

2024 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, updated and approved in 2024. 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 2024 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 2024 field season the Clark Fork Coalition (CFC) managed 14 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 NRD, as well additional pertinent locations funded by the Columbia Basin Water Transaction Program (CBWTP).

Methods

Streamflow was manually measured every 2-4 weeks between June and September by CFC staff at the primary monitoring sites (Table 1). Individual flow measurements were tabulated using a Hach FH950 digital flow meter following standards outlined in Rantz (1982) using the standard 0.6 tenths depth method. At least 20 equidistant velocity verticals were measured in each cross section using an averaging period of 40 seconds. No individual velocity measurement represented more than 10% of the observed flow in accordance with USGS measurement protocols. Each measurement location was free of large disturbances as much as possible (i.e. boulders, aquatic growth, inflowing or outflowing side channels, eddies, etc.). A fiberglass tape was stretched across the cross-section ensuring that it was oriented perpendicular to flow and secured using bank pins or rebar stakes. Depths and velocities were then measured at each vertical to the nearest 0.05 ft and 0.01 ft/s. The measurer held the wading rod vertical and steady with the base on top of the substrate, positioning the probe directly parallel to the flow. The accuracy of a velocity-area measurement under ideal, average, and poor conditions is +/- 2, 6, and 20% (Sauer and Meyer, 1992).

Upper Clark Fork River Basin Primary Monitoring Sites	
Stream	Site
Cottonwood Creek	In Deer Lodge
Clark Fork River	Galen Road
	Below West Side Ditch at Gemback Road
	Above Valiton Ditch
	Sager Lane
	Near Headgate
Valiton Ditch	
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

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

To ensure data reliability, a pre-season field test of all flow meters was performed at a single site near Missoula. Throughout the season, the flow meters were calibrated biweekly, and more frequently if needed.

At the 14 primary monitoring sites (Table 1) a continuous HOBO datalogger recorded both pressure (psi) and water temperature (°C) at hourly intervals. The instream HOBO dataloggers' pressure data represent total pressure (water column equivalent + barometric pressure). In order to accurately determine the true changes in water level, barometric pressure fluctuations were removed from the

data by deploying a second datalogger within 1000 vertical feet of the instream loggers to collect ambient pressure, which fluctuates in response to atmospheric storm events.

After barometric compensation at each site, the post processing data represents hourly water depths, which 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 hydrographs of hourly flows for each site.

Although the locations of monitoring sites typically remain the same from season to season, 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 are generated each year to account for these natural morphological changes.

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 and water temperatures are represented by the highest individual daily readings.

Meteorological data were retrieved from the US Bureau of Reclamation's AgriMet database.

Additional spot measurements were taken throughout the monitoring season at 7 sites (Table 2). Rating curves and hydrographs were not created for these sites.

Upper Clark Fork River Basin Spot Measurement Sites	
Stream	Site
Cottonwood Creek	Above Applegate Upper Diversion (Sherm Anderson's Corral Bridge)
	At Baggs Creek Confluence
	Below Applegate Upper Diversion
Dry Cottonwood Creek	Dry Cottonwood Creek-Upper
Mill Creek	At Highway 1
Warm Springs	Frontage Road
	Near Upper POD
Brock Creek	Near Upper POD
Valiton Ditch	Near End of Ditch

Table 2- Locations of secondary monitoring sites where spot measurements were taken. Data from these sites are in Table 4.

We also deployed temperature loggers (Onset TidbiT v2) at 6 additional sites to investigate their influence on mainstem river temperatures throughout the summer (Table 3).

Upper Clark Fork River Basin Temperature Monitoring Sites
Arrowstone Spring
Broken Circle (BC) Spring
Phase 7 Lower Spring
Brock Creek
Warm Springs at Frontage Road
Clark Fork River above Brock Creek

Table 3- Locations of temperature monitoring sites. Data from these sites are displayed in figures 13-16.

Upper Clark Fork 2024 Primary Monitoring Sites

Legend

Monitoring Locations:

- Clark Fork River (Red circle)
- Cottonwood Creek (Purple circle)
- Racetrack Creek (Yellow circle)
- Lost Creek (Green circle)
- Valiton Ditch (Orange circle)
- Dry Cottonwood Creek (Light Blue circle)
- USGS Gages (Black circle)

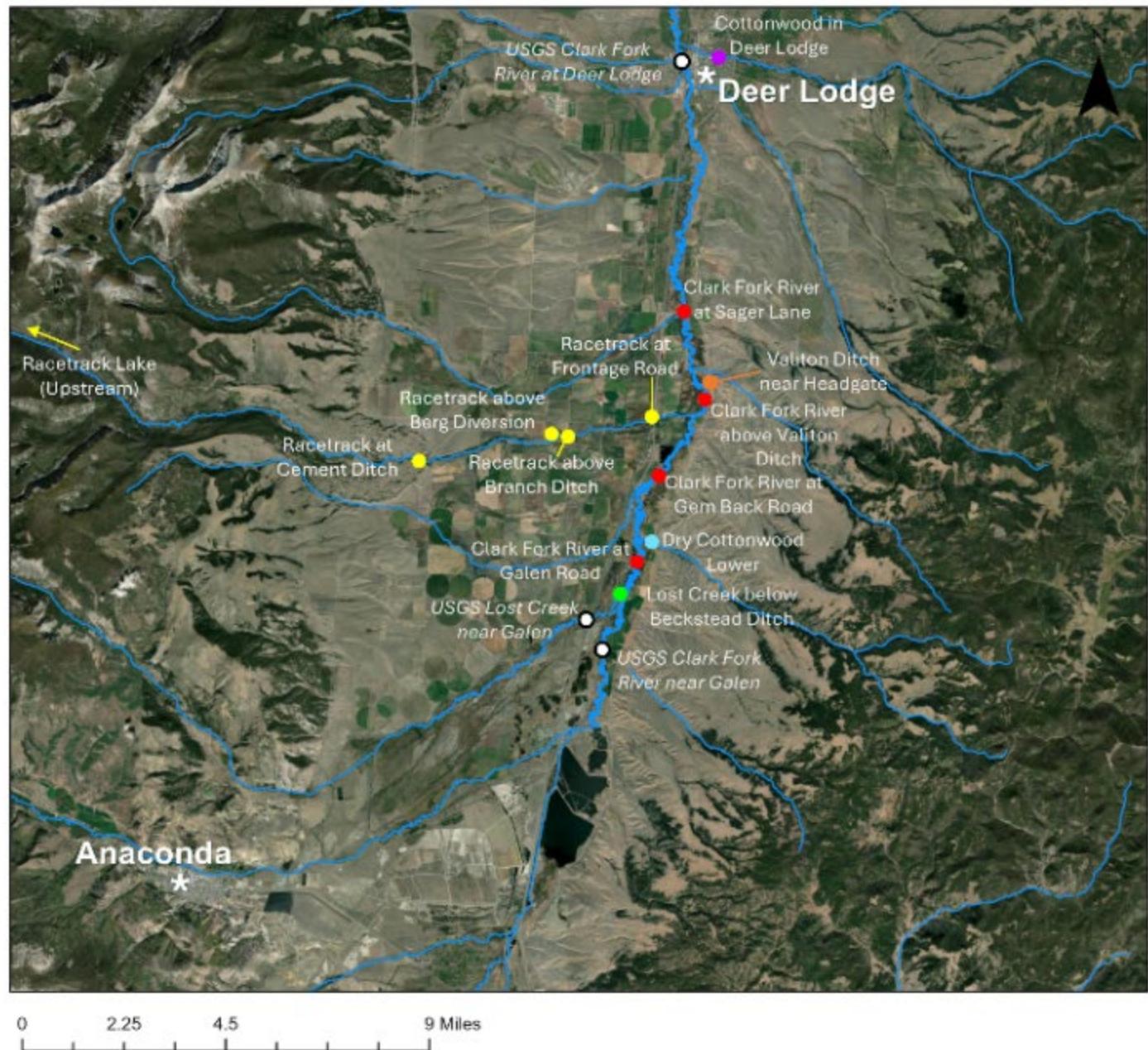
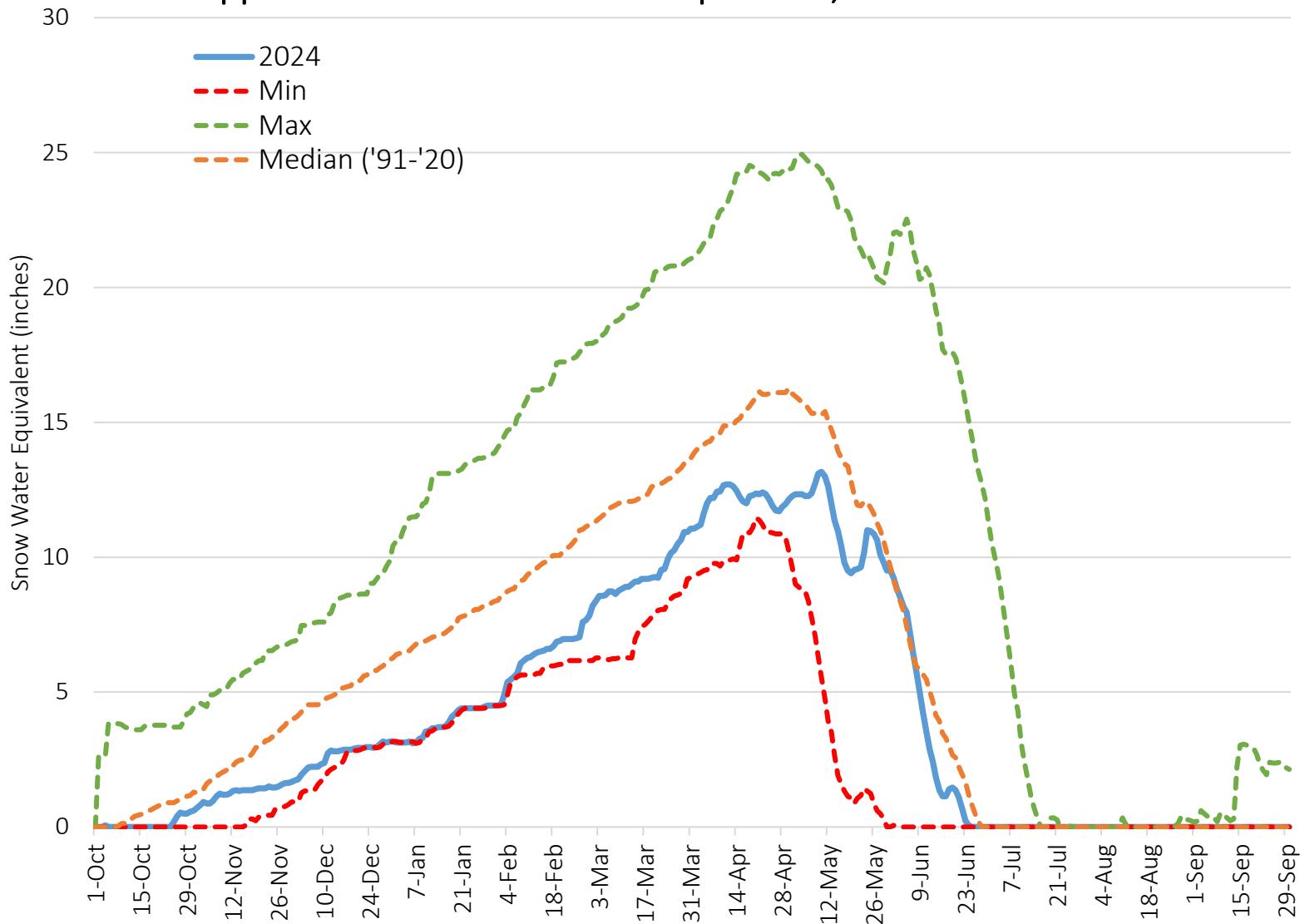


Figure 1: Map of 2024 primary monitoring locations.

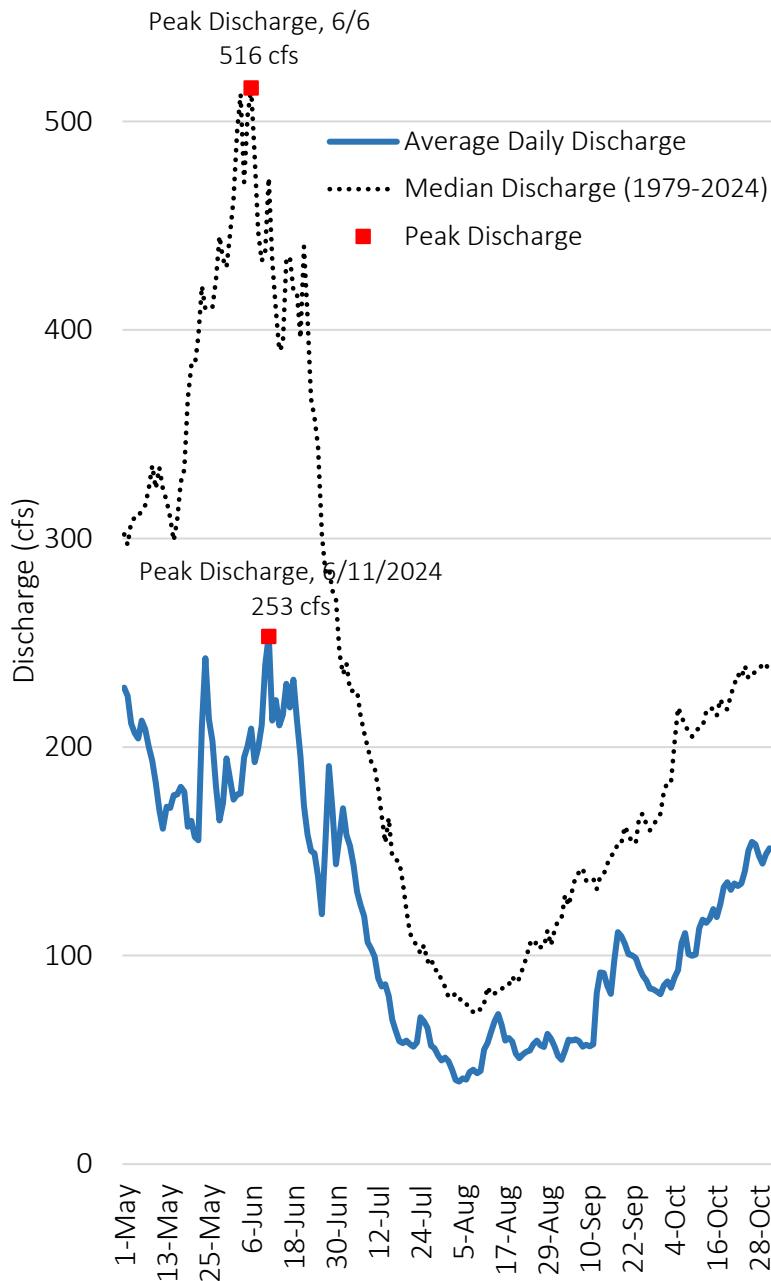
Upper Clark Fork Snow Water Equivalent, 2024 Water Year



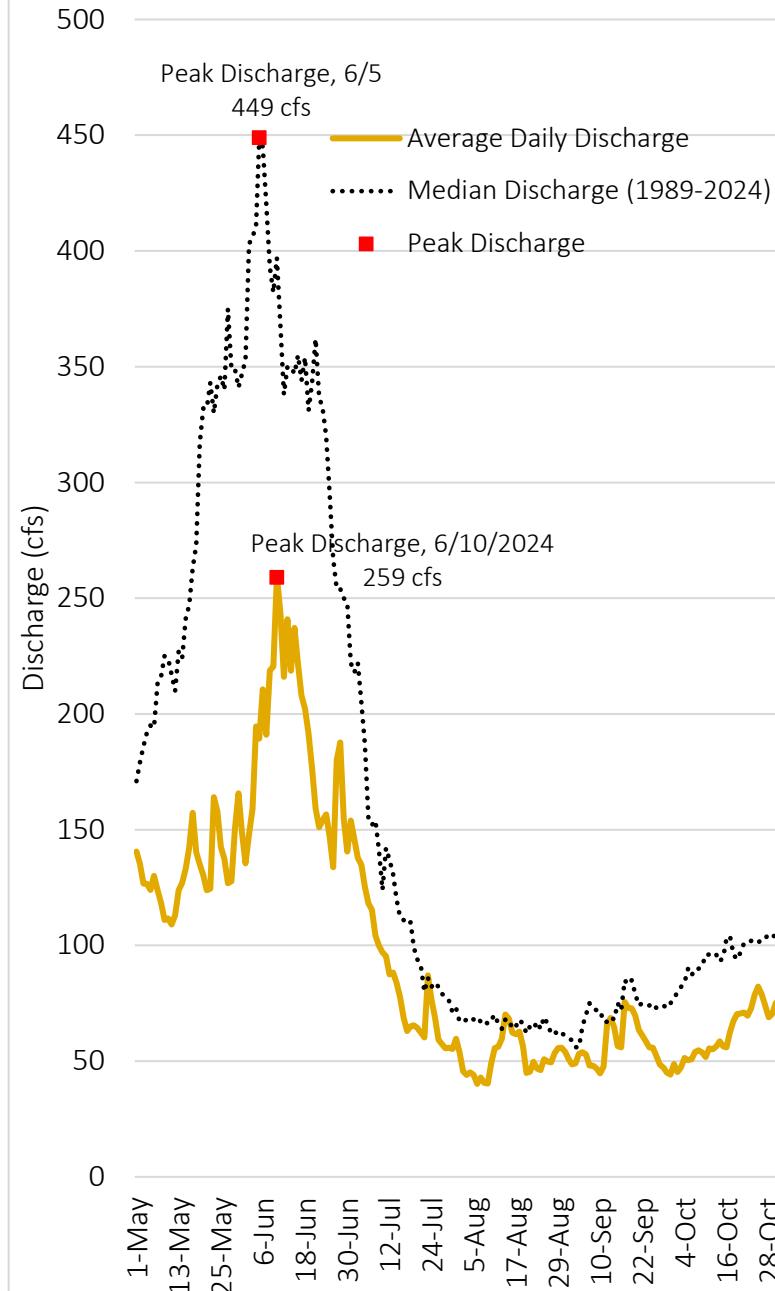
Much of Montana endured its fifth consecutive year of abnormally dry conditions in 2024, including the Upper Clark Fork basin. The UCF saw 76% of normal precipitation in April, bringing the seasonal accumulation (October-April) to 73% of the median. The snowpack in the UCF by the end of May was well below normal at 56% of the median, compared to 123% at the same time in 2023 (NRCS, 2024). The UCF also experienced its lowest snow water equivalent (SWE) on record from 12/21/2023 through 2/6/2024, establishing a new minimum SWE for this time period (considering 3 UCF SNOTEL sites over the 45-year period of record). SWE generally remained depressed in the 10th percentile through early May, until cooler than average spring temperatures delayed snowmelt, bringing SWE to approximately median levels in early June.

Figure 2: Upper Clark Fork Snow Water Equivalent, 2024 Water Year (October 1, 2023-September 30, 2024). Minimums and maximums were determined using 45 years of data from 1980-2024 from three Upper Clark Fork SNOTEL stations (Barker Lakes, Basin Creek, and Warm Springs).

USGS Clark Fork River at Deer Lodge, Peak Flows



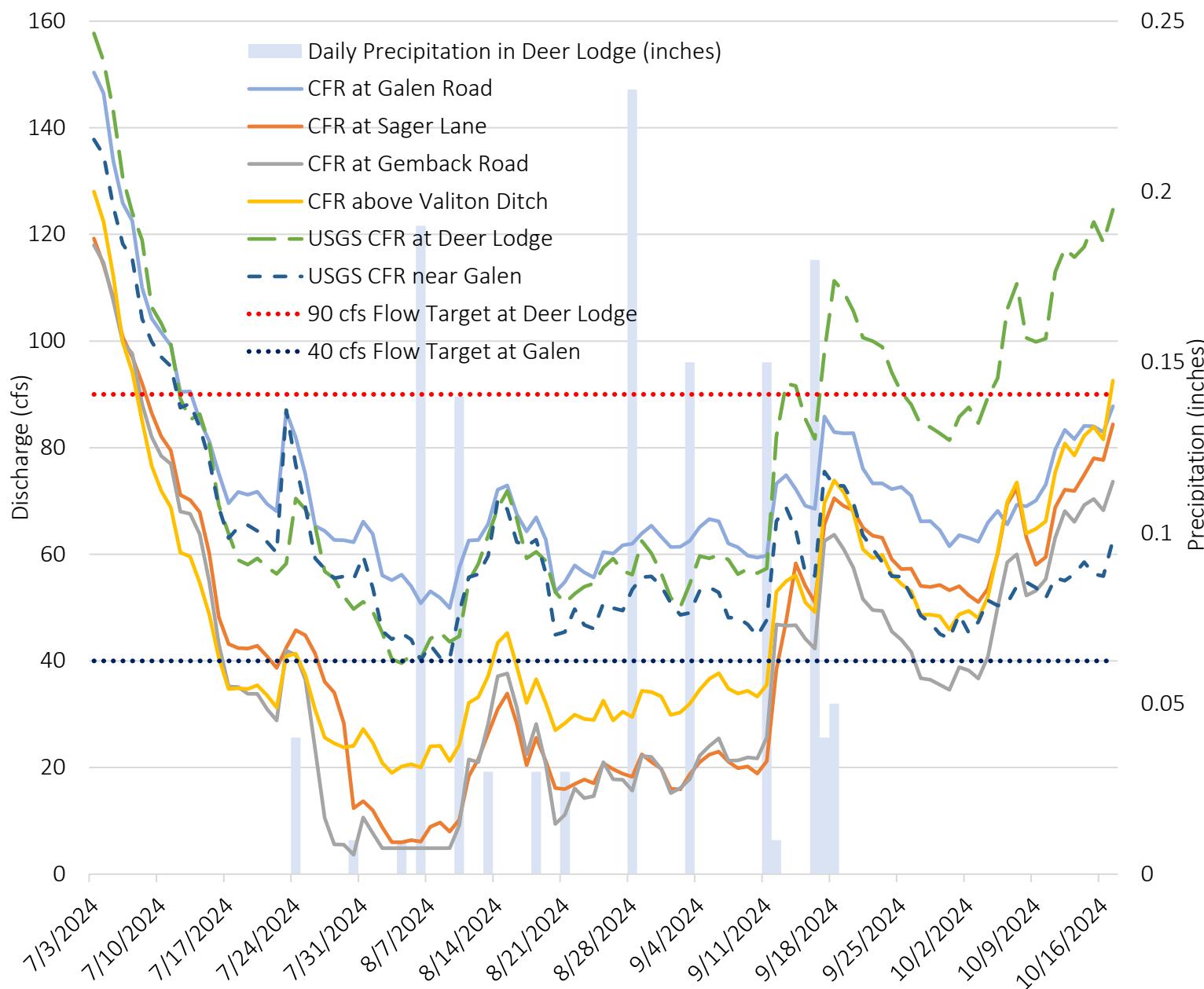
USGS Clark Fork River near Galen, Peak Flows



Due to the below average spring snowpack, streamflow runoff conditions in the UCF were historically low this year. At the USGS gages in Deer Lodge and Galen, flows peaked at 253 and 259 cfs, compared to normal median peaks of 516 and 449 cfs, respectively. Between these two stations, these 2024 flow maximums were on average 226.5 cfs lower than normal peak flows. Cooler than average spring temperatures also delayed runoff in 2024, with both USGS gages peaking approximately 5 days after normal spring maximums.

Figure 3: Upper Clark Fork River mainstem USGS gages, 2024 vs median peak flow comparisons.

Clark Fork River Average Daily Discharge: 2024



Dewatering of the mainstem of the UCF is one of the highest concerns for the basin, especially during July and August when precipitation is typically lowest and irrigation demand is highest. Through a wetted perimeter analysis, Fish, Wildlife, and Parks (FWP) identified 90 cfs as the critical discharge rate below which habitat is rapidly lost for the Clark Fork River near Deer Lodge (FWP, 1986). On the mainstem near Galen, 40 cfs was identified as the minimum flow needed. These critical lower limits are visualized alongside the 6 CFC and USGS mainstem gages. Three CFC gages (at Sager Lane, above Valiton Ditch, and at Gemback Road) remained well below the 40 cfs flow target from approximately mid-July through early September. The CFC gage at Galen Road and the USGS gage near Galen remained above the 40 cfs flow target, but flows at the USGS gage in Deer Lodge were well below the 90 cfs flow target from July through early September.

Figure 4: Upper Clark Fork River Average Daily Discharges at 6 mainstem Clark Fork River sites managed by the CFC and USGS.

Clark Fork River at Gemback Road 8-Year Comparison: Average Daily Discharge

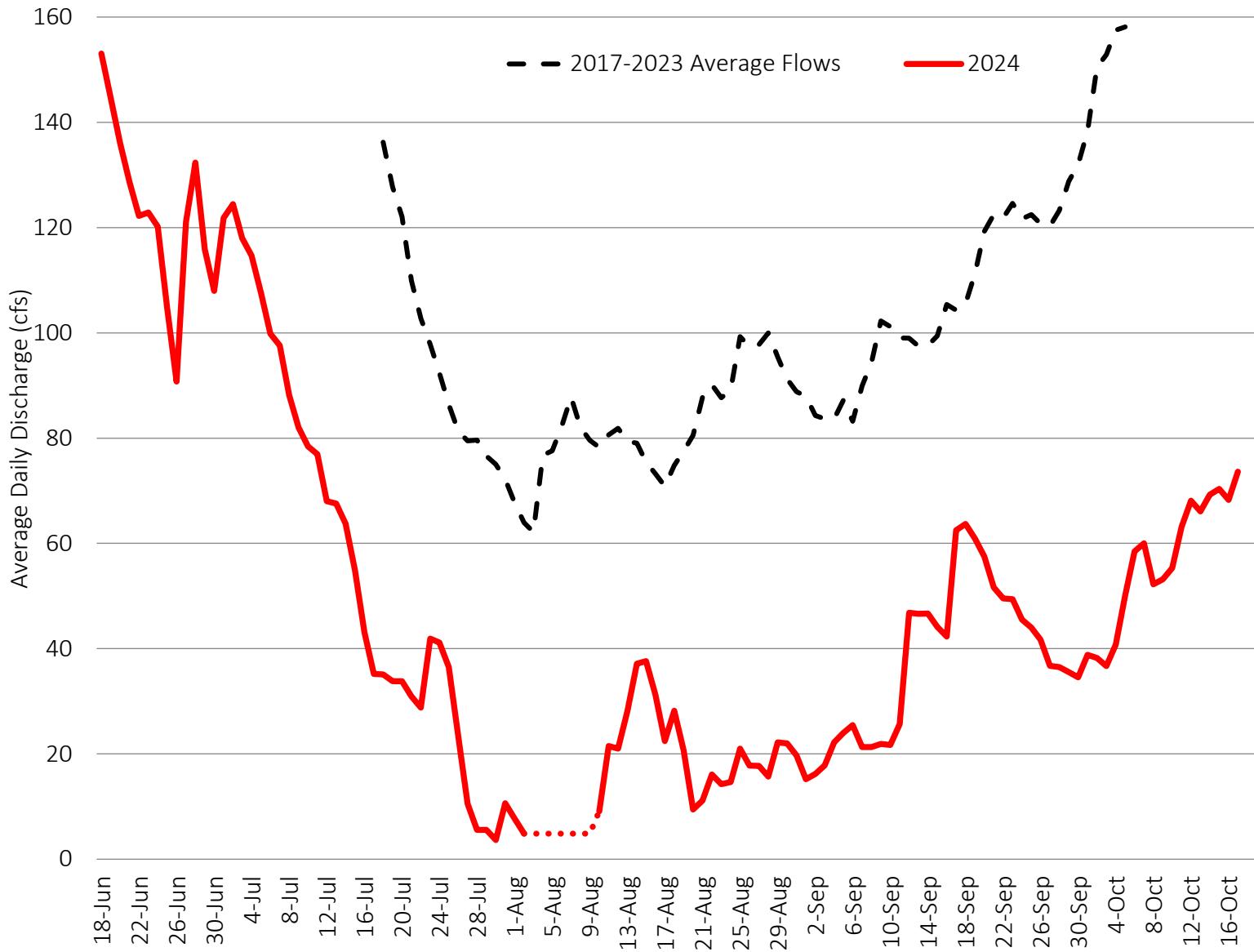
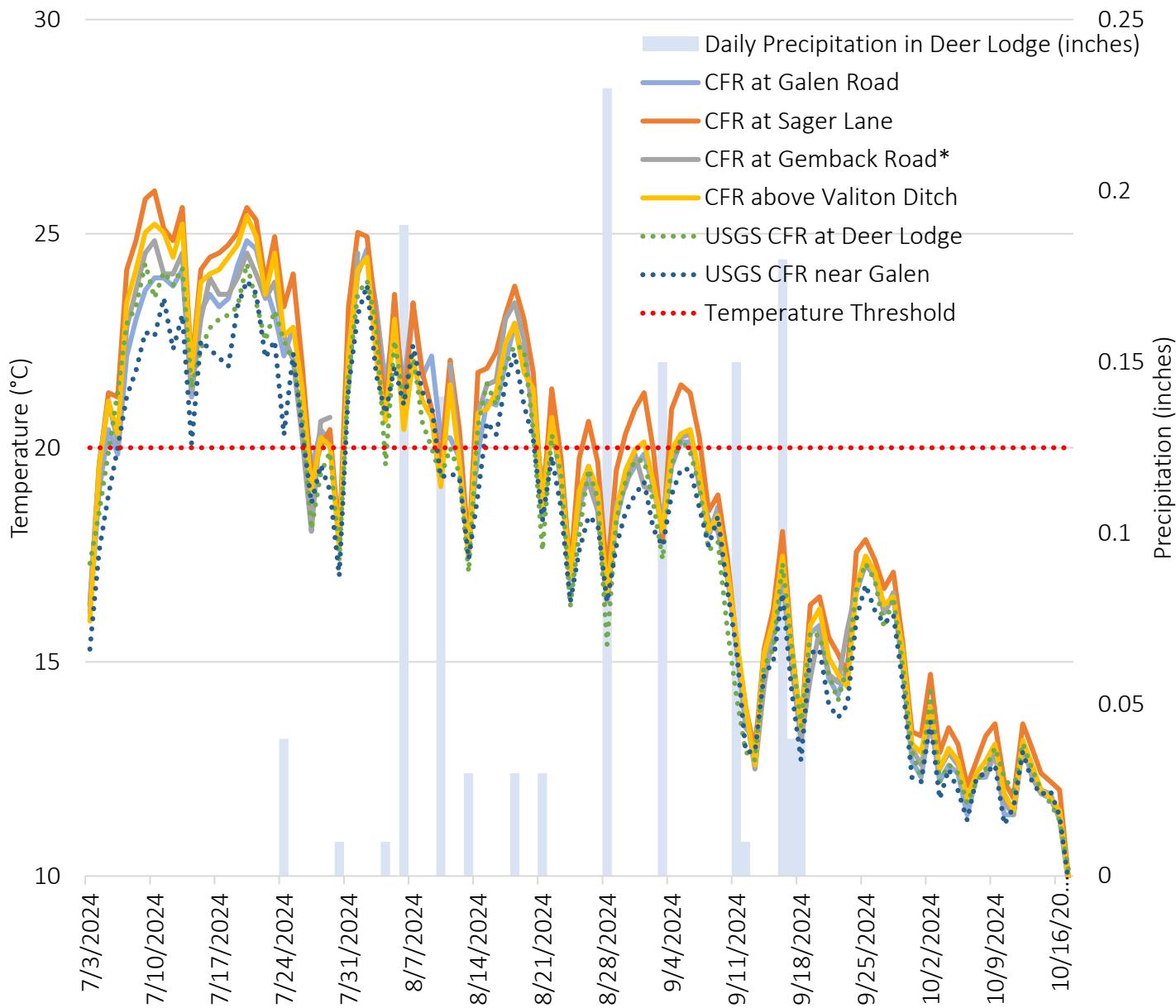


Figure 5: Upper Clark Fork River at Gemback Road 8-year flow comparison (2017-2024)

The lowest mainstem flows were measured at the CFC monitoring site at Gemback Road. On 8/30/2024 flows reached a minimum of 3.64 cfs, marking the beginning of extremely low mainstem flows at all sites, which lasted about a week until a precipitation event on 8/10/2024 slightly elevated flows through mid-August. From August 2-9 the logger went dry, and although manual discharge measurements were not taken during this time period, flows likely dropped below 3.64 cfs. Flows at Gemback Road from 2017 through 2023 were averaged and graphed alongside 2024 data in Figure 5. 2024 flows were on average 70.58 cfs below the 2017-2023 mean flows throughout the overlapping periods of record for the 8 years of data.

Clark Fork River Daily Maximum Water Temperatures: 2024



Daily water temperatures reached highs above 20°C an average of 49 days at all CFC sites. This threshold represents the maximum temperature at which adverse effects to cutthroat and bull trout are minimized (Bear *et al.*, 2007; Selong *et al.*, 2001). The USGS gages near Galen and at Deer Lodge and the CFC gage at Galen Road had the highest flows throughout the monitoring period, and predictably had the lowest temperatures. The highest temperatures were recorded at Gemback Road where flows were lowest, although some of these temperatures were excluded from the graph when the logger went dry in August. Sager Lane also exhibited extremely low flows and high temperatures, with 61 days above the 20°C threshold (compared to 38 days above this threshold in 2023). Sager Lane was on average 1.7°C warmer than the USGS gage near Galen throughout the monitoring period, reaching a maximum temperature difference of 4.9°C on 6/23/2024, when flows were 20.1 cfs lower at Sager Lane than the USGS gage near Galen. A lack of precipitation persisted throughout September and October; however, September 7th was the last day of the monitoring period with temperatures above 20°C, after which temperatures dropped at all sites due to shorter days and cooler air temperatures.

Figure 6: Upper Clark Fork River maximum daily thermographs for the 2024 irrigation season. Some CFR at Gemback Road temperatures were excluded from the graph when the logger went dry in early August.

Cottonwood Creek Average Daily Discharge: 2024

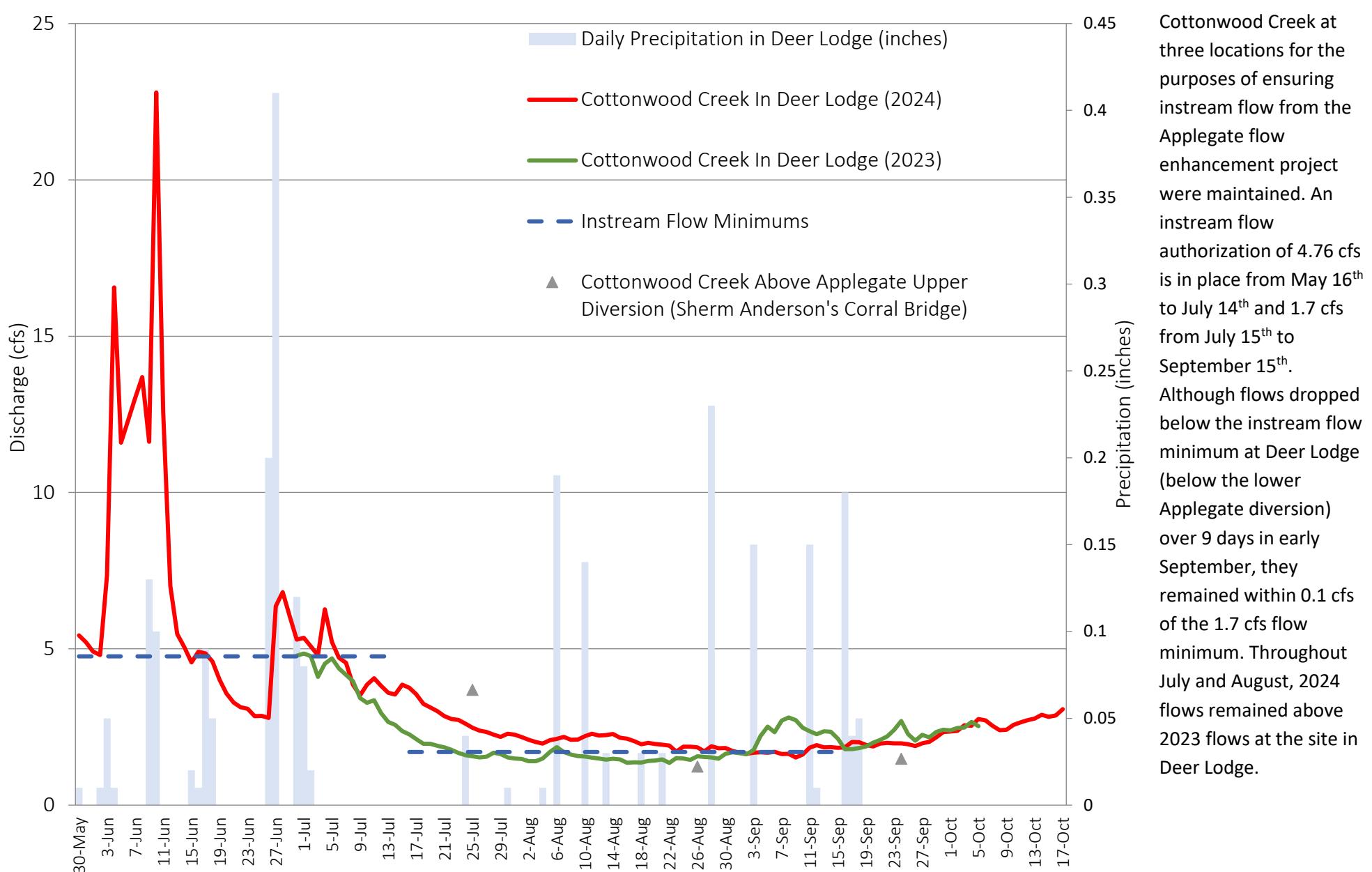


Figure 7: Cottonwood Creek average daily hydrographs for the 2024 irrigation season.

Cottonwood Creek in Deer Lodge Daily Max Temperatures

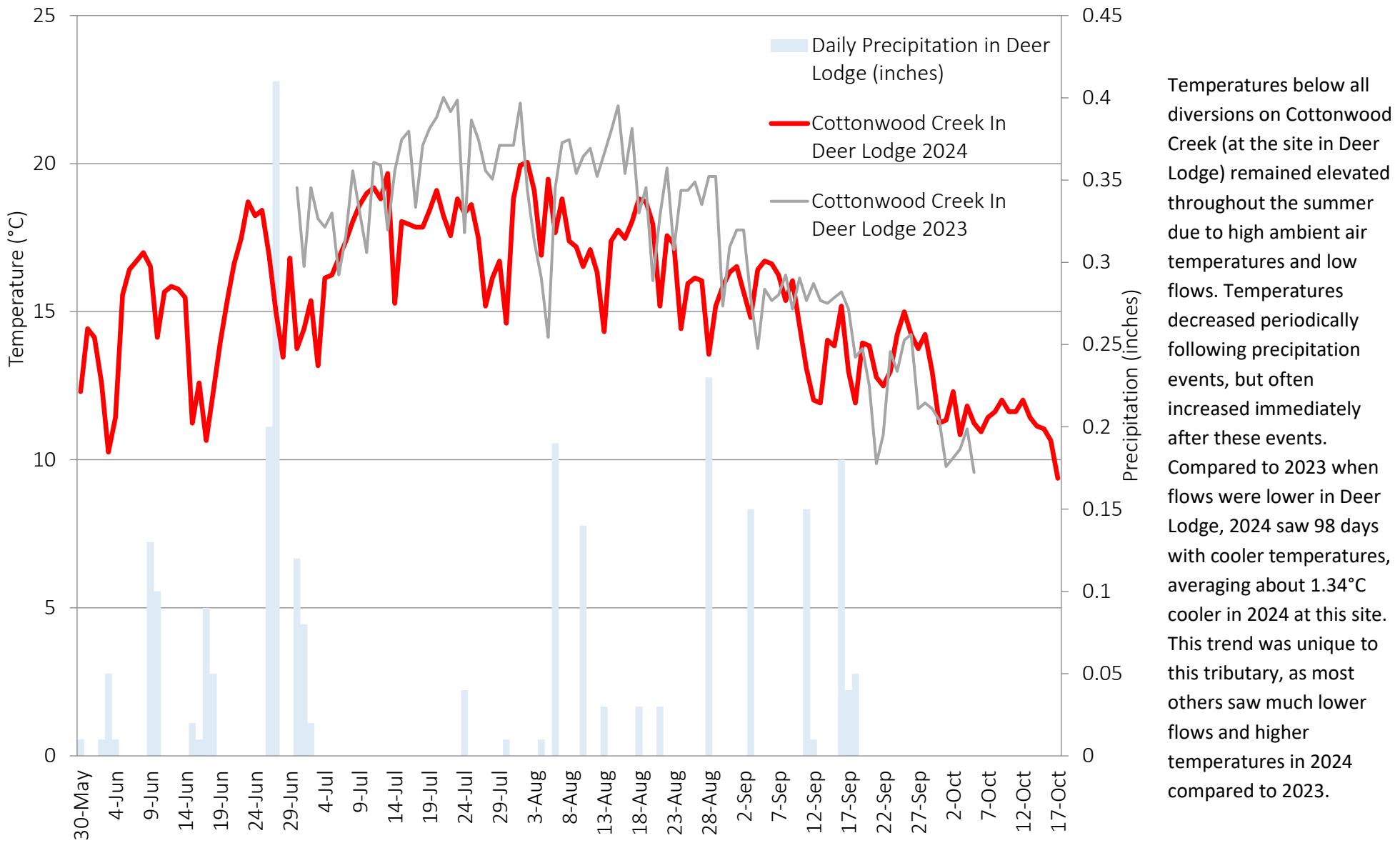


Figure 8: Cottonwood Creek maximum daily thermographs for the 2024 irrigation season.

Dry Cottonwood Creek Average Daily Discharge: 2024

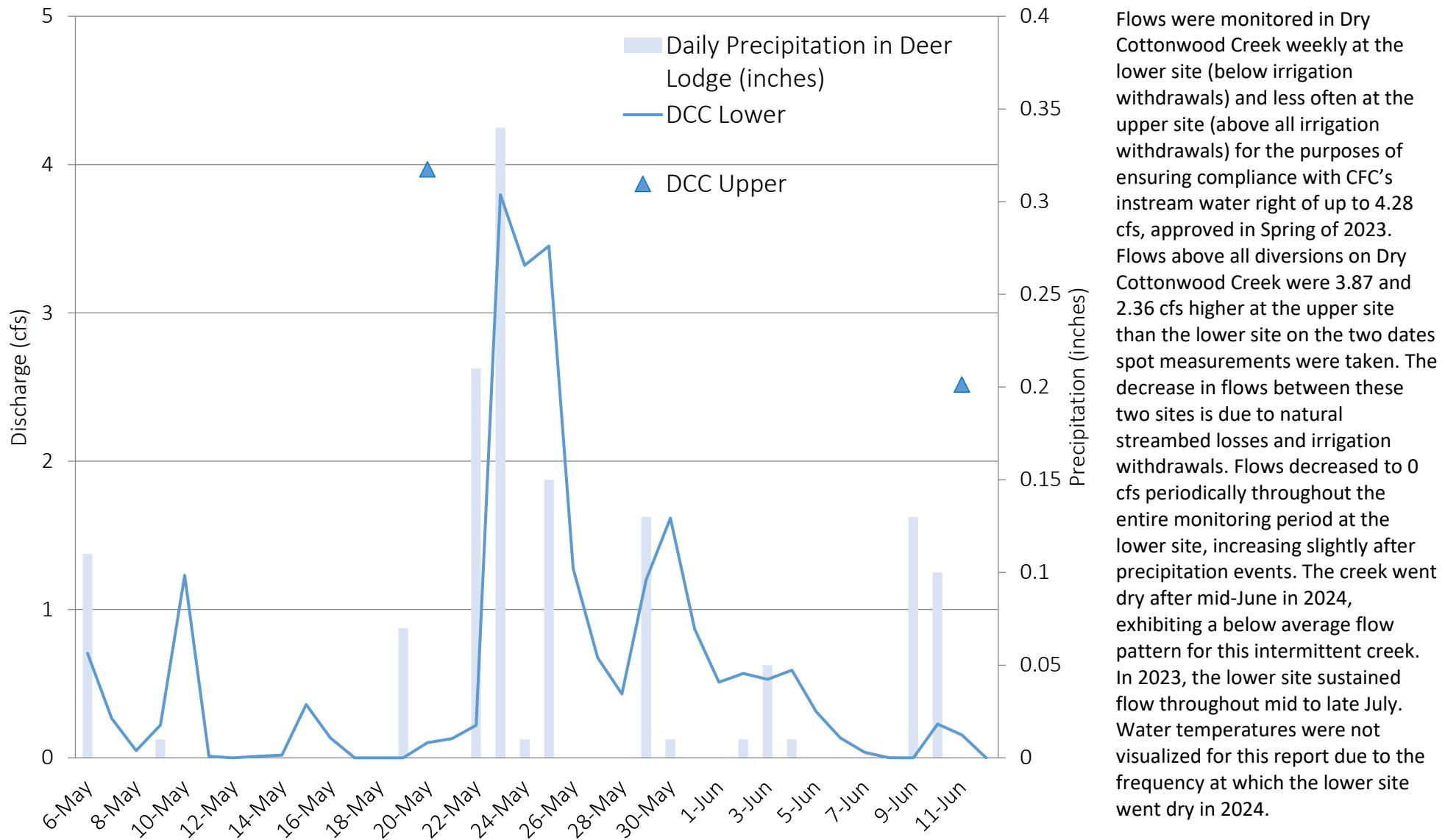


Figure 9: Dry Cottonwood Creek (lower site) average daily hydrograph for the 2024 irrigation season.

Valiton Ditch Discharge Measurements: 2024

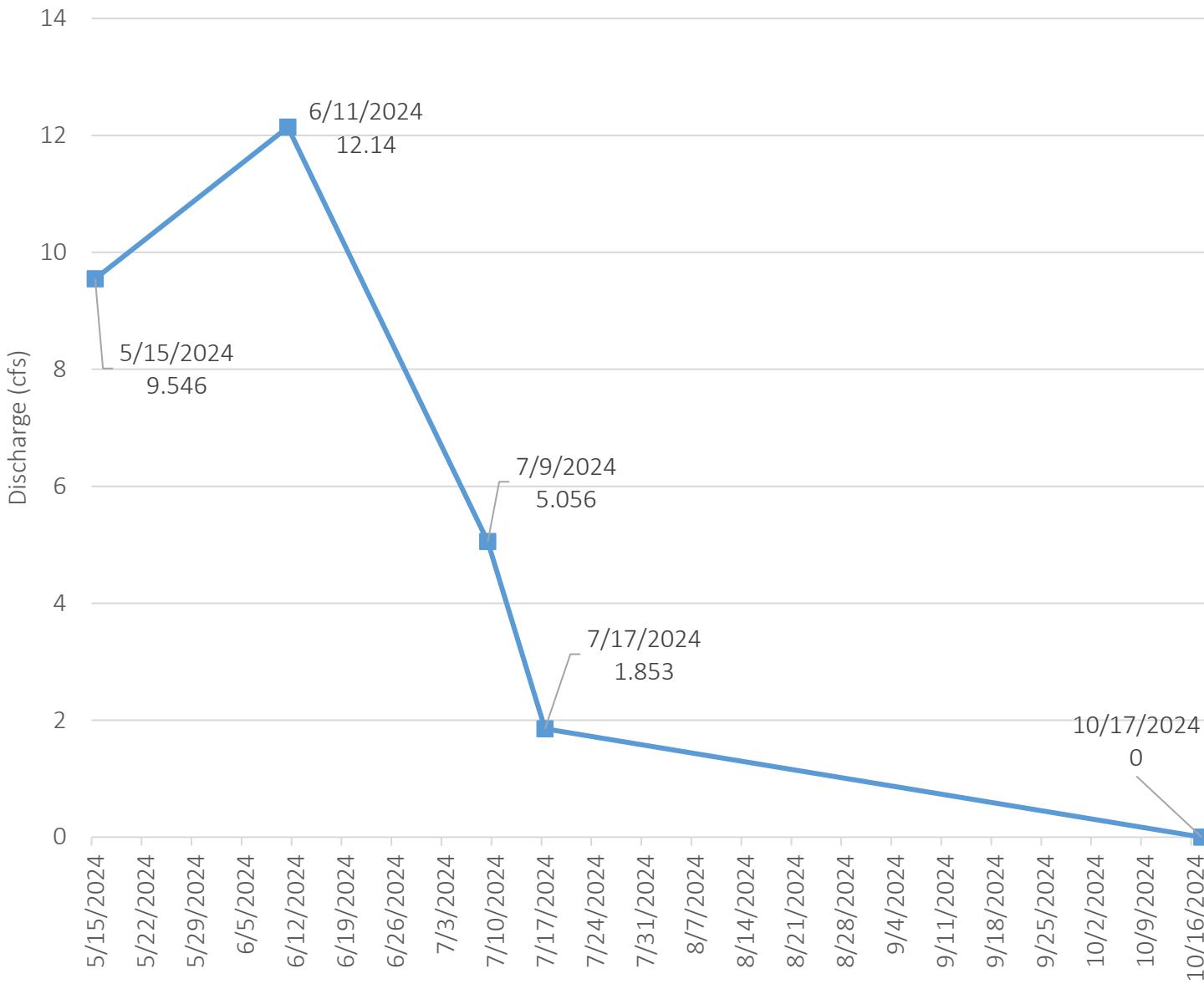
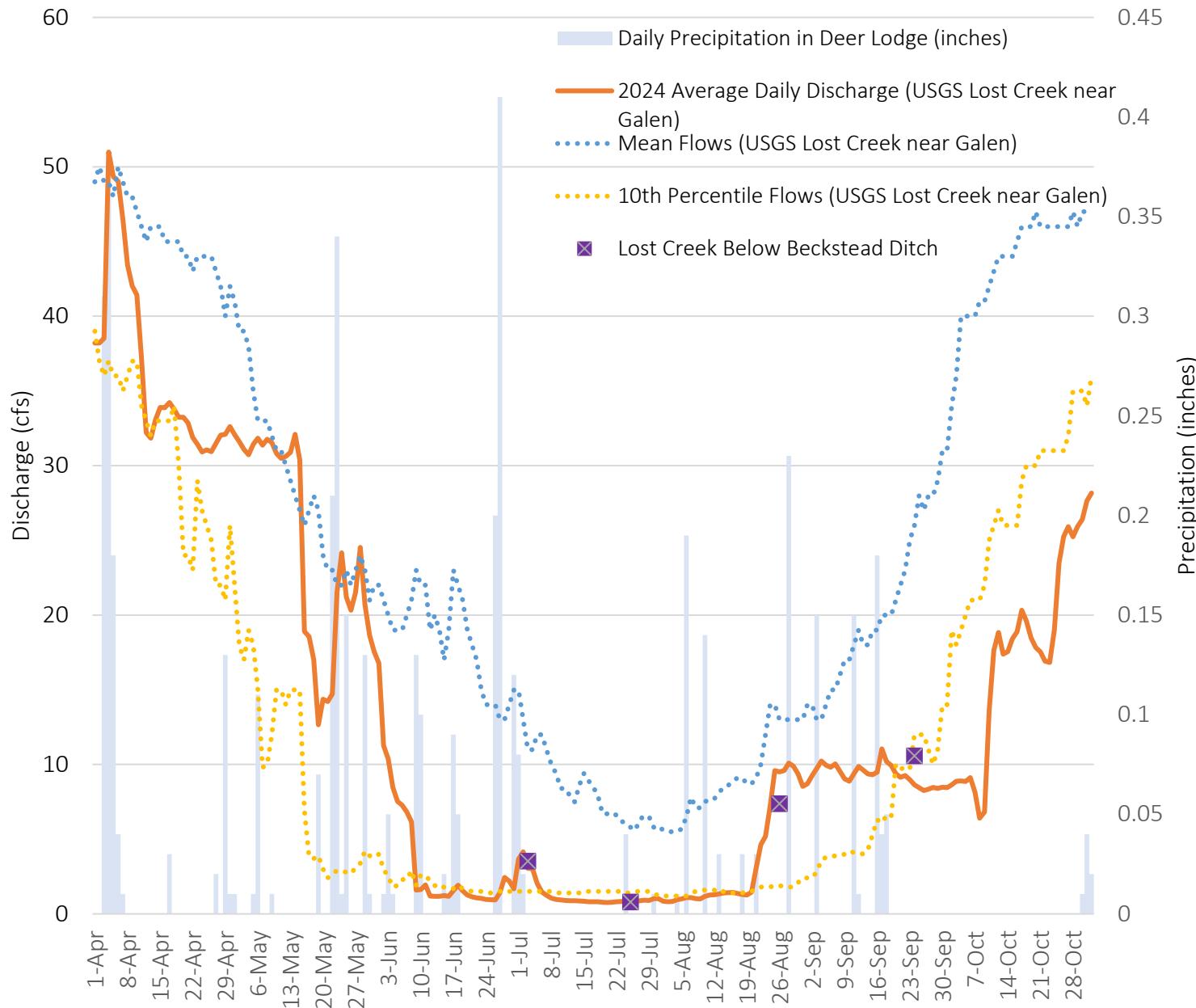


Figure 10: Valiton Ditch manual discharge measurements for the 2024 irrigation season.

This is the seventh year of monitoring by the CFC on the Valiton Ditch, which withdraws water from the Clark Fork River above Sager Lane and below the Racetrack confluence. 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 May and June ranged from 9.5 to 12.14 cfs, followed by a reduction in flow in July as a result of the Reduction in Water Use Agreement among water users at this location. The ditch was confirmed closed and dry when we retrieved our logger and ceased monitoring on 10/17/2024.

Discharge data at this site are often more error prone than other sites due to the amount of mid-summer 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. Manual discharge measurements are displayed in Figure 10.

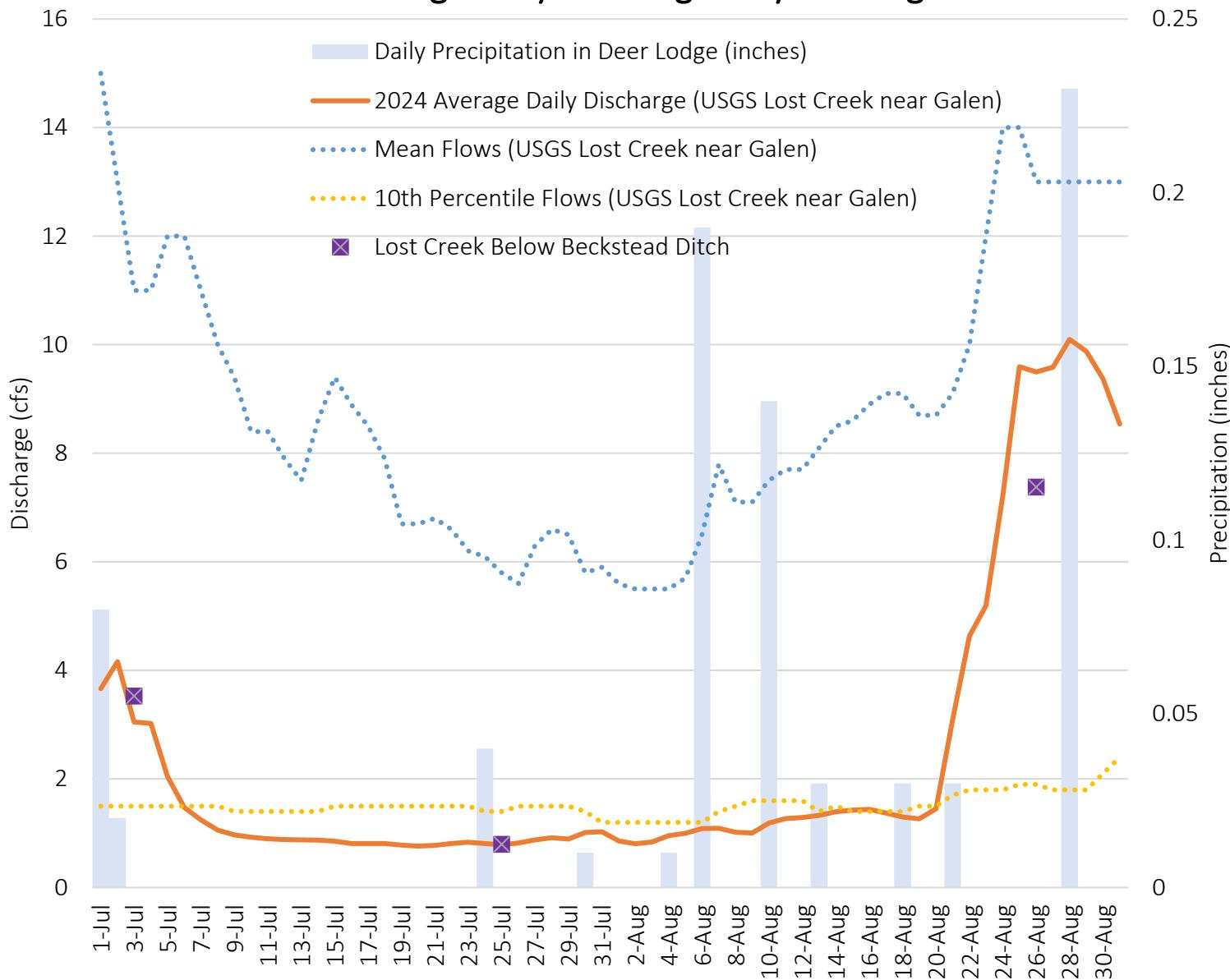
Lost Creek Average Daily Discharge: 2024



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. A hydrograph could not be made for the CFC site below the Beckstead Ditch in 2024 due to a beaver dam that was built upstream of the site mid-season, which increased water levels. Manual measurements from this site were graphed against the Lost Creek USGS gage at the frontage road. See figure 12 for August flows at these sites.

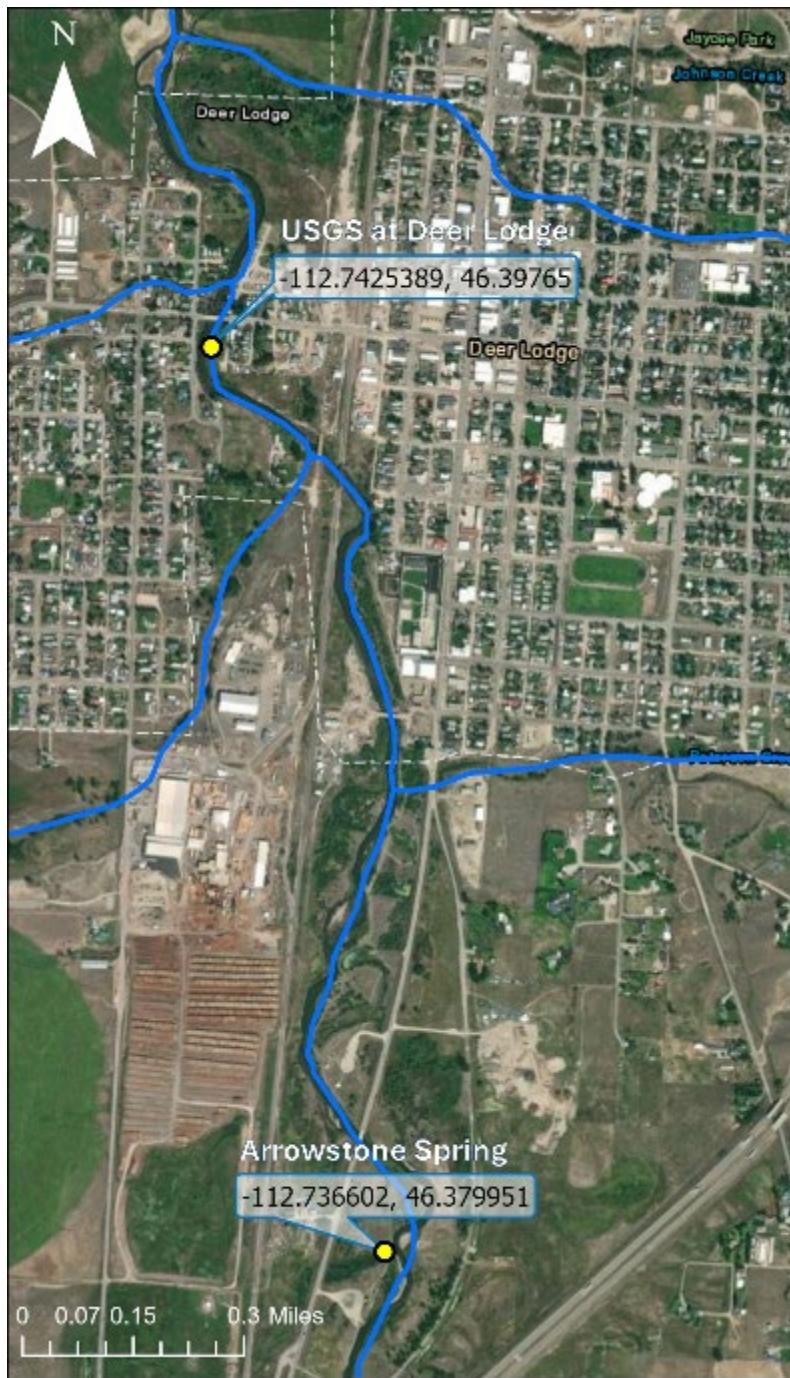
Figure 11: Lost Creek average daily discharge for the Lost Creek USGS gage near Galen and manual discharge for the CFC gage below Beckstead Ditch. Mean and percentile data calculated using 21 years of USGS data from 2004-2024.

Lost Creek Average Daily Discharge: July and August 2024

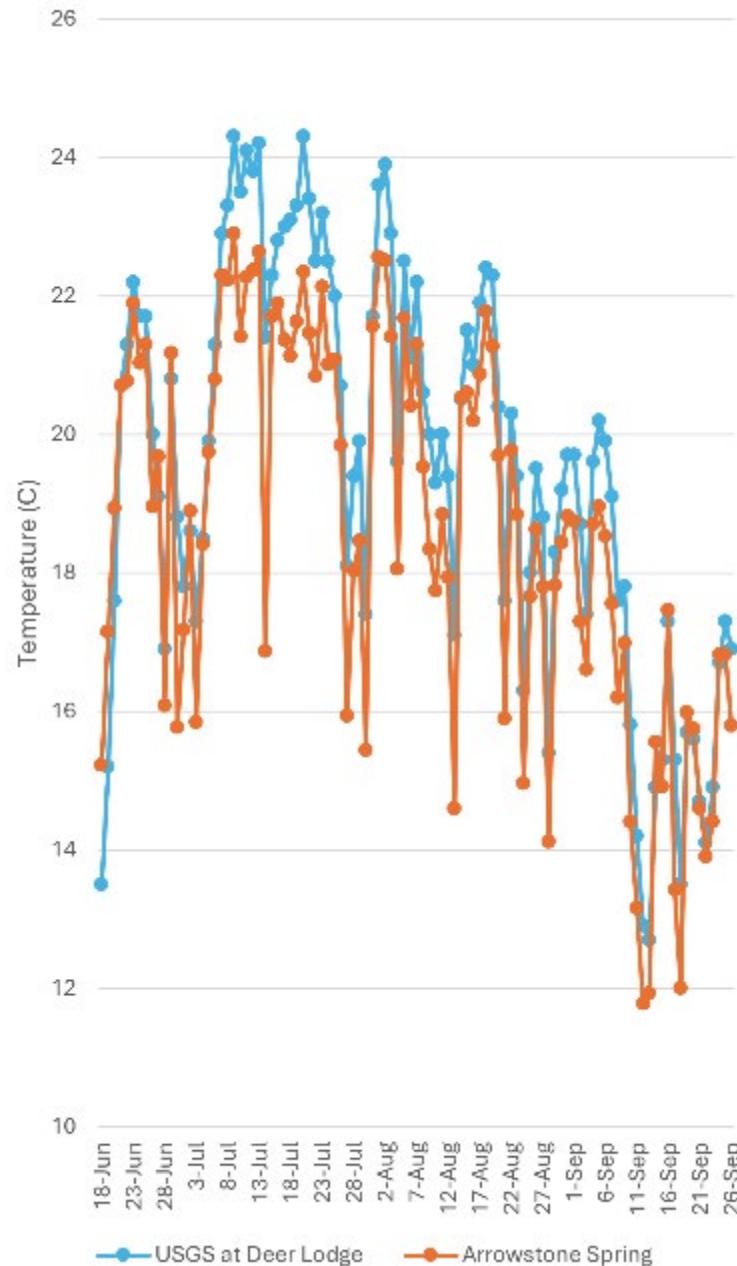


3 of the 4 manual measurements taken below the Beckstead Ditch were in excess of the instream right; however, in July and August, flows decreased to levels within the 10th percentile of daily mean values, remaining depressed at or below the 10th percentile throughout July and August until August 20th. 0.797 cfs was measured below the Beckstead Ditch on July 25th, marking a historically low flow period for both the CFC and USGS sites. 2024 flows at the USGS site were the lowest on record for 68 days (over the 20-year period of record from 2004 to 2024). This is due to both the drought conditions and irrigation withdrawals in July and August.

Figure 12: Lost Creek average daily discharge for the Lost Creek USGS gage near Galen and manual discharge for the CFC age below Beckstead Ditch. Mean and percentile data calculated using 21 years of USGS data from 2004-2024.



Daily Maximum Temperatures



A temperature logger was deployed in the Arrowstone Spring at the boat launch, just south of Deer Lodge. These temperatures were compared to the mainstem USGS gage at Deer Lodge to determine how the spring was influencing mainstem water temperatures throughout the summer.

Arrowstone Spring was generally cooler throughout July and August compared to the mainstem USGS gage at Deer Lodge. Maximum Arrowstone Spring temperatures were on average 1.3°C lower in July and 1.0°C lower in August compared to the river.

Figure 13: Temperature comparison between Clark Fork River USGS at Deer Lodge and Arrowstone Spring.

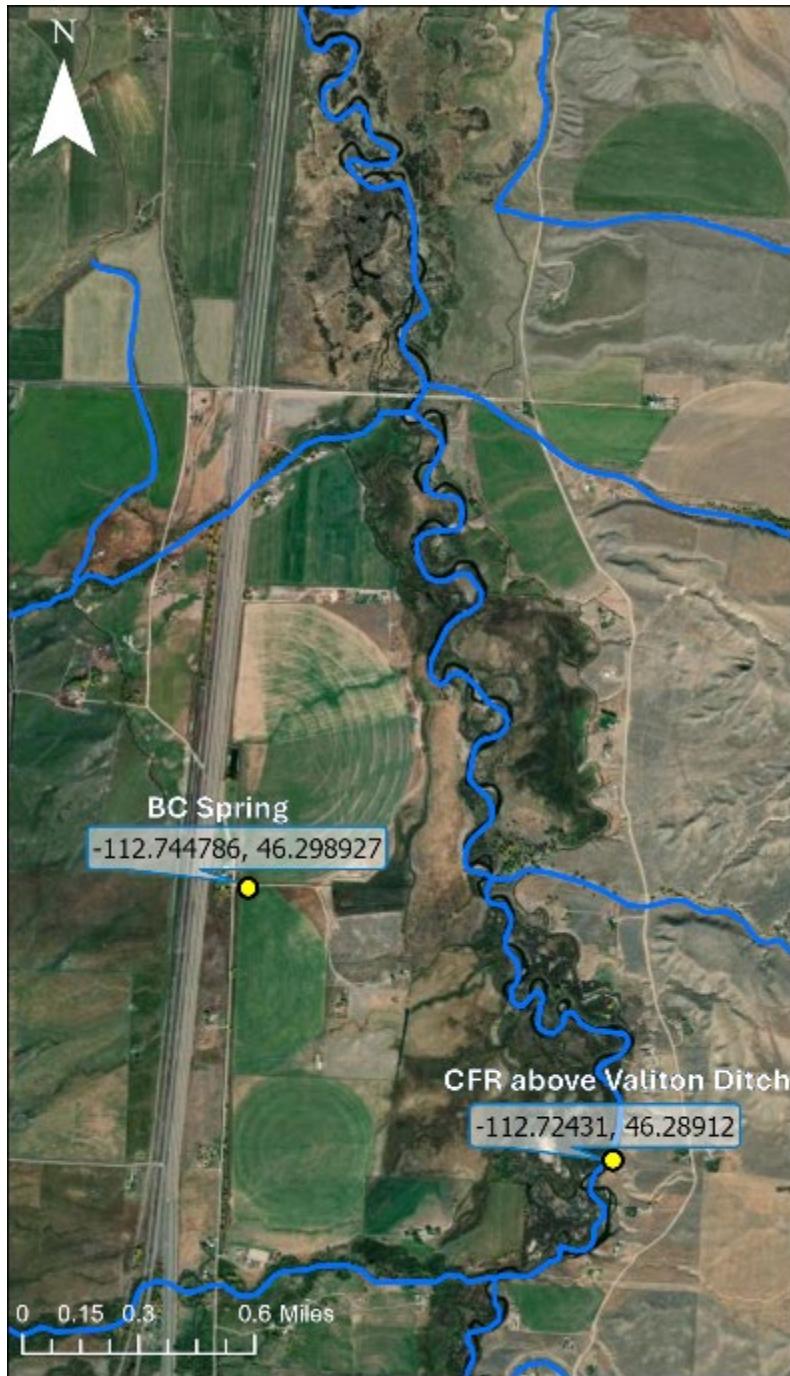
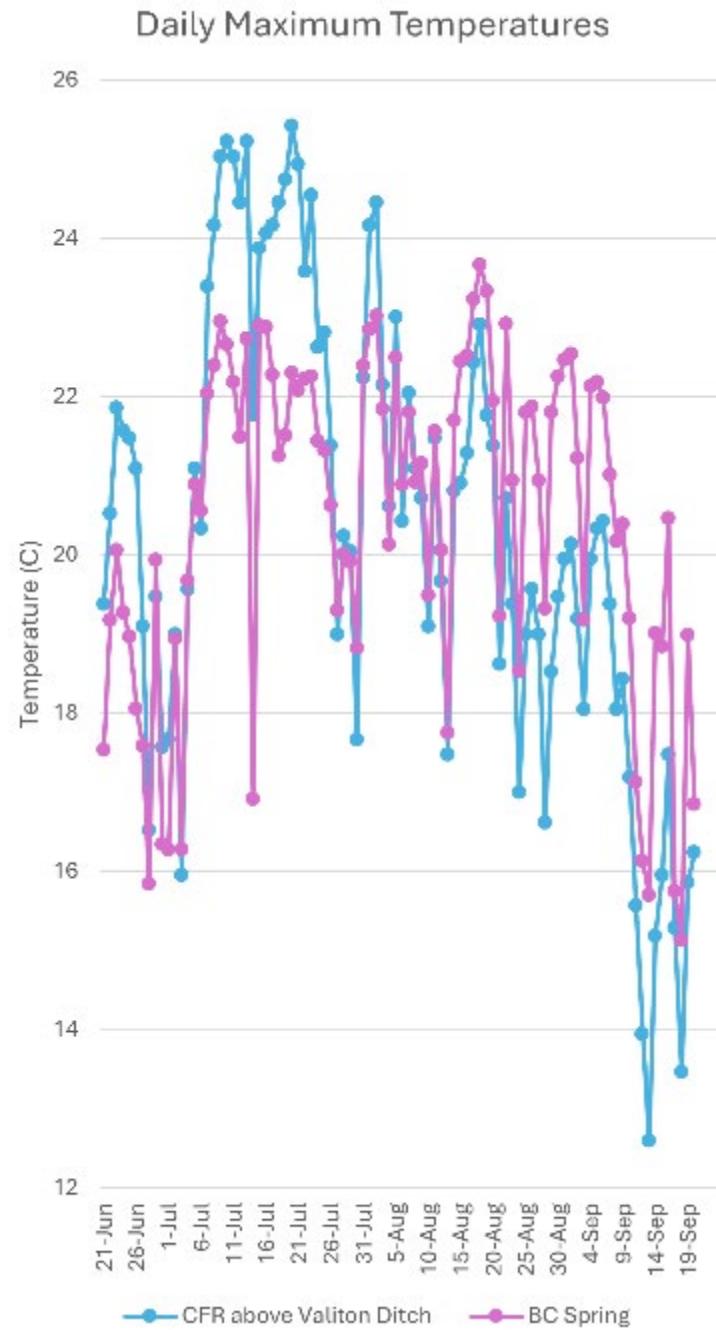


Figure 14: Temperature comparison between Clark Fork River above Valiton Ditch and BC Spring.



The Broken Circle Spring was on average 1.4°C cooler than CFR above Valiton Ditch in July. In August, the mainstem site was cooler than the BC Spring by about 0.9°C. Considering the entire period of record for the BC Spring site (June 21-September 20), temperature differences between the two sites were negligible (0.1°C cooler in the river than the spring).

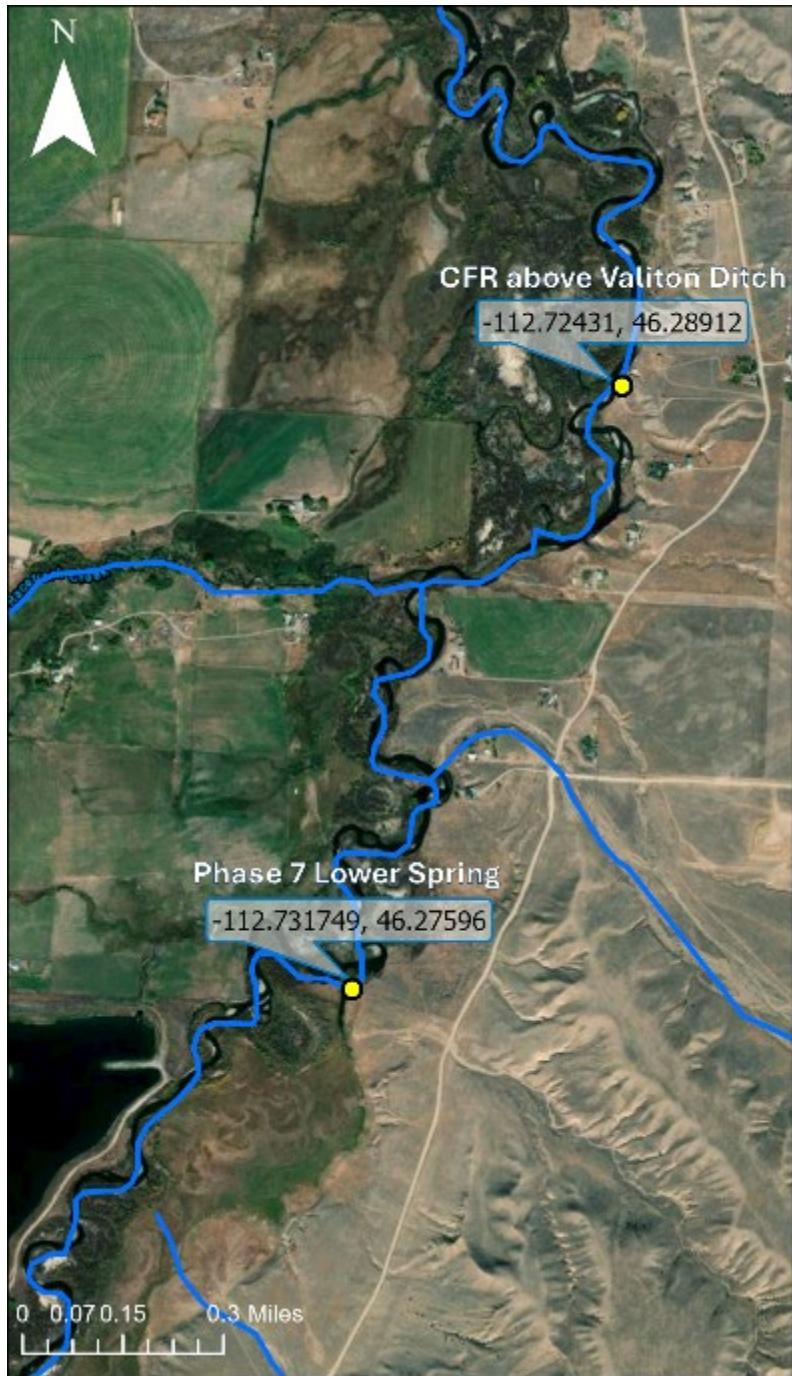
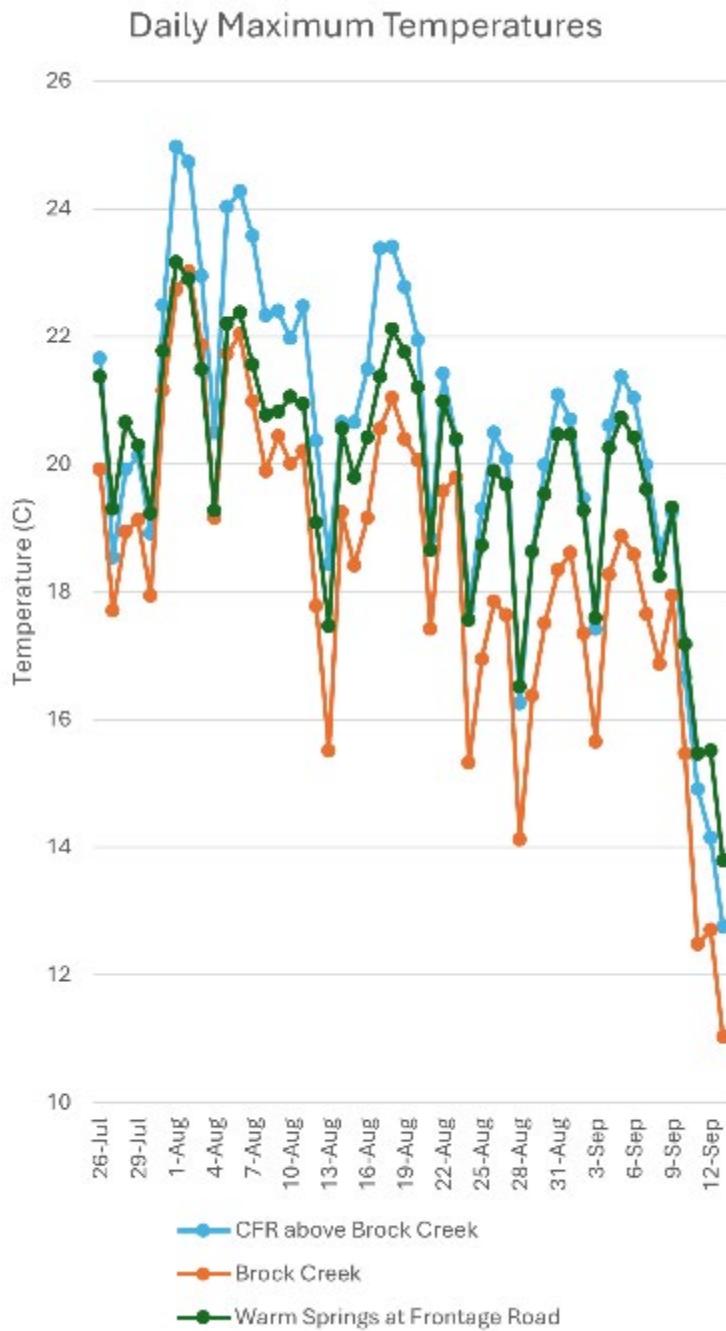
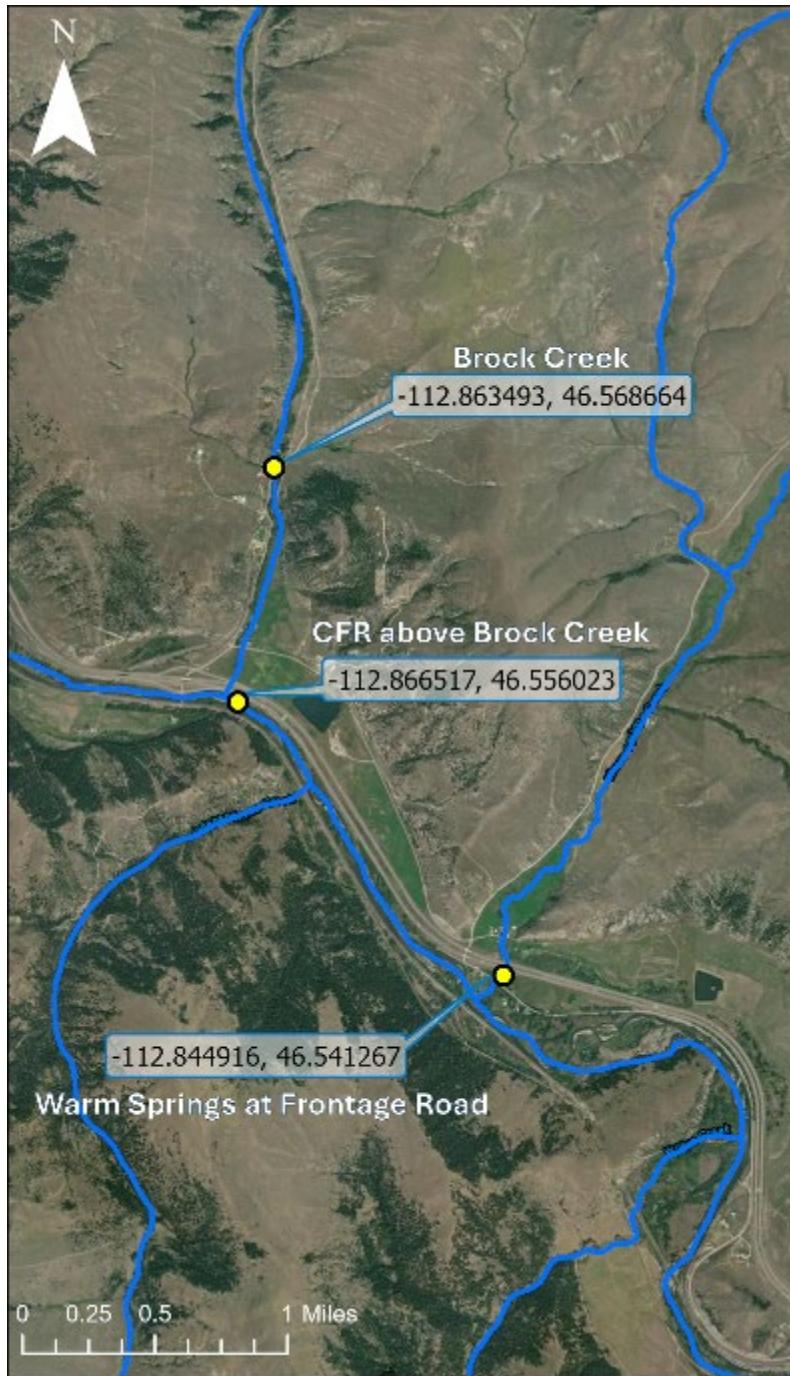


Figure 15: Temperature comparison between Clark Fork River above Valiton Ditch and Phase 7 Lower Spring.

A temperature logger was deployed near the downstream end of the Phase 7 lower spring, just before it enters the mainstem of the Clark Fork River. Water originates from the ground about $\frac{1}{4}$ mile upstream of this location and flows through a wide, shallow, wetland complex. CFC deployed a second logger closer to the top of the spring, however due to excessive growth of aquatic vegetation we were unable to locate and retrieve this logger. Temperatures in the Phase 7 lower spring were generally warmer than the river throughout July (by approximately 1°C). In August, the spring was $\sim 0.5^{\circ}\text{C}$ cooler than the river.



To inform potential project development, CFC deployed temperature loggers in the Brock Creek and Warm Springs Creek and the mainstem river upstream of Brock Creek. Brock Creek was on average 2°C cooler than the river over the entire period of record (July 26-September 13).

Warm Springs at the Frontage Road was warmer than the river in July (by 0.2°C) and cooler in August (by 1°C). Over the entire period of record, maximum temperatures were on average 0.6°C cooler than the river.

Figure 16: Temperature comparison between Clark Fork River above Brock Creek, Brock Creek, and Warm Springs at Frontage Road.

2024 Manual Discharge Measurements

Location	Date	Time	Discharge (cfs)
Dry Cottonwood Upper	5/20/2024	11:15 AM	3.97
	6/11/2024	10:43 AM	2.52
	6/20/2024	1:40 PM	1.63
Valiton Ditch near Headgate	5/15/2024	1:38 PM	9.55
	6/11/2024	2:30 PM	12.14
	7/9/2024	3:00 PM	5.06
	7/17/2024	3:10 PM	1.85
Valiton Ditch near End of Ditch	7/9/2024	3:30 PM	0.25
Berg Diversion	7/16/2024	4:41 PM	3.40
	7/18/2024	1:35 PM	5.74
Cottonwood at Sherm's	7/25/2024	10:35 AM	3.69
	8/26/2024	10:24 AM	1.24
	9/24/2024	10:00 AM	1.48
Cottonwood Below Applegate Lower Diversion	7/25/2024	11:40 AM	0.25
	8/26/2024	11:00 AM	1.0
Cottonwood at Baggs Creek Confluence	3/8/2024	3:30 PM	2.37
Cottonwood Below Applegate Upper Diversion	7/25/2024	11:10 AM	2.39
Mill Creek @ Hwy 1	8/22/2024	2:45 PM	2.16
Warm Springs Frontage Road Br.	7/26/2024	1:20 PM	4.40
Warm Springs near Upper POD	7/26/2024	1:40 PM	7.10
Brock Creek at Upper POD	7/26/2024	3:12 AM	0.23

Table 3- Spot measurements collected in 2024.

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