FISH OPERATIONS PLAN IMPLEMENTATION REPORT

May 2017

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 2017 Fish Operations Plan (2017 FOP) posted to the Technical Management Team (TMT) website on March 6, 2017. The 2017 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 2017 FOP, the FCRPS operations will be consistent with the 2014 NOAA Fisheries Supplemental Biological Opinion (2014 Supplemental BiOp), the United States Fish and Wildlife Service's 2000 and 2006 Biological Opinions, and/or other operative documents, including the 2017 Water Management Plan (WMP), WMP seasonal updates, and the 2017 Fish Passage Plan (FPP).

The Corps' May 2017 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 2017 FOP in May 2017.

Data Reporting

I. For each project providing fish passage operations, this report contains one graph per operational month (May) displaying the performance of the fish passage spill program, with hourly spill, FOP spill, generation, and total flows. The monthly graphs begin on May 1 and end on May 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 May 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 2017 FOP.
- The thick green line represents the adjusted FOP spill.[2] 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 2017 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 Dam (50 kcfs); and
    - minimum spill at John Day Dam is 25 percent of project outflow.

II. The average daily %TDG for the 12 highest hours for all projects is shown in the May 2017 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 2017 FOP, the dotted pink line will be below or above the heavy green line in the figures.[3] Actual deviations from the target operation during voluntary spill hours are described below in the May 2017 Spill Variance Table (Table 1).[4] 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

[2] For the month of May, the plot for John Day dam shows actual spill (dotted pink line) at the adjusted FOP spill level (thick green line). As a result of setting spill caps to manage TDG, the adjusted spill level was below FOP spill level (thin green line).

[3] The actual thickness of the heavy green line (adjusted FOP spill) is not representative of the spill cap range; if the dotted pink line is slightly outside the thick green line, it should not be construed to indicate a spill variance or involuntary spill.

[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, and passing debris.

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 stops to most closely approximate the 2017 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)[5] 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 2017 FOP for Bonneville and The Dalles dams[6], which may range up to ±3 kcfs) as compared to those specified in the 2017 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 2017 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

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

[6] As specified in the 2017 FOP (p. 14), this applies when the spill level is below 40% of total flow at The Dalles Dam.

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 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 2017 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.

May Operations

The month of May was characterized by above average flows for the lower Snake and lower Columbia Rivers along with above average air temperatures and below average precipitation across most of the Columbia River basin. The NOAA Northwest River Forecast Center[7] indicated that the May 2017 adjusted runoff for the Snake River at Lower Granite was 146% of the 30-year average (1981-2010) with a volume of 10.1 MAF (Million Acre Feet). The May 2017 adjusted runoff for the Columbia River at The Dalles was 141% of average with a volume of 35.8 MAF. High flows in May were primarily driven by snowmelt and resulted in involuntary spill in the lower Snake and lower Columbia. The May 2017 observed precipitation was 55% of average on the Snake River above Ice Harbor and 66% of average on the Columbia River above The Dalles. The May 2017 observed temperatures were 1.6°F above average in the Snake River basin above Ice Harbor and 2.7°F above average in the Columbia River basin above The Dalles.

During the May 2017 reporting period, the planned 2017 FOP spill operations were carried out as follows:

- Lower Granite Dam - The hourly target spill level was 20 kcfs, 24 hours/day.
- Little Goose Dam - The hourly target spill level was 30% of total project outflow, 24 hours/day.
- Lower Monumental Dam - The hourly target spill level was the %TDG cap 24 hours/day.
- Ice Harbor Dam - The hourly target spill level was alternated between two day treatments of 30% of total project outflow, 24 hours/day vs. 45 kcfs during the daytime and the %TDG cap during the nighttime. Nighttime spill hours are 1800–0500.
- McNary Dam - The hourly target spill level was 40% of total project outflow, 24 hours/day.
- John Day Dam - The hourly target spill level was alternated between two day treatments of 30% and 40% of total project outflow, 24 hours/day. Spill level changes occur 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 was 100 kcfs, 24 hours/day.

Operational Adjustments

There are no operational adjustments to report for May 2017.

[7] Retrieved June 1, 2017: https://www.nwrfc.noaa.gov/runoff/runoff_summary.php?date=06/01/2017

Table 1: Spill Variance Table – May 2017 (5/1 to 5/31)

Project	Parameter	Date	Time[8]	Hours	Type	Reason
Lower Monumental	Reduced Spill	5/3/17	1900-2300	5	Maintenance	Hourly spill ranged from 23 to 38 kcfs (below FOP 55 kcfs ±2 kcfs) due to the malfunctioning of navigational lockage gate.
Lower Monumental	Reduced Spill	5/18/17	1400-1600	3	Operational Limitation	Hourly spill decreased to 44-52 kcfs (below 55 kcfs ± 2 kcfs range). The forebay elevation was within 0.1 feet of MOP (537 ft) and variable inflow was causing rapid changes in forebay elevation. To avoid a sustained forebay elevation drop below MOP, spill was reduced to increase the forebay elevation.

Table 2: Pre-Coordinated Operations – May 2017 (5/1 to 5/31)

Project	**Date**	**Type**	**Description of Event**	**Regional Coordination**
Lower Monumental	Daily, from 5/2 through 5/26, then every other day from 5/28 through 5/31	Navigation	Spill was reduced for safe passage of fish barges crossing project tailwater.	2017 FOP, pages 2, 4 and 7

[8] 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: May 2017 Average Percent TDG Values Table (5/1 to 5/31)[9]

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
5/1/2017	107	117	114	121	115	120	116	119	113	121	~~121~~	112	120	~~120~~	113	119	~~119~~	118	123	~~123~~
5/2/2017	106	121	113	121	119	121	116	120	114	~~121~~	121	114	122	~~122~~	115	122	~~122~~	120	124	~~124~~
5/3/2017	106	121	113	121	123	120	118	120	117	~~121~~	121	114	~~121~~	122	116	~~121~~	121	124	124	~~124~~
5/4/2017	108	113	117	120	125	120	121	119	119	121	~~121~~	119	121	~~120~~	118	~~120~~	121	124	~~124~~	124
5/5/2017	109	120	120	125	124	121	121	119	119	122	~~122~~	119	122	~~122~~	118	120	~~120~~	122	124	~~124~~
5/6/2017	108	126	116	127	123	123	120	121	116	124	~~124~~	118	128	~~128~~	115	120	~~120~~	116	~~123~~	124
5/7/2017	105	128	113	128	128	124	118	123	114	129	~~129~~	115	133	~~133~~	119	~~123~~	123	119	126	~~126~~
5/8/2017	107	126	119	128	131	126	122	126	117	~~129~~	129	117	136	~~136~~	122	125	~~125~~	124	128	~~128~~
5/9/2017	109	127	121	128	132	127	125	126	120	130	~~130~~	124	~~135~~	136	124	~~125~~	125	126	128	~~128~~
5/10/2017	109	127	121	128	132	126	125	125	121	~~130~~	130	127	136	~~136~~	127	126	~~125~~	127	~~127~~	127
5/11/2017	109	127	122	129	132	125	125	125	121	128	~~128~~	127	~~136~~	136	127	~~125~~	125	125	127	~~127~~
5/12/2017	108	129	120	129	131	127	124	130	119	129	~~129~~	125	~~133~~	133	123	~~124~~	124	124	127	~~127~~
5/13/2017	107	130	120	130	130	127	123	130	117	~~129~~	129	123	134	~~134~~	122	~~123~~	124	124	127	~~127~~
5/14/2017	108	129	121	128	130	127	123	129	117	~~124~~	128	120	~~131~~	133	120	~~123~~	123	123	~~126~~	127
5/15/2017	109	127	122	127	130	126	124	125	118	~~130~~	130	118	131	~~131~~	120	~~122~~	122	123	126	~~126~~
5/16/2017	109	125	122	125	130	124	124	123	118	~~126~~	129	118	~~130~~	131	120	~~122~~	122	122	126	~~126~~
5/17/2017	109	123	121	124	126	124	122	122	117	~~124~~	125	117	~~130~~	130	117	~~120~~	121	120	~~125~~	125
5/18/2017	105	119	117	120	124	122	121	120	117	124	~~124~~	115	134	~~134~~	120	122	~~122~~	121	~~125~~	125
5/19/2017	106	118	116	118	123	121	121	120	119	124	~~124~~	116	~~132~~	132	120	123	~~123~~	123	~~125~~	125
5/20/2017	107	117	116	116	123	121	121	120	120	~~124~~	124	119	~~128~~	128	119	~~122~~	122	124	~~124~~	125
5/21/2017	107	119	115	117	118	120	120	118	120	~~122~~	123	122	~~128~~	128	121	124	~~124~~	124	124	~~124~~
5/22/2017	106	119	115	119	118	120	119	119	120	123	~~123~~	123	129	~~129~~	123	125	~~125~~	125	~~123~~	123
5/23/2017	107	119	119	119	121	122	120	119	121	123	~~123~~	124	123	~~123~~	123	~~124~~	125	126	124	~~124~~
5/24/2017	108	123	120	123	121	123	120	122	121	124	~~124~~	124	123	~~123~~	121	~~122~~	124	124	123	~~123~~
5/25/2017	107	124	117	124	123	126	120	125	118	~~124~~	124	118	126	~~126~~	122	~~123~~	123	121	126	~~126~~
5/26/2017	106	124	117	125	125	124	122	125	118	124	~~124~~	117	~~124~~	125	121	~~122~~	123	124	127	~~127~~
5/27/2017	107	122	118	121	125	122	122	122	119	~~124~~	124	120	~~122~~	124	119	122	~~122~~	124	~~126~~	127
5/28/2017	108	121	119	121	123	122	122	121	120	124	~~124~~	123	~~121~~	121	121	~~124~~	124	124	~~125~~	125
5/29/2017	108	121	119	120	124	121	122	121	121	124	~~124~~	124	122	~~122~~	121	~~124~~	124	124	~~124~~	125
5/30/2017	108	123	119	122	123	122	122	121	121	124	~~124~~	124	122	~~122~~	121	~~123~~	123	123	126	~~125~~
5/31/2017	108	125	118	125	123	125	121	125	120	125	~~125~~	122	125	~~125~~	119	~~122~~	122	120	128	~~128~~

[9] Two TDG values are reported for fixed monitoring stations where both Oregon's standard and Washington's criteria applies. The two states' standards/criteria and calculation methodologies differ as represented in the two columns. The smaller of the two values is denoted with a strikethrough because the Corps operates to the more stringent standard/criteria.

Figure 1

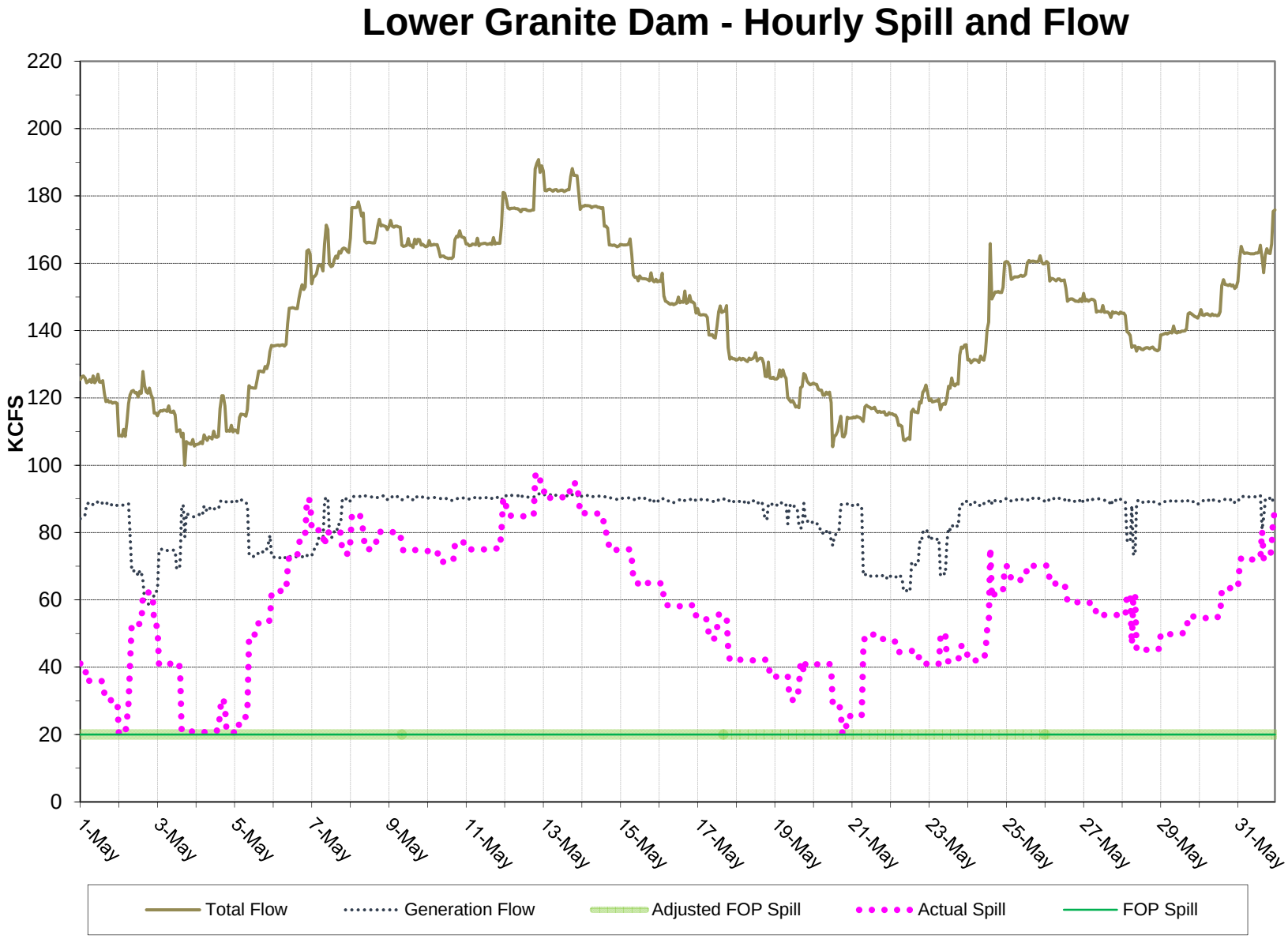

Lower Granite Dam - Hourly Spill and Flow
KCFS
220
200
180
160
140
120
100
80
60
40
20
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 2

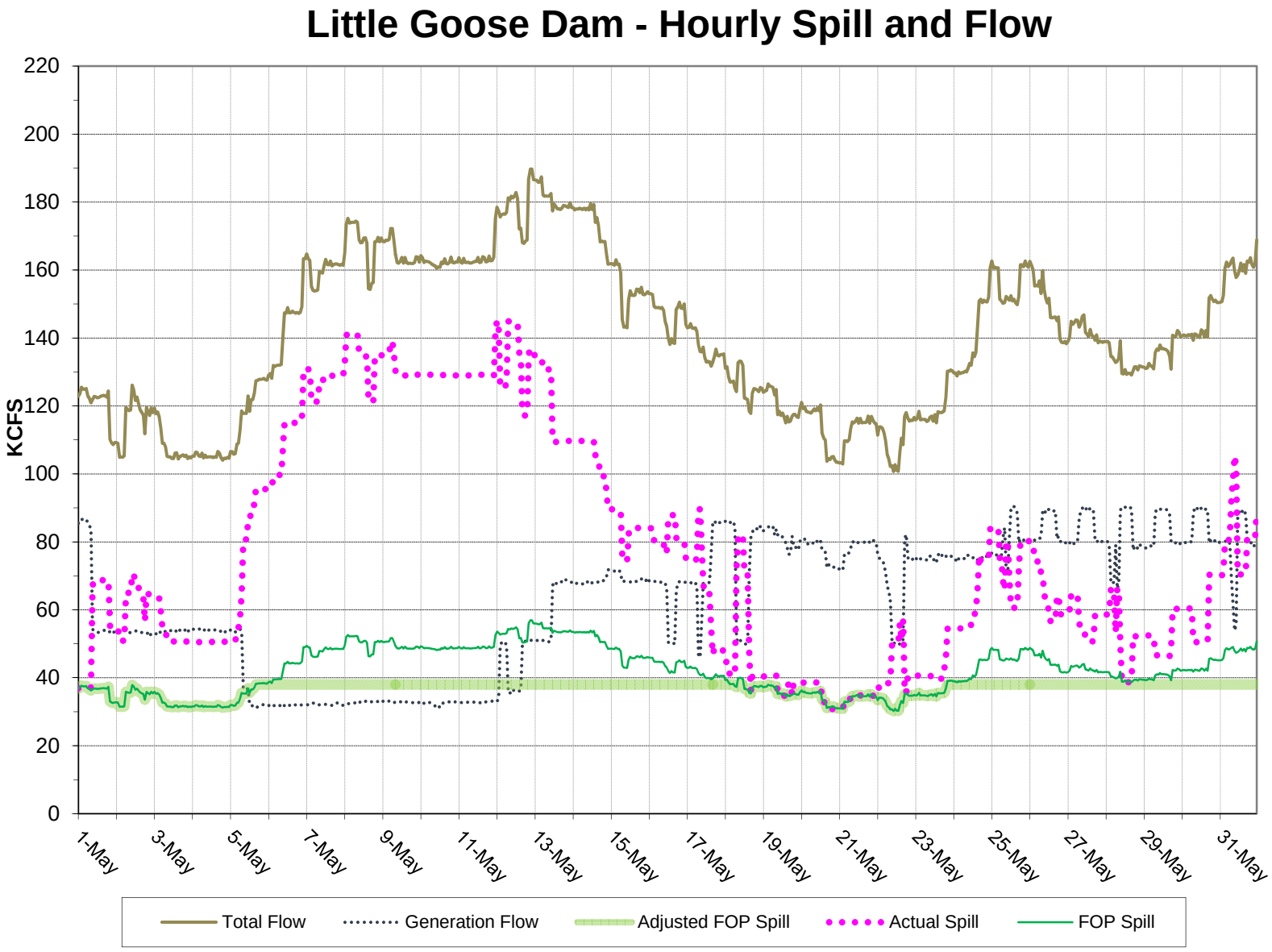

Little Goose Dam - Hourly Spill and Flow
KCFS
220
200
180
160
140
120
100
80
60
40
20
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 3

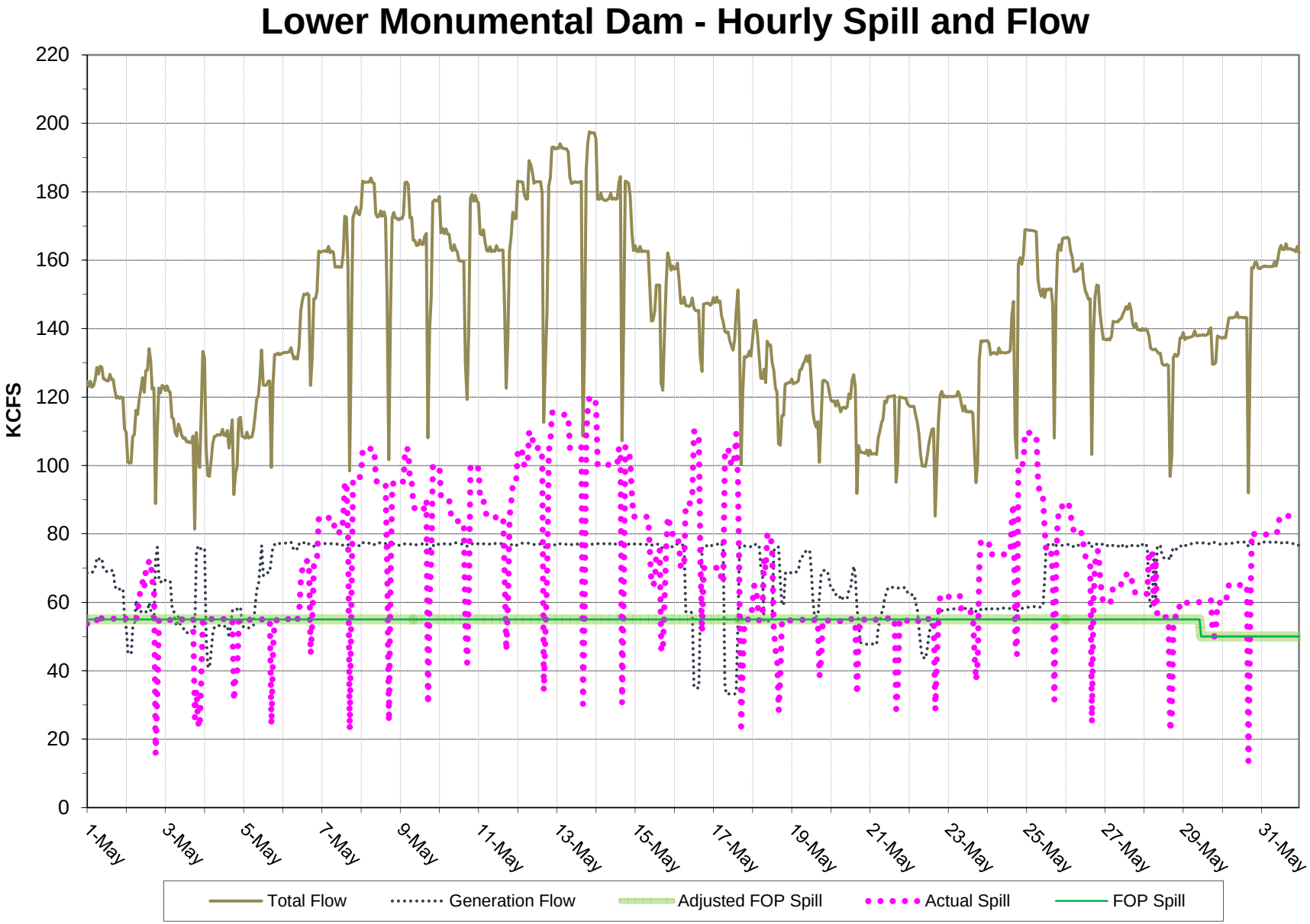

Lower Monumental Dam - Hourly Spill and Flow
KCFS
220
200
180
160
140
120
100
80
60
40
20
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 4

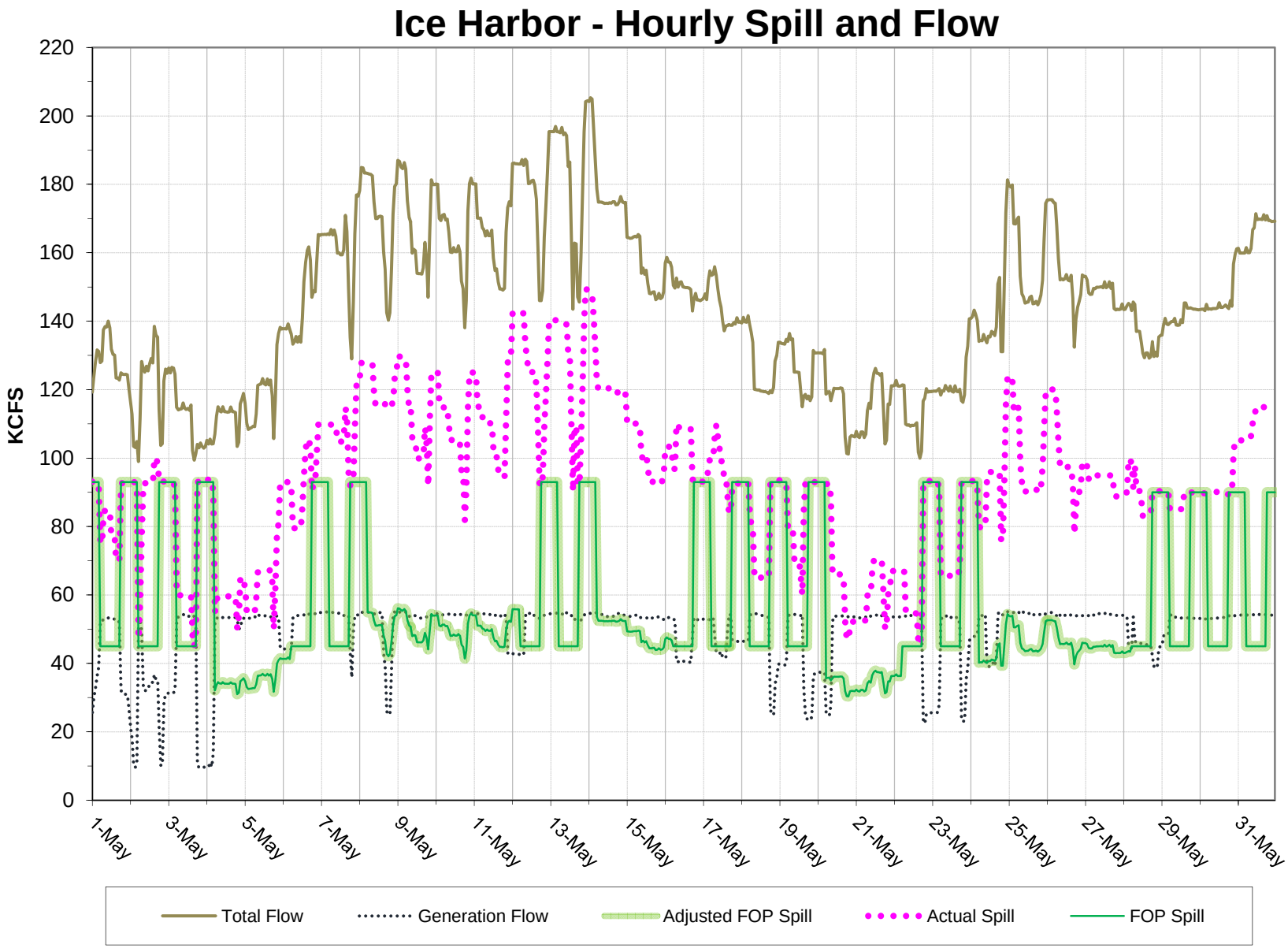

Ice Harbor - Hourly Spill and Flow
KCFS
220
200
180
160
140
120
100
80
60
40
20
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 5

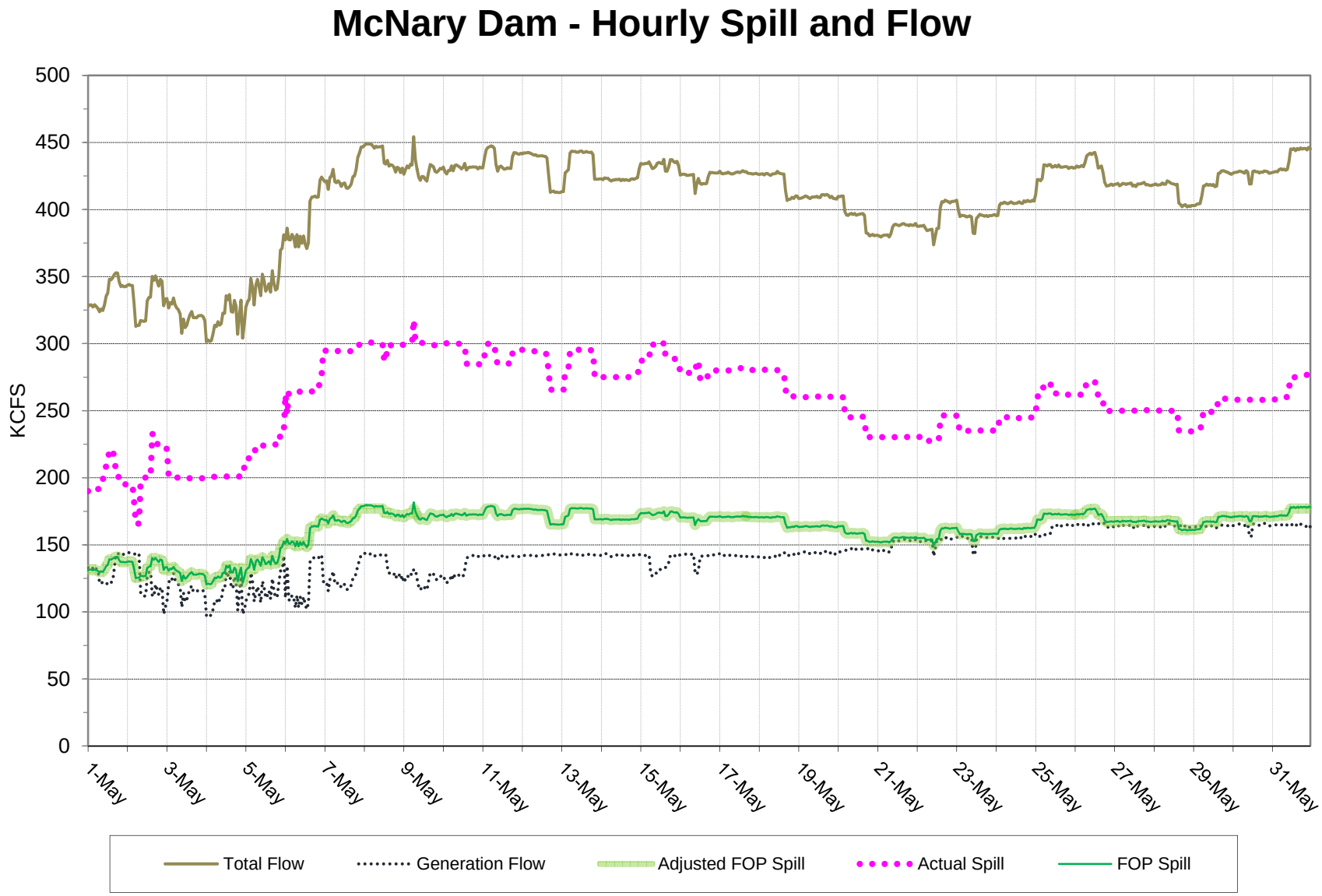

McNary Dam - Hourly Spill and Flow
KCFS
500
450
400
350
300
250
200
150
100
50
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 6

John Day Dam - Hourly Spill and Flow

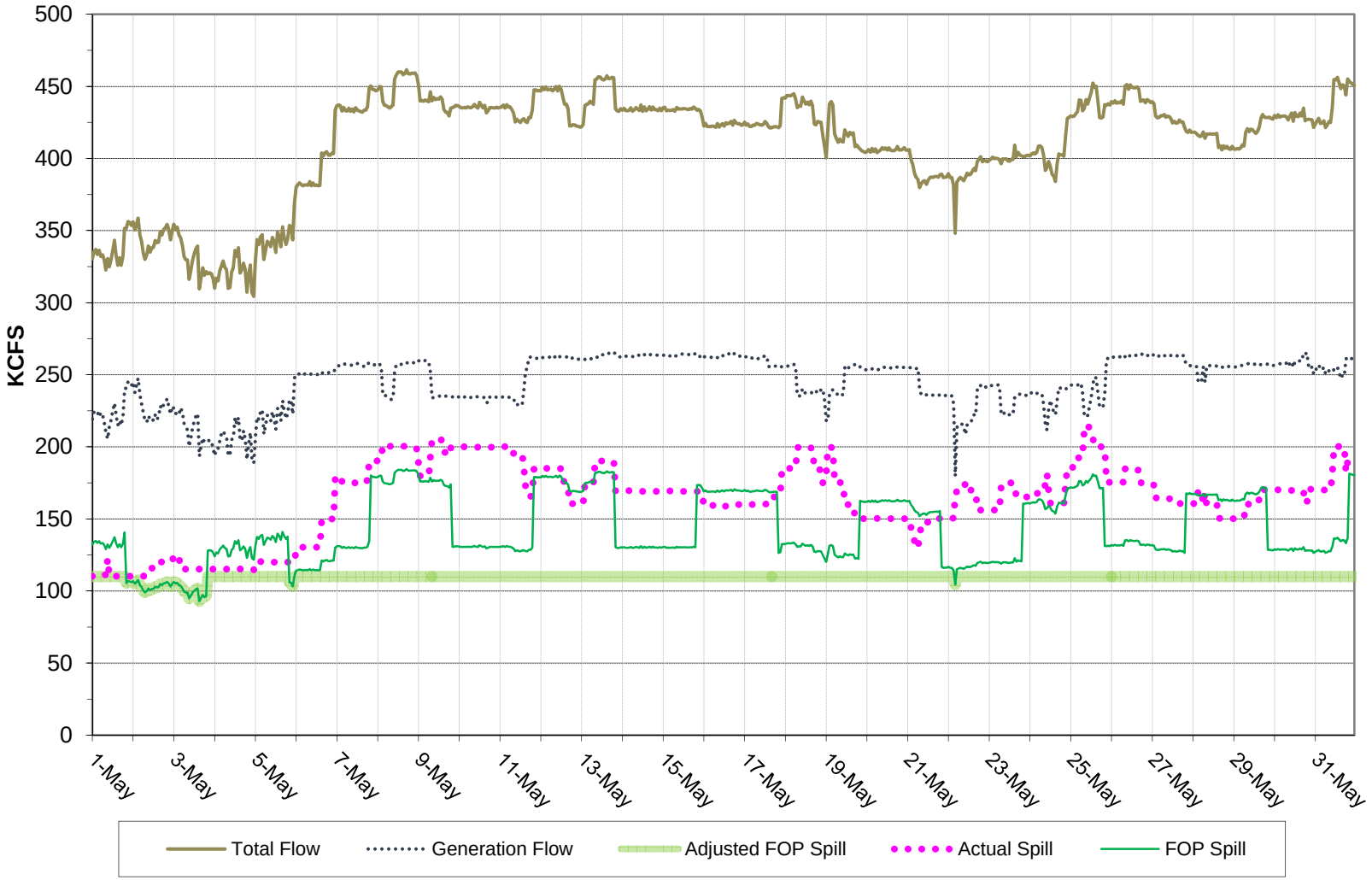


Figure 7

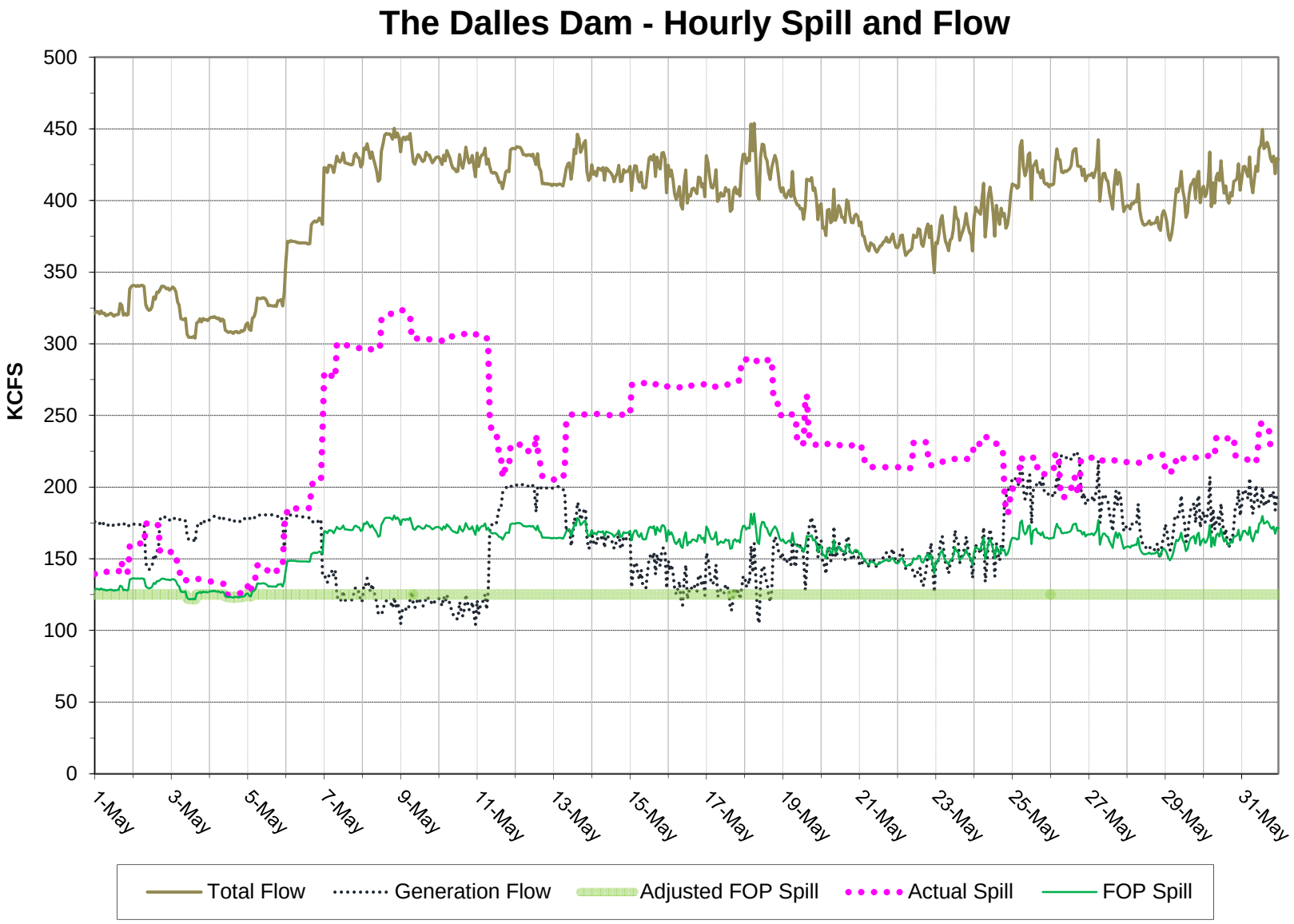
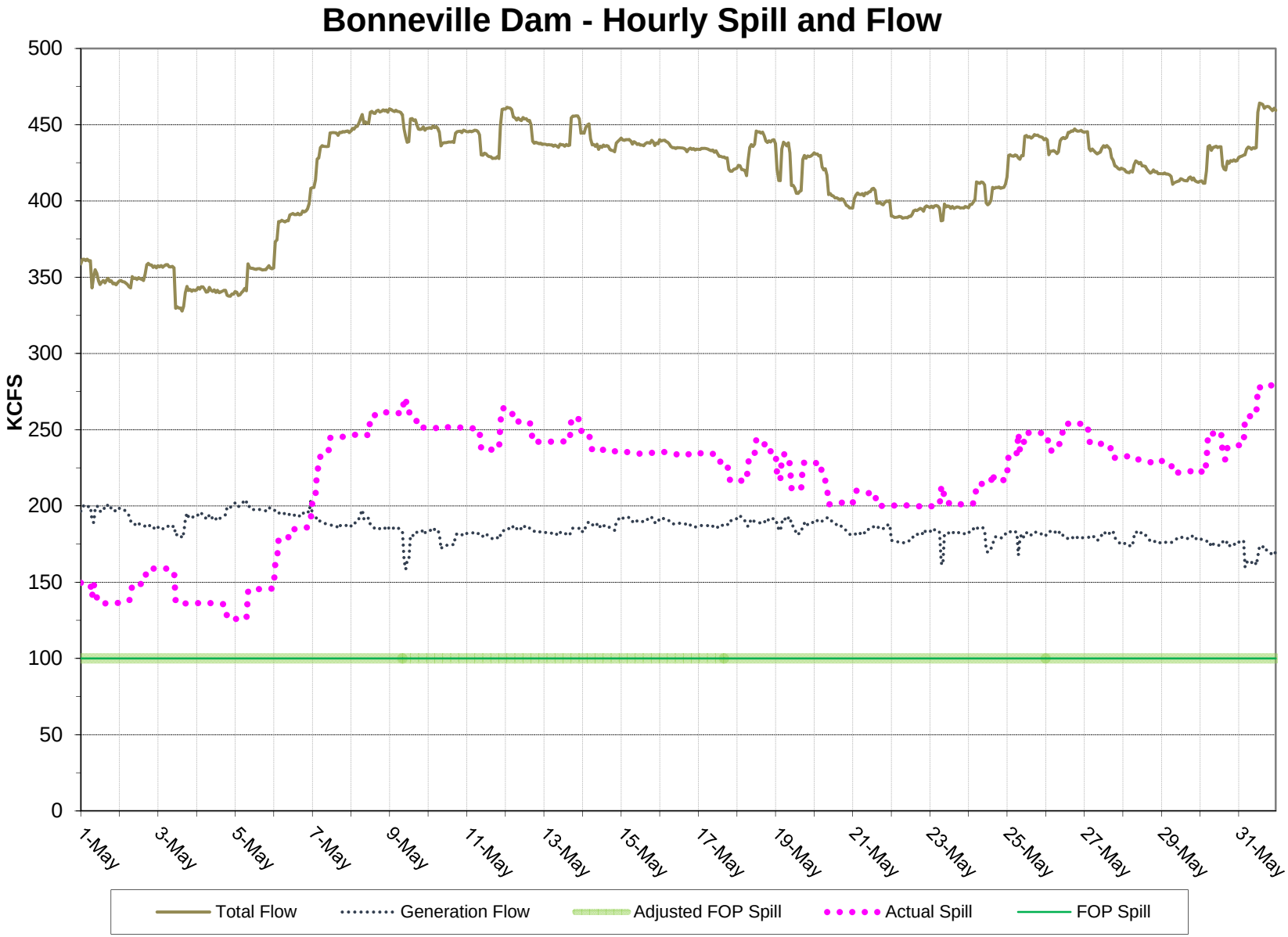

The Dalles Dam - Hourly Spill and Flow
KCFS
500
450
400
350
300
250
200
150
100
50
0
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Total Flow
Generation Flow
Adjusted FOP Spill
Actual Spill
FOP Spill

Figure 8


Bonneville Dam - Hourly Spill and Flow
KCFS
500
450
400
350
300
250
200
150
100
50
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 FOP Spill
Actual Spill
FOP Spill