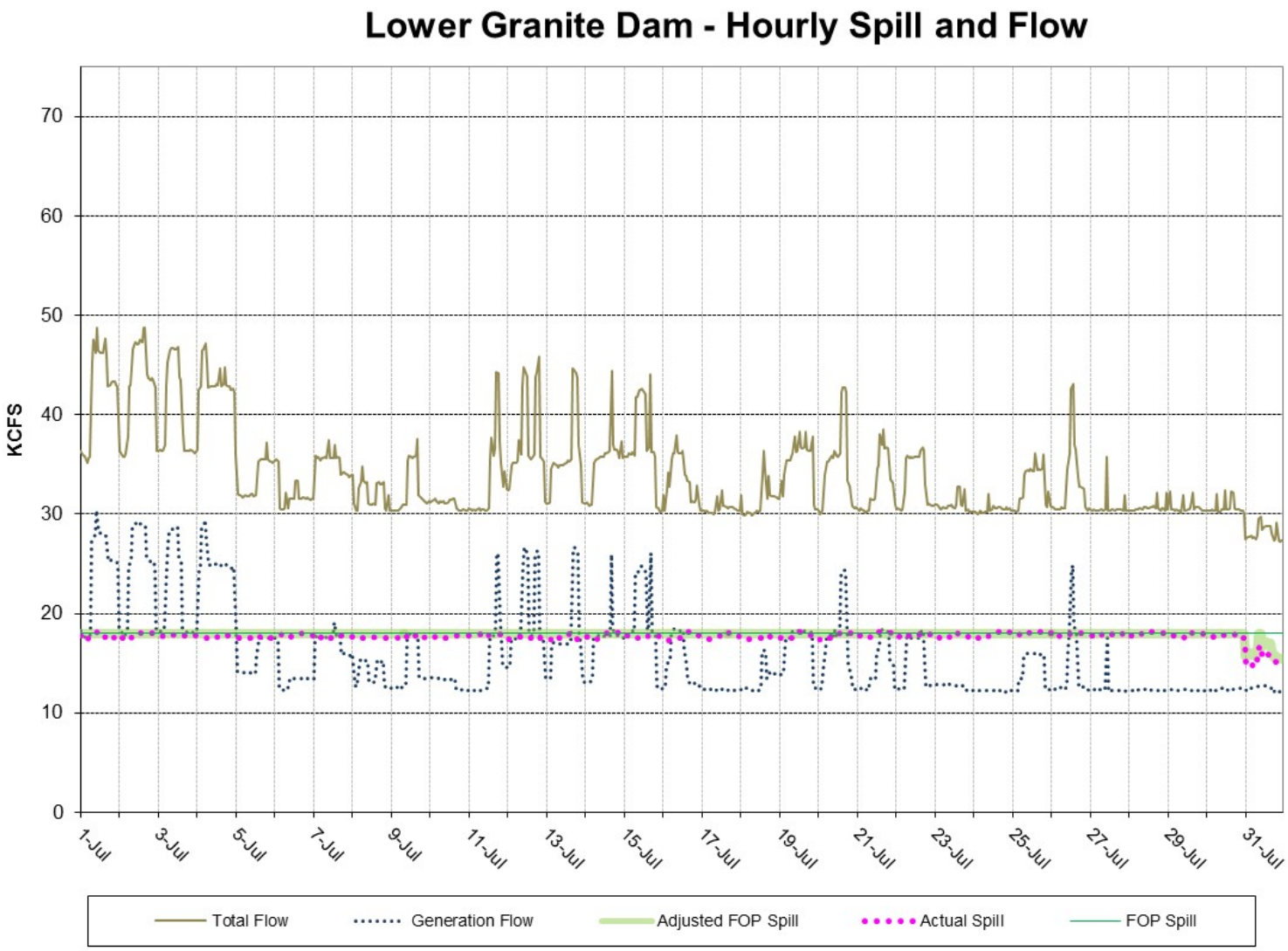

Lower Granite Dam - Hourly Spill and Flow
KCFS
70
60
50
40
30
20
10
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 2

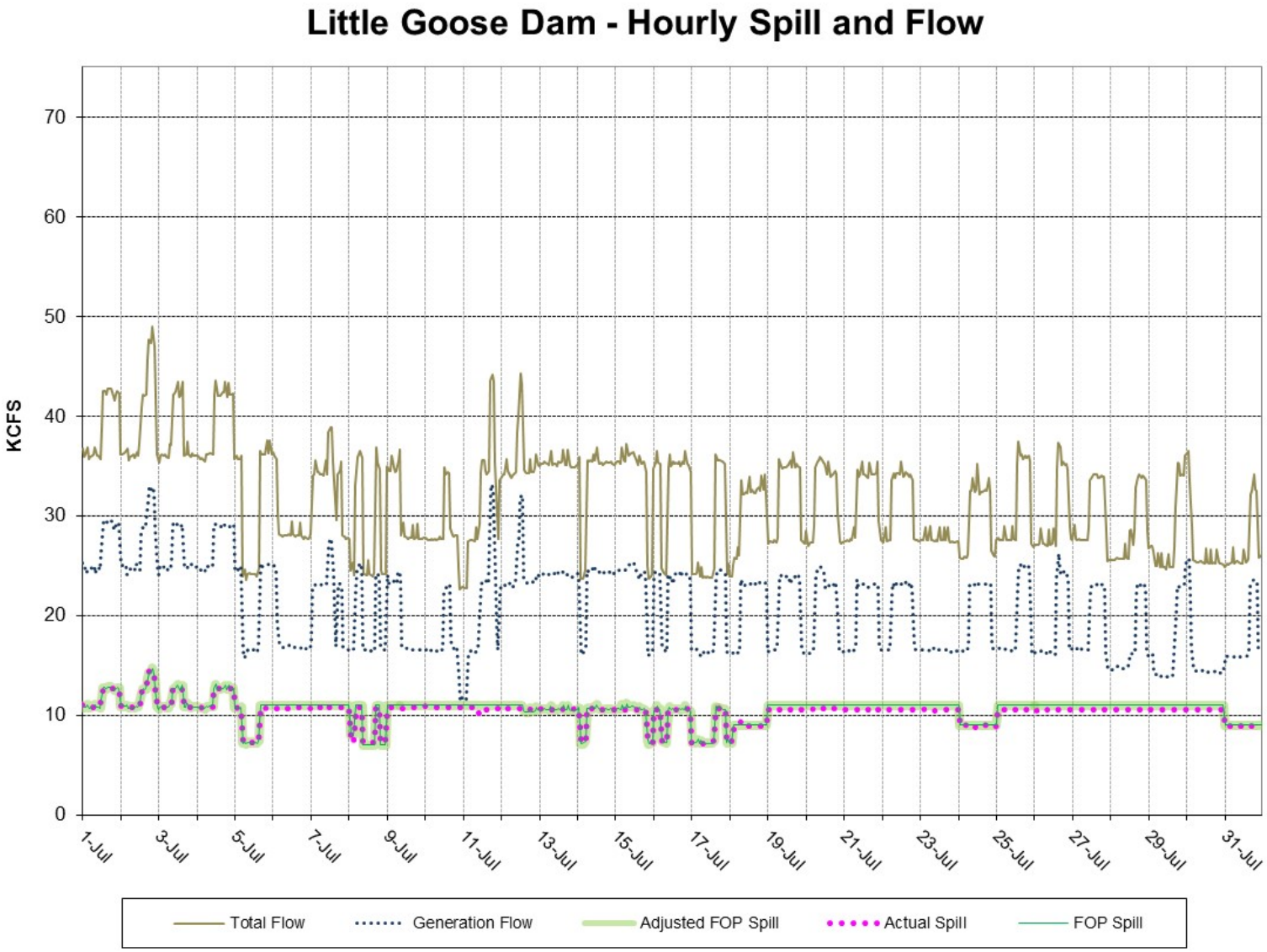

Little Goose Dam - Hourly Spill and Flow
KCFS
70
60
50
40
30
20
10
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 3

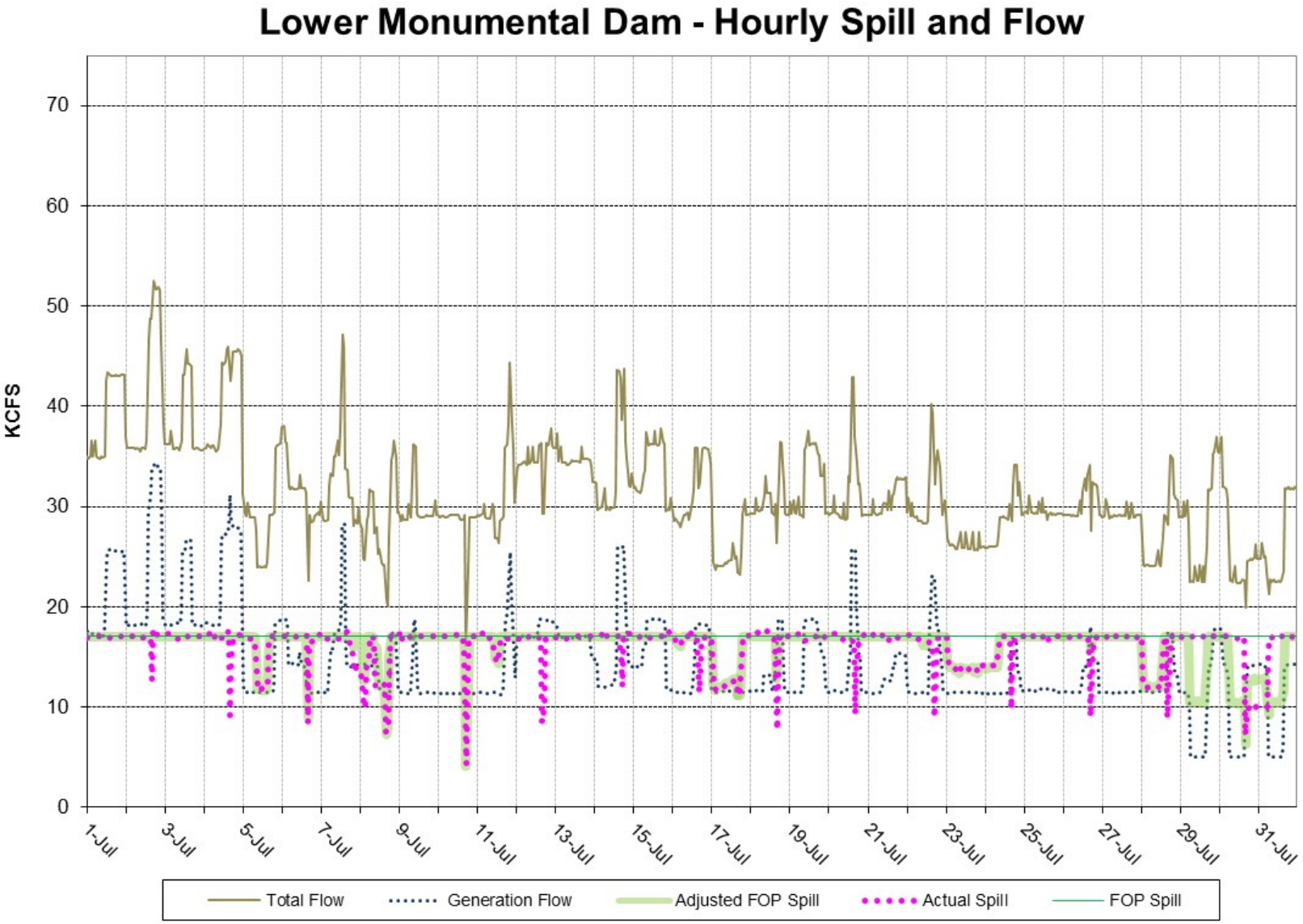

Lower Monumental Dam - Hourly Spill and Flow
KCFS
70
60
50
40
30
20
10
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 4

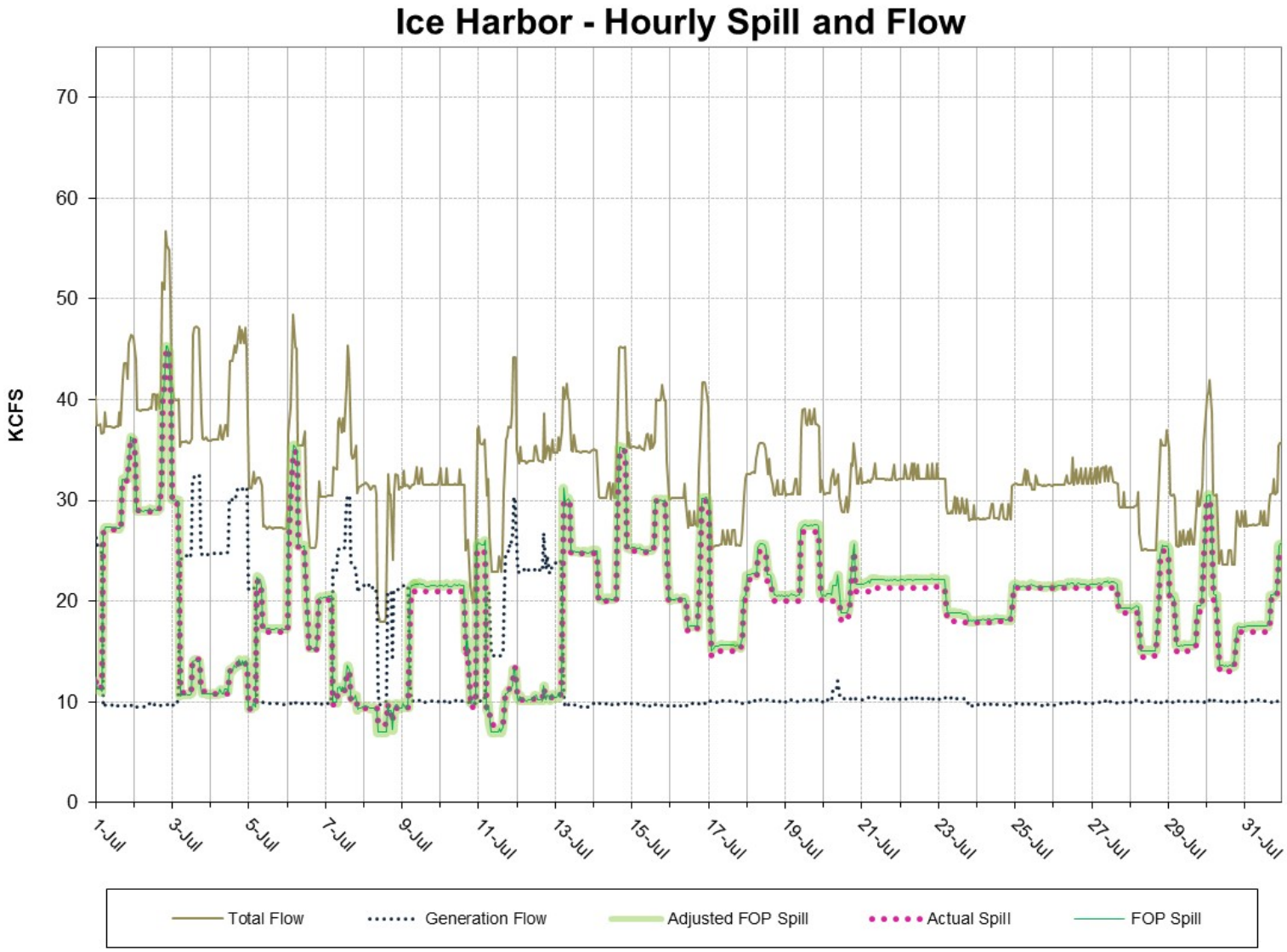

Ice Harbor - Hourly Spill and Flow
KCFS
70
60
50
40
30
20
10
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 5

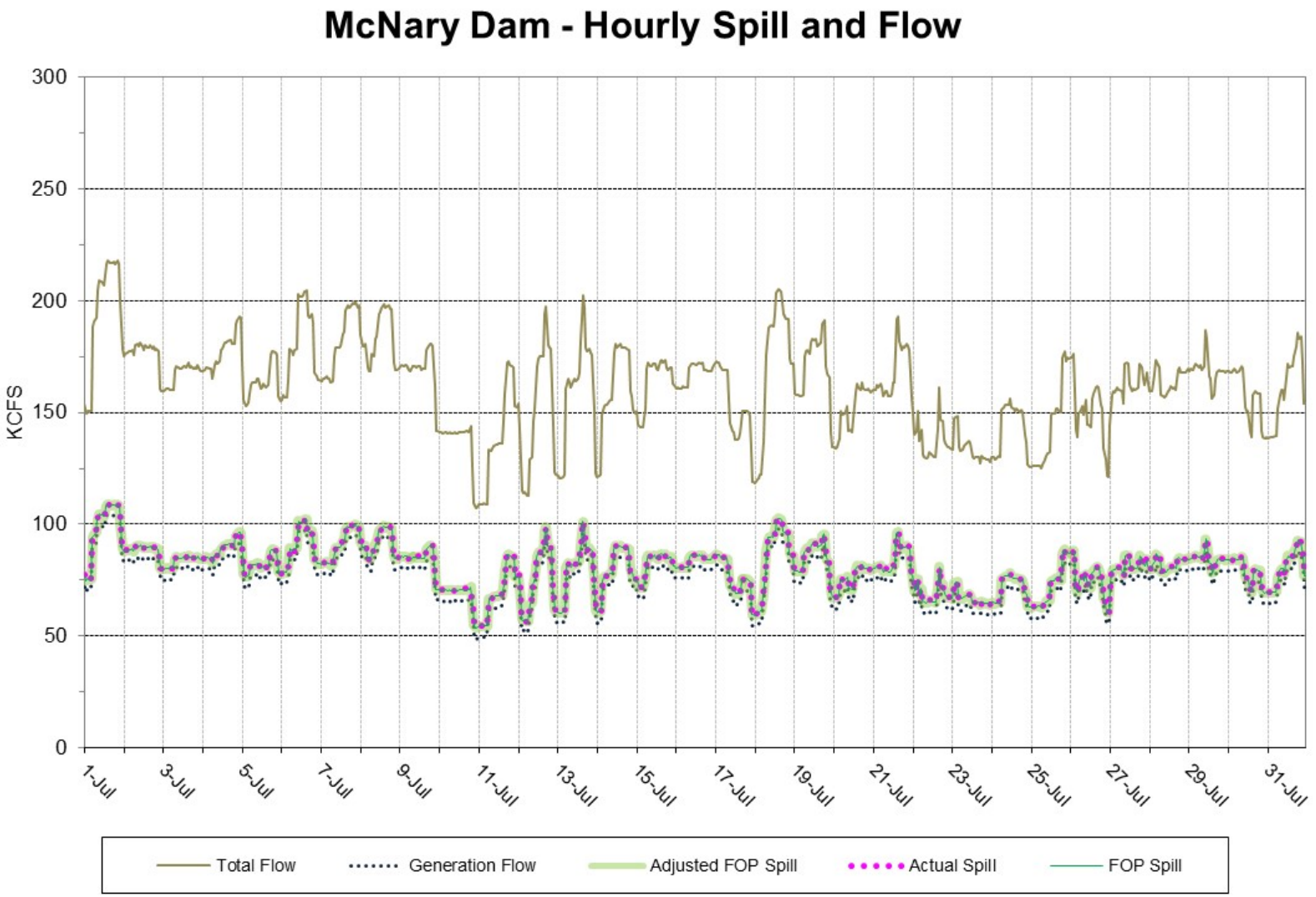

McNary Dam - Hourly Spill and Flow
KCFS
300
250
200
150
100
50
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 6

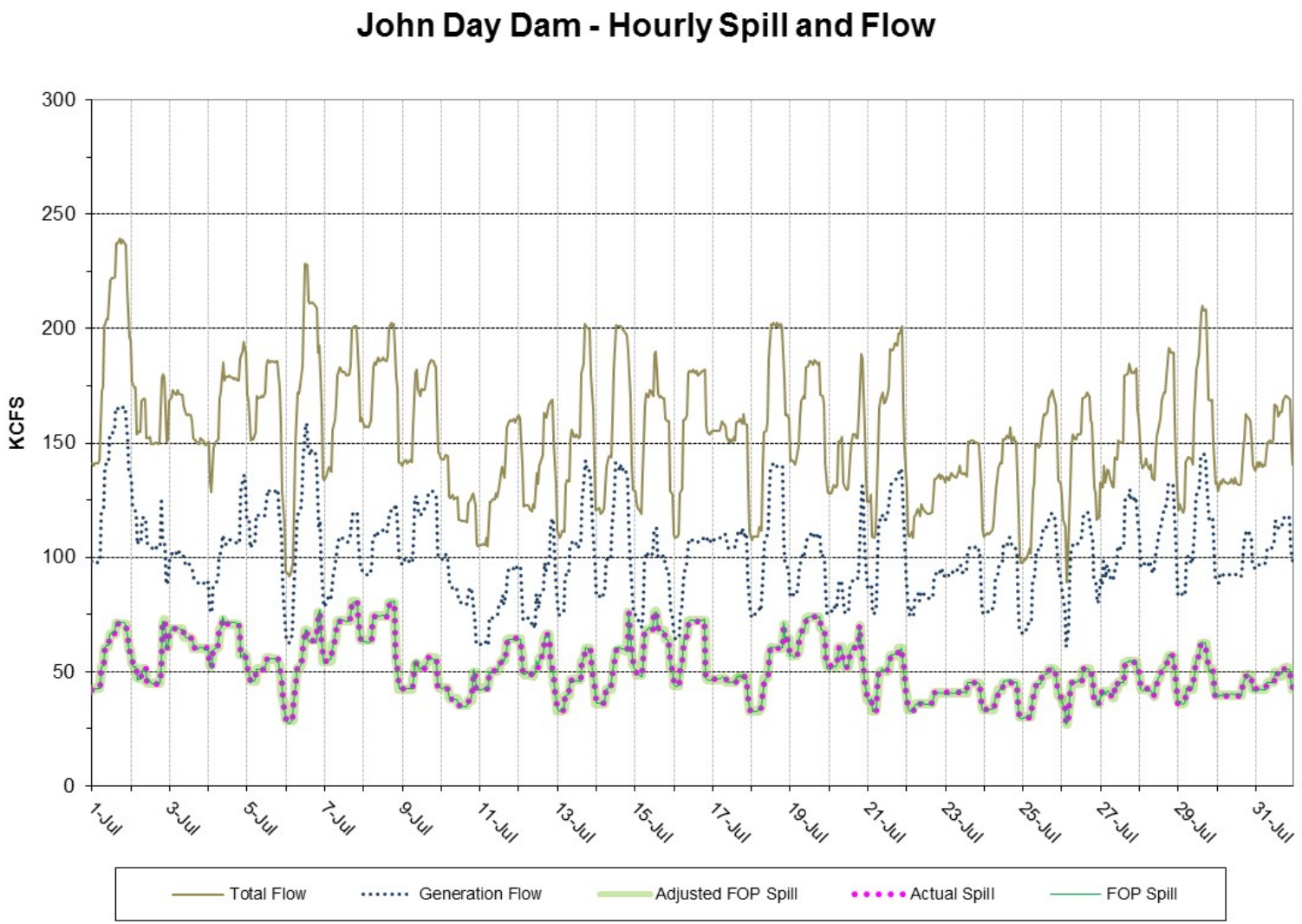

John Day Dam - Hourly Spill and Flow
KCFS
300
250
200
150
100
50
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 7

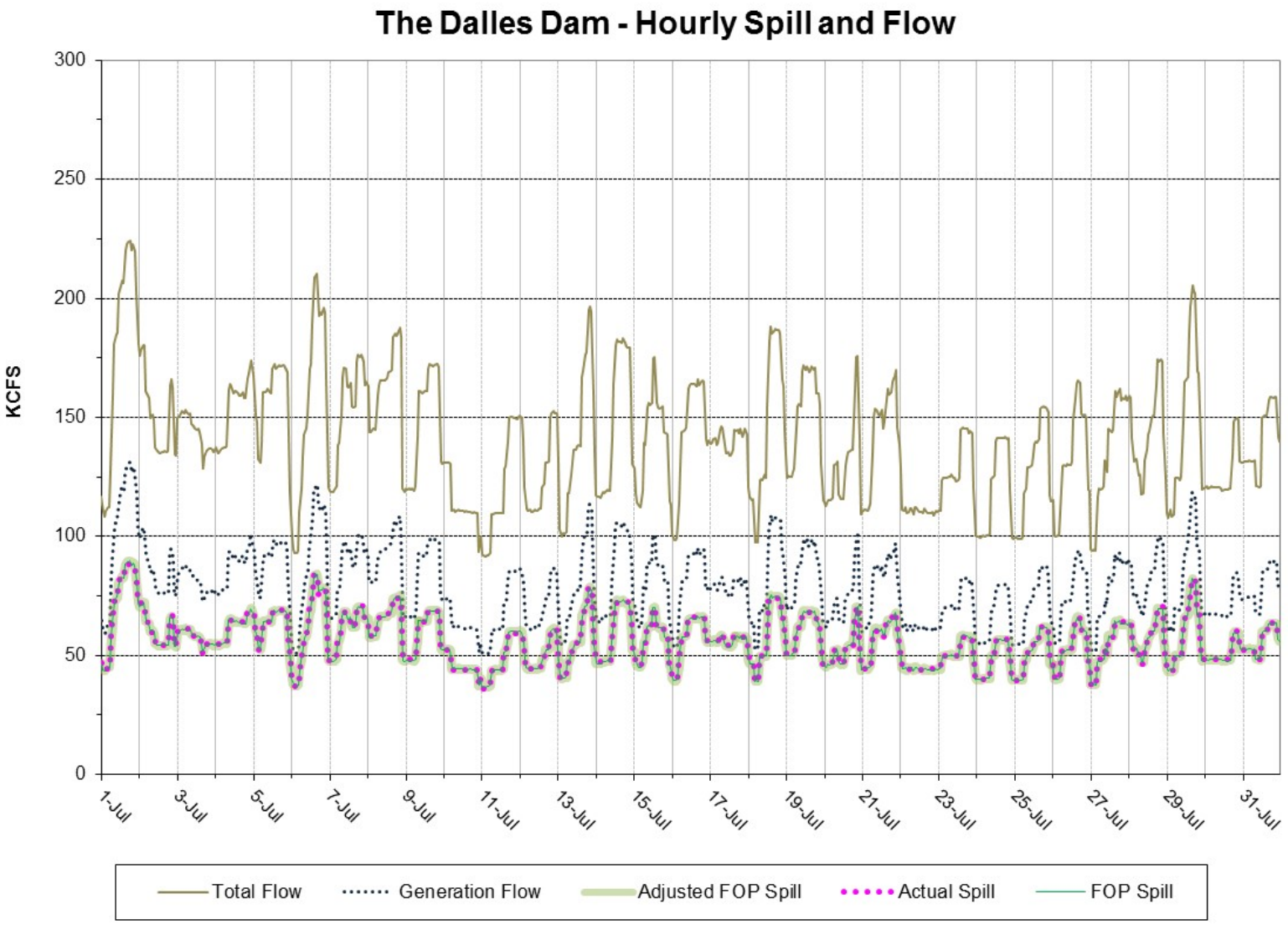
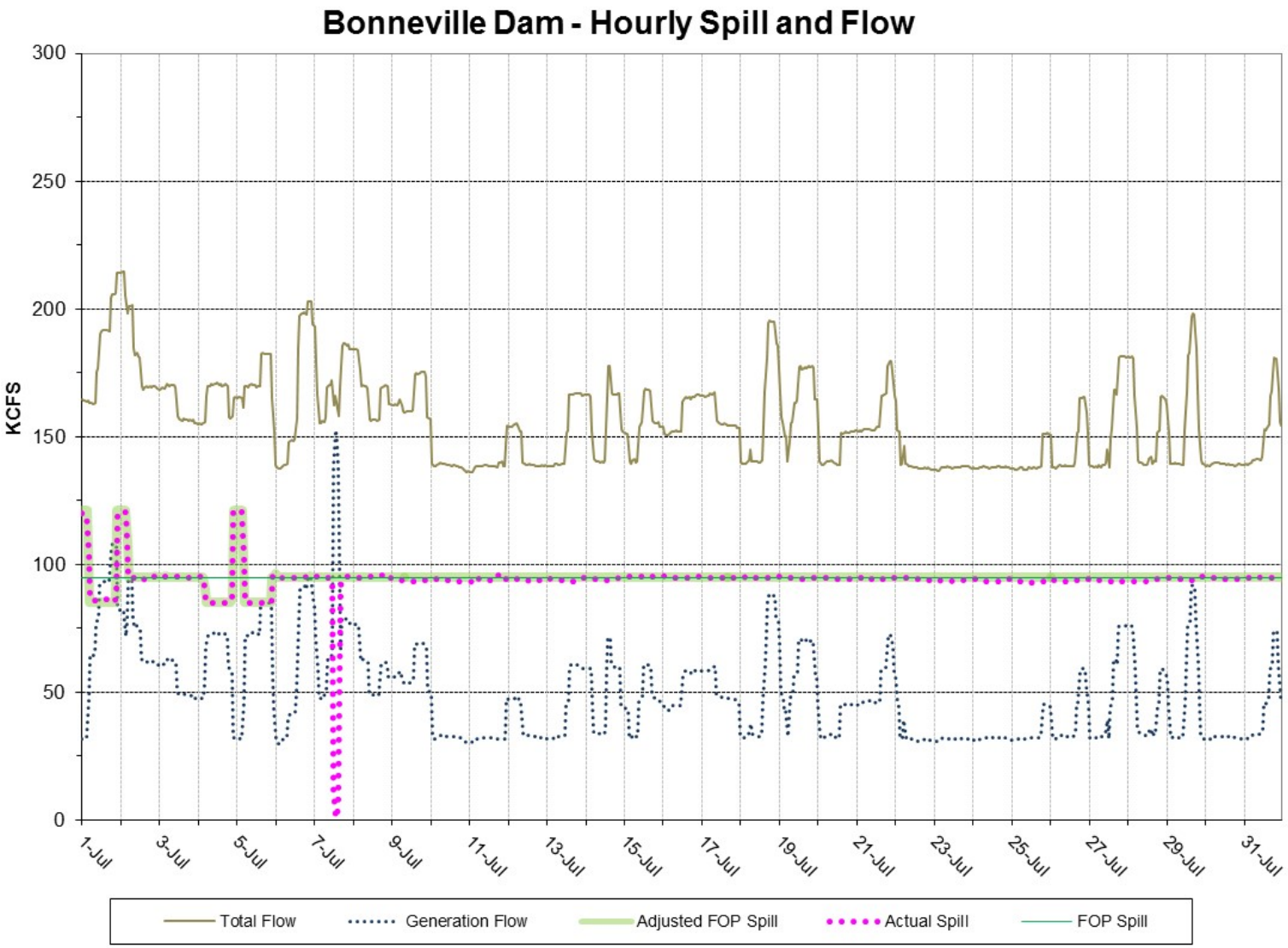

The Dalles Dam - Hourly Spill and Flow
KCFS
300
250
200
150
100
50
0
1-Jul
3-Jul
5-Jul
7-Jul
9-Jul
11-Jul
13-Jul
15-Jul
17-Jul
19-Jul
21-Jul
23-Jul
25-Jul
27-Jul
29-Jul
31-Jul
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 8


Bonneville Dam - Hourly Spill and Flow
KCFS
300
250
200
150
100
50
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
Adjusted FOP Spill
Actual Spill
FOP Spill