GRAND COUNTY
LEARNING BY DOING

2020 ANNUAL OPERATIONS REPORT

January 4, 2020

Introduction

Learning By Doing (LBD) Operations Guidelines require that each year the Operations Subcommittee submit an Operations Report to the LBD Management Committee. This report summarizes 2020 LBD-related operations, including:

- Denver Water Moffat Collection System spill bypasses[1] totaling approximately 21,000 acre-feet (af) during runoff season, maintenance bypasses totaling 1,600 af from the North Ranch Creek component of the Moffat Collection System, and maintenance bypasses totaling 259 af at the Fraser River and Jim Creek diversions.
- Denver Water and Northern Water participation in Coordinated Reservoir Operations (CROS) to enhance peak runoff at the Moffat Collection System and Willow Creek and Williams Fork Reservoirs.
- Release of 5,412 af from the Endangered Fish Pool in Granby Reservoir for the Upper Colorado River Endangered Fish Recovery Program (Recovery Program).

The LBD Cooperative Effort is a commitment by LBD entities to restore or enhance the condition of the aquatic environment in Grand County. The Cooperative Effort Area (CEA) includes the Colorado, Fraser, and Williams Fork River basins, upstream of the Colorado River confluence with the Blue River. A map of the Fraser River Collection System (**Attachment A**), a map of the Colorado River from Granby Reservoir to the Williams Fork River (**Attachment B**), and a list of LBD water sources and quantities offering flexibility (**Attachment D**) can be found at the end of this report.

2020 Snowpack and Water Supply Forecasts

Figure 1 is a map depicting NRCS April 1, 2020 Snow Water Equivalent (SWE) for SNOTEL sites in Colorado. A graph of the 2020 Snow Water Equivalent at SNOTEL sites above Kremmling versus time is shown in **Figure 2**. The Colorado Basin River Forecast Center (CBRFC) April 1, 2020 Most Probable Runoff Forecast at Kremmling was 103 percent of average (890 thousand acre-feet [kaf], see evolving forecast graph, **Figure 3**). The actual runoff at Kremmling was 91 percent of average (781 kaf).

[1] "Voluntary/environmental bypasses" are releases pursuant to the CRCA; "required bypasses" are releases pursuant to a permit or ROD; "maintenance bypasses" are releases to allow for maintenance; "spill bypasses" are releases as a result of a full reservoir or system constraint (full East Slope reservoirs).

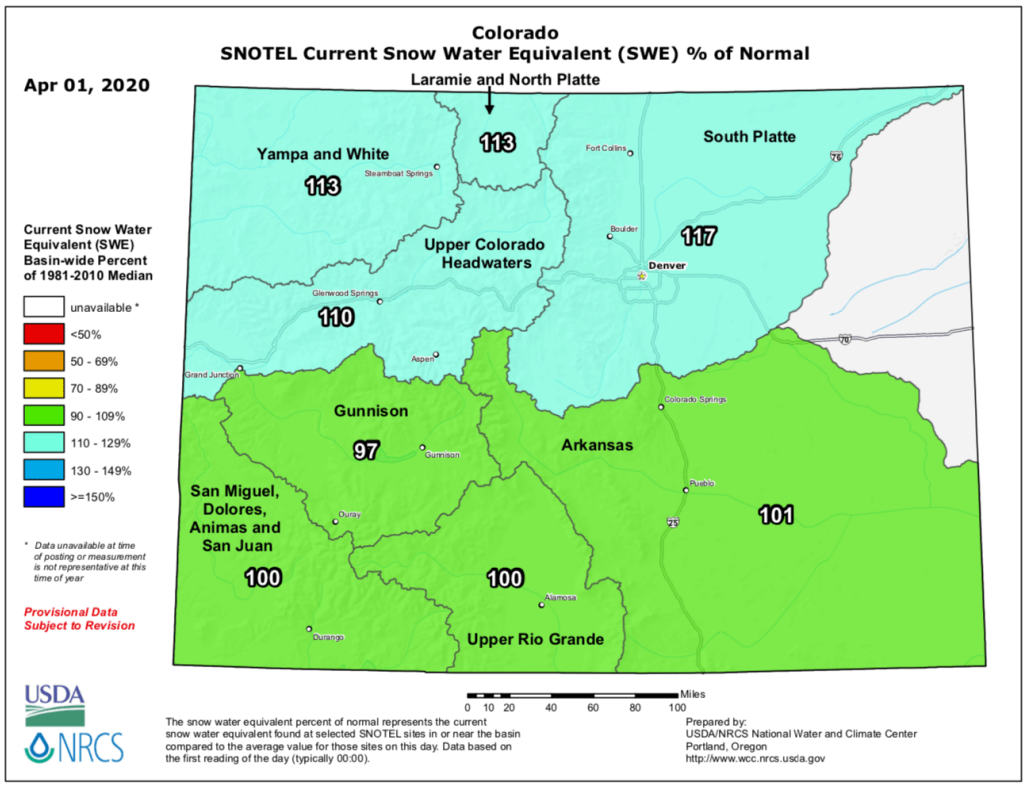
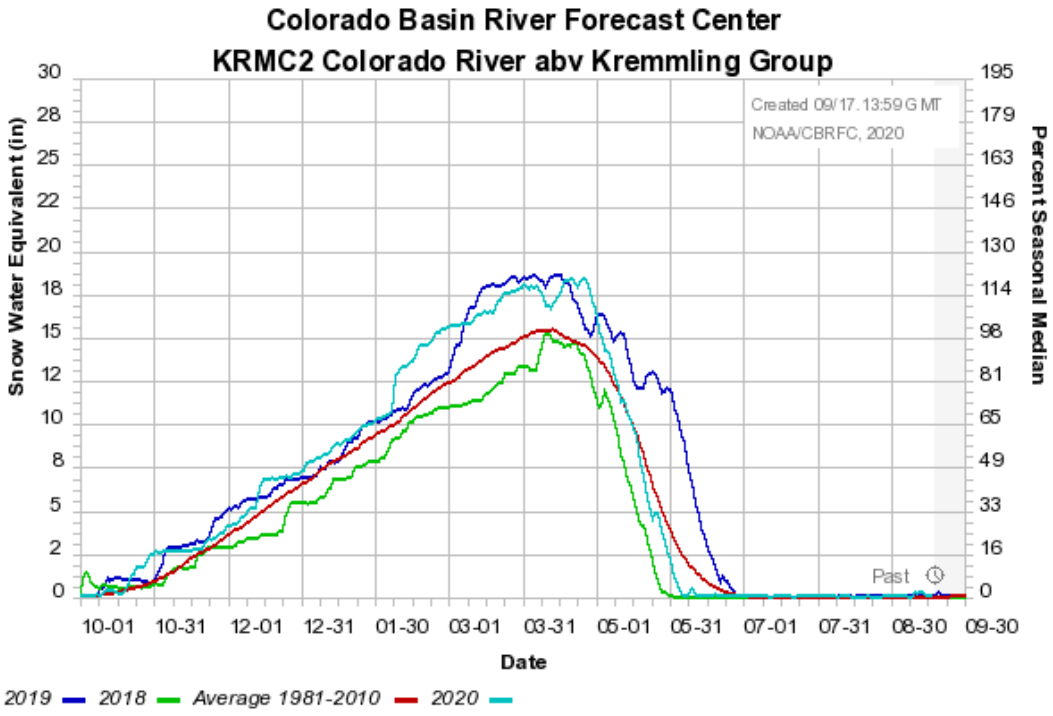
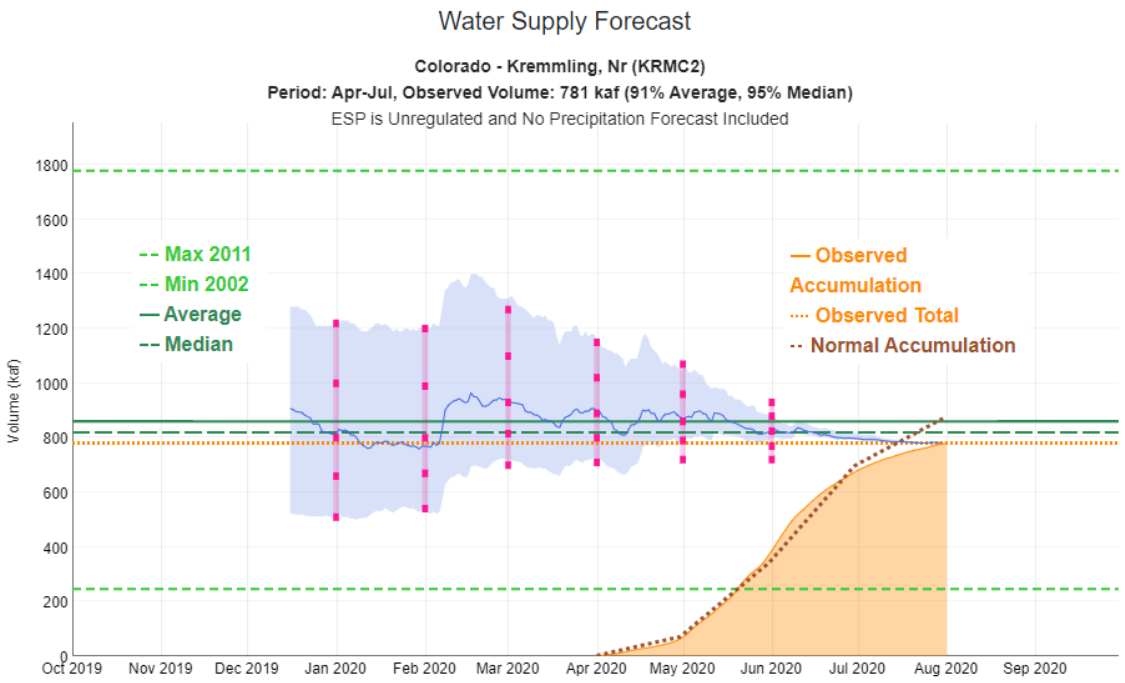


Figure 1: NRCS April 1, 2020 Snowpack Summary



Figures 2: CBRFC 2020 Evolving Snowpack (Snow Water Equivalent) above Kremmling



Figures 3: CBRFC 2020 Evolving Water Supply Forecast at Kremmling

Forecasts subsequent to April 1 and actual runoff volumes in the Upper Colorado River Basin were much reduced from April 1 forecasts, especially to the south, following a near-average snow accumulation season, due to warm and dry conditions in the late spring and early summer, see **Figure 4**.

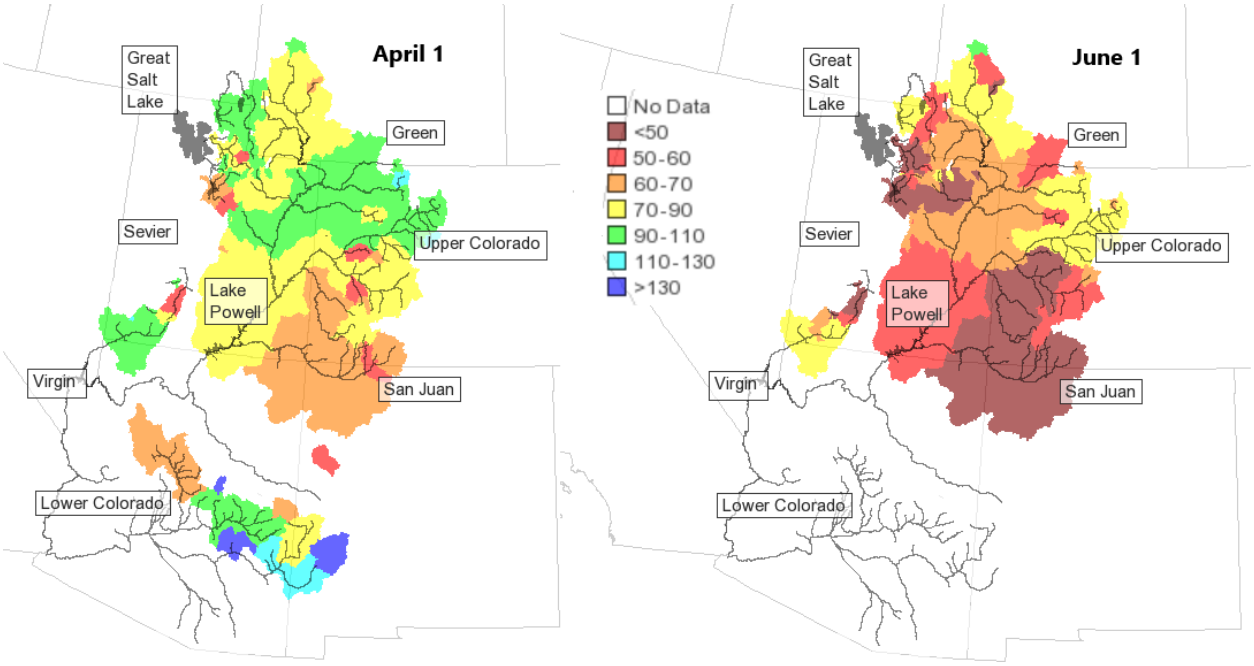


Figure 4: CBRFC April 1 and June 1, 2020 Water Supply Forecasts as a Percent of Average

Runoff Operations

The Operations Subcommittee held weekly teleconference calls to discuss runoff operations beginning May 12, 2020. Discussion focused on the potential for CROS releases, Moffat Collection System spill bypass potential and stream prioritization, Granby Reservoir fill and Windy Gap pumping status.

Denver Water Operations

The Moffat Collection System began spill bypasses on May 17th starting with Cabin Creek, Hurd Creek, and Hamilton Creek diversions. Ranch Creek, St. Louis Creek, Vasquez Creek, and the Fraser River soon followed. Based on recommendations from LBD, Denver Water continued diverting water from the upper Williams Fork Basin (Jones Pass) until mid-June. Gross and Ralston Reservoirs filled in mid-June and thereafter Denver Water matched Moffat Collection System diversions to water demands. **Figure 5** shows 2020 Moffat Tunnel diversions. **Figure 6** shows streamflow at Ranch Creek near Fraser including maintenance bypasses for the Ranch Creek Canal project. Denver Water bypassed (maintenance and spill) about 21,000 af in June and July (**Figure 7**).

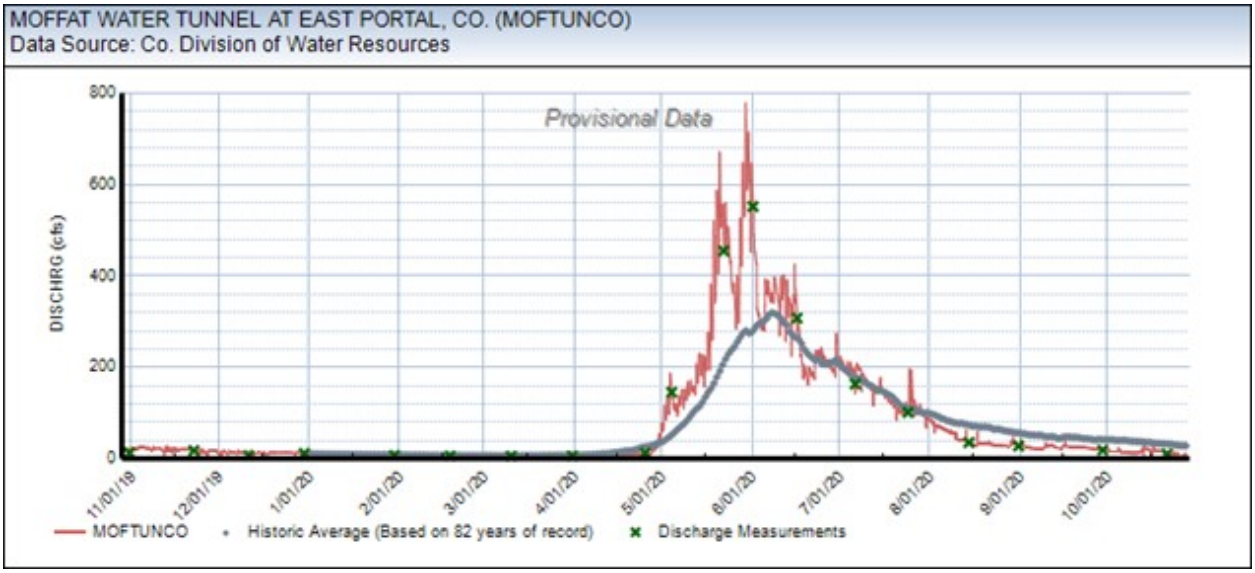


Figure 5: 2020 Moffat Tunnel Diversions

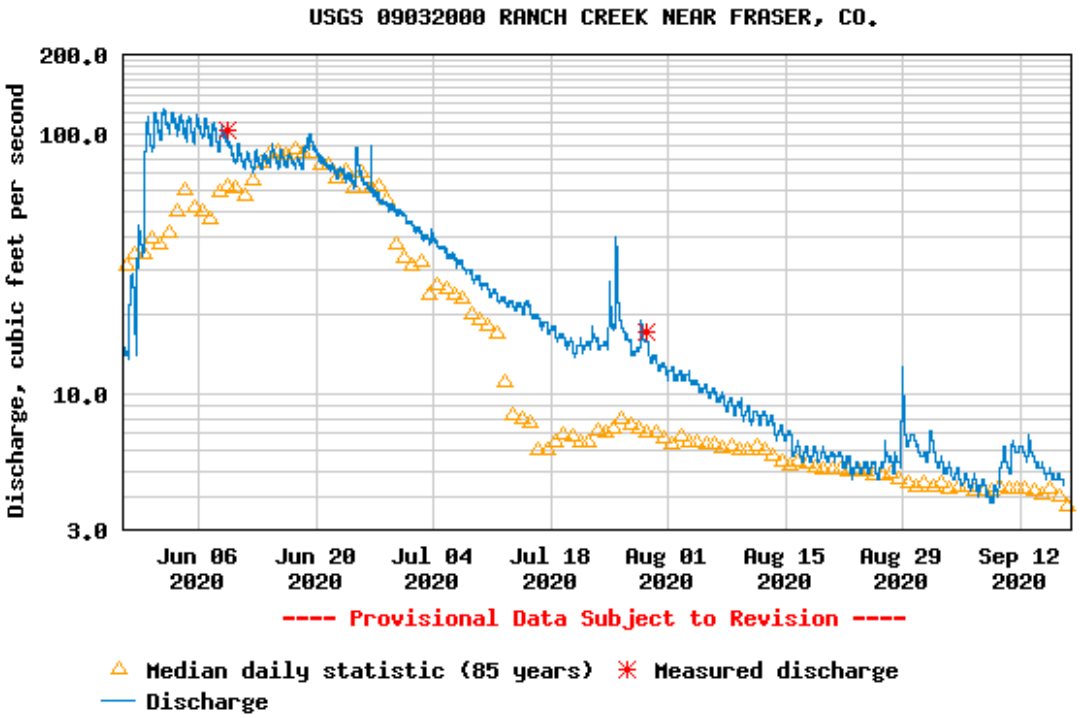


Figure 6: USGS Streamflow Ranch Creek near Fraser

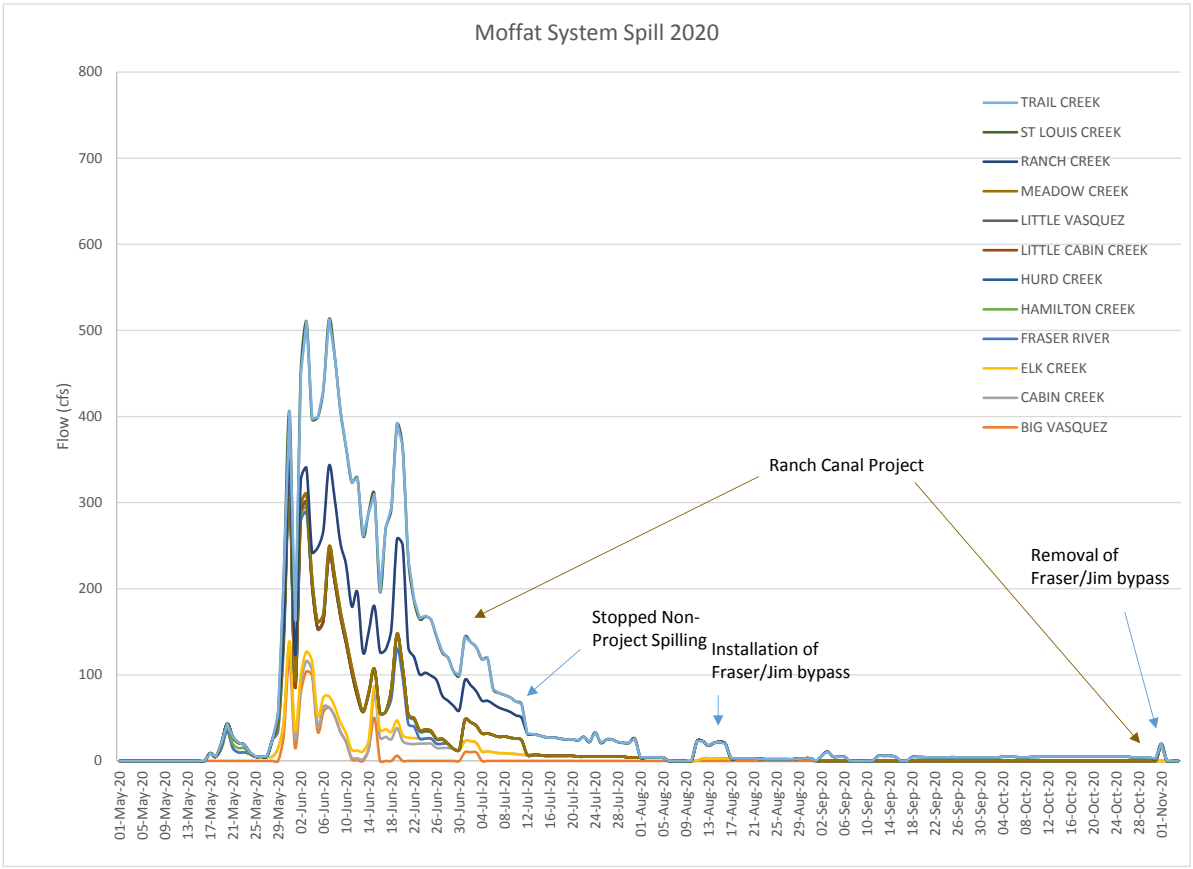


Figure 7: Denver Water Moffat System Bypasses (Maintenance and Spill) in 2020

Except for 2012, Moffat Collection System spill bypasses occurred in every year since 2005 (**Figure 8**). In 2016 and 2017, the Subcommittee targeted Cabin, Vasquez and Trail Creeks for voluntary spill bypasses. Trail Creek was chosen because it had fewer spill bypasses in the recent past. 2018 voluntary spill bypasses targeted Big Vasquez, St Louis, and Trail Creeks. In 2019 spill bypasses targeted Ranch and St Louis Creeks. In 2020 Moffat spill bypasses began in Cabin, Hurd, and Hamilton Creeks. In terms of prioritization of spill bypasses on Ranch Creek tributaries, all else being the same, it makes sense to spill bypass higher up in the valley. Cabin Creek makes more sense geographically than Trail Creek, because Ranch Creek starts its slow, flat section where Cabin Creek joins Ranch Creek. Cabin Creek also has fish populations that should be considered in prioritization of spill bypasses.

The Grand County Stream Management Plan recommended flushing flows at different points in the Fraser River basin: Fraser River (80 cfs), St. Louis Creek (70 cfs), Vasquez Creek (50 cfs), and Ranch Creek (40 cfs). At the request of the Forest Service, a flushing flow was added on Cabin Creek (40 cfs). These flows were made conditions of the 404 Permit for the Moffat Project. All flushing flow targets were met in 2020. Ultimately, assessment of the effectiveness of these spill bypasses and prioritization of spill bypass locations requires a quantitative analysis based on field studies. LBD is considering implementing sediment sampling to monitor sediment transport. Denver Water provided flushing flow information (i.e., location, flow rate, duration) corresponding with each stream that has a permit-required flushing flow (**Attachment E**).

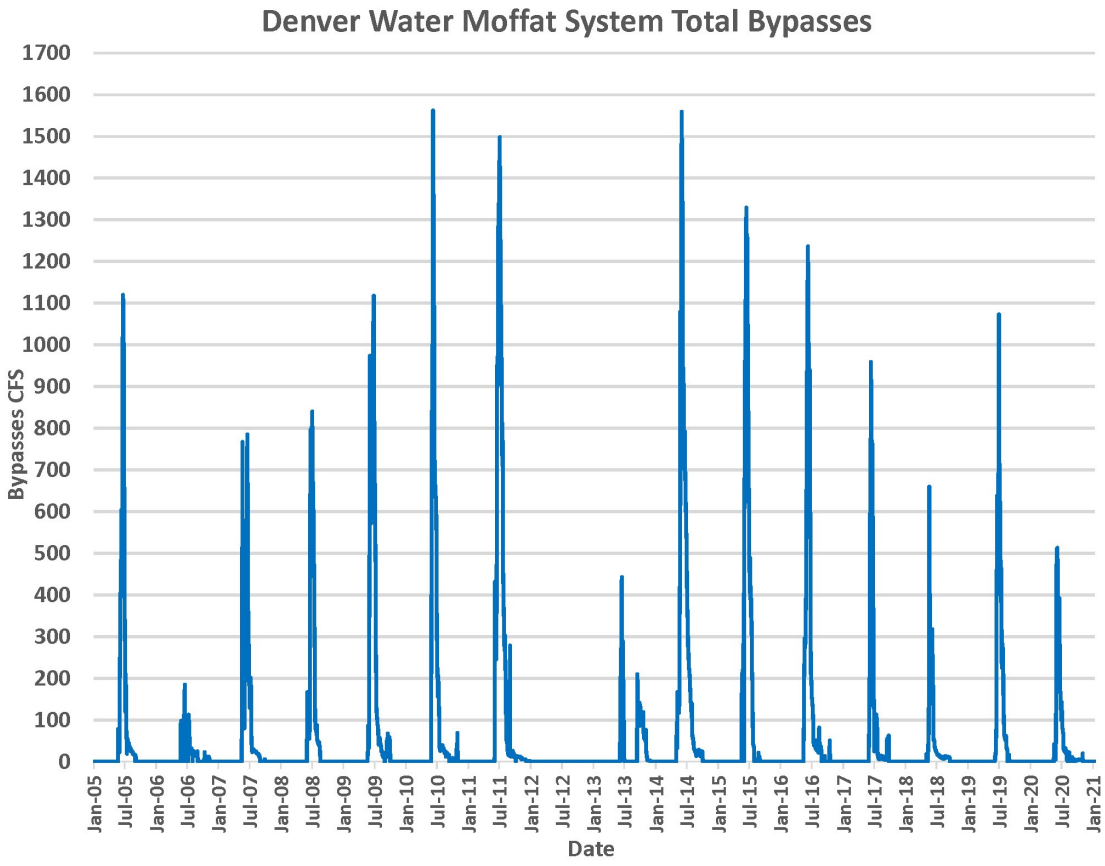


Figure 8: Moffat System Bypasses 2005 to 2020

Coordinated Reservoir Operations (CROS)

As part of the Recovery Program, when the projected Cameo peak flow is above 12,700 cfs and below the flood capacity of about 25,500 cfs, Denver Water, the River District and the Bureau of Reclamation (Reclamation) participate in CROS to benefit the Endangered Fish in the Grand Valley area by augmenting peak runoff (May-June). In early May the 2020 peak flow in the Grand Valley was projected to be about 13,500 cfs (see evolving peak forecast plot, **Figure 9**).

CROS teleconference calls began May 14, 2020 when the peak forecast dropped to 13,100 cfs, and uncertainty in the remaining high elevation snowpack cast doubt on whether peak augmentation efforts would occur. Limited CROS operations began May 29th targeting the perceived seasonal peak June 3rd. Cameo peaked on June 2nd at 12,800 cfs. Willow Creek, Williams Fork, Wolford Mountain, and Green Mountain Reservoir operations are shown in **Figures 10 through 13**. Although Wolford Mountain and Green Mountain Reservoir operations did not directly affect the LBD CEA, they contributed to flows in the Wild and Scenic Alternative Management reach below Kremmling and the seasonal peak in the Grand Valley in concert with operations within the CEA.

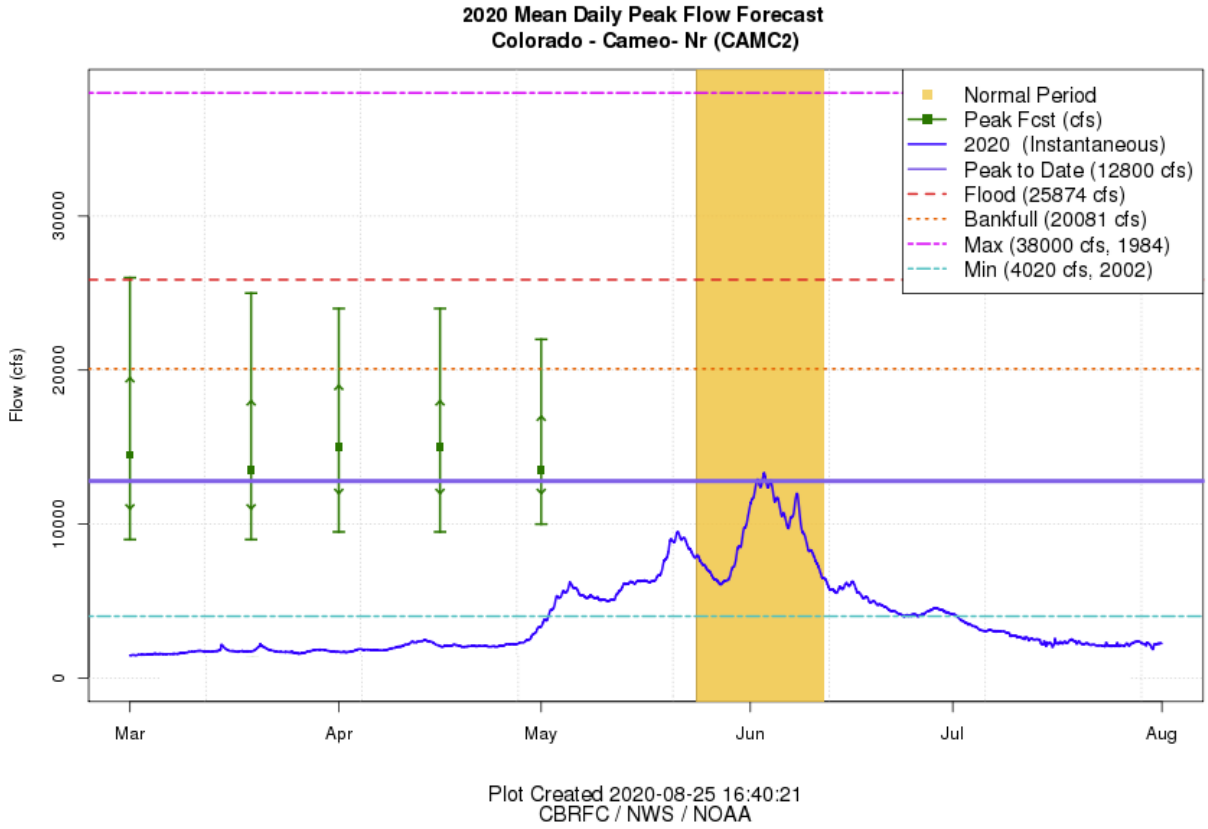


Figure 9: 2020 CBRFC Mean Daily Peak Flow Forecast for Cameo

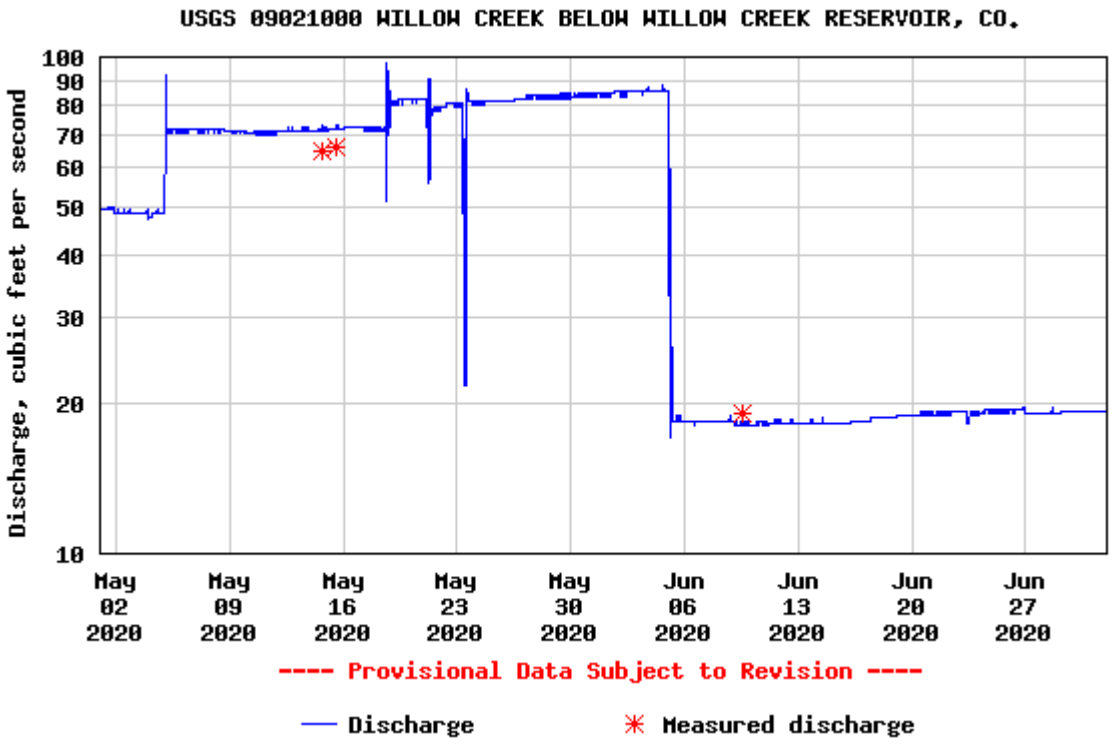


Figure 10: USGS Streamflow Willow Creek below Willow Creek Reservoir during CROS

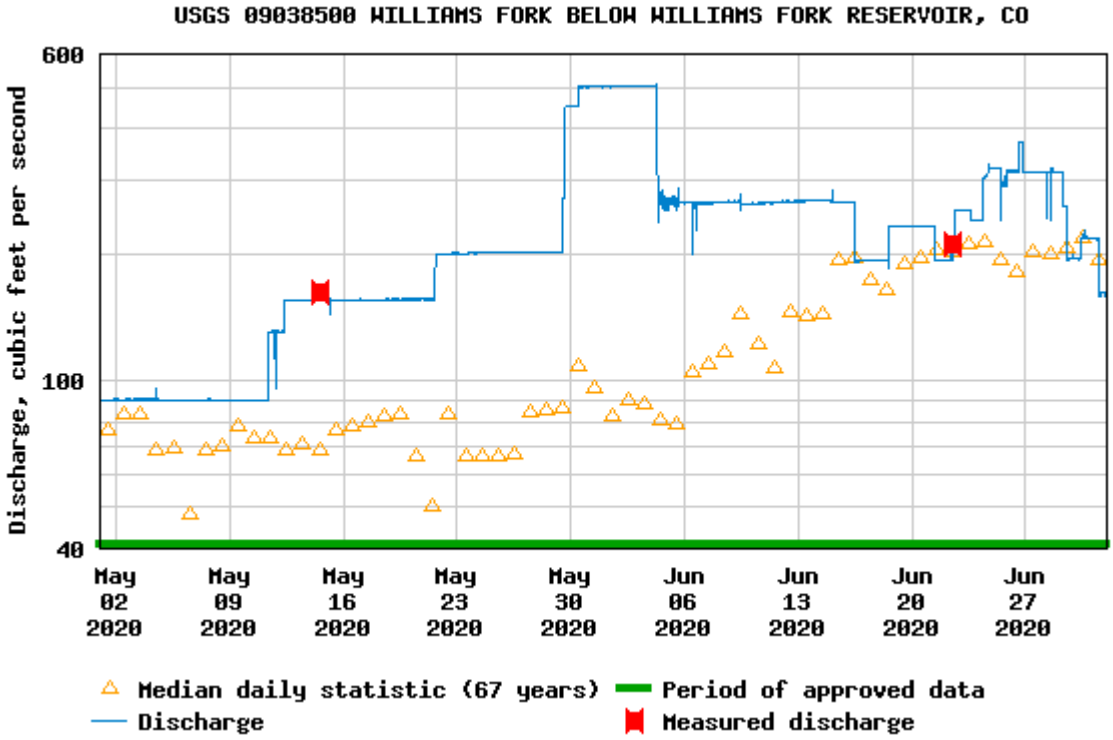


Figure 11: USGS Streamflow Williams Fork below Williams Fork Reservoir during CROS

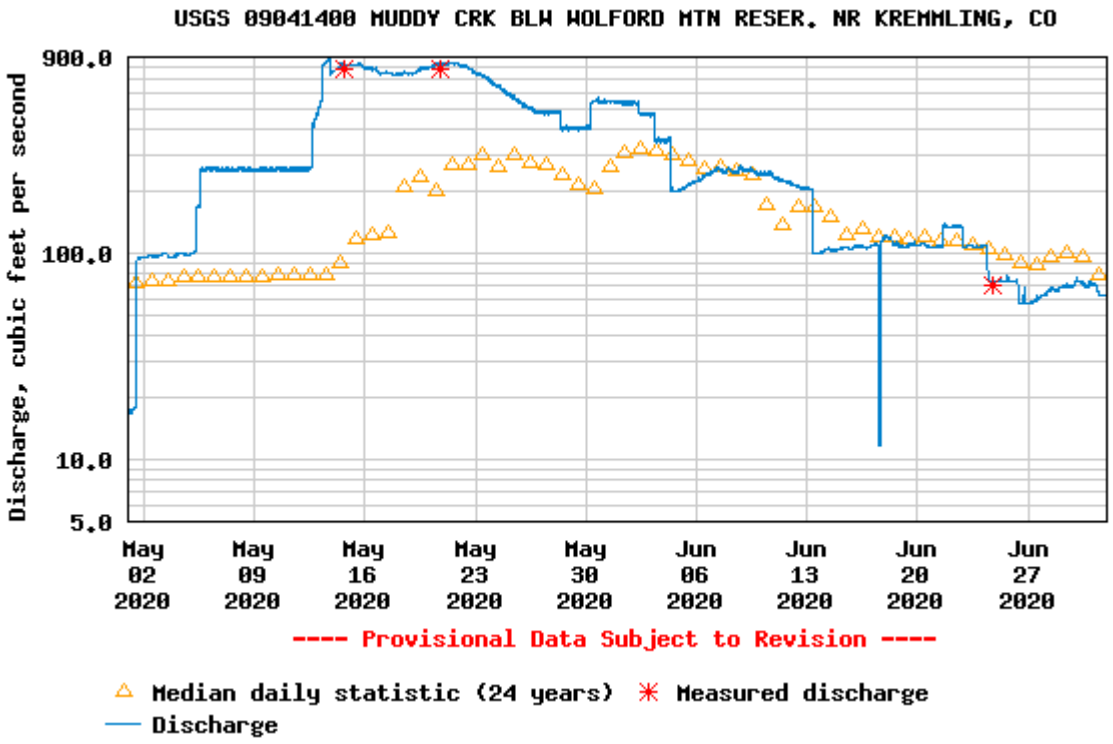


Figure 12: USGS Streamflow Muddy Creek below Wolford Mountain Reservoir during CROS

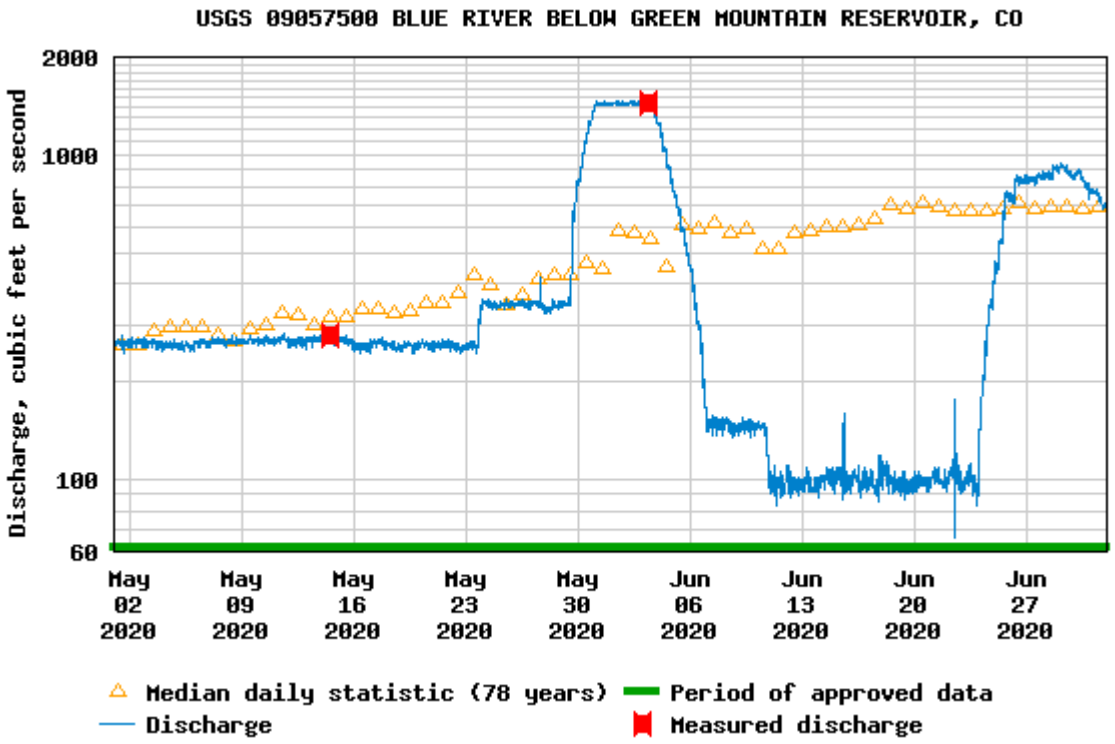


Figure 13: USGS Streamflow Blue River Below Green Mountain Reservoir during CROS

Granby Fill and Windy Gap Pumping Operations

The 2020 Colorado Big Thompson Annual Operating Plan (CBT AOP) April 1 Most Probable Forecast model predicted that Granby Reservoir would fill and spill under the Most Probable run, but not under the Minimum Probable scenario run. Historically, Granby Reservoir spilled in 2011, 2014, 2015, 2016, 2017, and again in 2019, but not in 2020, see **Figure 14**. Windy Gap was not predicted to pump to Granby Reservoir due to the probability of spill in the April 1 CBT AOP. In 2019 Windy Gap water pumped into Granby later spilled.

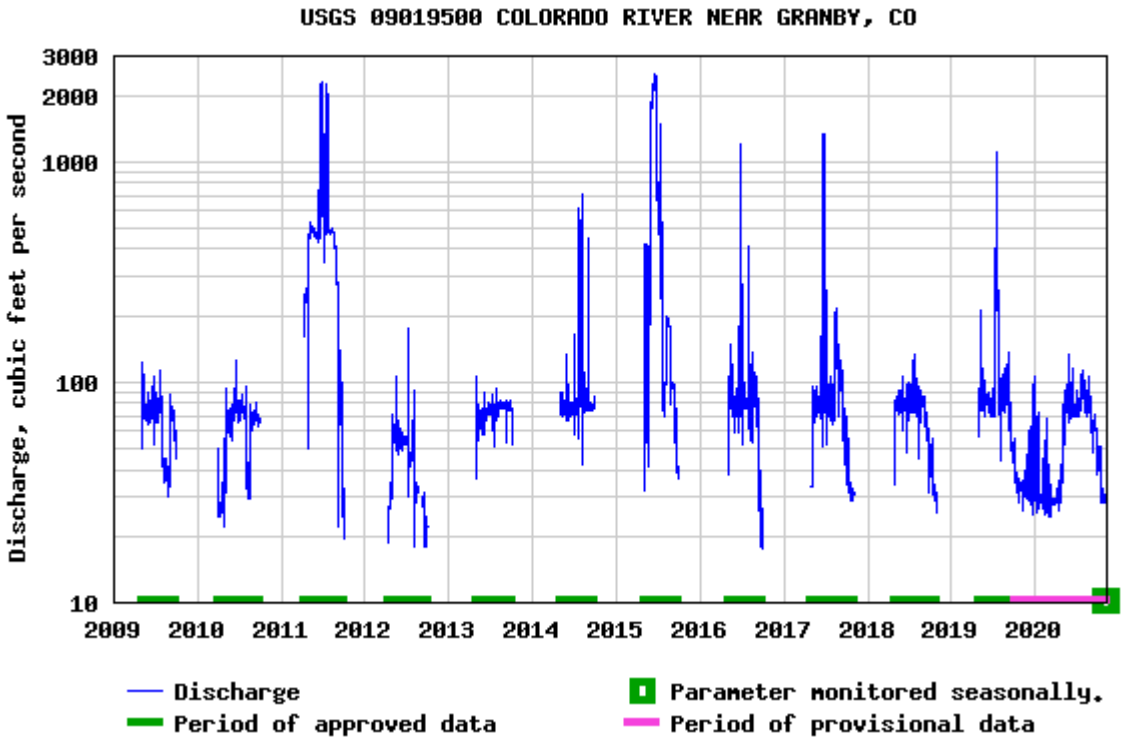


Figure 14: USGS Streamflow Colorado River near Granby 2009 to 2020

<u>In-Season Operations</u>

The Operations Subcommittee continued weekly teleconference calls to discuss in-season operations through early September. As the year transitioned from Spring runoff to Summer flows, precipitation decreased, and air temperature increased. This led to decreased flows throughout the LBD CEA during the summer and very low base flows in the Grand Valley, much like in 2018. Monthly precipitation in the Colorado River Basin is shown in **Figure 15** as a percent of average. Record low precipitation was observed in August as drought conditions worsened across much of Colorado. Hot and dry conditions contributed to multiple wildfires in Colorado, including the Williams Fork and East Troublesome wildfires in Grand County, see **Attachment C**. The East Troublesome fire did not impact Colorado River operations but caused a brief emergency shutdown of portions of the CBT Collection System, and the Williams Fork fire made it necessary to remove snow from Jones Pass in October to accomodate access east to west to help fight the fire.

Additionally, Denver Water implemented several measures to protect infrastructure on the west side of Jones Pass. These fire scars have a high potential to impact aquatic resources, sedimentation, future operations and water quality within the LBD CEA.

Each week prior to the LBD operations call, the River District forwarded flow forecasts and graphs of discharge flows below Grand County facilities, and Grand County sent Daily Maximum Temperature (DM) and Maximum Weekly Average Temperatures (MWAT) water temperature charts from several locations. Water temperatures are assessed at 65 sites throughout the CEA using time-series data obtained from several sites monitored by GCWIN, USGS, BLM, and Northern Water (see historical Colorado River example **Figures 16a and 16b**). These analyses can be critical to allocating bypass water in locations where real-time data are unavailable. Comprehensive stream temperature assessments for prior years can be obtained from the Learning By Doing website at: https://www.grandcountylearningbydoing.org/reports.html.

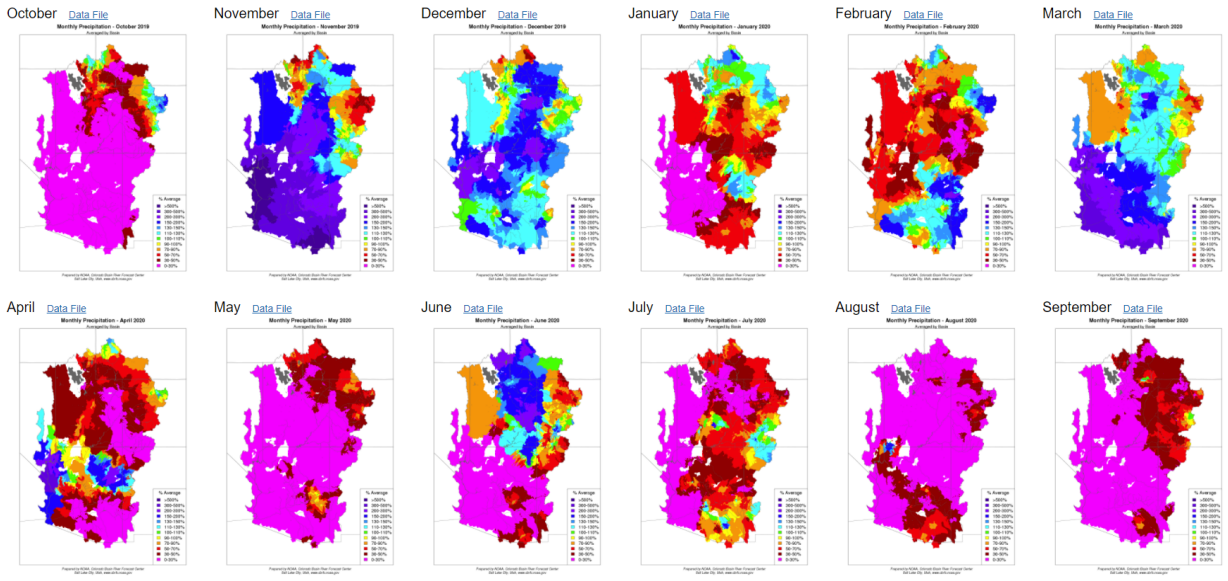


Figure 15: CBRFC October 2019 to September 2020 Monthly Precipitation as a Percent of Average

Real-time temperature data are available at a few USGS sites and three mainstem Colorado River sites maintained by Northern Water. Data from multiple sites can be plotted together to reflect temperature increases in gaged reaches (see Ranch Creek example **Figure 17**). Northern Water's temperature data at stream gages below Windy Gap, at Hot Sulphur Springs and at Parshall can be compared to chronic and acute temperature standards (see **Figure 18**).

Denver Water Operations

Pursuant to the 2012 Colorado River Cooperative Agreement (CRCA), each year beginning with the year Denver Water's Moffat Collection System Project (aka Gross Reservoir Expansion Project or Moffat Project) becomes operational, Denver Water will commit to releasing 1,000 af of water from its Moffat Collection System to streams in Grand County for the purposes of benefiting the aquatic environment.

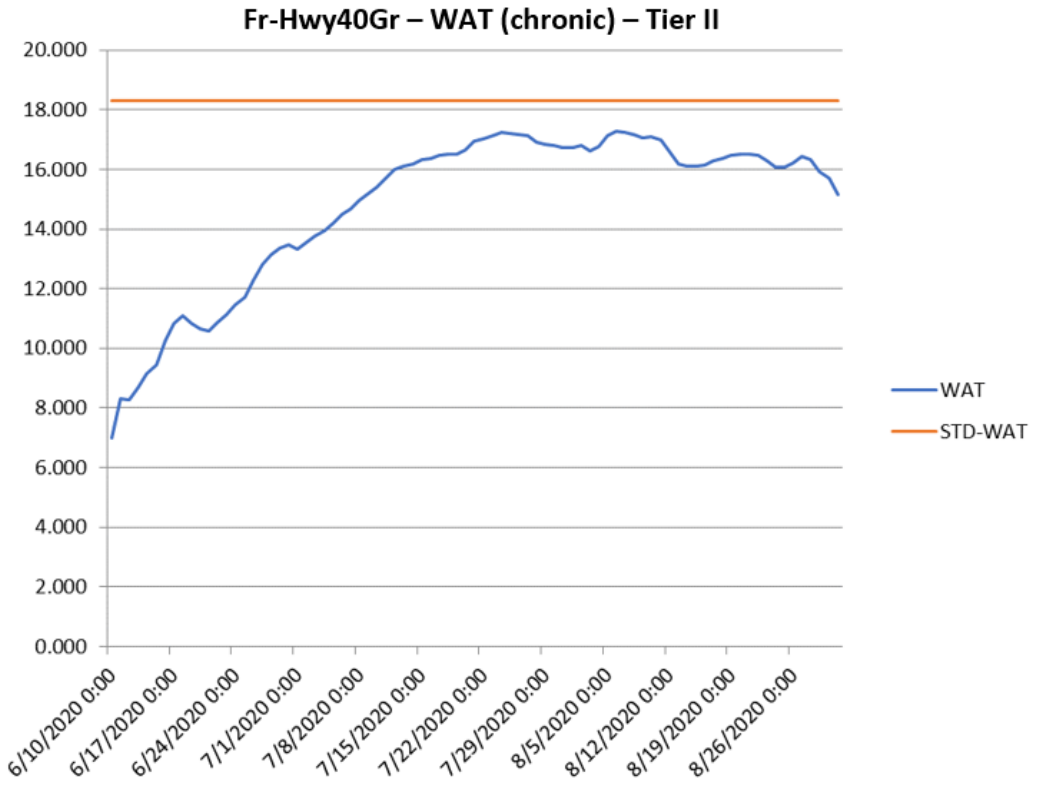


Figure 16a: MWAT (Chronic) at Fraser River near Hwy 40

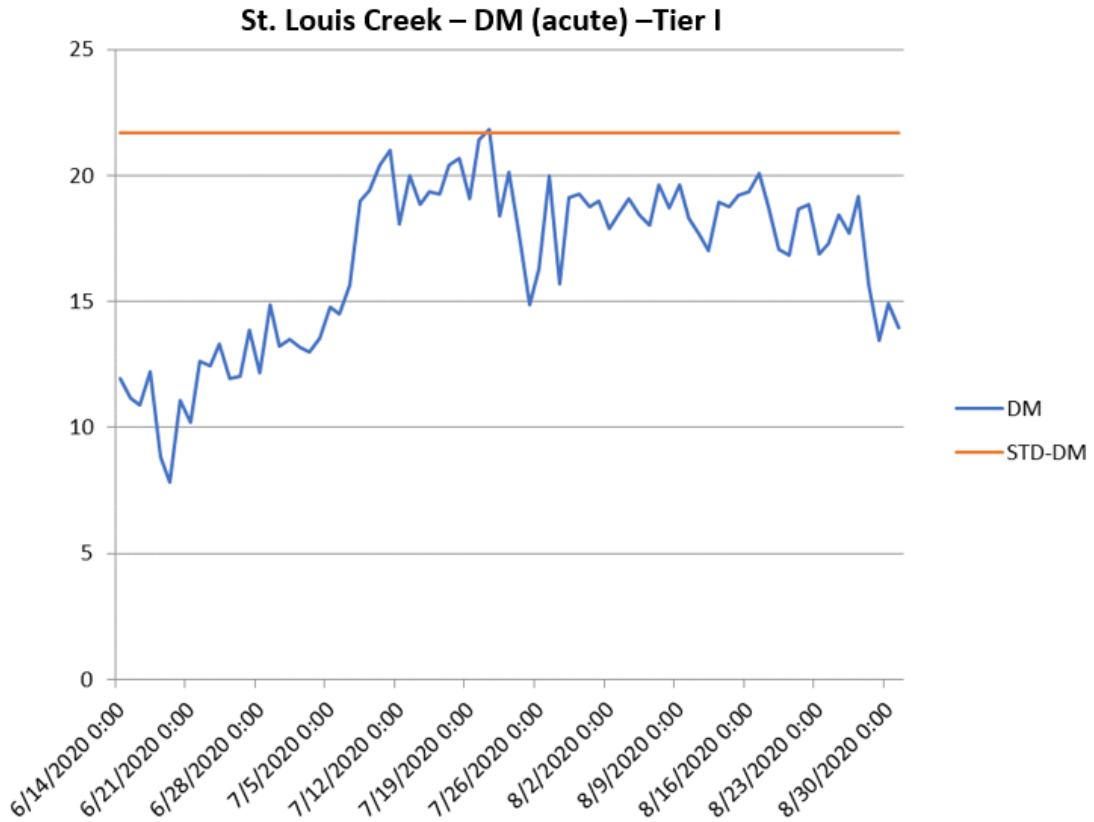


Figure 16b: DM (Acute) Temperature Data Analyses at St Louis Creek

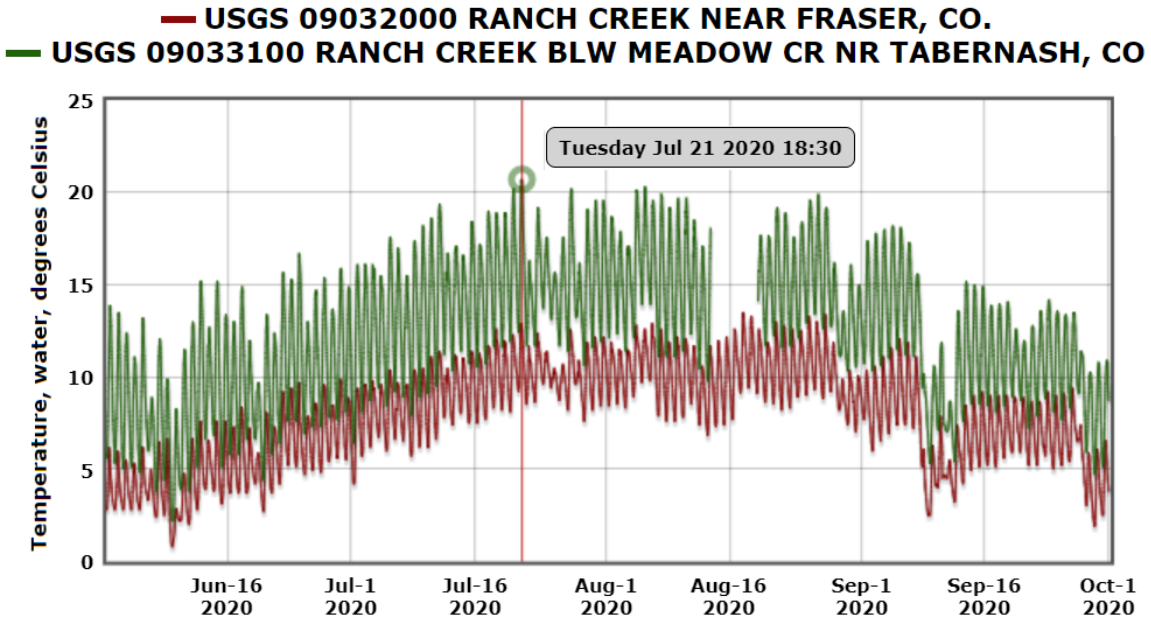


Figure 17: USGS Temperature Comparison Ranch Creek near Fraser and Tabernash

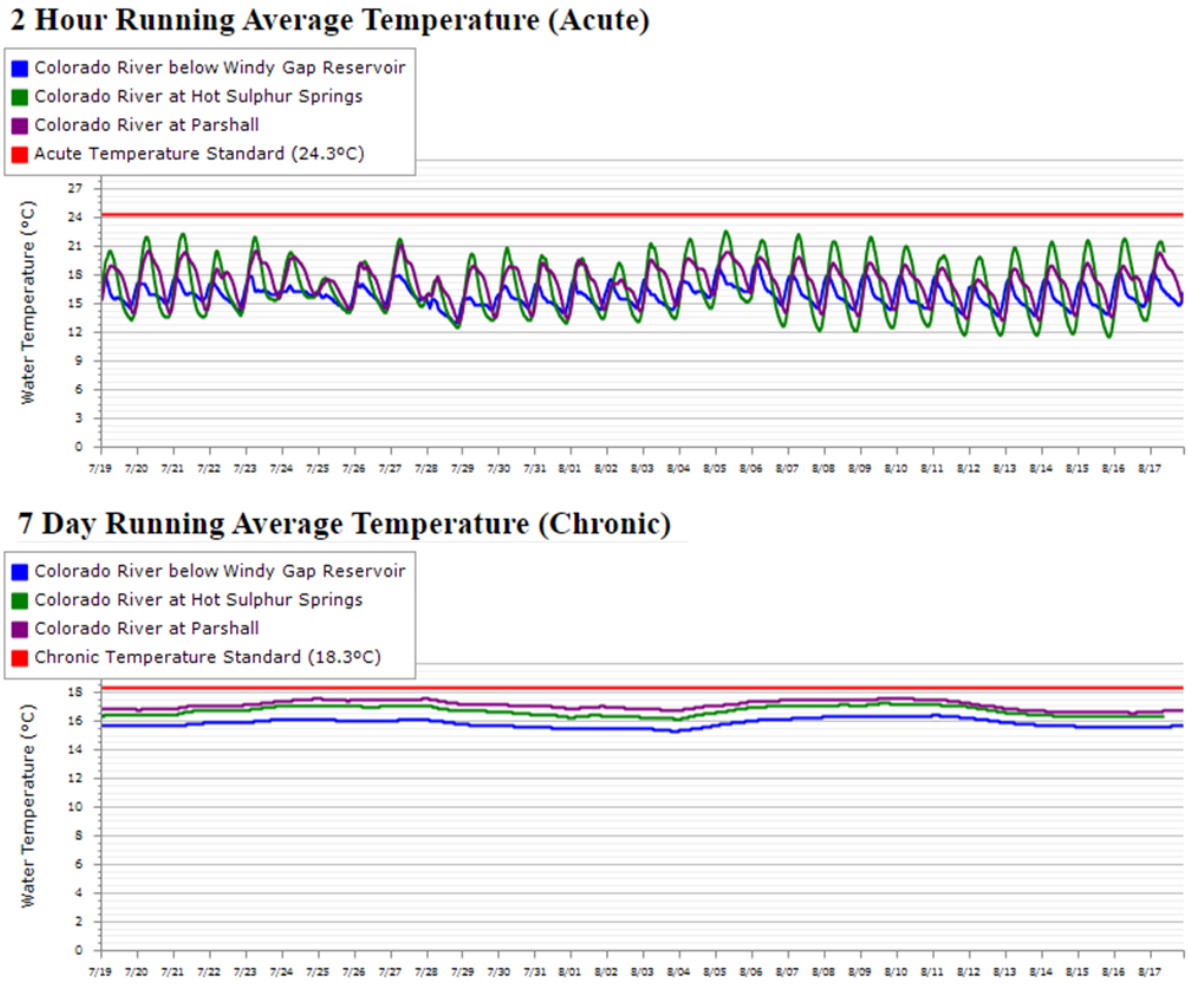


Figure 18: Northern Water Real-time Temperature Gages

Although the Moffat Project is not yet operational, in 2015, 2016 and 2017 Denver Water worked with Grand County and LBD to coordinate voluntary bypasses ("Voluntary Water") from its Moffat Collection System to benefit the aquatic environment, targeting Ranch Creek and tributaries. No voluntary water was made available to LBD in 2018, 2019 or 2020 due to planned maintenance bypass operations, which increased bypasses without the need to trigger voluntary water releases.

Denver Water bypassed all diversions from Meadow Creek to Buck Creek to accommodate work on both Englewood's Cabin Meadow Creek system and the Ranch Canal from June 26th until October 27th. About 1,600 af of additional water was bypassed due to the work on the Ranch Canal and Englewood's Cabin Meadow Creek system. Maintenance bypasses at the Fraser River and Jim Creek diversions from August 10th to August 17th and from October 20th to November 2nd allowed Winter Park Water and Sanitation District to tie into the Fraser Jim Canal as a back-up water source. Approximately 225 af was bypassed in August and 34 af in October to accommodate this project. Denver Water's 2020 LBD in-season operations are summarized in **Attachment E**.

Mainstem Colorado Calls

The Shoshone Power Plant experienced multiple outages in 2020. Causes ranged from icing conditions in February to the Grizzly Creek fire in August, to maintenance addressing leakage in the diversion tunnel in late September and through October. The Shoshone Outage Protocol (ShOP) was in effect in March and April, and for two days on the decending limb before Xcel brought the Power Plant back online, placing a Call July 23rd. Less than one week later the plant was offline again, resulting in a Cameo administrative Call July 29th. ShOP was again operated for one day on August 5th. The Grizzly Creek fire resulted in the evacuation of Shoshone on August 11th, at which point the Cameo Call controlled the entire basin. Xcel brought Shoshone back online in early September until a tunnel maintenance outage began September 22nd. The Cameo Call remained on until October 26th.

Granby Operations

Releases below Granby Reservoir are dictated by the 1961 Operating Principles. Late season water supply flexibility is provided below Granby through the availability of 5,412.5 af (5412 water) to the Recovery Program. During wet years, 5412 water can be released from Granby Reservoir and exchanged after August 1st into Green Mountain, Williams Fork and/or Wolford Mountain Reservoirs for later release to the 15-mile reach in the Grand Valley to benefit the Endangered Fish. The 5412 releases aid in maintaining a 75 cfs flow at the USGS Granby gage in August and September for the benefit of the cold-water fishery. The release schedule is determined by the US Fish and Wildlife Service, with input from other entities, including Grand County, Northern Water, and LBD.

In 2020, dry conditions dictated a mid-July release of the 5412 water from Granby to benefit the 15-mile reach (see **Figure 19**). 5412 releases maintained 75 cfs in August and 60 cfs through mid-September below Granby Reservoir. Williams Fork, Wolford Mountain, and Green Mountain Reservoir operations are shown in **Figures 20 through 22**. Williams Fork Reservoir releases dropped to 45 cfs briefly in mid-September to facilitate water quality sampling by LBD, and to 30 cfs in mid-October to facilitate sampling required by permit.

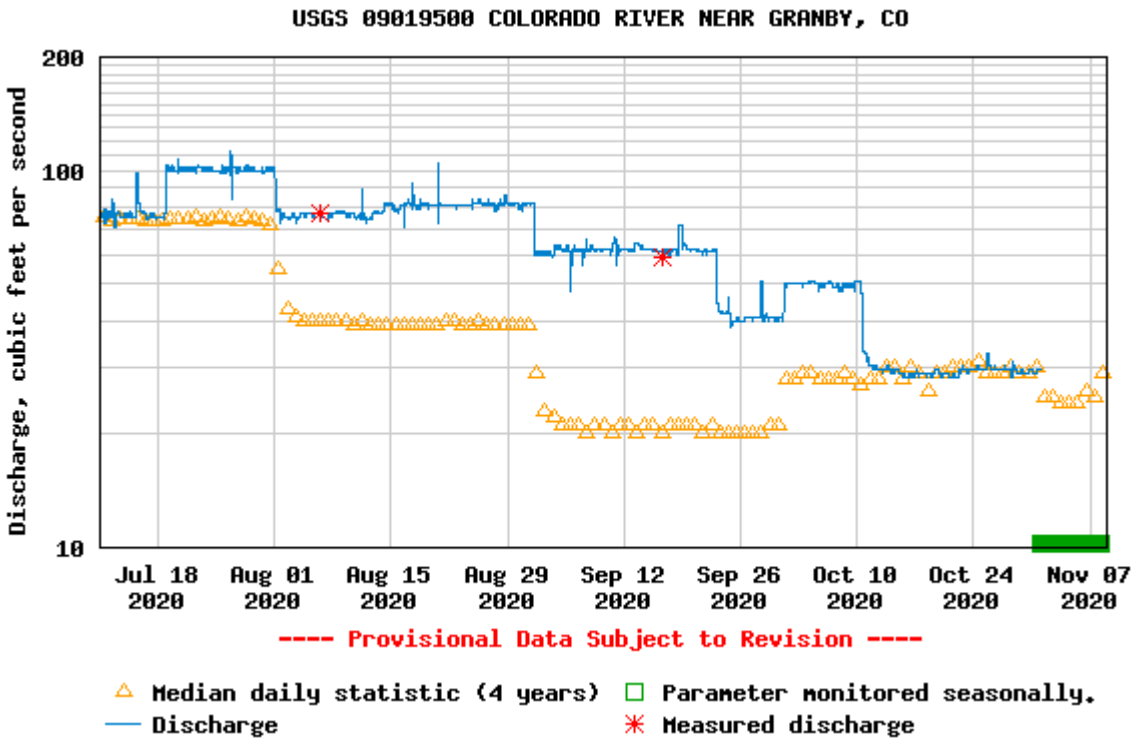


Figure 19: USGS Steamflow Colorado River near Granby "Y-gage"

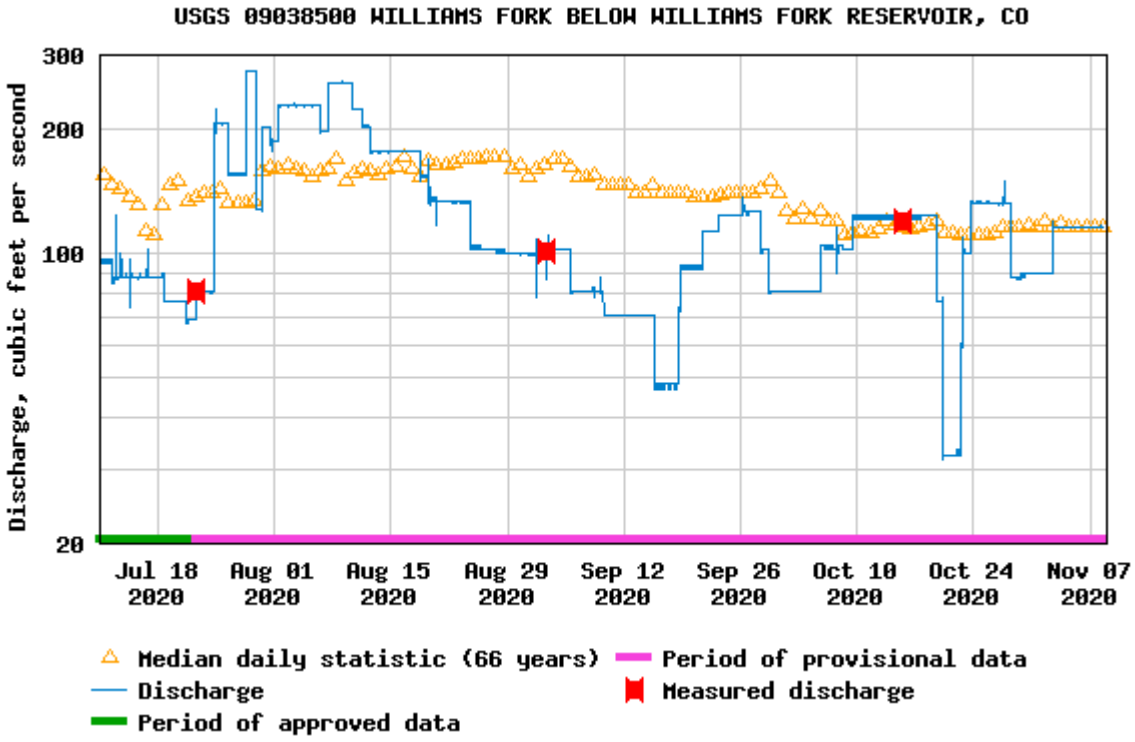


Figure 20: USGS Steamflow Williams Fork River below Williams Fork Reservoir

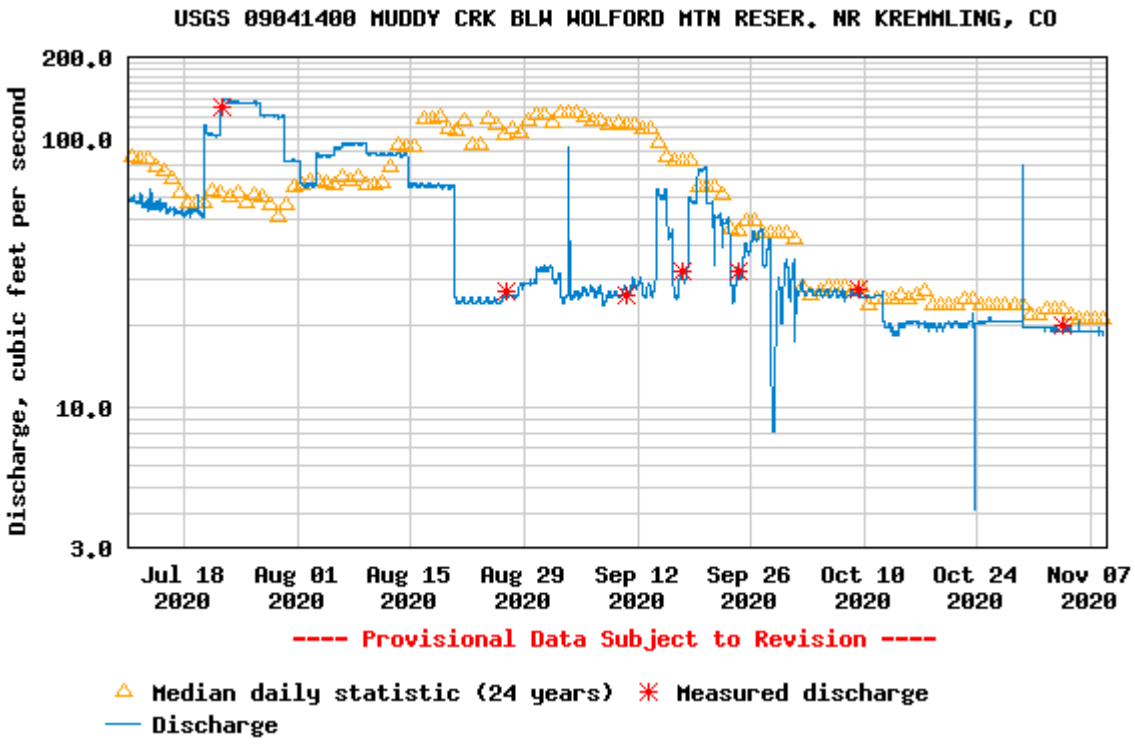


Figure 21: USGS Steamflow Muddy Creek below Wolford Reservoir

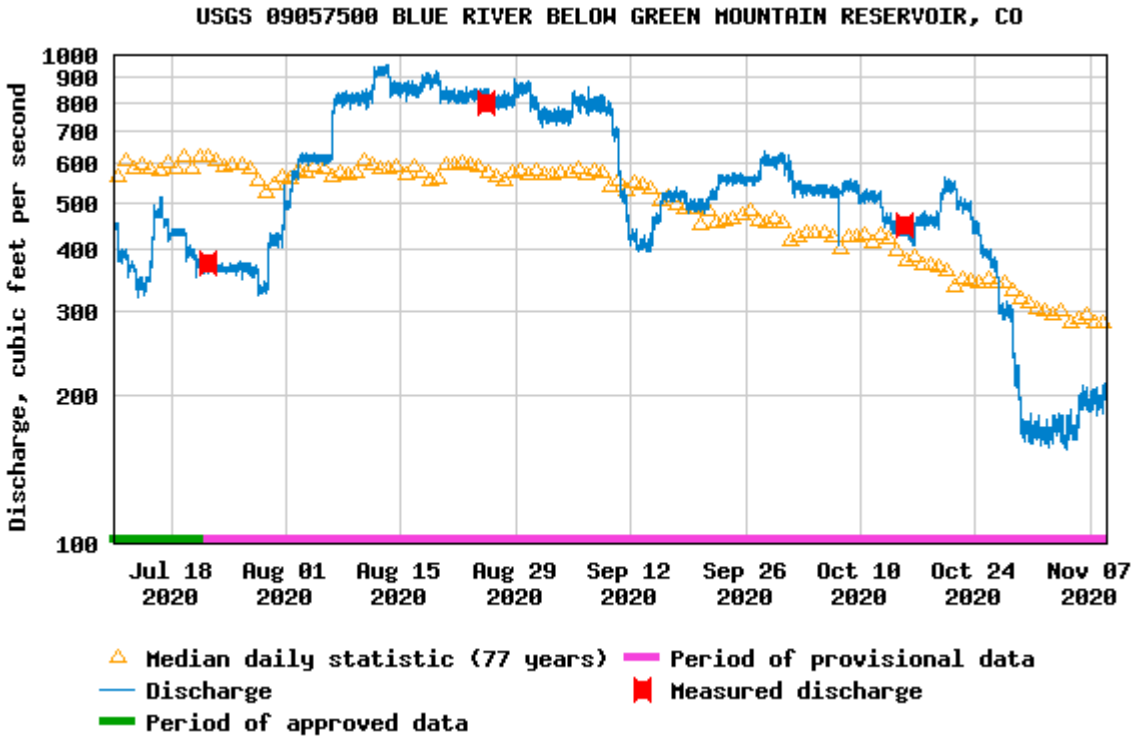


Figure 22: USGS Steamflow Blue River below Green Mountain Reservoir

Grand Lake Clarity and Operations in the Three Lakes

2020 Grand Lake Adaptive Management (GLAM) Clarity operations had very limited flexibility due to operational changes and maintenance on different infrastructure within the C-BT project. The Cottonwood Siphon outage and Soldier Canyon Dam outlet maintenance at Horsetooth Reservoir interrupted normal system conveyance, and early runoff and rapidly declining inflows led to a mid-season operational plan and spill forecast changes. Additionally, the Northern Water Board changed the quota from 70 percent to 80 percent on June 11, increasing the amount of water diverted to the East Slope.

In the 2019 July to September clarity season, Adams Tunnel diversions followed a pattern of 300 cfs on Sunday/Monday, and 500+ cfs from Tuesday through Saturday as flows allowed. This cyclic diversion and associated pumping pattern disrupts the water columns and is thought to help prevent stratification and algal blooms in Shadow Mountain Reservoir, which can have a direct impact on Grand Lake clarity as water moves from the Granby pump canal, through Shadow Mountain Reservoir to Grand Lake and the Adams Tunnel.

In 2020 however, East Slope demands kept July to September Adams Tunnel diversions relatively high (**Figure 23**). **Figures 24 and 25** show Farr Pumping, Shadow Mountain flows and East and North Inlet combined inflow for the 2020 GLAM Season. Clarity goal qualifiers (3.8 meter average, and 2.5 meter minimum Secchi depth from July 1 – September 11) in Grand Lake were not met starting on July 9, and the 2.5 m minimum Secchi goal qualifier was not met beginning on July 27. The Grand Lake Adaptive Management Committee continues to assess operational effects on water quality in the Three Lakes System; the exact mechanisms contributing to the high clarity in 2018 and 2019 and low clarity in 2020 are still being evaluated.

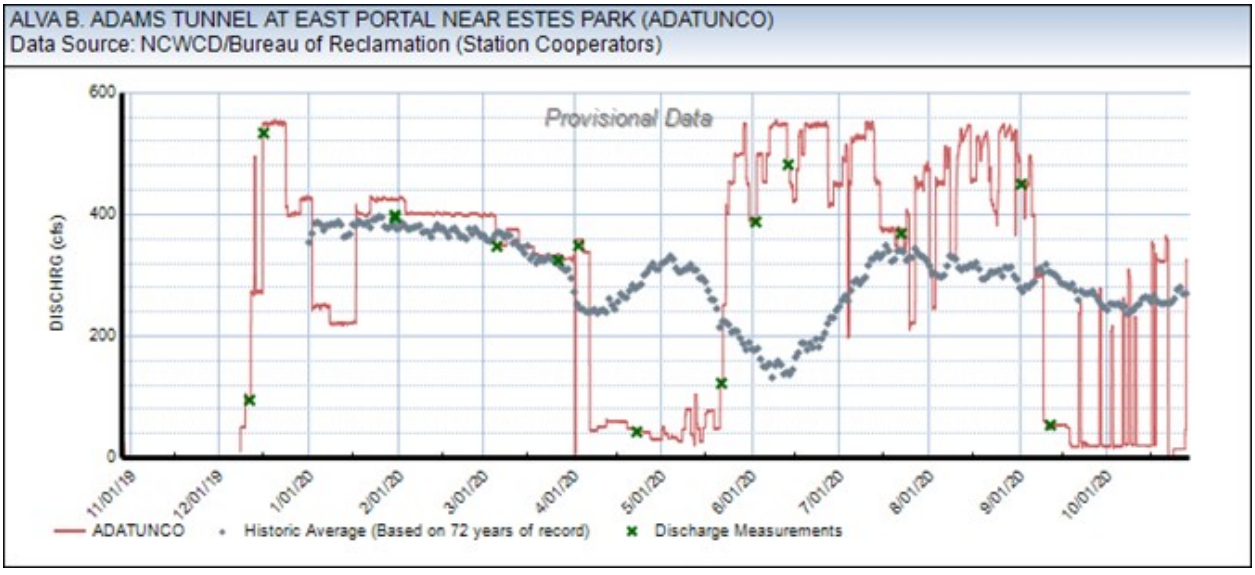


Figure 23: 2020 Adams Tunnel Diversions

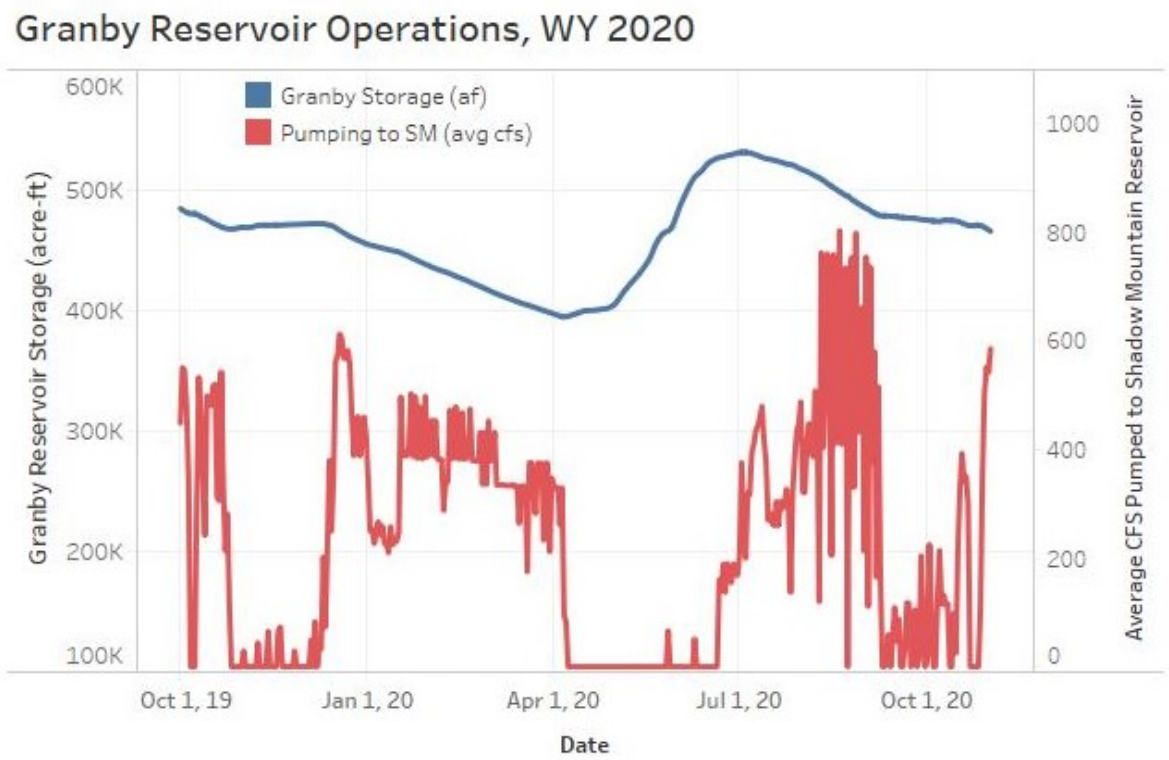


Figure 24: Granby Reservoir Elevation and Farr Pumping, WY 2020

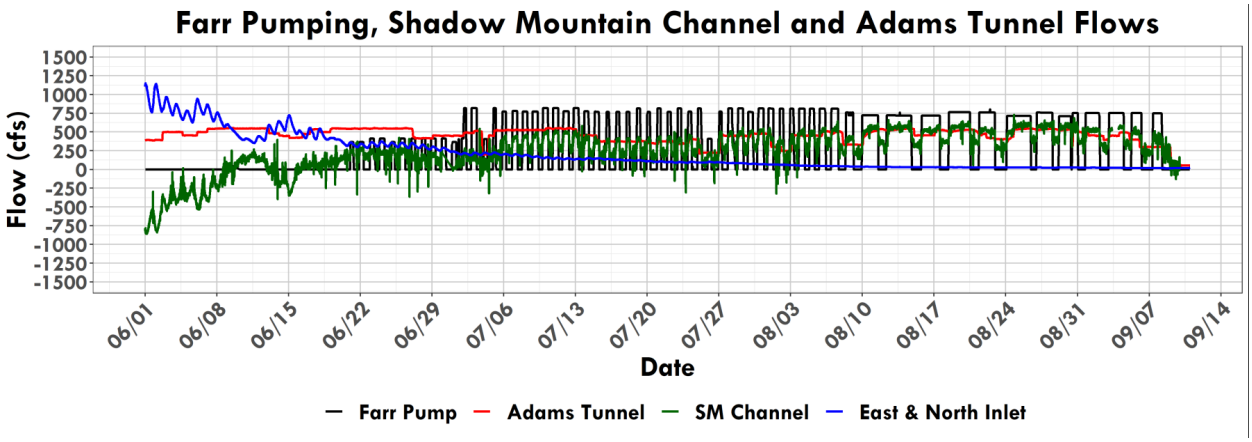


Figure 25: Farr Pumping, Adams Tunnel Diversions, Shadow Mountain Flows and East & North Inlet Combined Inflow for the 2020 Grand Lake Aquatic Management (GLAM) Season