2023 Upper Clark Fork River Basin Surface Water Monitoring Report

NRDP Contract 90022-TO 2.1

Prepared by the Clark Fork Coalition

Abstract

The purpose of this report is to present the results of seasonal water temperature and streamflow monitoring on the upper Clark Fork River and tributaries where existing data is lacking. Flow monitoring also occurred on instream flow projects to assist with monitoring related to project development and implementation.

These flow studies assist in implementing projects identified in the Natural Resource Damage Program's *Final Upper Clark Fork River Basin Aquatic and Terrestrial Restoration Plans* (Restoration Plans), updated and approved February 2019. Group 1 Projects that may supply instream flows to the area of the Clark Fork River between Galen and Deer Lodge are the highest priority. Second in priority are Group 2 projects that supply flow to Priority 1 tributaries and third in priority are Group 3 projects that supply flow to Priority 2 tributaries. In the 2019 revision to the Restoration Plan it was determined that all projects in Group 1, Group 2, and Group 3 will be investigated at the same time.

The overarching goal of the project is to better understand summer streamflow and water temperature conditions in the Upper Clark Fork River Basin. The stretch of the mainstem of the Clark Fork River between Galen and Deer Lodge and tributaries that feed it face chronic dewatering issues and typically experience the lowest flows during periods of peak demand in late July and early August. The data collected for this task order is integral to the understanding of surface water and groundwater dynamics in the most dewatered portion of the Upper Clark Fork Basin.

Introduction

In accordance with NRDP Contract 90022-TO 2.1, for the 2023 field season the Clark Fork Coalition (CFC) managed 16 continuous flow and temperature monitoring sites (Table 1). These locations have been monitored by the CFC for multiple seasons and provide valuable data on the severity of these dewatered systems. The purpose of the monitoring is to provide information that quantifies the impacts of low flows and high water temperatures on aquatic ecosystems in the upper Clark Fork Basin. The data also help to quantify the magnitude and timing of water conditions on the Upper Clark Fork River and priority tributaries. Water temperature data were also collected to determine if water temperatures exceeded threshold levels considered sustainable for salmonids.

This report provides a narrative of streamflow and water temperature conditions observed at each of monitoring sites funded by the NRDP, as well additional pertinent locations funded by the Columbia

Basin Water Transaction Program (CBWTP). The monitoring sites are summarized in Table 1 below and are displayed in the map in Figure 1.

Methods

Upper Clark Fork River Basin Monitoring Sites	
Stream	**Site**
Cottonwood Creek	Above Applegate Upper Diversion (Sherm Anderson's Corral Bridge)
	in Deer Lodge
Clark Fork River	Galen Road
	Below West Side Ditch @ Gemback Road
	Above Valiton Ditch
	Sager Lane
Valiton Ditch	At POD
Lost Creek	Below Beckstead Ditch
Racetrack Creek	Outflow from Reservoir
	At Cement Ditch
	Above Berg Diversion
	Ted Beck's Bridge
	Above Branch Ditch
	Frontage Road
Dry Cottonwood Creek	Dry Cottonwood Creek-Lower
	Dry Cottonwood Creek-Upper

Table 1- Locations of primary monitoring sites managed by the CFC in the upper Clark Fork Basin.

At each of the 16 monitoring sites (Table 1), a continuous data logger (HOBO) recorded both stage height (ft) and water temperature (°C) at 60-minute intervals. In addition to these continuously monitored sites, spot discharge measurements were recorded at the following sites: *Cottonwood Below Upper Diversion* and *Racetrack Creek at Confluence (Table 2).*

At three of the above sites (Dry Cottonwood-Upper, Valiton Ditch, and Lost Creek below Beckstead Ditch), hydrographs could not be extrapolated from the manual discharge data. At the Dry Cottonwood-Upper site, excess sedimentation after precipitation-induced runoff events filled the datalogger's housing, artificially increasing stage values. Data at the Valiton Ditch site is often more error prone than other sites due to the amount of vegetation and lack of streambed structure. As a result, these data could not be correlated to the stage data with enough accuracy to build a hydrograph. The logger at the Lost Creek below Beckstead Ditch site showed an extreme mid-season stage increase, likely due to a sensor malfunction or the sensor being moved/tampered with. The data for these three sites are presented in Table 2.

Streamflow (cfs) was manually measured every 2-4 weeks between June and September by CFC staff. Individual flow measurements were tabulated using a Hach digital flow meter following standards

established by the USGS. To assure data reliability, the flow meters were calibrated biweekly throughout the field season (and more frequently if needed). In accordance with the USGS measurement protocols, no individual velocity measurements in a stream cross section represented more than 10% of the total observed flow.

The HOBO dataloggers' instream pressure data were compared to barometric pressure post-season to extrapolate hourly water depths at each site. The water depth data were correlated to flow by graphing stage height (ft) vs discharge (cfs) and fitting a trendline to the data using the least squares method. Using the equation from the rating curves, flow data were extrapolated to develop a hydrograph of hourly flows for each site. Although the locations of monitoring sites typically remain the same from season to season, small changes to a stream's cross-sectional geometry (caused by natural morphological processes) may significantly impact the accuracy of previous year's rating curves. Because of this, new rating curves were generated at all of the sites for the 2023 data.

The hydrographs and thermographs contained in appendix A were constructed from the extrapolated flow data and water temperature recordings from the dataloggers. Streamflow data represent daily averages; maximum daily water temperatures represent the highest individual daily reading. Meteorological data was retrieved from the US Bureau of Reclamation's AgriMet database (https://www.usbr.gov/main/agrihydro.html).

Results

Streamflow and water temperature graphs for the 2023 monitoring season are provided in Figures 2-13.

Analysis & Conclusions

Clark Fork River, Figures 2-4

After two consecutive years of below average streamflow conditions, 2023 flows on the mainstem of the Upper Clark Fork River remained at or above average throughout the summer (Figure 2). According to the NRCS Montana Water and Climate Center, the Upper Clark Fork basin snow water equivalent percent average was 111% on 5/1/2023. Precipitation remained elevated above average throughout the spring and summer, and the water year-to-date percent average was 116% for the Upper Clark Fork basin on 9/1/2023. Flows at all sites increased during and after precipitation events, with the two highest precipitation days delivering approximately 0.4 and 0.21 inches of rain in Deer Lodge on August 6th and 22nd.

Flows remained above the minimum flow target near Galen (40 cfs) throughout the summer and above the 90 cfs target at Deer Lodge (Figure 2). The lowest flows at all Clark Fork River sites occurred on August 17th. Flows are often lowest at CFR at Gemback Road, which had an average daily discharge of 56.25 cfs on 8/17/2023. Compared to 2017, one of the lowest flow years in CFC's records, CFR at Gemback Road reached a yearly low of 11.65 cfs in late August (Figure 3).

Similar to the trends in flows, water temperatures were heavily influenced by rain events in 2023 (Figure 4). Daily water temperatures reached highs above 20°C an average of 31 days at all sites. This threshold represents the temperature at which adverse effects to native trout species are limited. The highest temperature recorded in 2023 was 24.35°C at Sager Lane on August 15th. This site experienced 38 days

with maximum temperatures above 20°C. September 2nd was the last day of the monitoring period with water temperatures above 20°C, after which temperatures dropped at all sites due to more precipitation, shorter days, and cooler air temperatures.

Racetrack Creek
Figures 5-8

During the 2023 field season, Racetrack Creek followed a flow pattern that was similar to other area streams (Figure 5). After a typical snowmelt driven runoff, natural flows on Racetrack Creek began a recession toward irrigation influenced baseflow levels in early July.

Releases from Racetrack Lake started on August 1st and extended until August 27th. The CFC telemetry station at the outlet of the dam was activated on July 16th to track outflows from the reservoir, which averaged 12.98 cfs during the course of the release with 8.33 cfs allocated for instream flow. According to the Water Commissioner Record, there was 32" overflow, 450" for the creek and 45" shrink for total release rate of 527" or 13.18 cfs. The Water Commissioner made 9 trips to the reservoir (every 3 days on average) to perform adjustments to the outflow.

Flows just below the Cement Ditch POD averaged 7.67 cfs during the release and fell to ~0 cfs within 2 days of the end of the release, remaining depressed until fall precipitation augmented flows on Racetrack Creek. Flows at all sites increased during and after rain events throughout the release. Flows were also monitored Above Berg Diversion, Above Branch Diversion and at the Frontage Road to meet measurement conditions of the DNRC and the Water Management Plan with the Racetrack Water Users.

Water temperatures remained low at the Frontage Road site (12-18 °C) during the release (Figure 7), while water temperatures at our station in the Clark Fork River just downstream of the Racetrack Creek confluence (Huey Long) averaged 16 to 24 °C during the release, which speaks to the high quality of the Racetrack Creek instream flow entering the Clark Fork River.

Cottonwood Creek
Figures 9-10

Flows were monitored in Cottonwood Creek at three locations for the purposes of ensuring instream flow from the Applegate flow enhancement project were maintained (Figure 9). An instream flow authorization of 4.76 cfs is in place from May 16th to July 14th and 1.7 cfs from July 15th to September 15th. Flows remained above 1.7 cfs in September at Deer Lodge (below the lower Applegate diversion); however, flows were below the 1.7 cfs value throughout most of August due to senior upstream irrigation uses and typical mid-summer dryness. Spot measurements were also taken below the upper diversion after July 15th to ensure compliance (Table 2).

Temperatures below all diversions on Cottonwood Creek (at the site in Deer Lodge) remained elevated throughout the summer due to high ambient air temperatures and low flows (Figure 10). Temperatures decreased periodically following precipitation events, but often increased immediately after these events. On average, maximum daily temperatures were 2.7 °C cooler at the highest site (above Applegate upper diversion) compared to the lowest site (in Deer Lodge).

Dry Cottonwood Creek
Figures 11-12 and Table 2

Flows were monitored in Dry Cottonwood Creek at two locations for the purposes of ensuring compliance with the Clark Fork Coalition's instream water right of up to 4.28 cfs, approved in Spring of 2023 (Figure 11). Flows above all diversions on Dry Cottonwood Creek were 4.15 cfs on average higher than flows below all diversions. Temperatures at the upper site remained 3.03 °C cooler than the lower site on average (Figure 12). Flows dropped to 0 cfs by mid to late July at the lower site, exhibiting a typical mid-summer flow pattern for this intermittent creek.

Valiton Ditch at Headgate
Figure 13 and Table 2

This is the sixth year of monitoring by the CFC on Valiton Ditch, which withdraws water from the Clark Fork River above Sager Lane and below the Racetrack confluence (Figure 13). The purpose of this effort is to better understand the magnitude of irrigation use at this location as it relates to NRDP's Reduction in Water Use Agreement and assist with future planning and design for diversion improvements at this location. Manual flows in the ditch ranged from 8.5-11.5 cfs from late May through June. Flows in the ditch in July to August 18th were lower, ranging from 2.8-4.1 cfs (two manual discharge measurements were taken in this time period), and later season measurements (September 4th and September 27th) increased to 7.2-8.2 cfs. Reductions in diverted flows mid-summer were apparent as a result of the Reduction in Water Use Agreement among 2 of the 3 water users at this location between July 15th and September 6th. Higher diverted volumes were measured before and after this time period of reduced withdrawals.

Lost Creek (below Beckstead Ditch)
Figure 14 and Table 2

Flow measurements below the Beckstead ditch on lower Lost Creek were conducted to ensure compliance with the Lampert Ranch split-season lease, which requires that 1.93 cfs be left instream from July 1st- August 31st of each year (Figure 14). Flows in excess of the instream right were recorded at this location for the entire summer. Flow decreased to a minimum of 14.52 cfs in mid-August before increasing in September and October, reaching 38.19 cfs on 10/6/2023, the highest of all manual discharge measurements taken at this site.

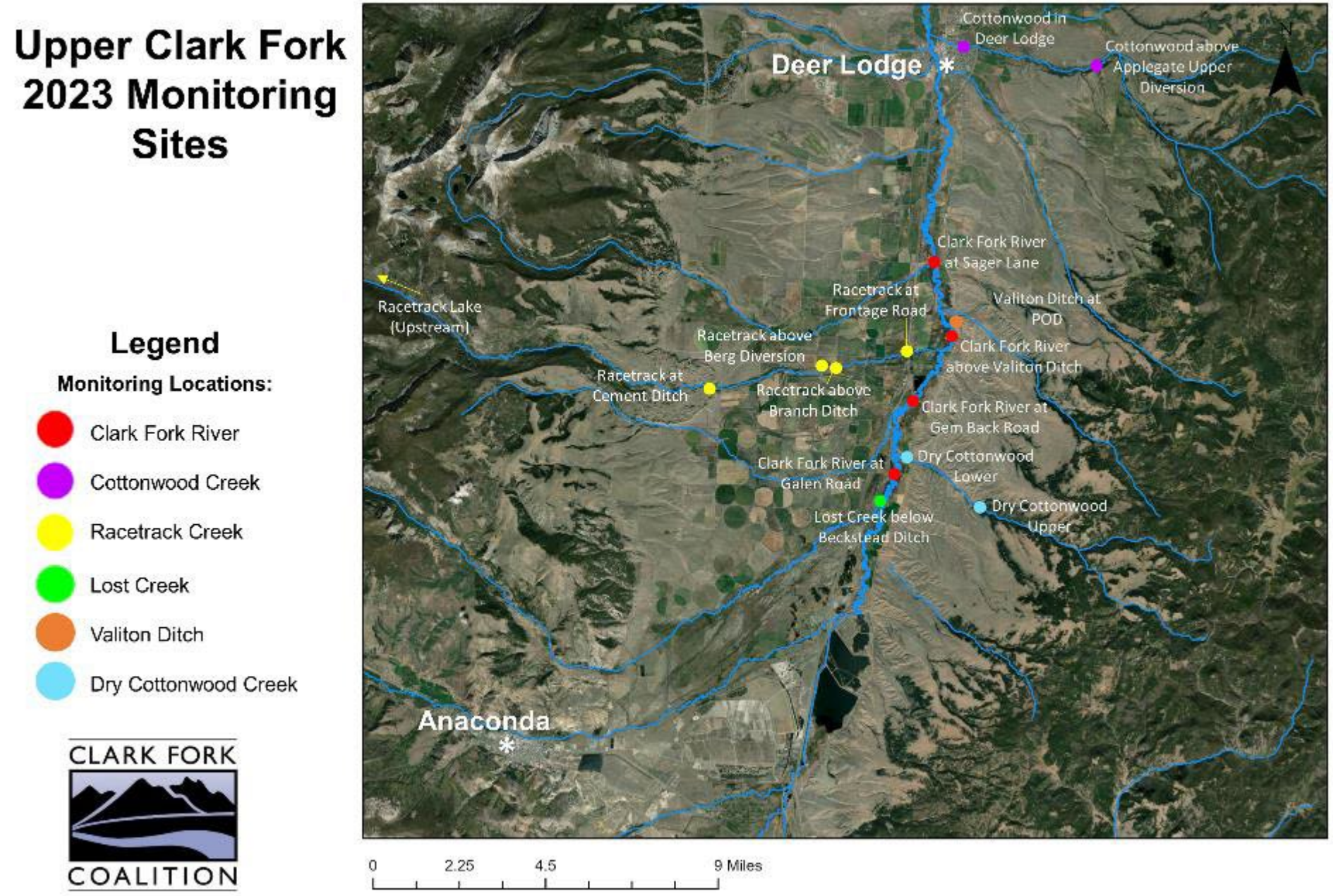

Figure 1: Map of 2023 monitoring locations

2023 Manual Discharge Measurements

Location	***Date***	***Time of Measurement***	***Discharge (cfs)***
Lost Creek	6/30/2023	10:30 AM	26.414
	7/5/2023	9:35 AM	22.267
	8/18/2023	2:00 PM	14.515
	9/20/2023	2:45 PM	27.372
	10/6/2023	3:30 PM	38.187
Cottonwood Below Upper Diversion (@ Martanda)	7/18/2023	10:10 AM	1.44
	8/10/2023	10:45 AM	1.354
	9/21/2023	12:30 PM	1.507
Dry Cottonwood Upper	5/3/2023	11:55 AM	21.46
	5/19/2023	12:30 PM	12.876
	6/1/2023	12:45 PM	5.754
	6/7/2023	12:45 PM	5.067
	6/13/2023	12:15 PM	9.587
Valiton Ditch	5/24/2023	11:25 AM	8.477
	6/7/2023	2:00 AM	11.509
	6/20/2023	1:50 PM	10.8124
	7/26/2023	11:30 AM	2.771
	8/18/2023	1:10 PM	4.095
	9/14/2023	10:55 AM	8.187
	9/26/2023	1:55 PM	7.16
Racetrack Creek @ Confluence	8/3/2023	11:05 AM	6.363
	8/15/2023	12:00 PM	4.591

Table 2- Spot measurements for the 2023 irrigation season.

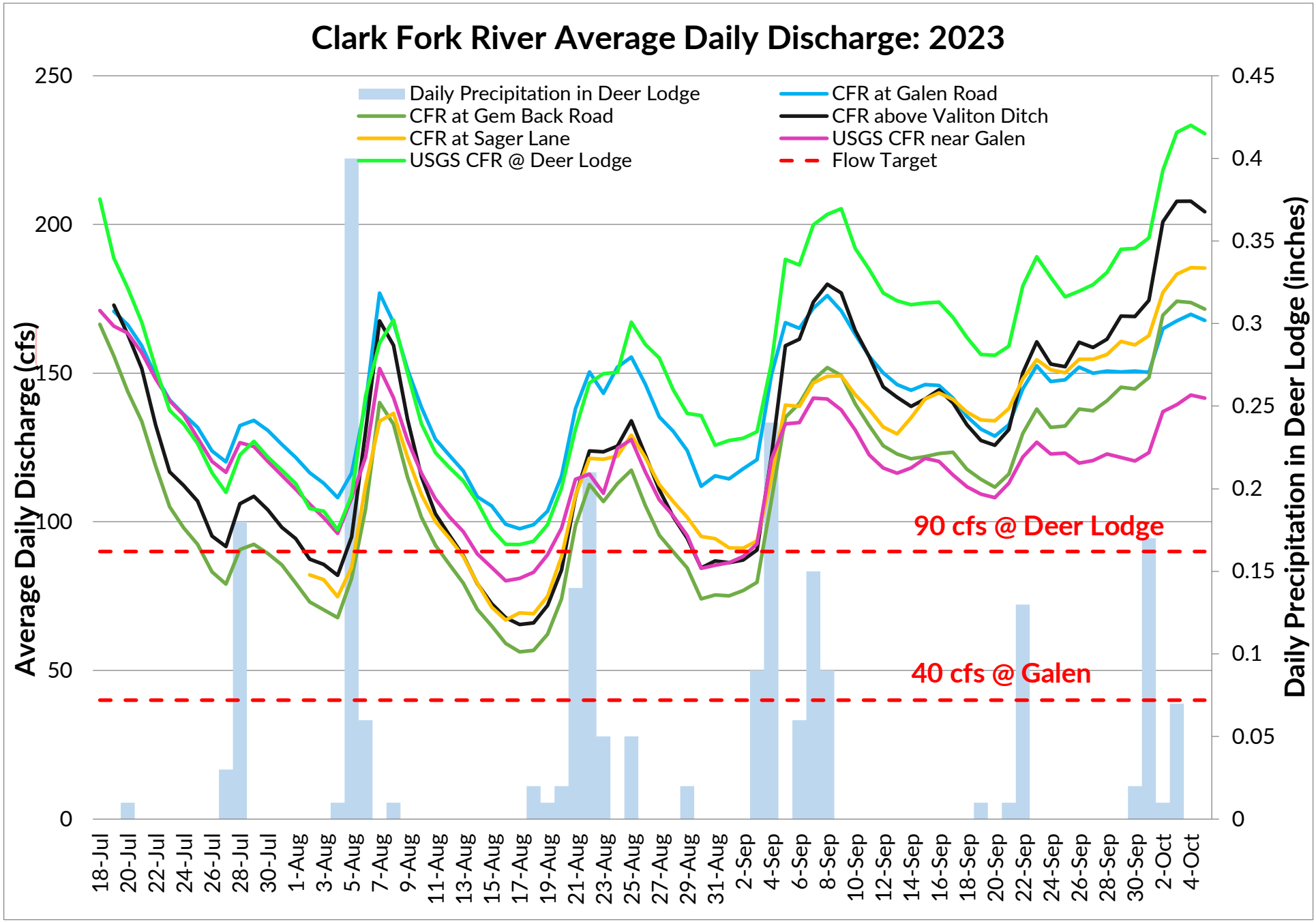

Figure 2: Upper Clark Fork River average daily hydrographs for the 2023 irrigation season.

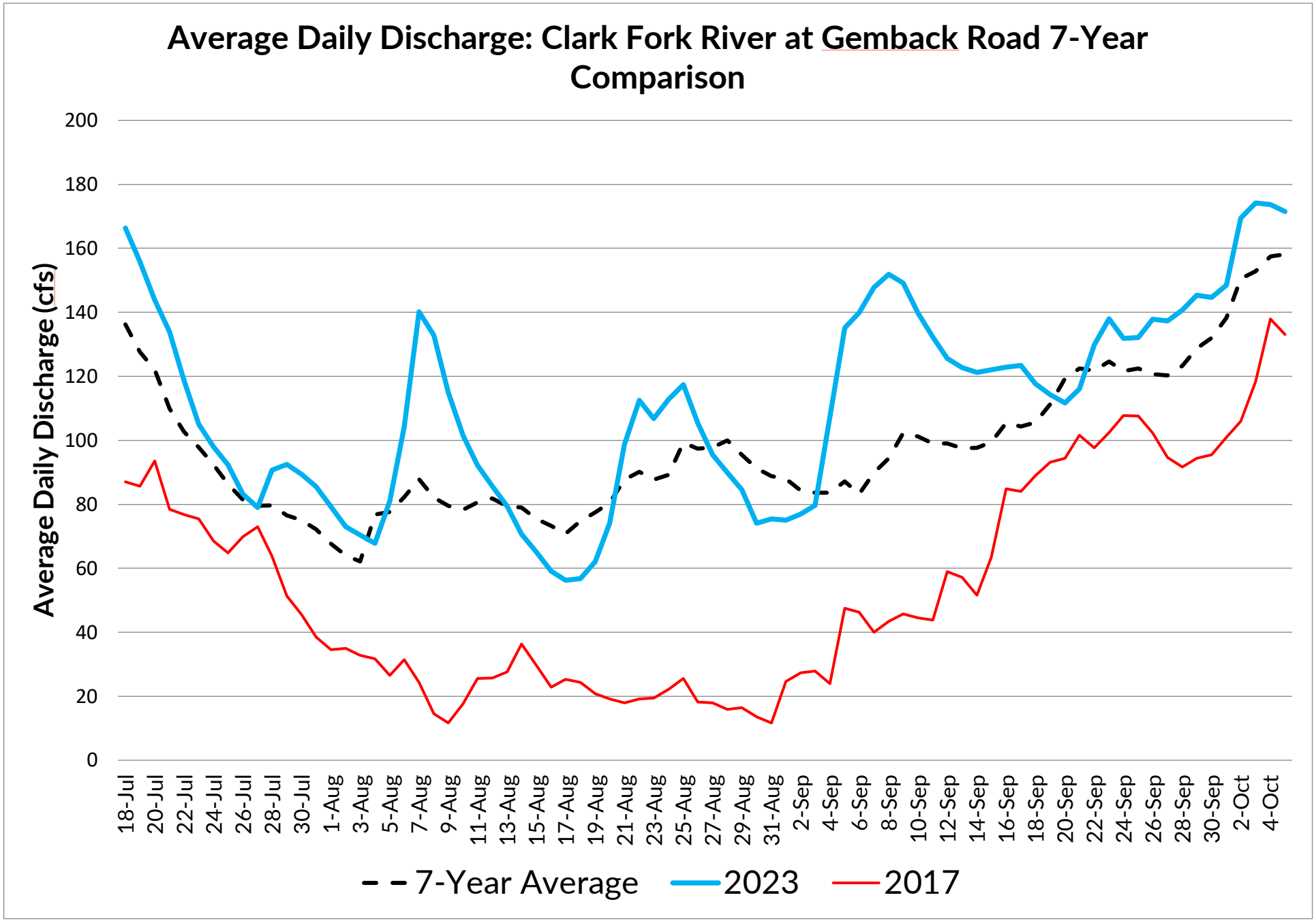

Figure 3: Upper Clark Fork River at Gemback Road average daily discharge in 2023 and 2017, compared to a 7-year average.

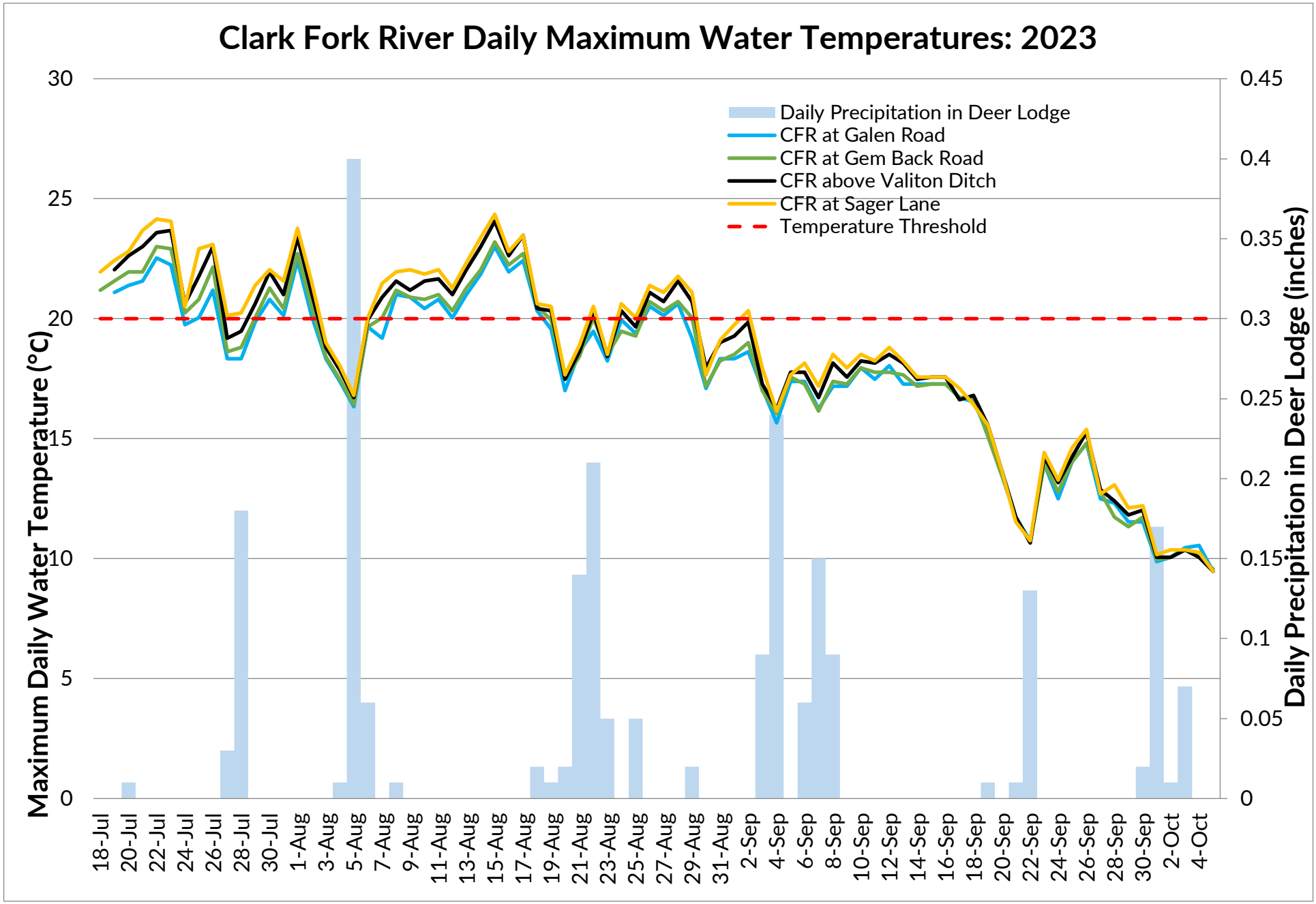

Figure 4: Upper Clark Fork River maximum daily thermographs for the 2023 irrigation season. 20°C temperature threshold indicates the maximum temperature at which adverse effects to cutthroat and bull trout are minimized (Bear et al., 2007; Selong et al., 2001).

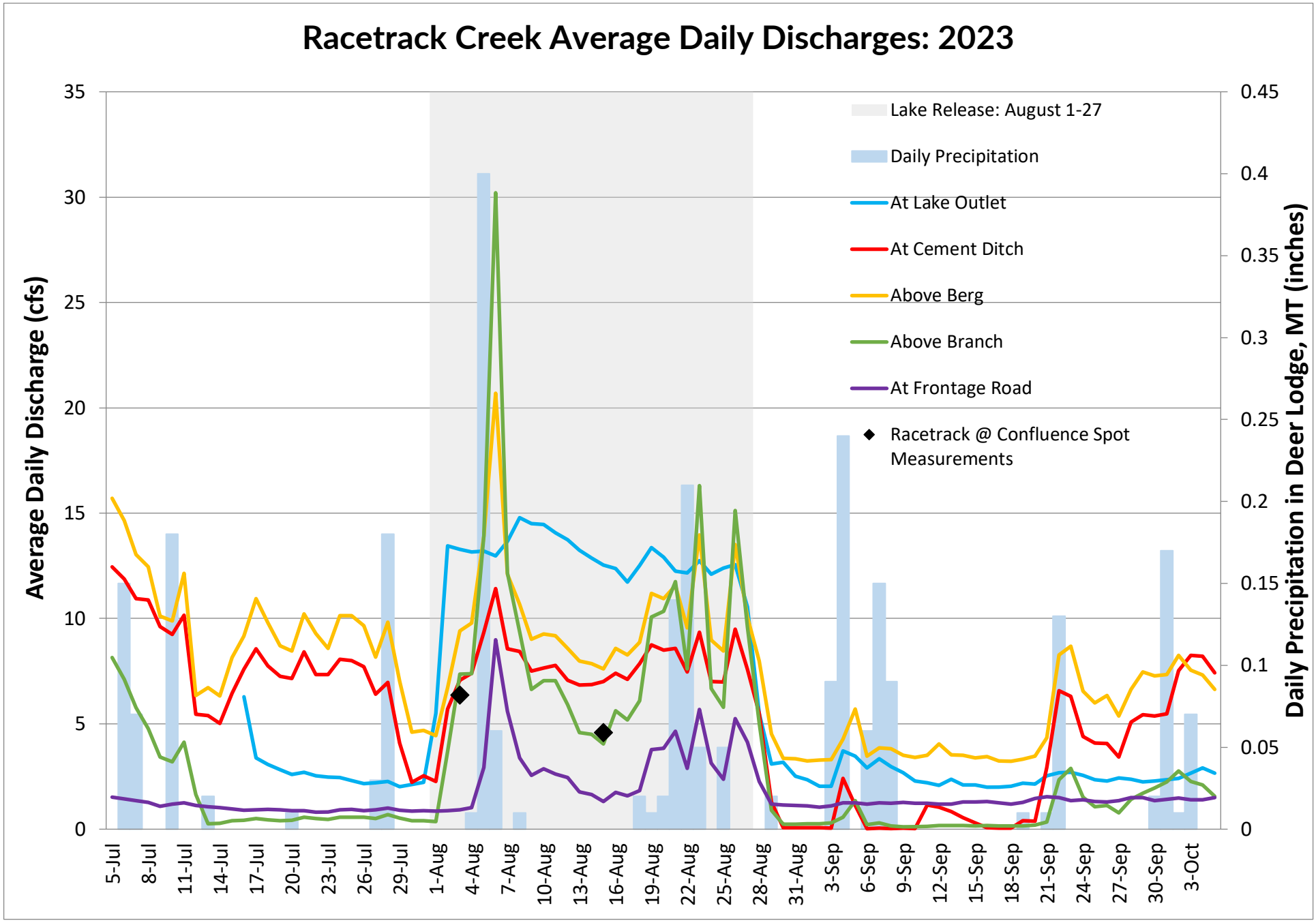

Figure 5: Racetrack Creek average daily hydrographs for the 2023 irrigation season.

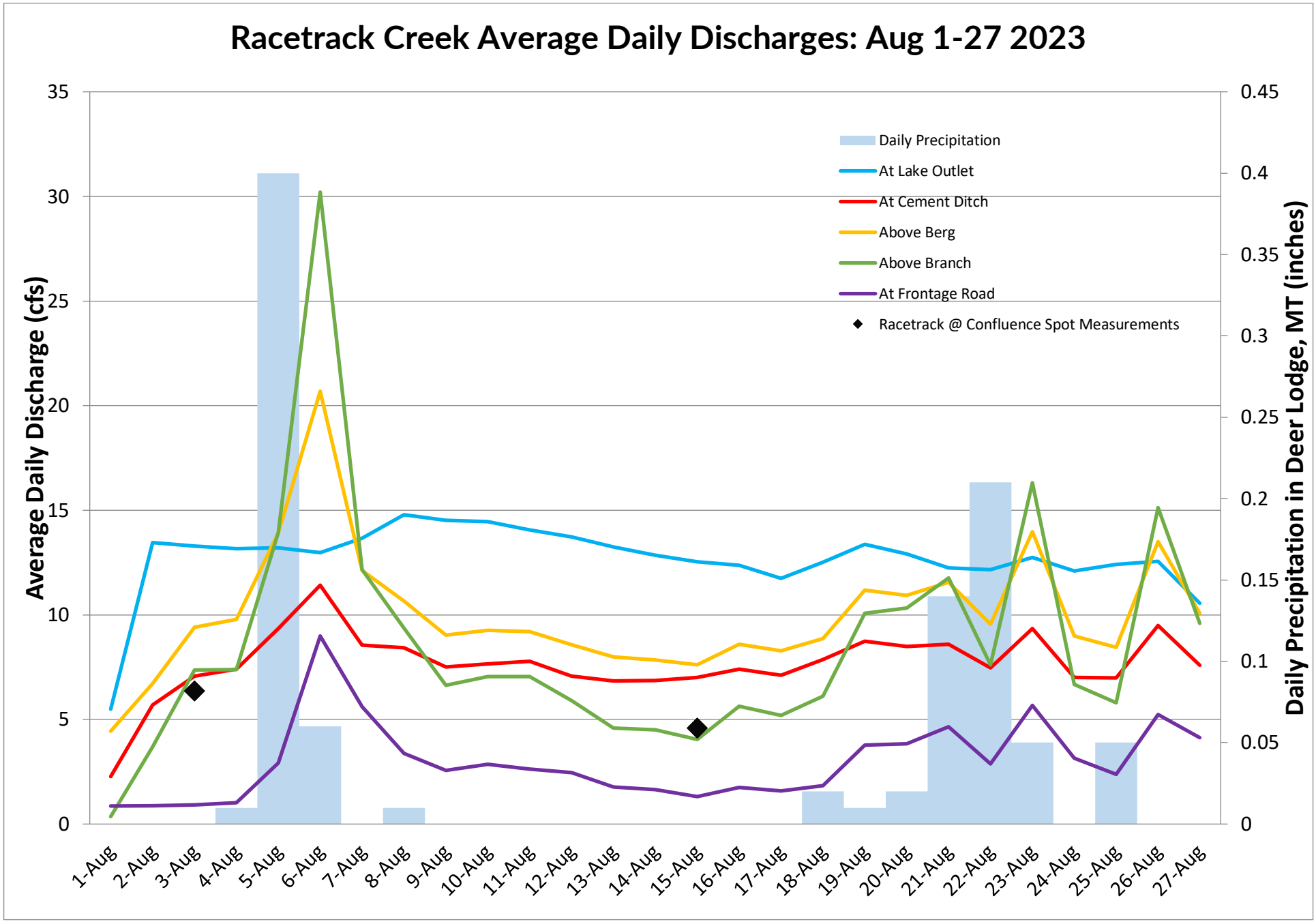

Figure 6: Racetrack Creek average daily hydrographs during the 2023 Racetrack Lake release from August 1-August 27.

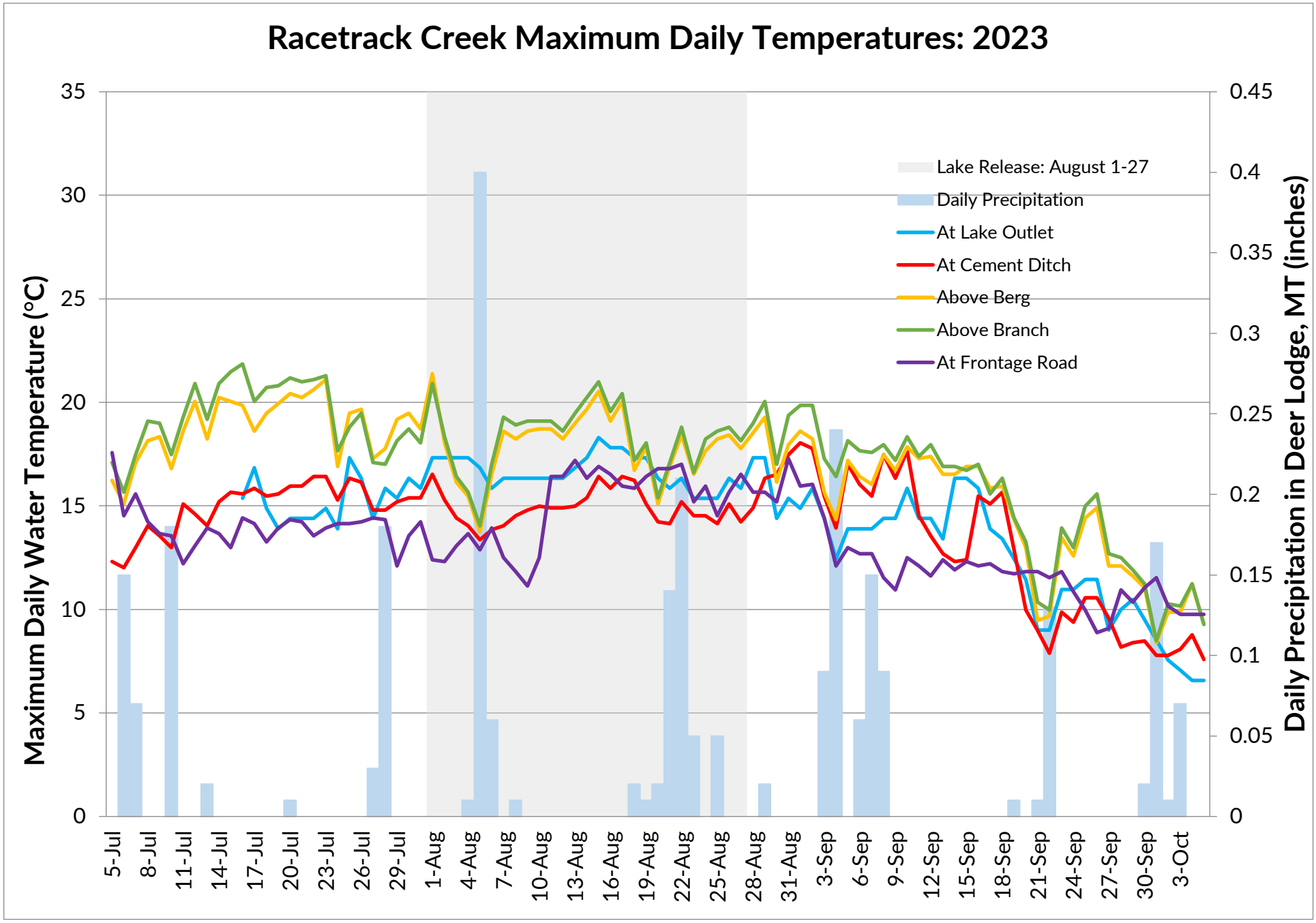

Figure 7: Racetrack Creek maximum daily thermographs for the 2023 irrigation season.

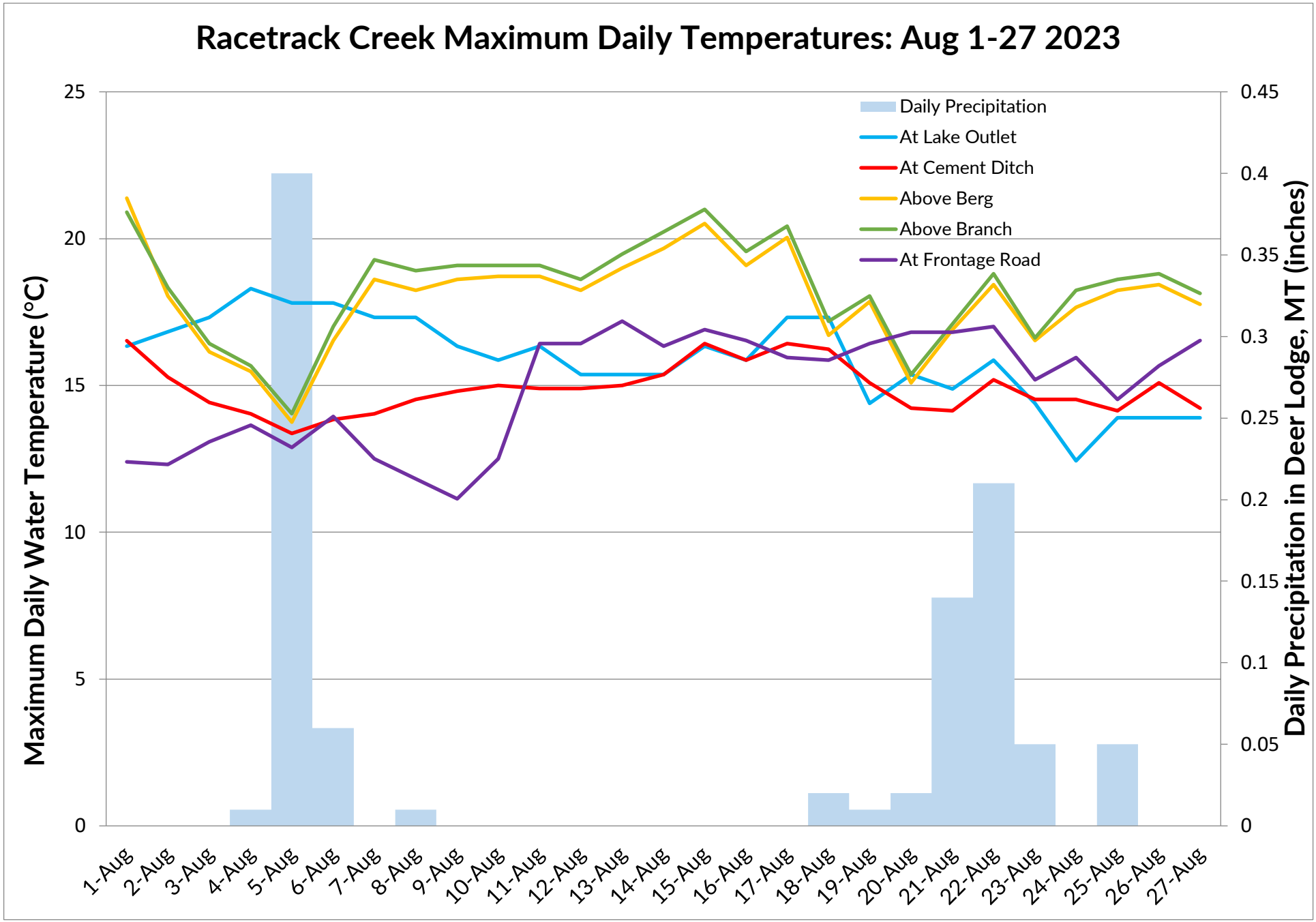

Figure 8: Racetrack Creek maximum daily thermographs during the Racetrack Lake release from August 1-August 27.

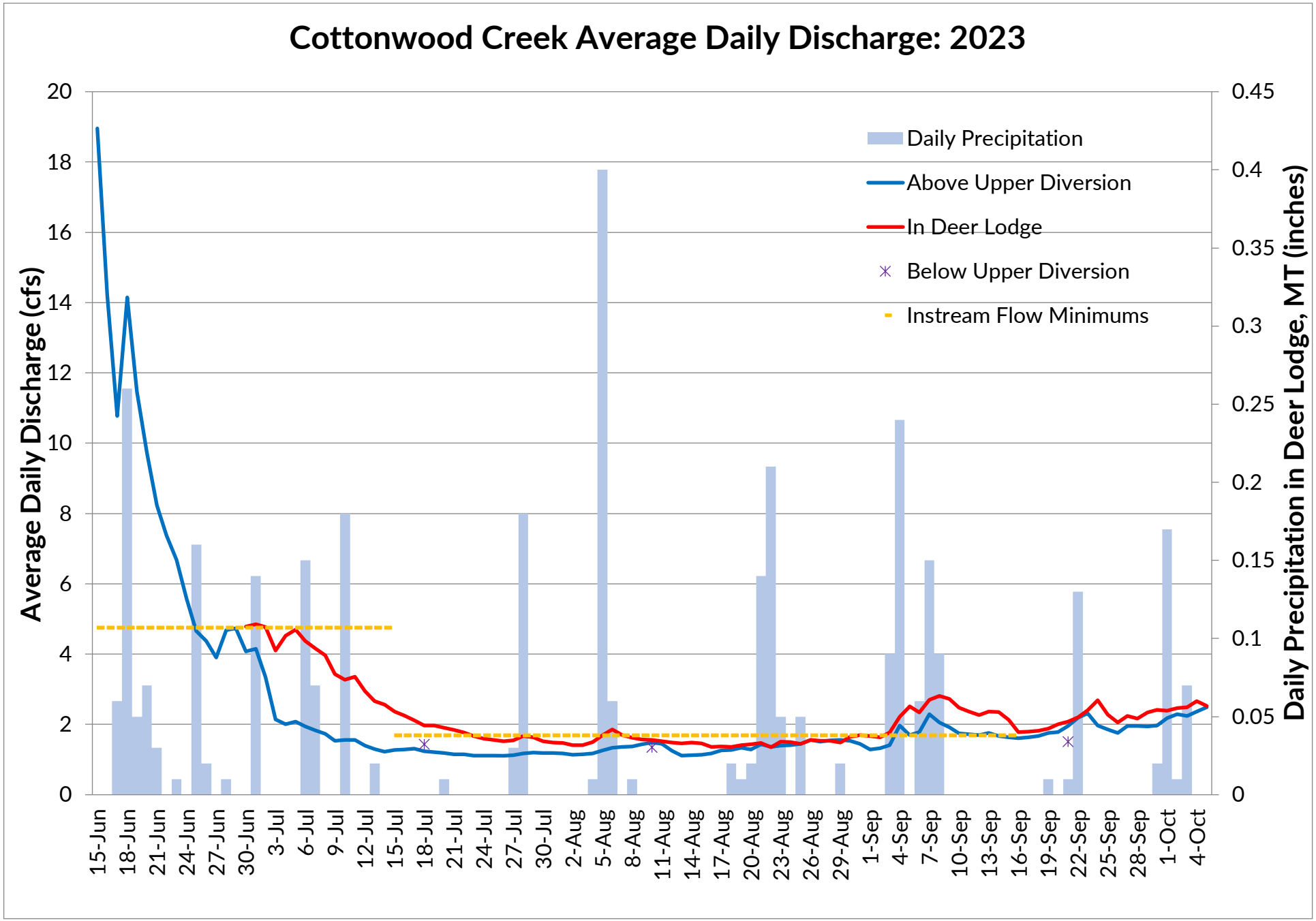

Figure 9: Cottonwood Creek average daily hydrographs for the 2023 irrigation season.

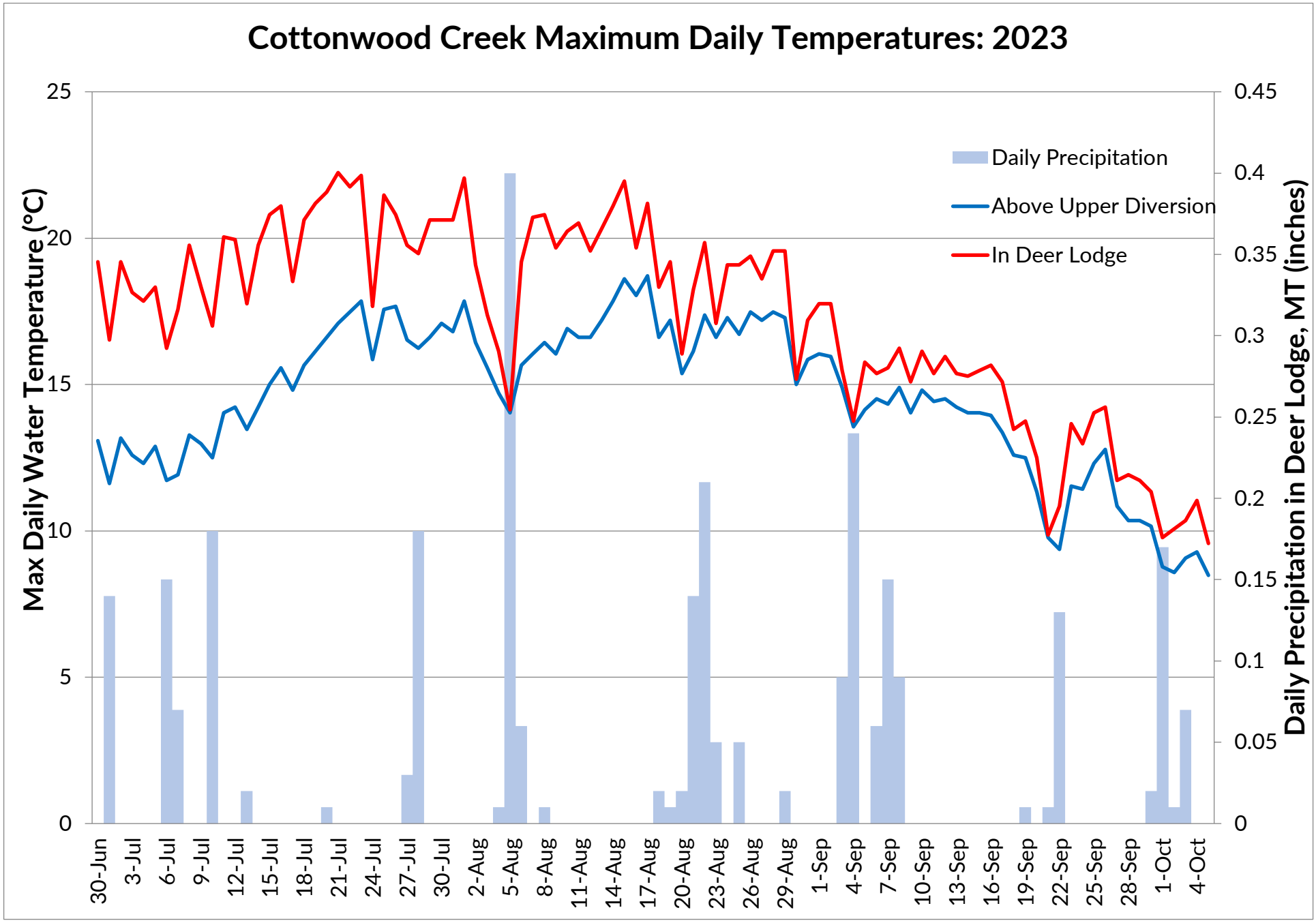

Figure 10: Cottonwood Creek maximum daily thermographs for the 2023 irrigation season.

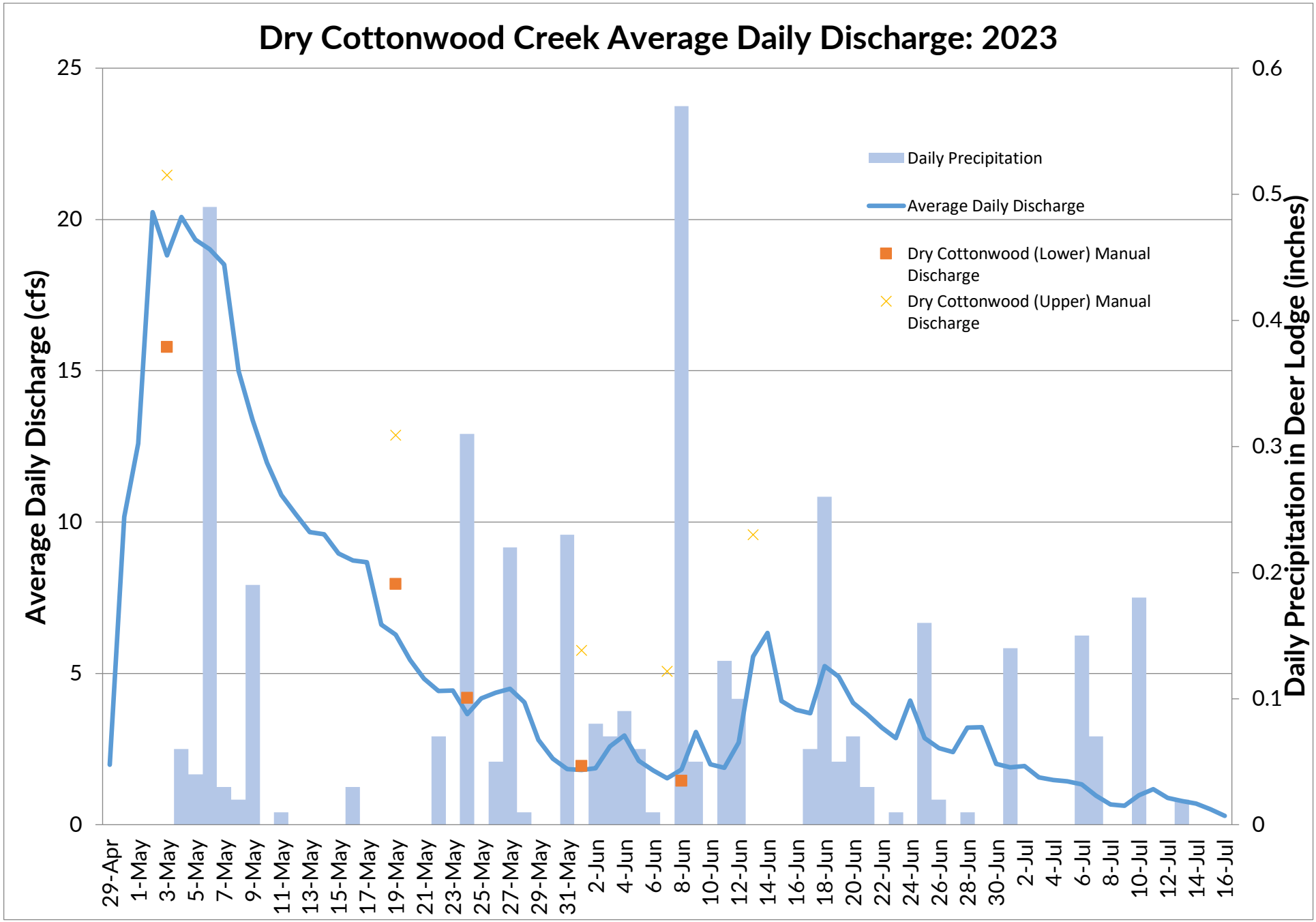

Figure 11: Dry Cottonwood Creek (lower site) average daily hydrographs for the 2023 irrigation season.

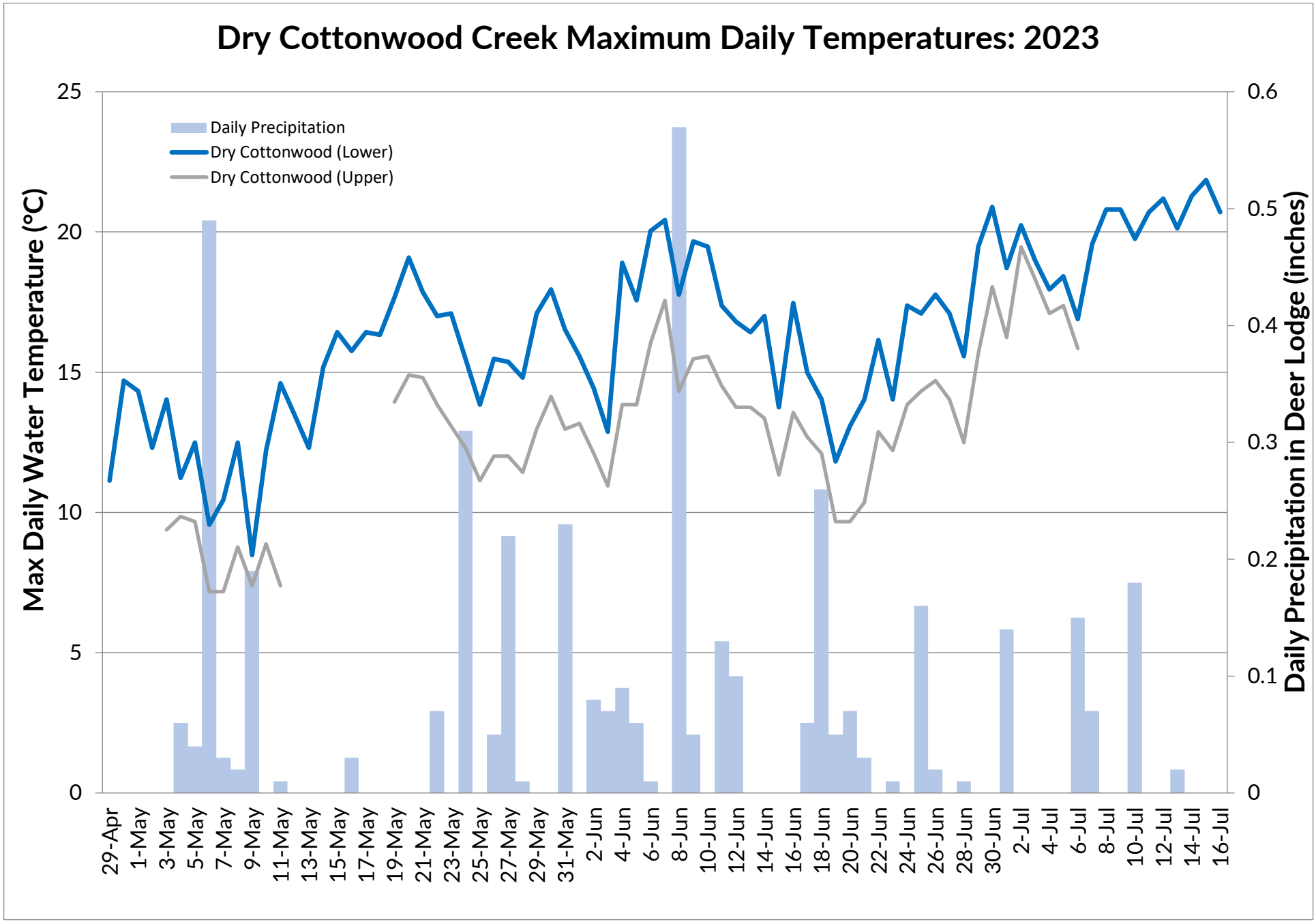

Figure 12: Dry Cottonwood Creek maximum daily thermographs for the 2023 irrigation season. Gaps in DCC upper data represent time periods when HOBO logger went dry.

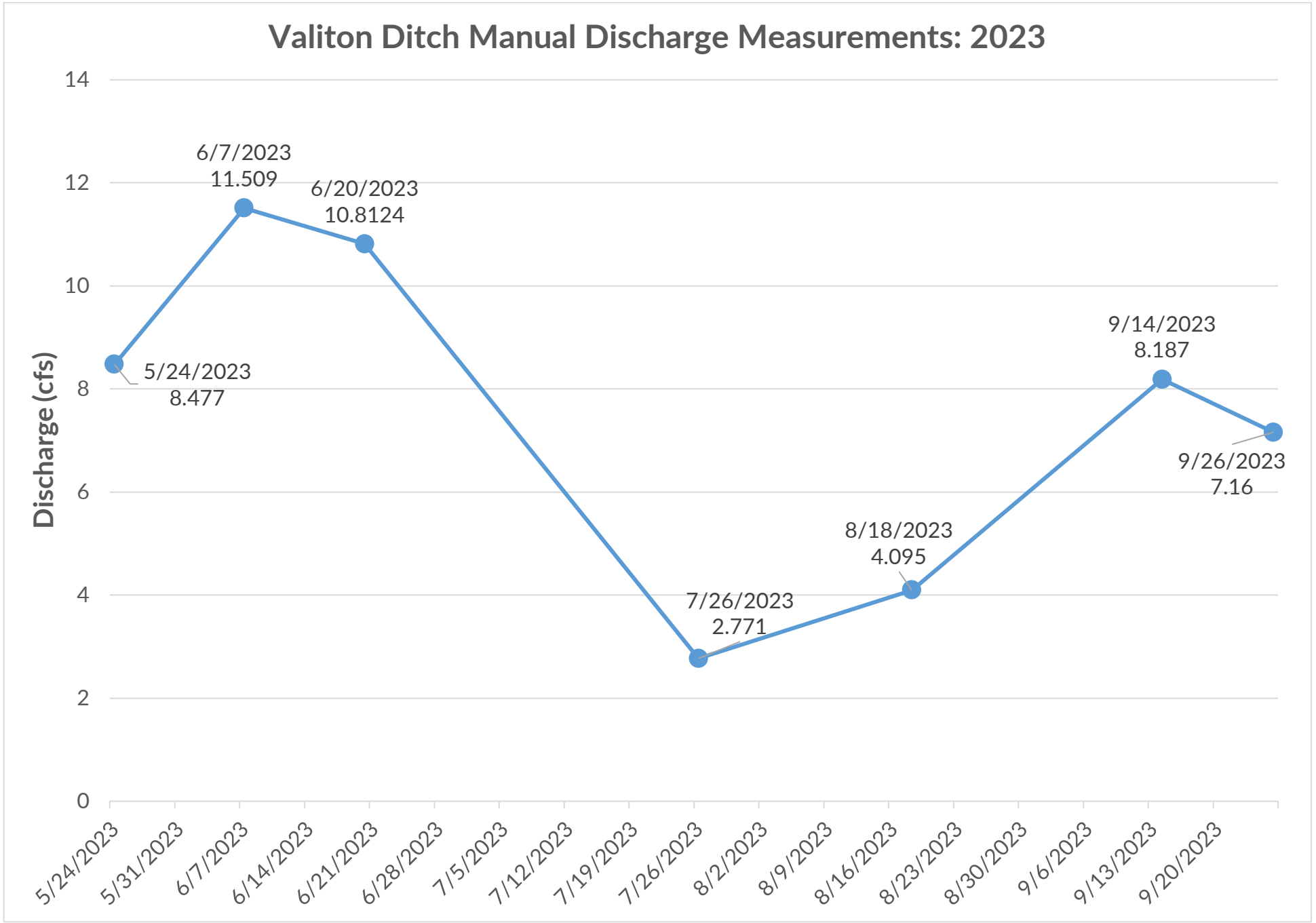

Figure 13: Valiton Ditch spot flow measurements throughout the 2023 irrigation season.

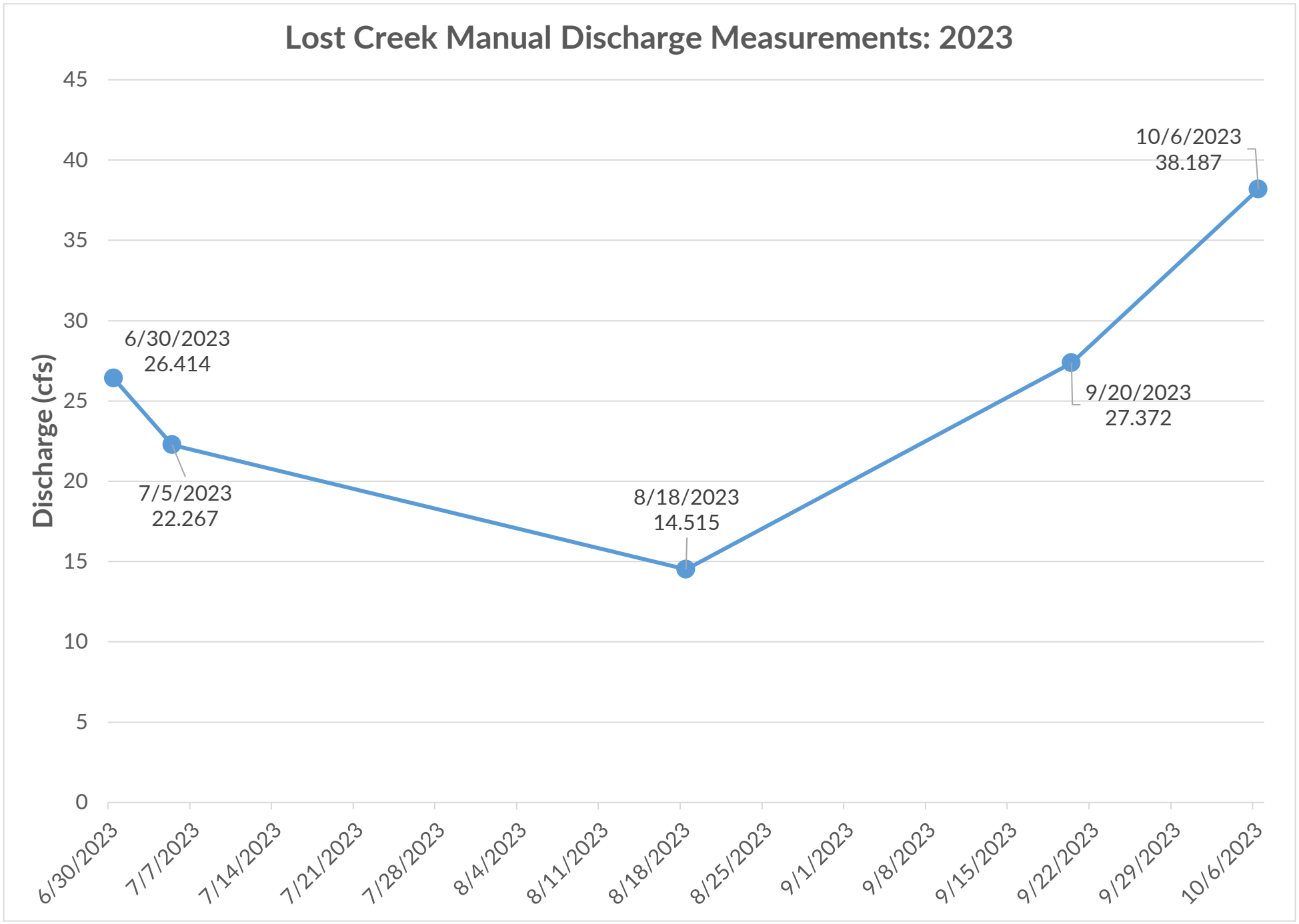

Figure 14: Lost Creek spot flow measurements throughout the 2023 irrigation season.