2016 Summer Water Supply Season – Retrospective
Prepared: January 27, 2017, Portland Water Bureau

The following retrospective describes the 2016 drawdown season including the weather, demands, groundwater use, water efficiency and conservation, and fish flows.

Weather

The accumulation of snowpack during the winter of 2015-16 was above average early in the season, fell below average in early- to mid-February, and melted off 6-8 weeks before average. Snow was not a large contributor to summer supply from Bull Run in 2016 because the spring snowmelt was finished by early May, before drawdown of the reservoirs began. It is typical for snow to only be a small contributor to supply in the Bull Run watershed due to its elevation. When the snowpack is significantly greater than normal, however, it can help delay the onset of drawdown. For the winter of 2015-16, the low elevation snow monitoring site at South Fork (2690' elevation) recorded a maximum accumulation of 6.2 inches of snow water equivalent (SWE; the depth of liquid water if the snowpack was completely melted). The mid-elevation site at North Fork (3060' elevation) recorded a maximum of 15.9 inches SWE. The highest elevation site at Blazed Alder (3650' elevation) had a maximum SWE of 26.3 inches SWE. The maximum SWE accumulation for 2016 at South Fork was 67% of the 1999-2015 average. The North Fork maximum SWE was 56% of average, and the Blazed Alder SWE was 70% of average. The timing of maximum snowpack was mid-January to early February for South Fork and North Fork and late March for Blazed Alder. Snow water equivalent data are presented graphically in Figure 1.

Precipitation during 2016 was, overall, above average in the Bull Run watershed. Total rainfall for the calendar year was 86 inches at Headworks, approximately 6 inches more than the annual average from 1899-2015. Figure 2 shows monthly precipitation at Headworks. The driest month was August, with 0.6 inches of rainfall recorded at Headworks during the month. October was the wettest month, with 16.1 inches of rainfall recorded at Headworks, or 250% of the historical October average.

Temperatures in Portland in 2016 were overall slightly above average, with warmer than average temperatures in the first half of the year, and variable temperatures relative to average for the latter half of the year. The annual average temperature for Portland was 0.5°F above average.

Demand

Historic winter base demand peaked between 1979 and 1991 at an average of approximately 100 million gallons per day (MGD). Since then winter base demand (November-March) has declined, with demand over the past 5 years approximately 15% lower at an average of about 85 MGD. In 2016, demand ran about 97% of the average for the previous five years; Figure 3 shows demand from 2016 and the preceding five-year period, based on 7-day moving averages. Monthly averages (not shown) ranged from 90% to 105% of the monthly averages for the previous five years. The first half of the year was near the previous five years' average, while the latter half of the year was below the average. These demand numbers reflect the total amount of water supplied to serve Portland retail and wholesale customers, and is not equivalent to the total amount of water that is metered and billed.

Bull Run Supply

Drawdown of the Bull Run reservoirs began on May 30, but rains in mid-June refilled the reservoirs, and continuous drawdown started on June 30, close to the historical onset of drawdown. The reservoirs reached their minimum storage on October 4, when 3.6 of 9.9 billion gallons (BG) of usable storage (36%) remained in the reservoirs. The reservoirs completed filling on October 13, though increased

downstream releases for fish resulted in a few subsequent small drawdowns. Figure 4 shows the 2016 drawdown of the Bull Run reservoirs.

Groundwater Use

Each year, the PWB conducts a groundwater maintenance operation in order to conduct water quality monitoring, exercise pumps and identify needed repairs. The maintenance operation in 2016 began on July 25 and continued for 17 days, ending August 10. One main pump unit was operated around the clock producing roughly 18 MGD of groundwater. A total of 280 MG of groundwater were produced during the 2016 maintenance operation.

Groundwater is blended with surface water at Powell Butte. The daily blend during the 2016 maintenance operation ranged between 14% and 19% groundwater. The Sand and Gravel Aquifer (SGA) provided 88% of the total groundwater contribution to the distribution system, the Blue Lake Aquifer (BLA) provided 7% and the Troutdale Sandstone Aquifer (TSA) provided 5%. Figure 5 shows the daily and cumulative groundwater discharge by aquifer during the 2016 maintenance operation.

Groundwater Use Model

Since 2007, a probabilistic Groundwater Use Model has been incorporated into summer supply planning. The Groundwater Use Model uses current-year demand projections, historical reservoir inflows, and anticipated fish flow releases into the Lower Bull Run River to develop a series of reservoir drawdown curves—one for each weather year from 1940 to 2015. These projected drawdown curves are used to determine suggested groundwater pumping rates based on the remaining volume of Bull Run storage above baseline elevations, and the calendar date. These pump rates are set such that they would have kept the Bull Run Reservoirs above their baseline storage levels for all 75 of the historic weather years, while minimizing the volume of pumped groundwater and maintaining a relatively constant pumping rate throughout the drawdown season. The Groundwater Use model is based on the assumption that the temperatures and precipitation patterns in 2016 would be within the range of observed weather since 1940.

The Groundwater Use Model was run in the spring of 2016 before drawdown began. The model does not incorporate weather forecasts and is therefore run only once each year. Subsequent application of the Groundwater Use Model involves comparison of the actual course of drawdown to the groundwater pumping curves generated by the model. Figure 6 shows the groundwater pumping curves that were developed, along with the actual reservoir volumes that were observed during the drawdown season. During drawdown, if the actual storage volume in the Bull Run reservoirs drops below a groundwater pumping curve, then the pumping rate corresponding to that curve is recommended to augment supply.

Bull Run Lake Release

A release of water from Bull Run Lake occurred July 20-August 17. Water was released from the lake at a rate of 20 cubic feet per second (cfs), or 13 MGD. Observed downstream increases in flow were 10-13 cfs (7-9 MGD). This discrepancy may be a result of the release affecting the seepage rate from the lake through the unconsolidated landslide deposits forming a natural dam.

Instream Flows and Fish Habitat Management

The bureau managed water releases downstream of Bull Run Reservoir 2 to meet minimum flow requirements and water temperature targets for the lower Bull Run River, which are required by the Bull Run Water Supply Habitat Conservation Plan (HCP). This was the third year that PWB was using the new gate levels on the Reservoir 2 north tower intake to meet downstream water temperature targets.

Minimum flow levels are typically 120 cfs until June 15, then ramp down by 5 cfs per day until the end of June, when minimum levels are kept between approximately 20-40 cfs to manage for temperature. However, in 2016, critical spring conditions, in which drawdown commences prior to June 15, occurred, with drawdown initially starting May 30. From June 1-7, flow releases in the lower Bull Run River were gradually decreased to summer levels and changed twice a day (within the range of 20 to 50 cfs or more) to meet downstream water temperature targets. Each day's flow target was determined by the temperature of the water being released from Headworks and the forecast maximum air temperature for that day. These flow variations were designed to meet the water temperature goal of keeping the 7-day average of the daily maximum water temperatures at the warmest point on the Bull Run River below the temperature target, which moves according to temperatures observed at the Little Sandy River. The year 2016 was the third year following these temperature targets, and conversations with regulators are ongoing.

Critical fall downstream flows were implemented in 2014 and 2015 and as a result critical fall could not be implemented in 2016, nor can they be declared in 2018 and 2019 (declarations cannot be made for more than two consecutive years or four years after declaring). August and September cumulative inflows to Bull Run reservoirs were greater than the tenth percentile for all historic years (1940-2015). Therefore, critical fall conditions were not met, and the limitation on implementing a critical fall was irrelevant. Normal downstream flows were implemented October and November. Minimum flow levels then increased on October 1 to be 50% of the reservoir inflow (calculated on a weekly basis) with a minimum of 70 cfs and a maximum of 400 cfs. On November 1, the targets changed to 40% of the reservoir inflow with a minimum of 150 cfs and a cap of 400 cfs. Starting in December, the minimum flow in the lower Bull Run River was set at 120 cfs and will remain there until spring 2017. Figure 7 shows mean daily flow for the Lower Bull Run River throughout the drawdown season.

The City met downstream water temperature targets in the HCP for 2016 with the exception of some days in the fall. Figure 8 shows temperature of the Lower Bull Run River. Throughout the management season, the City presented the 2016 water temperature information to the Oregon Department of Environmental Quality, the National Marine Fisheries Service, and the Oregon Department of Fish and Wildlife. Those agencies directed the City to continue to monitor water temperatures in the lower Bull Run River and to work with them each year, starting in May, on operational measures to improve performance of the system for temperature control.

Cold Water Transfer

The bureau conducted a cold water transfer in 2016 to move cold water from Reservoir 1 downstream into Reservoir 2, where it would be available for release to town or downstream. The transfer started on August 16 and continued through September 13, releasing a total of 5.6 BG of bottom water from Reservoir 1 via Dam 1 needle valves into Reservoir 2. The temperature effect of these releases was most apparent in the upper and middle elevations of Reservoir 2.

Water Efficiency and Conservation

The bureau's water efficiency programs worked with commercial, industrial, government, residential and multi-family customers to help them meet their water efficiency goals in 2016. Various water efficiency education, outreach, and assistance activities were carried out throughout the summer supply season. These included residential, regional, and Business, Industry, and Government (BIG) program activities as shown below.

Portland Water Bureau Business, Industry, and Government (BIG) Water Efficiency:

- Provided on-site water efficiency surveys, consumption analysis, irrigation system review, high water use investigations, and other customer support activities as requested by customers. Customers include manufacturers, offices, retail and particularly restaurants and multifamily buildings. The BIG program receives referrals from the bureau's customer service department, BES FOG program, directly from customers and the Sustainability at Work program housed at the Bureau of Planning and Sustainability.
- Continued testing the implementation of automatic meter reading devices as part of a pilot project that can potentially help customers observe and respond to daily water use.

Portland Water Bureau Residential Water Efficiency:

- Distributed water efficiency devices and information at the customer service walk-in center. These kits include showerheads, aerators, and toilet leak tablets.
- Provided $50 rebates to replace old toilets with high-efficiency toilets for residential, commercial and multifamily customers.
- Provided rebates for improving the water efficiency of automatic irrigation systems.
- Published a Customer Newsletter with water conservation information that is included in all bills that are sent out in the summer.
- Published blogs and social media messages regarding water conservation.
- Attended community events around the city during the summer, distributing water efficiency devices and information, through "Your Sustainable City" outreach partnership.
- Maintained the water-wise demonstration garden at the East Portland Neighborhood office in Hazelwood neighborhood to showcase water-efficient plant choices and irrigation technology.
- Partnered with the Portland Bureau of Transportation's Smart Trips program to deliver water conservation information by bicycle to new customers in the city through. The Portland Water Bureau component of this program is called "Smart Drips."

Regional Conservation:

The Portland Water Bureau is a member of the Regional Water Providers Consortium (RWPC), and an active participant in the Conservation subcommittee. The RWPC has a wide variety of conservation programming. Below is a summary of key offerings completed in the summer:

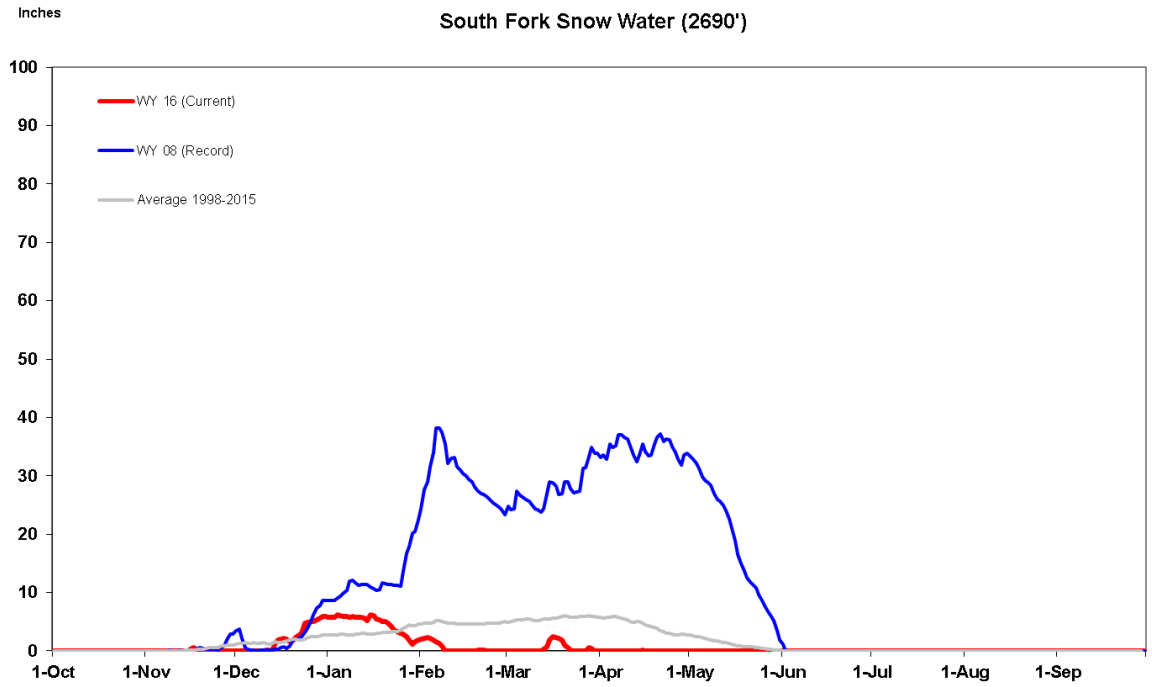
- Placed water conservation radio ads on approximately 7 Portland-area radio stations. Ad spots are airing from June through August.
- Partnered with TV outlets, KGW Channel 8, Garden Time and KUNP (Univision – Spanish language television) to run exclusive water conservation ads spots and news stories on all programs from June through August. Messaging is done through a series of stories in both English and Spanish.
- Distributed outreach materials to residential customers, nurseries, and media partners on efficient ways to save water outdoors in summer months. Outreach materials were also distributed through the RWPC website, events, and media channels (television, print, Spanish media).
- Sent out 4 e-newsletters to customers. Published weekly social media posts.
- Posted the Weekly Watering Number through the summer months as a resource tool for customers to gauge how much water to put down each week on one's landscape and garden. The Weekly Watering Number is available on the RWPC's website: www.conserveh2o.org. The Weekly Watering Number is available to access from April –

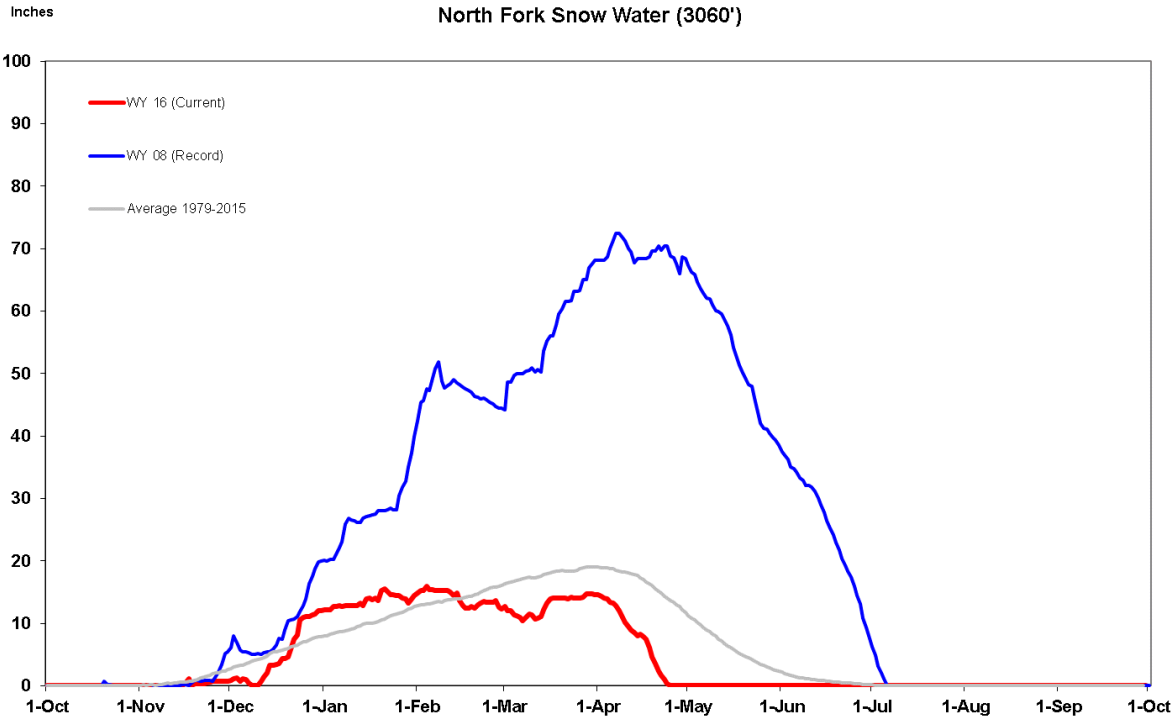
September. Also, all Consortium members have received the Weekly Watering Number widget to place directly on their entity's respective websites.

Conclusions

The reservoirs reached a minimum of 3.6 BG usable storage on October 4, 2016. The city was able to meet all in-town and in-stream demands using its baseline resources—Bull Run reservoirs, streamflow, conservation, and groundwater. Meetings of the Supply Planning Group, which occurred once a month, were integral to the successful management of summer operations. The group balances multiple objectives in order to ensure a reliable high quality water supply for all users while effectively managing costs.

Figure 1: Snow Water Equivalent, in Inches, at Snow Monitoring Sites in Bull Run during the Winter of 2015-16





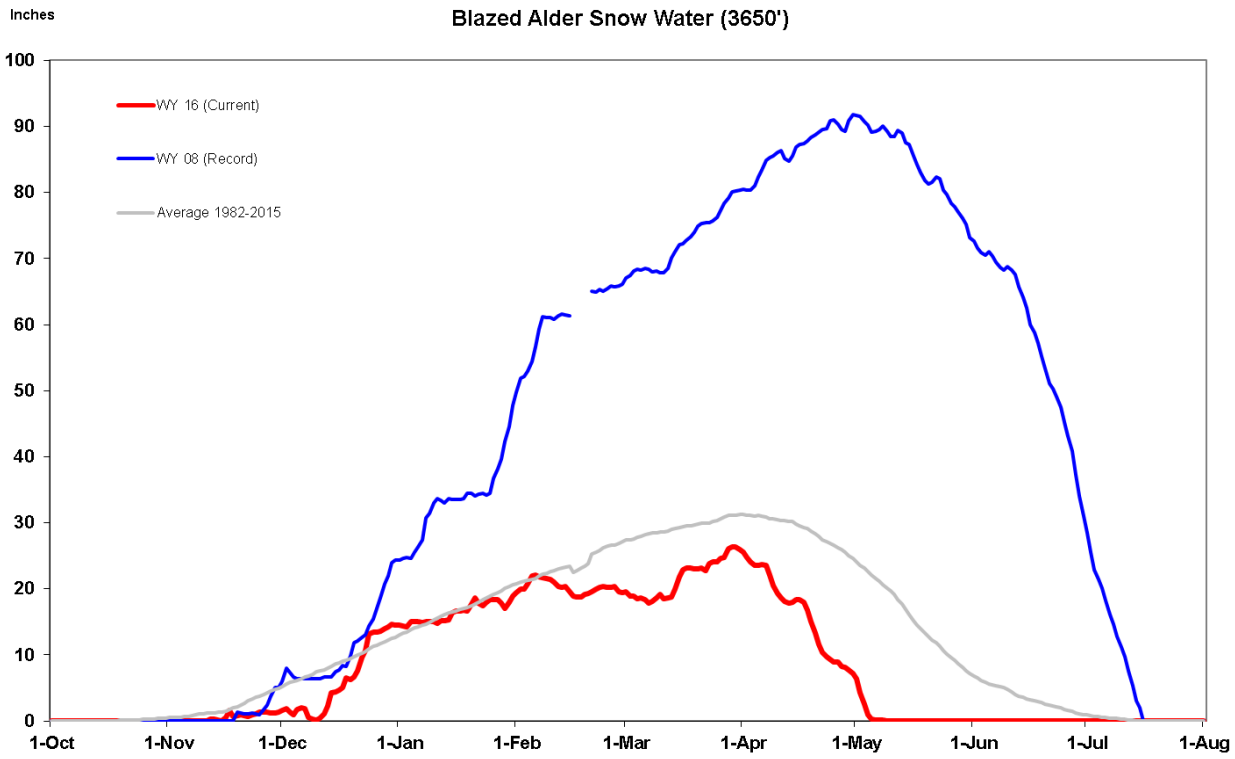

Inches
Blazed Alder Snow Water (3650')
100
90
80
70
60
50
40
30
20
10
0
WY 16 (Current)
WY 08 (Record)
Average 1982-2015
1-Oct
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug

Figure 2. Monthly Precipitation at Headworks, Bull Run, Oregon

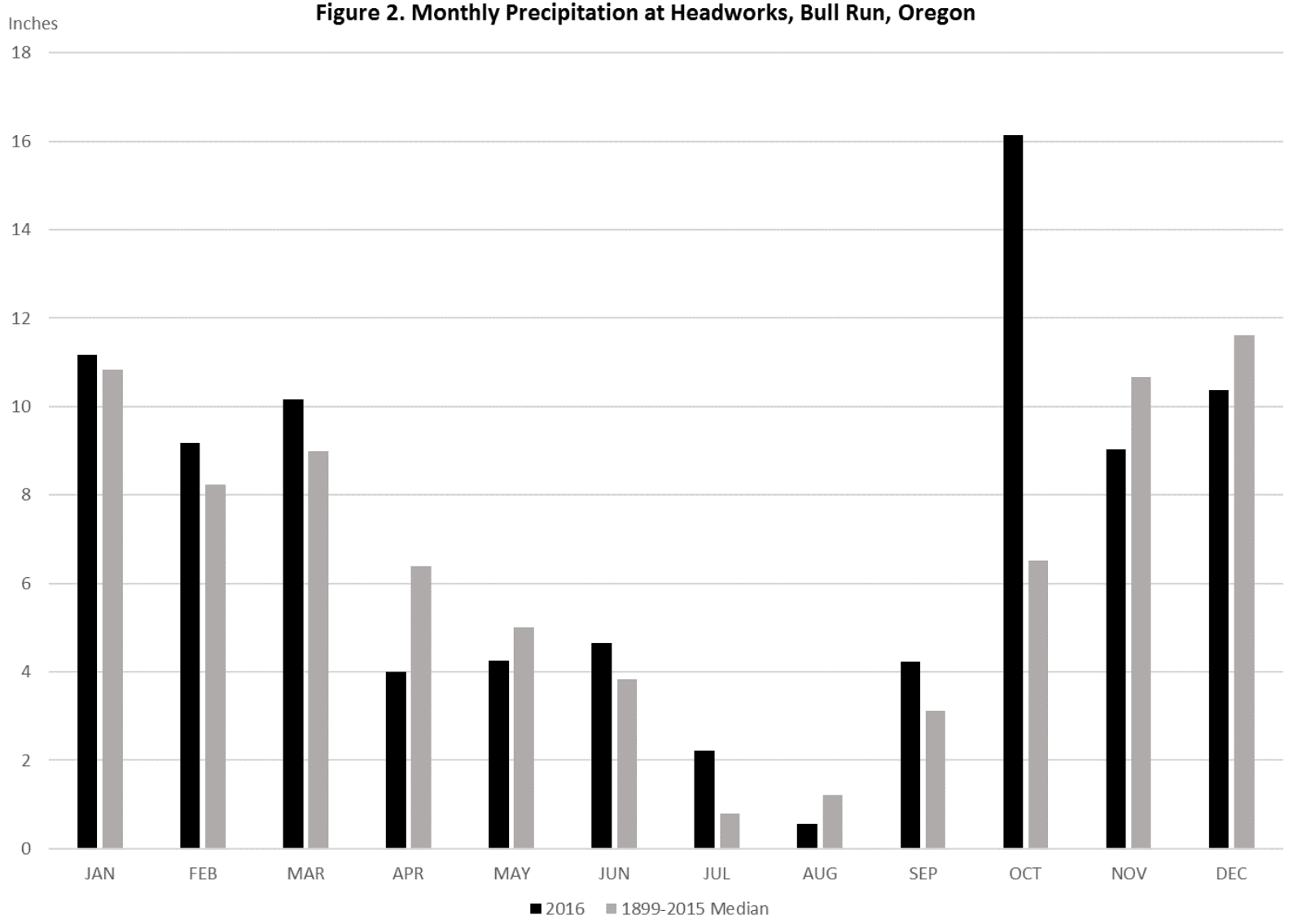


Figure 3. Current Demand Compared to Previous Five Years

7-day Moving Averages

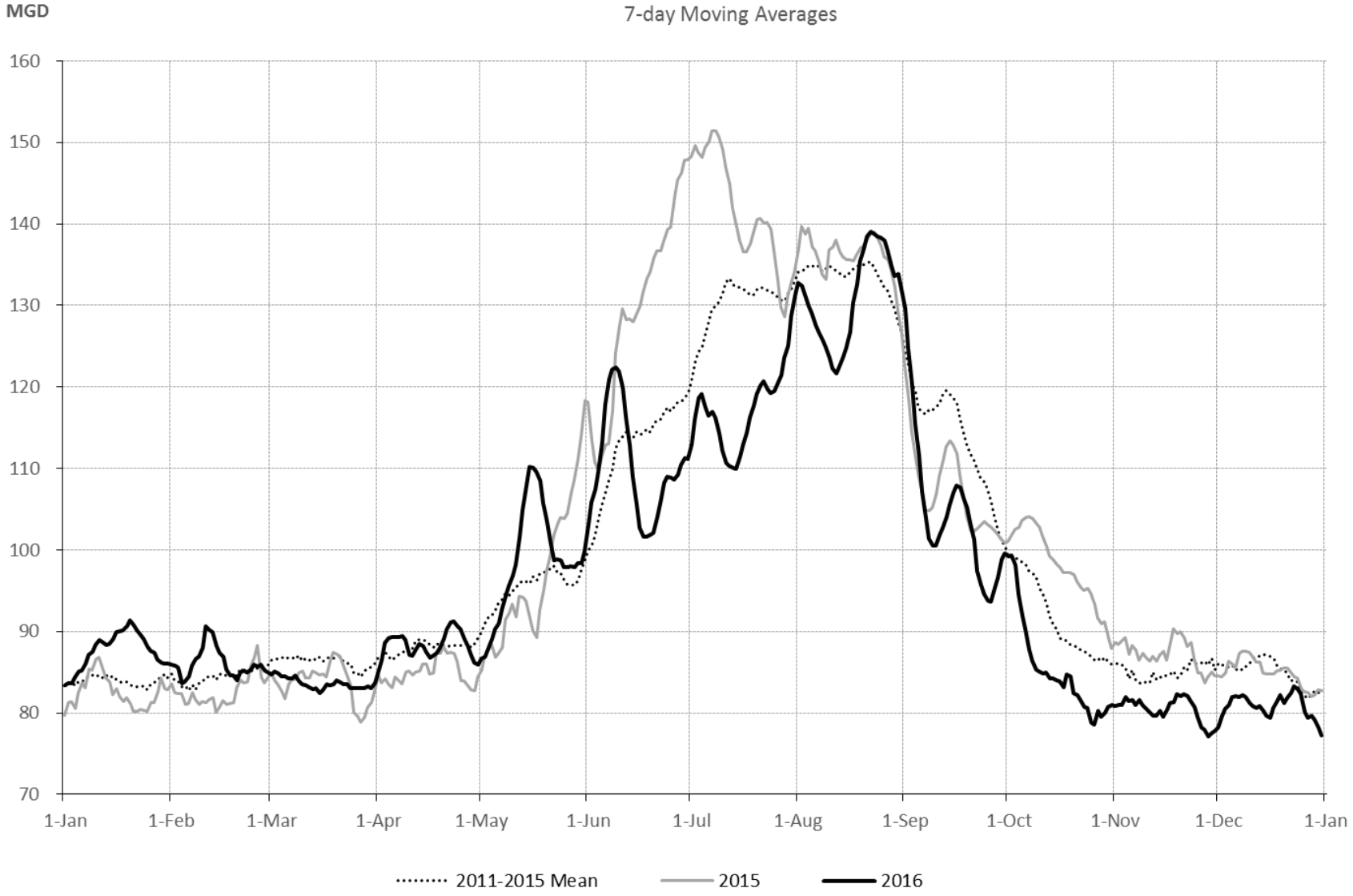


Figure 4. 2016 Bull Run Reservoir Drawdown and Refill

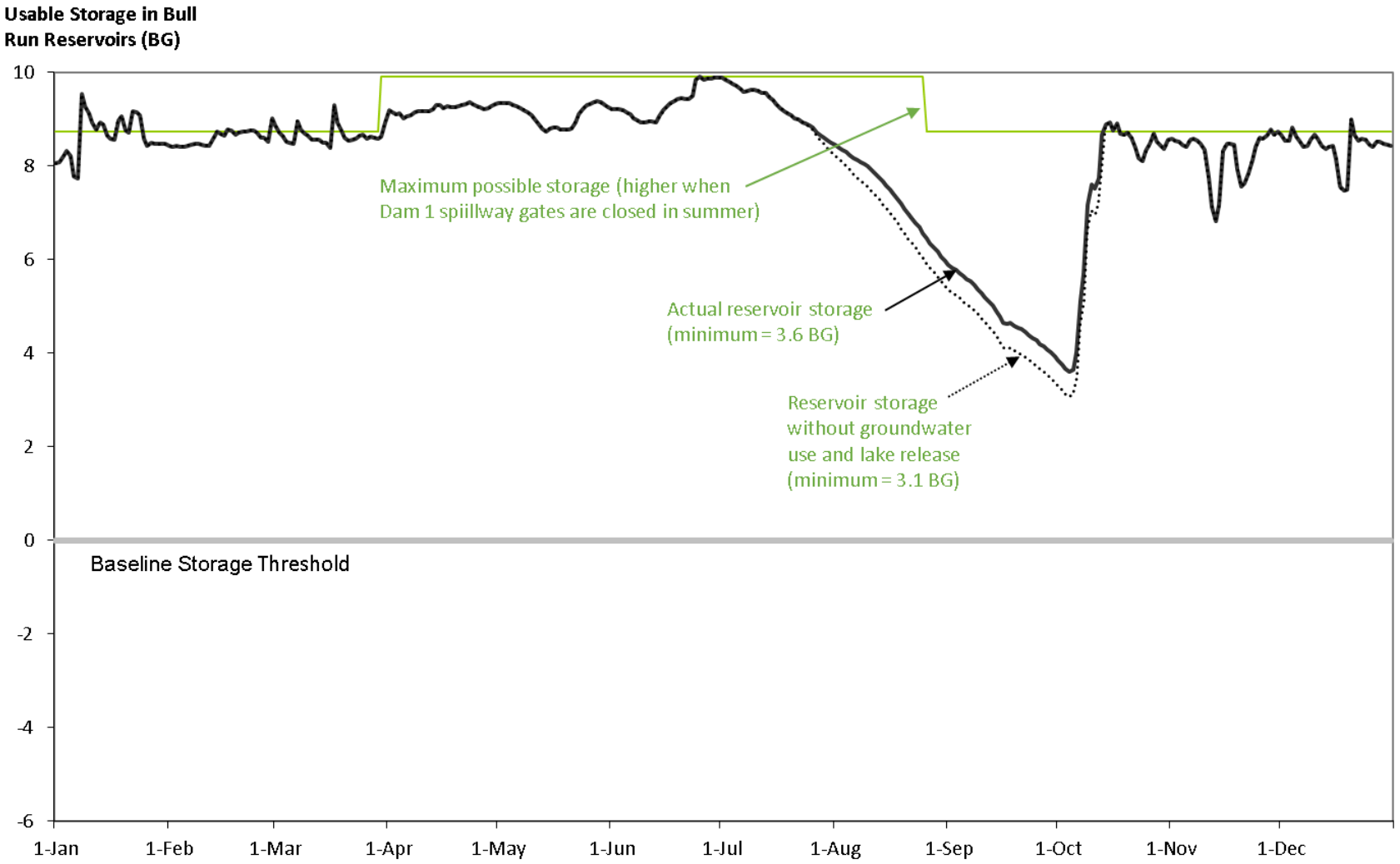


Figure 5: Groundwater Discharge to Supply - Summer 2016 Operations

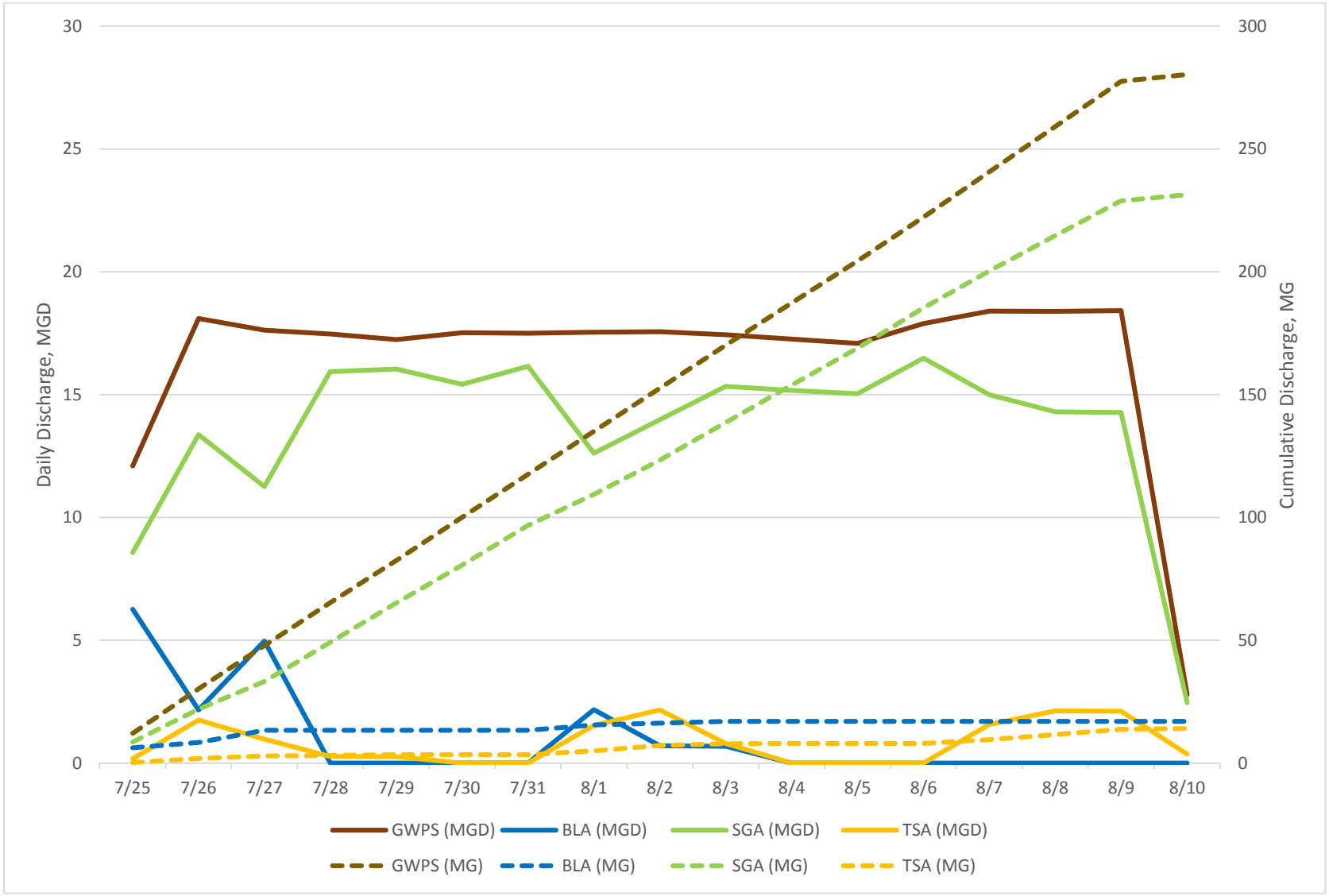


Figure 6. 2015 Observed Storage Volume and Modeled Groundwater Pumped Rates

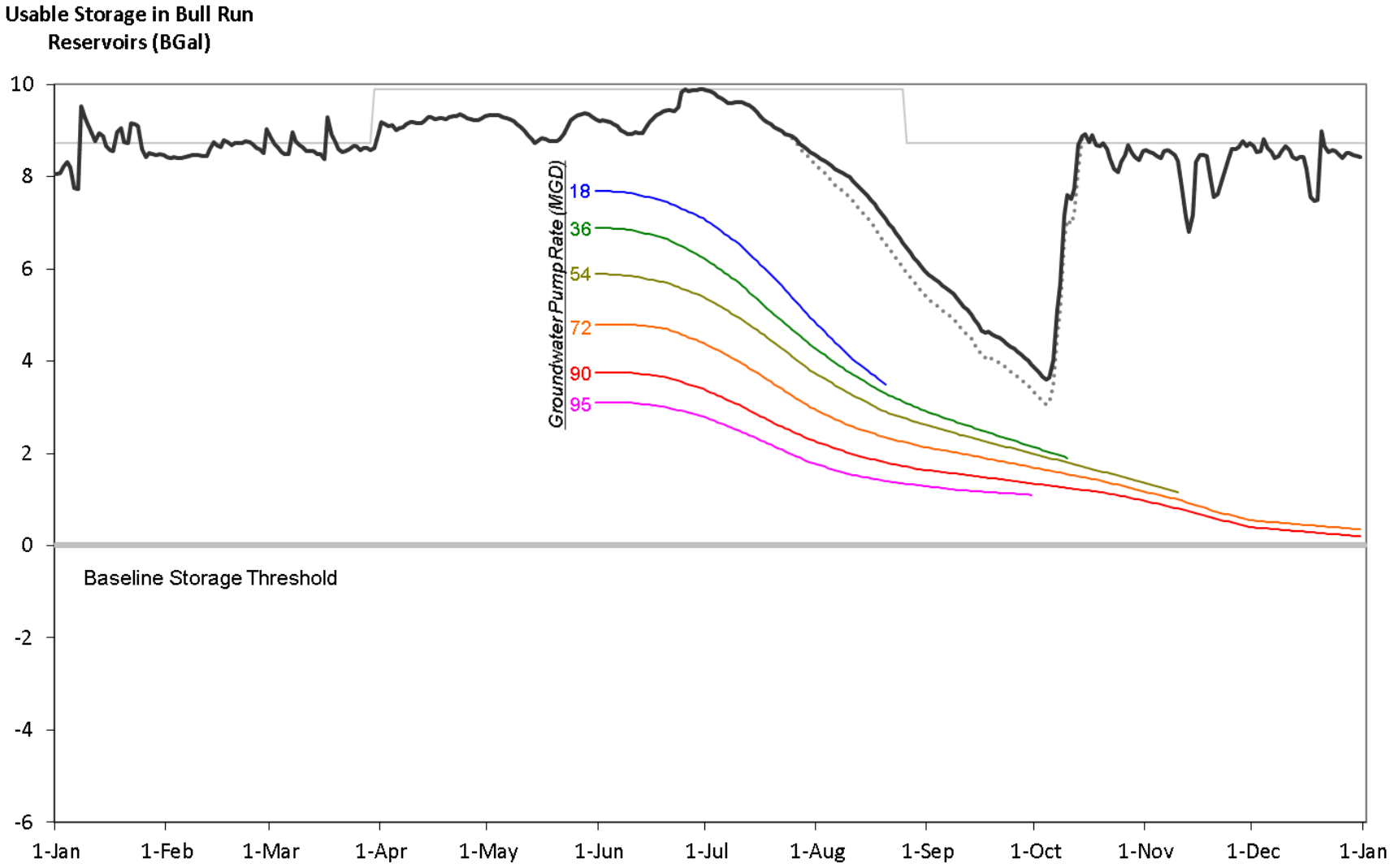


Figure 7. Mean Daily Flow at Lower Bull Run Bridge, USGS 14140000

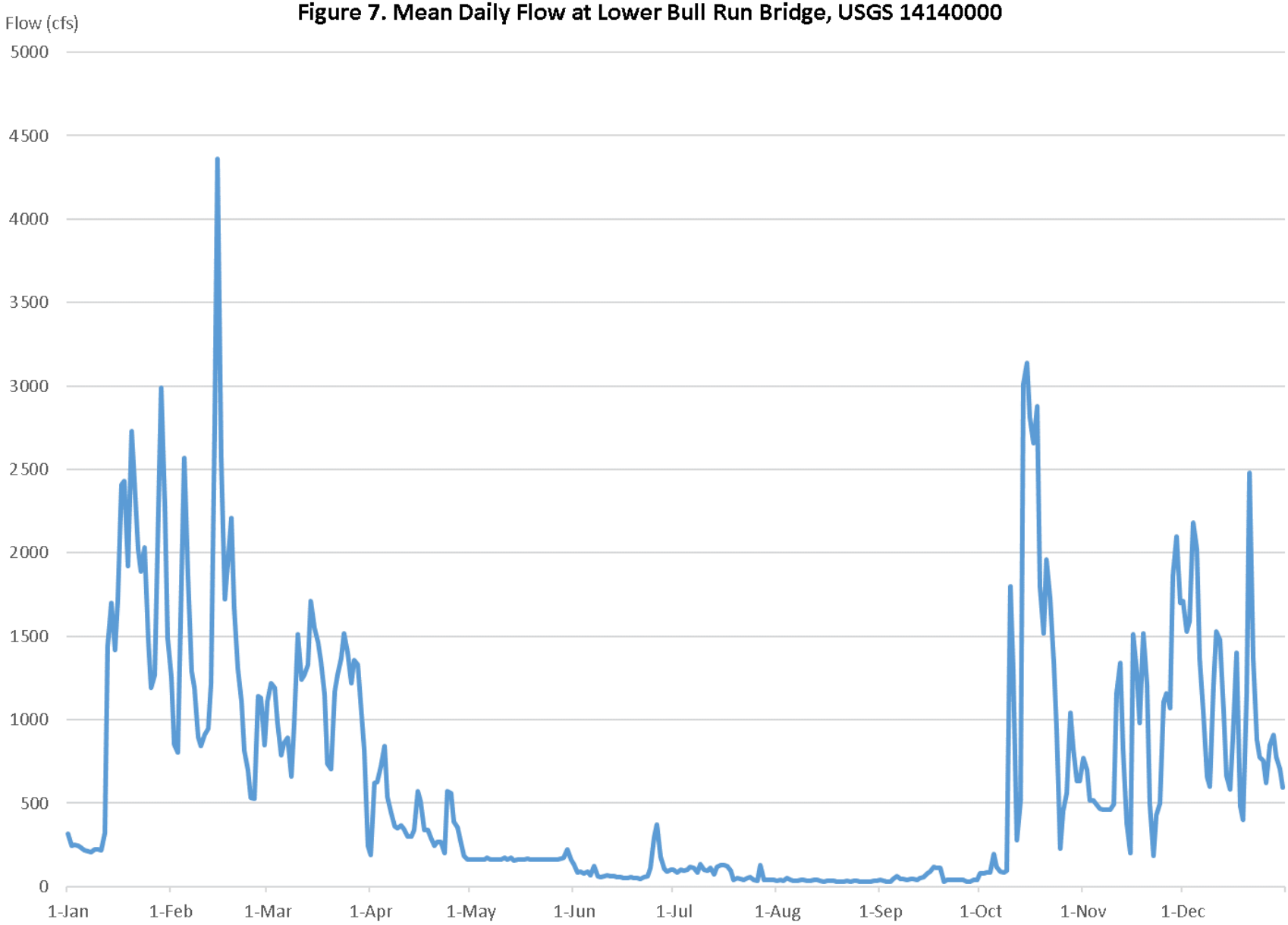


Figure 8. Water Temperature, of the Lower Bull Run River, Summer 2016

7-day Average of Daily Maxima, May 1 - November 15