GRAND COUNTY
LEARNING BY DOING

LBD 2019 ANNUAL OPERATIONS REPORT
May 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 2019 LBD related operations, including:

- Denver Water Moffat Collection System spill bypasses[1] totaling approximately 42,000 acre-feet (af) during runoff season, and maintenance bypasses totaling 100 af from the Fraser River Collection System,
- Northern Municipal Subdistrict pumping at Windy Gap Reservoir of over 12,000 af to Granby Reservoir, including 3,000 af for Middle Park Water Conservancy District, which subsequently spilled from Granby Reservoir in late June and July, and
- 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 Area or "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 C**) can be found at the end of this report.

2019 Snowpack and Water Supply Forecasts

On the following page is a map depicting NRCS April 1, 2019 Snow Water Equivalent (SWE) for SNOTEL sites in Colorado (**Figure 1**). A graph of the 2019 Snow Water Equivalent at SNOTEL sites above Kremmling versus time is shown in **Figure 2**. The Colorado Basin River Forecast Center (CBRFC) April 1, 2019 Most Probable Runoff Forecast at Kremmling was 113 percent of average (975 thousand acre-feet [kaf], see evolving forecast graph, **Figure 3**). The actual runoff at Kremmling was 129 percent of average (1,110 kaf). The highest sub-basin runoff forecast within the LBD CEA was in the Willow Creek basin at 125 percent of average (actual 144 percent), and the lowest was in the Fraser River basin at 102 percent of average (actual 102 percent). The April 1 Most Probable Runoff Forecast into Granby Reservoir was 107 percent of average (actual 125 percent).

[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).

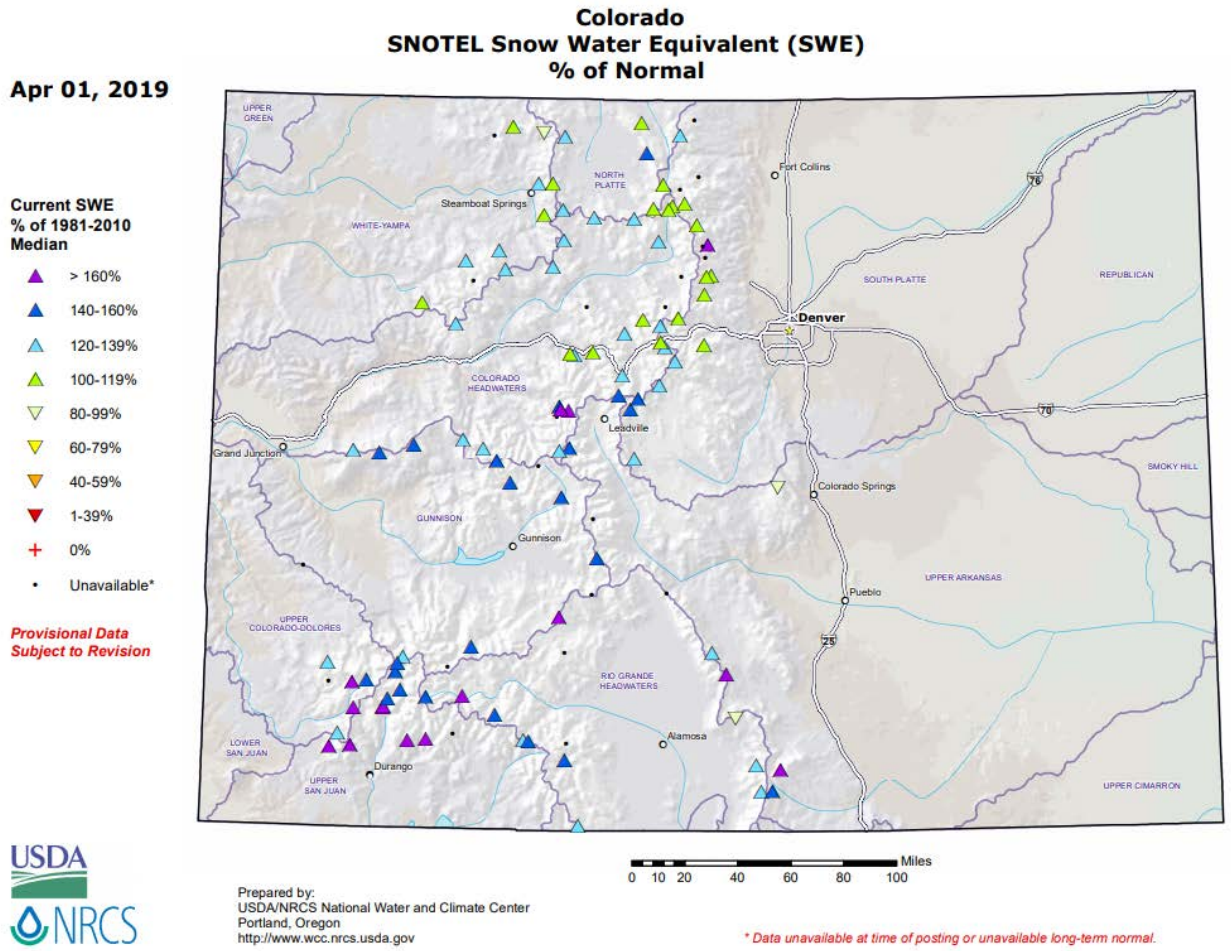
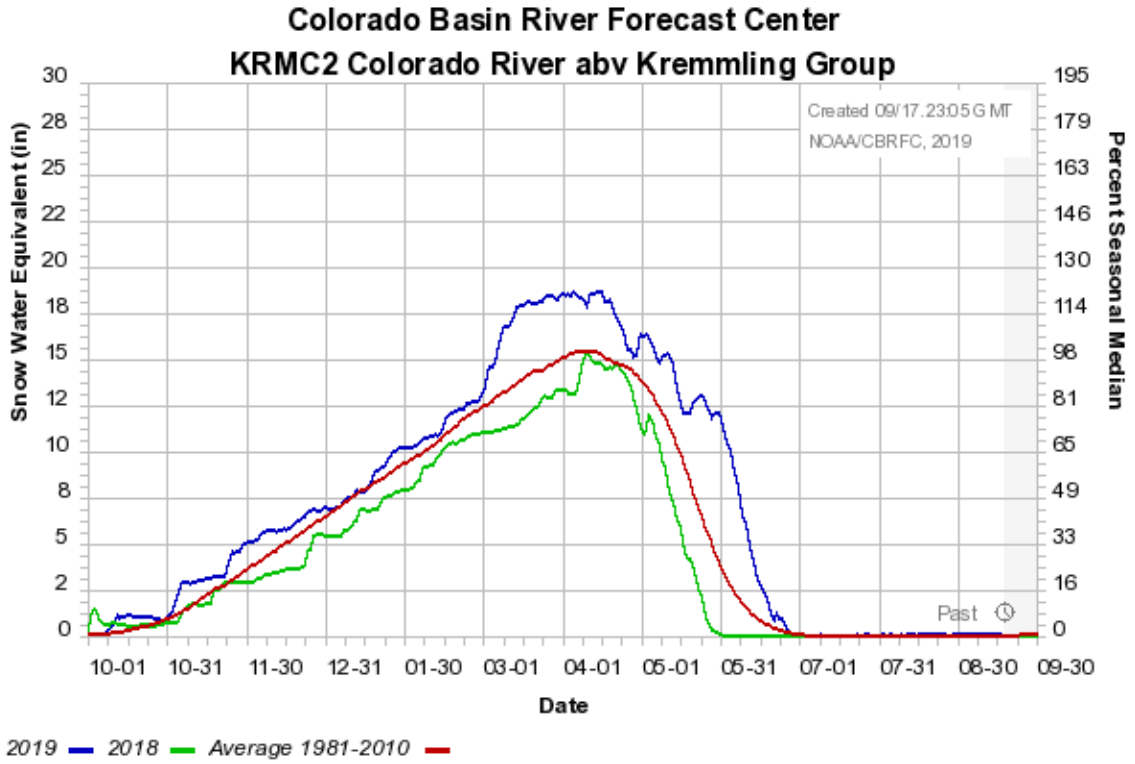


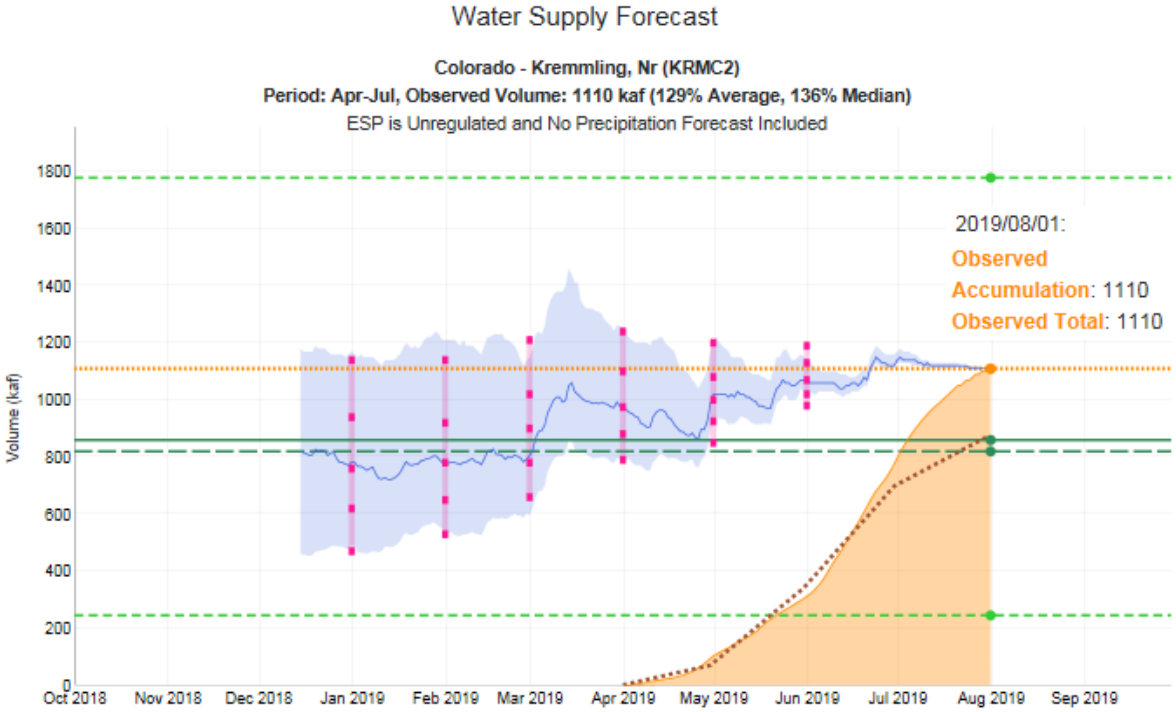
Figure 1: NRCS April 1, 2019 Snowpack Summary

2019 and Climate Variability

Consistent with climate models, general warming results in increased precipitation variability. In a warmer climate, summer temperatures dry out land surfaces faster, and individual storms tend to be "juicier". Following on the critically dry year of 2018 in the upper Colorado River basin, 2019 was a welcome change, with well above average precipitation from February through June. Seasonal climate variability continued as the climate dried out from July through October (see monthly precipitation in the Colorado River Basin, **Figure 4**). This variability created many challenges to LBD operators. A late spring storm over Grand County increased inflows, creating a spill at Granby Reservoir, and challenging Coordinated Reservoir Operations (CROS) with multiple increasing peaks in the Grand Valley. Further, release of Recovery Program water from Granby Reservoir was delayed due to the late runoff and sustained high flows in the 15-mile reach. Subsequently the River District created space in Wolford Reservoir to accommodate a transfer of Recovery Program water when flow was needed in the Colorado River between Granby and Kremmling, storing it temporarily in Wolford for release to the Recovery Program later in the season (for additional information on this exchange, see explanation in the "In-Season

Operations: Granby Operations" section, below). An extended dry period from July through October triggered downstream administrative Calls at Shoshone and Cameo and reduced base flows in the Colorado River, ultimately tapping Recovery Program Pools in Granby, Wolford Mountain and Green Mountain Reservoirs.





Figures 2 and 3: CBRFC 2019 Snowpack and Water Supply Forecast at Kremmling

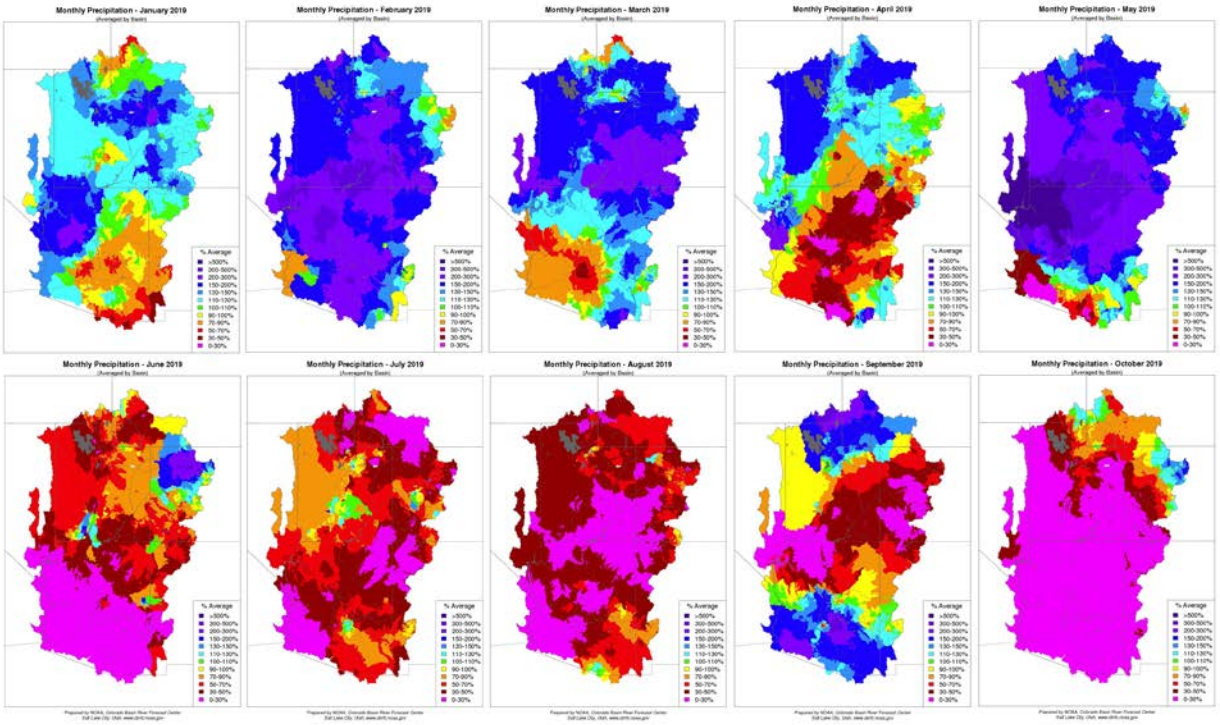


Figure 4: CBRFC January through October 2019 Monthly Precipitation as a Percent of Average

Runoff Operations

The Operations Subcommittee held weekly teleconference calls to discuss runoff operations beginning May 21st. Discussion focused on the impact of wet conditions on both sides of the Divide, the potential for increased Denver Water flexibility due to their in-priority status on South Boulder Creek, uncertainty in CROS planning, Moffat Collection System spill potential, Granby fill and Windy Gap pumping status, flushing flow stream prioritization (Fraser River basin), and timing of Operations Subcommittee calls relative to Historic Users Pool (HUP) calls.

Denver Water Operations

Denver Water coordinated water operations to accommodate two construction projects in 2019. The first was the replacement of the overhead portion of the Vasquez Siphon over the Fraser River and the second was a tie-in on the Jim Creek Canal by Winter Park Water and Sanitation (Jim Creek tie-in). The Vasquez Siphon work was completed in 2019, but the Jim Creek tie-in was delayed. Work on the Vasquez Siphon started in early May and was completed by the end of October. The total amount of water that could be taken from the collection system from the Vasquez side (including St. Louis Creek and diversions from the upper Williams Fork River basin) was limited to about 275 cfs during construction activities. To keep the work area in the Fraser River as dry as possible for this project, as well as for the Jim Creek pipeline project, Denver Water planned to maximize Fraser River diversions upstream of the project sites.

Wet conditions in the South Platte River basin (especially the north end of the collection system) enabled Denver Water to divert about 7,600 AF of South Boulder Creek water, which allowed additional bypass flows above the bypass flows for construction activities to be experienced in the Fraser River basin during runoff.

The Moffat Collection System started bypassing un-diverted water on Ranch Creek, Trail Creek and St. Louis Creek on June 8, 2019. Based on recommendations from LBD, Denver Water diverted from the Williams Fork River basin in order to bypass more water in the Fraser River basin on St. Louis and Ranch creeks. While this reduced the amount of water available for hydropower at Williams Fork Reservoir, it provided an environmental benefit to St. Louis and Ranch creeks. Over the next few weeks in June, more of Denver Water's diversions were bypassed due to increased available water on the West and East slopes. **Figure 5** shows 2019 Moffat Tunnel diversions. By July 1st, Gross and Ralston Reservoirs were close to full and Moffat Tunnel flows were reduced to prevent those Reservoirs from spilling. **Figure 6** shows the effect of spill bypasses on Ranch Creek near Fraser beginning mid-June. All bypasses in the Moffat Collection System had stopped by August 20th except for those needed for the Vasquez Siphon work. Denver Water bypassed just over 42,000 af between early June and late August (**Figure 7**).

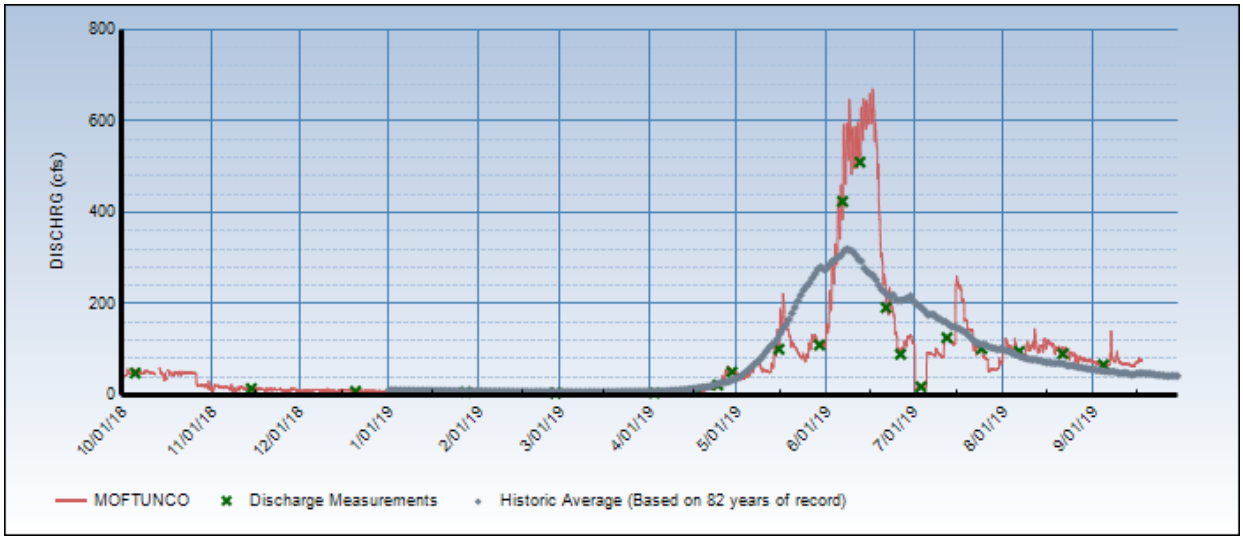


Figure 5: 2019 Moffat Tunnel Diversions

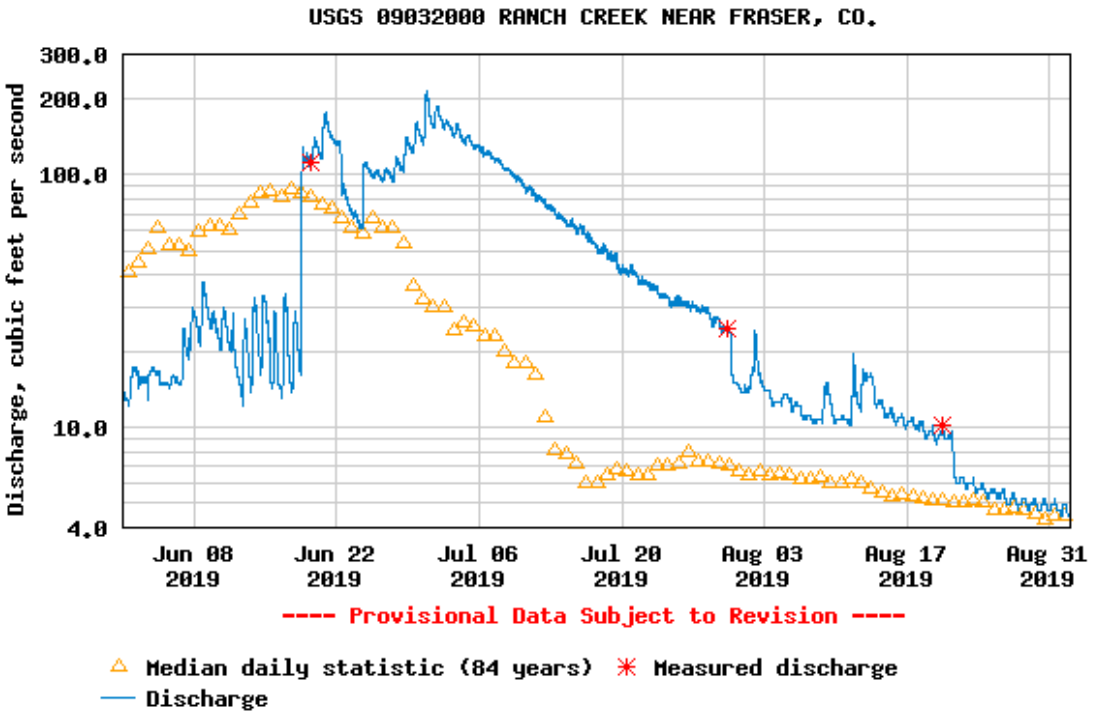


Figure 6: USGS Streamflow Ranch Creek near Fraser

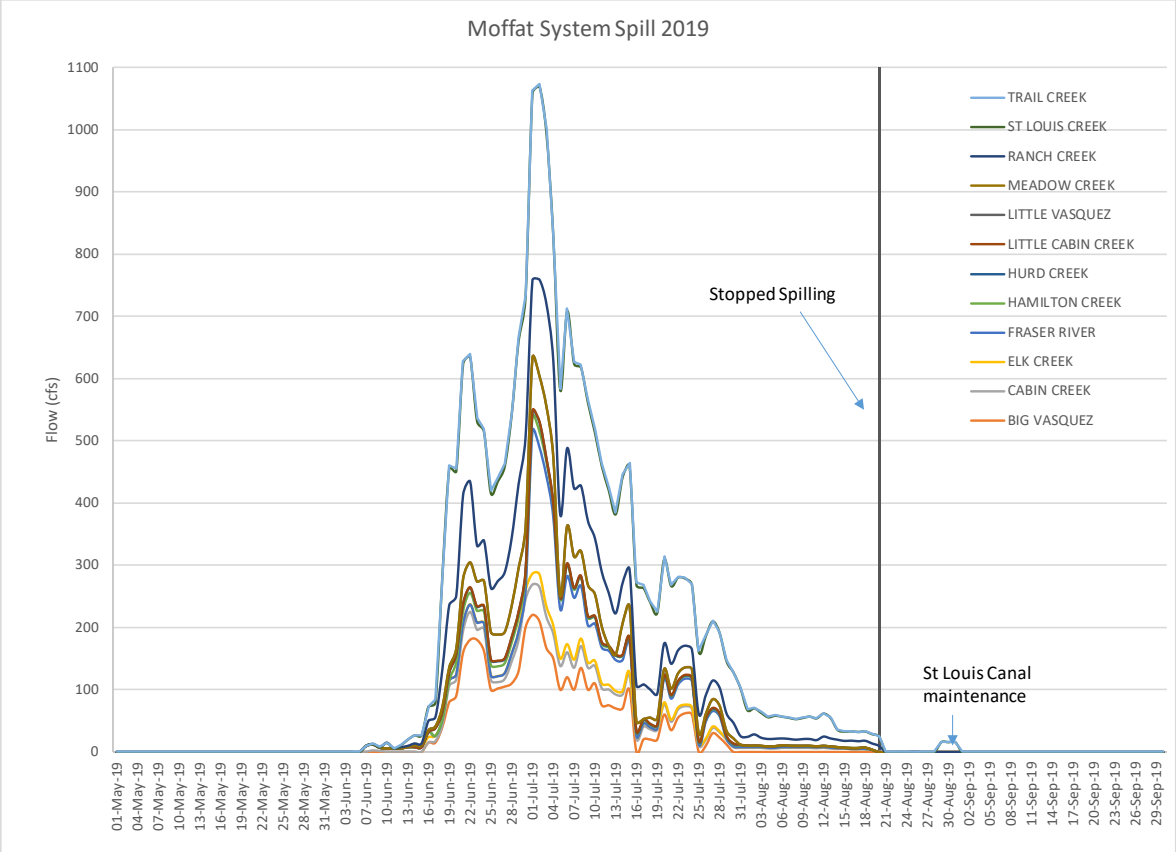


Figure 7: Denver Water Moffat System Bypasses in 2019

Moffat Bypass Prioritization

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 bypasses. Trail Creek was chosen because it had fewer spill bypasses in the recent past. 2018 voluntary spills targeted Big Vasquez, St Louis, and Trail creeks. In 2019 spill bypasses targeted Ranch and St Louis creeks, but due to the delayed runoff and uncertainty about timing and amount of spill through June, no runoff request could be submitted to the Management Committee. In terms of prioritization of spill bypasses on Ranch Creek tributaries, all else being the same, it makes sense to flush 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 comes in. 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. All target flows were met in 2019. 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, cfs, duration) corresponding with each permit-required flushing flow stream (**Attachment D**).

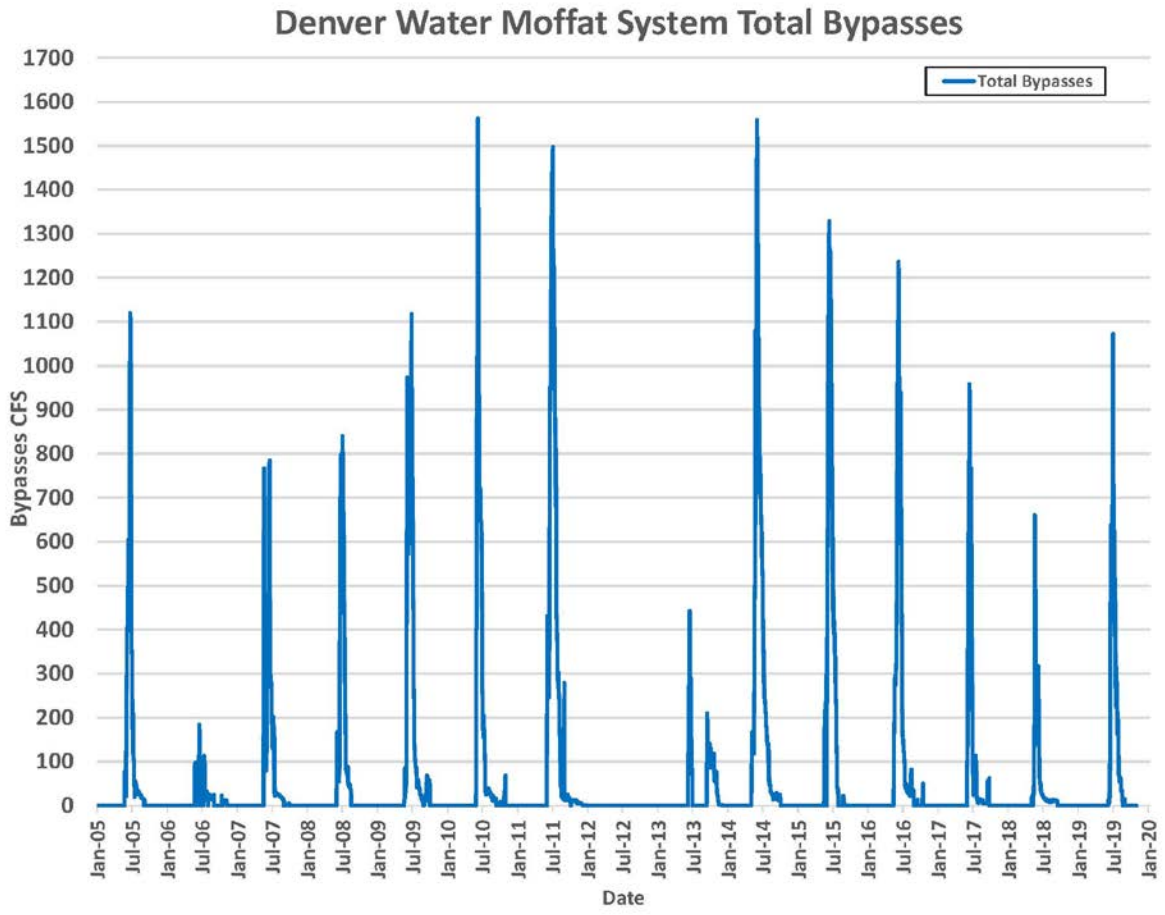


Figure 8: Moffat System Bypasses 2005 to 2019

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 2019 peak flow in the Grand Valley was projected to be about 20,000 cfs (see evolving peak forecast plot, **Figure 9**).

CROS teleconference calls began May 22nd when the peak forecast reached 21,000 cfs, and as snowpack continued to build, the potential for multiple peaks provided uncertainly as to when to initiate peak augmentation efforts. The Colorado Basin River Forecast Center provided modeling to aid in decision making. CROS operations began June 15th targeting the descending limb of the perceived seasonal peak due to concerns for potential flooding. Cameo peaked on June 15th at 20,400 cfs, but several late June storms (**Figure 10**) caused Cameo to peak again at 22,200 cfs on June 22nd and again at 23,200 cfs on July 2nd (seasonal peak). Green Mountain Reservoir operations are shown in **Figure 11**. Although these operations didn't 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.

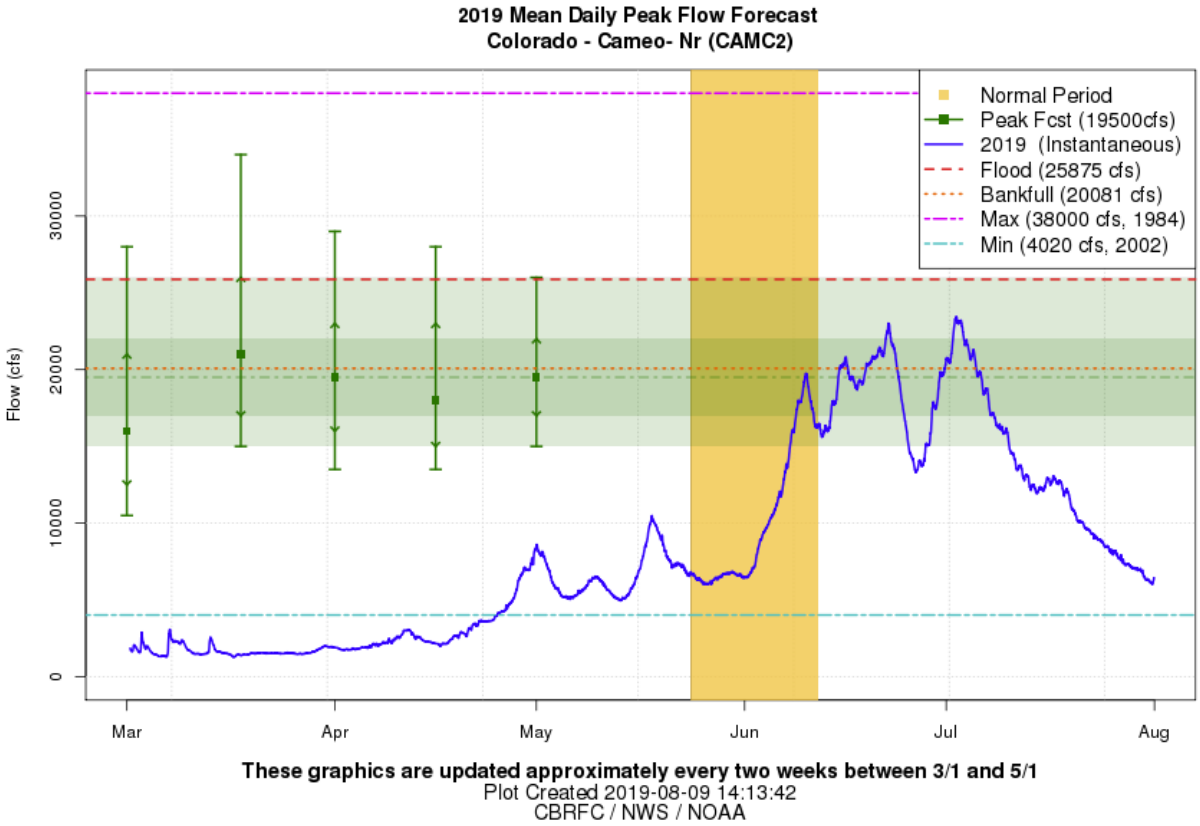


Figure 9: 2019 CBRFC Evolving Peak Flow Forecast for Cameo

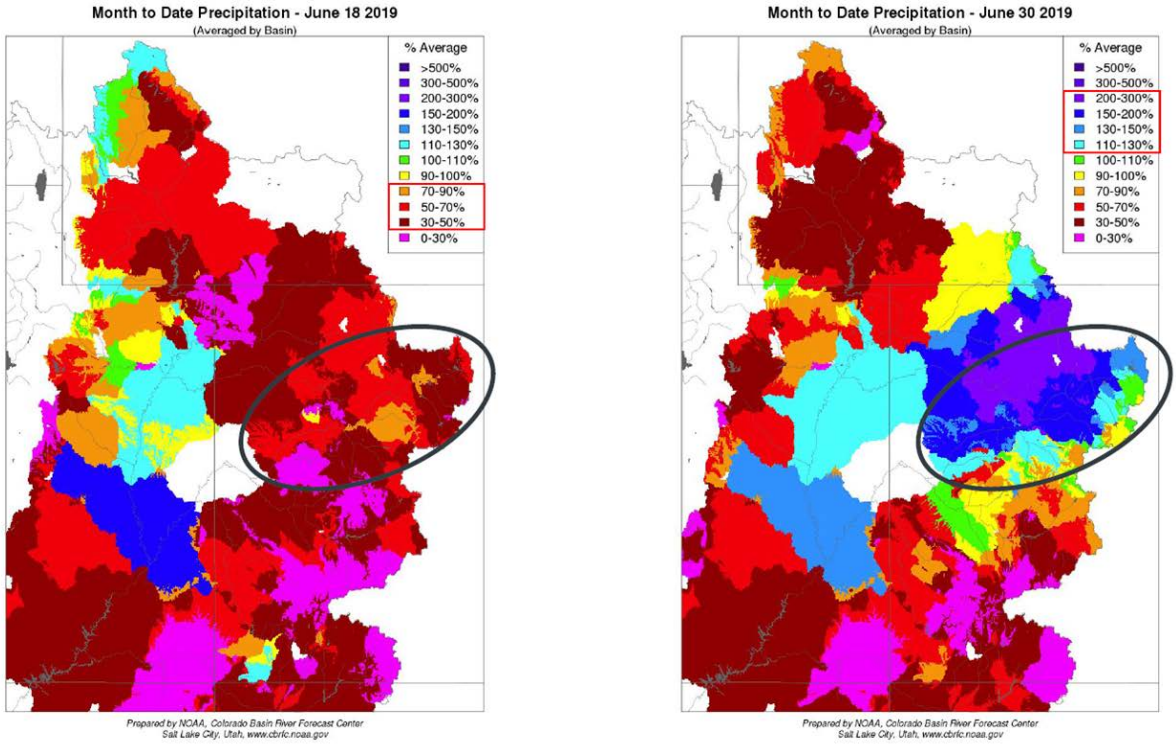


Figure 10: June Precipitation as a Percent of Average on June 18th and 30th

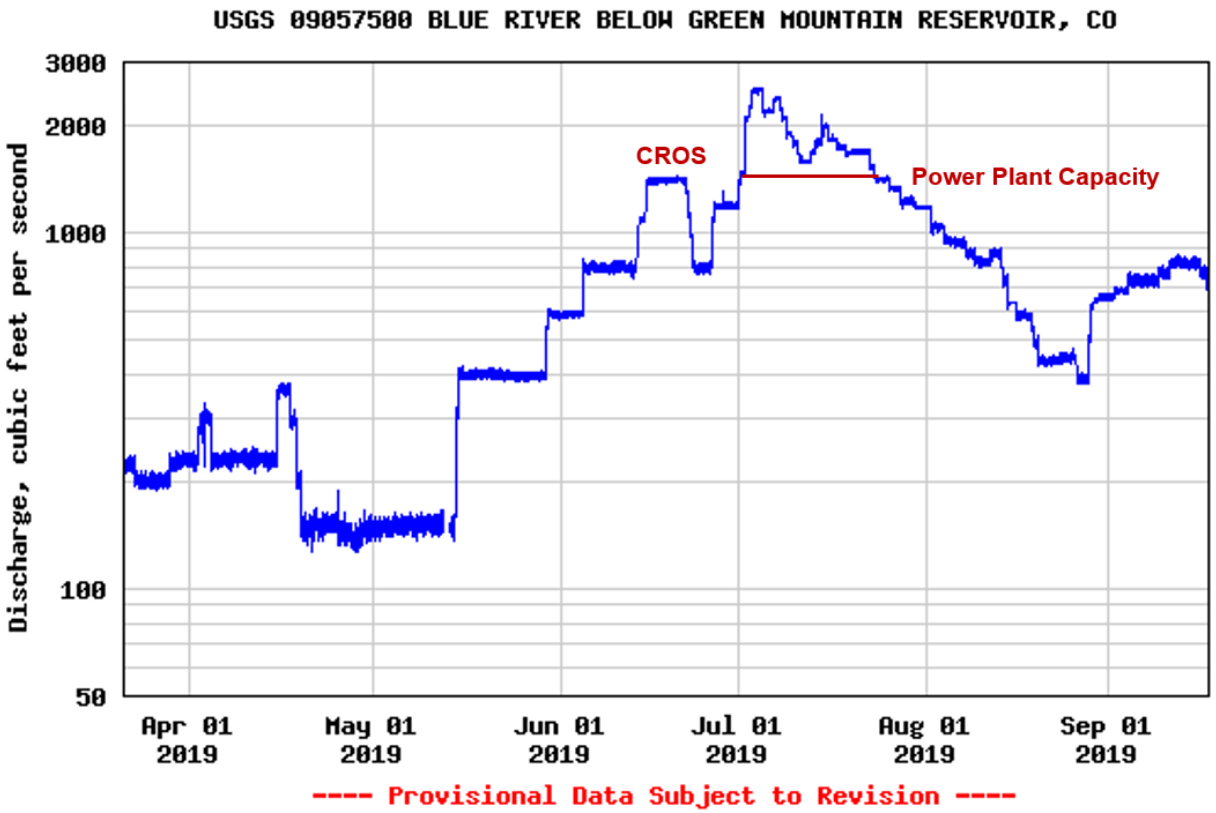


Figure 11: USGS Streamflow Blue River below Green Mountain Reservoir

Granby Fill and Windy Gap Pumping Operations

The 2019 Colorado Big Thompson Annual Operating Plan April 1 Most Probable Forecast model predicted that neither Willow Creek nor Granby Reservoir would spill. The model allowed for pumping at both Willow Creek (60,500 af) and Windy Gap (10,400 af) Pump Stations. Willow Creek began pumping to Granby Reservoir in April, followed by Windy Gap pumping to Granby Reservoir in May. Based on forecasted inflows, Windy Gap pumped at a one pump load on and off until June. Windy Gap pumping ceased during CROS operation to allow for water to pass through the Reservoir and increase the peak in the 15-mile reach of the Colorado River. Windy Gap pumped over 12,000 af in 2019. The first 3,000 af was credited to Middle Park under the 1980 and 1985 Agreements. A portion of any unused 2018 Middle Park water would have become available to Grand County in August 2019. However, late June storms increased the predicted inflows into Granby, creating a spill of about 17,800 af at Granby (**Figure 12**) and Willow Creek Reservoirs. This included all Windy Gap water pumped in 2019 and carryover Middle Park water pumped in 2018. Granby Reservoir spilled in 2011, 2014, 2015, 2016, 2017, and again in 2019, see **Figure 13**.

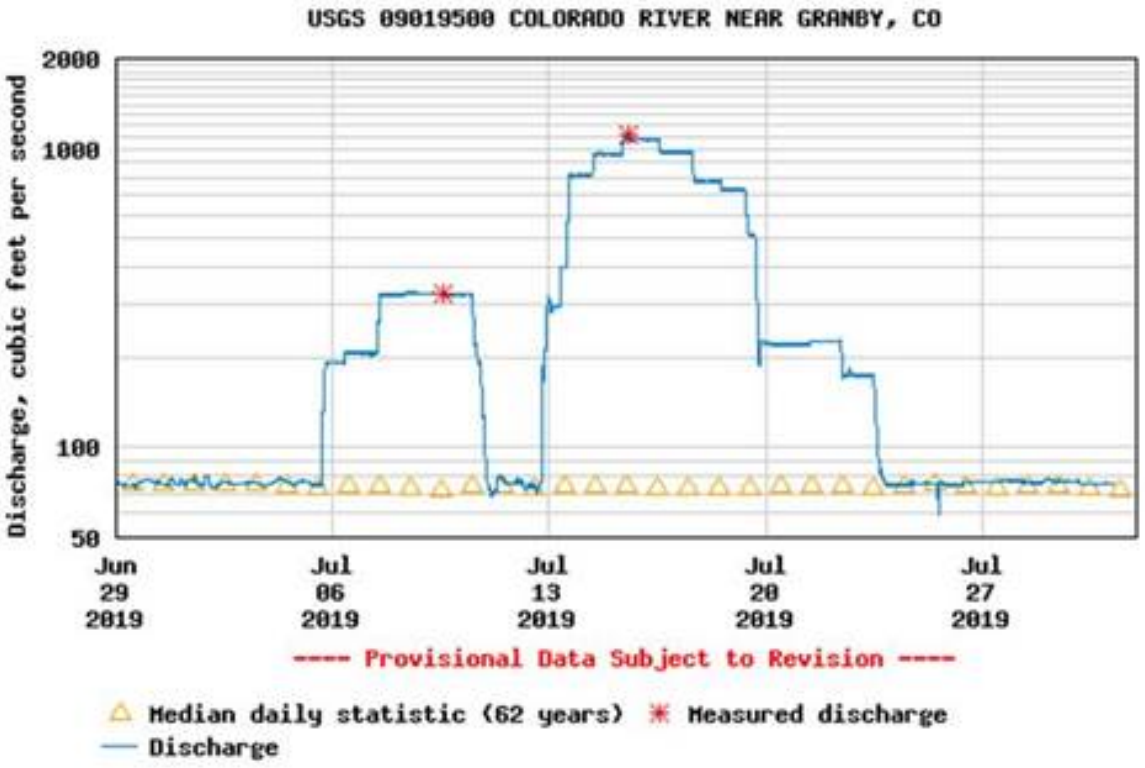


Figure 12: 2019 USGS Streamflow Colorado River near Granby ("Y Gage")

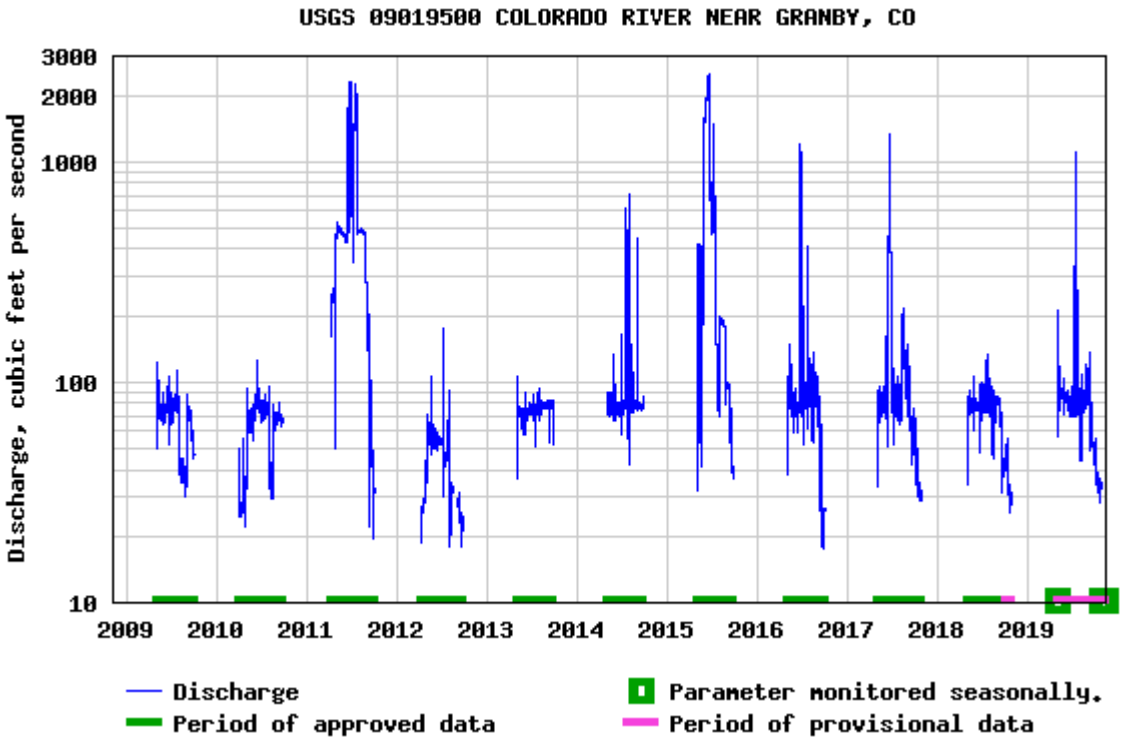


Figure 13: USGS Streamflow Colorado River near Granby 2009 to 2019

In-Season Operations

As the late runoff played out, the Operations Subcommittee continued weekly teleconference calls to discuss in-season operations through mid-September. The Operations Subcommittee weekly calls were rescheduled from Wednesday afternoons to Tuesday afternoons to allow LBD to have input on the Wednesday morning HUP calls.

Each week prior to the LBD operations call, Denver Water circulated a call sheet by email, 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 14a and 14b**. 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.

Real-time temperature data are available at a few USGS sites and three mainstem Colorado 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 15**. Northern Water's temperature data at gages below Windy Gap, at Hot Sulphur Springs and at Parshall can be compared to chronic and acute temperature standards, see **Figure 16**.

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. Although the Moffat Project was 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 or 2019 due to planned maintenance bypass operations, which increased flows without the need to trigger voluntary water releases. Denver Water 2019 LBD in-season operations are summarized in **Appendix D**.

Mainstem Colorado Calls

The Shoshone Junior Hydropower Call came on August 23rd for 5 days, followed by the Senior Call with Green Mountain/Colorado-Big Thompson (CBT) as the Swing Right (most junior water right able to divert) for 2 days. The Moffat Collection System became the Swing Right for 3 days in late August. Subsequently the Senior Shoshone Call with no Swing controlled the Upper Basin. The Cameo Hydropower Call came on September 25th and called out Junior water users below Shoshone.

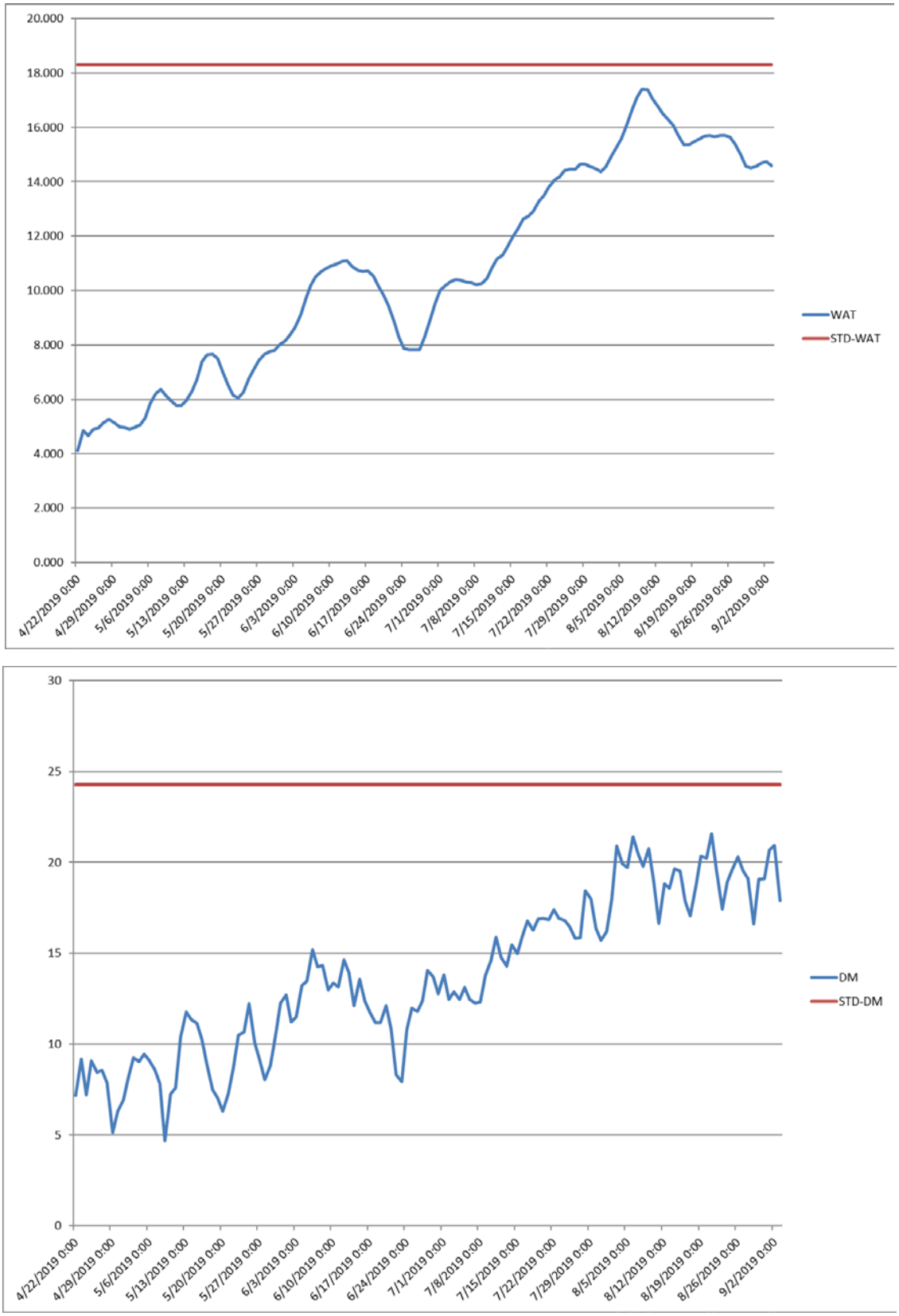


Figure 14a and 14b: MWAT (Chronic) and DM (Acute) Temperature Data Analyses at Fraser River near Highway 40

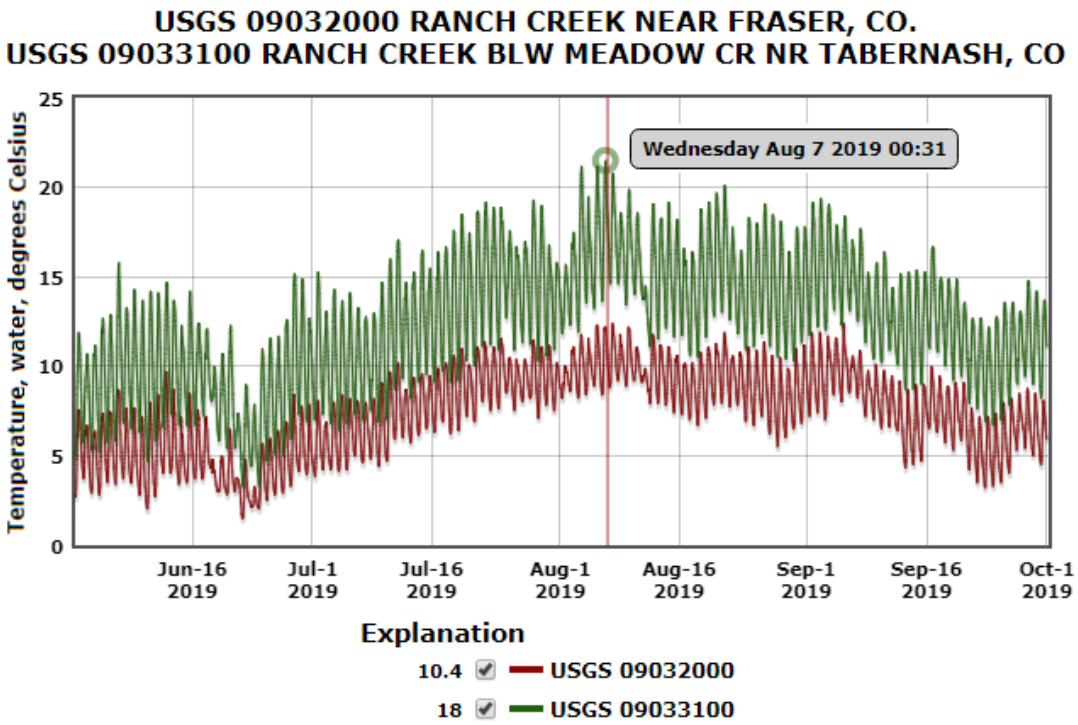


Figure 15: USGS Temperature Comparison Ranch Creek near Fraser and Tabernash

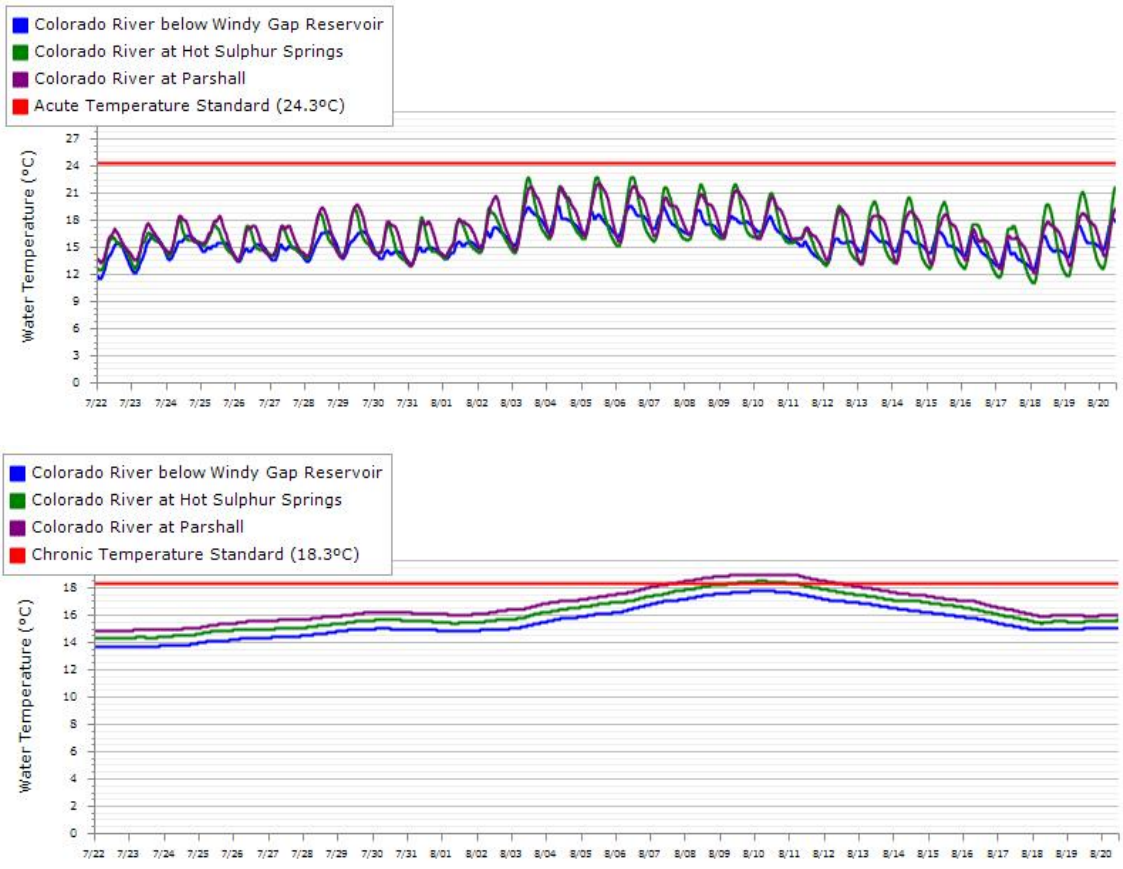


Figure 16: Northern Water Real-time Temperature Gages

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 Reservoirs for later release to the 15-mile reach in the Grand Valley for 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 agencies, including Grand County and LBD.

In 2019, wet conditions made release of the 5412 water from Granby to benefit the 15-mile reach unnecessary. Green Mountain, Wolford and Williams Fork Reservoirs were spilling in early August with low demands, so no space could be made to exchange and temporarily store Granby 5412 Fish water so as to benefit the cold water reach. Beginning August 5th the River District created capacity in Wolford Reservoir to accommodate temporary storage of 833 af, which commenced August 8th. **Figures 17 and 18** show these transfer operations.

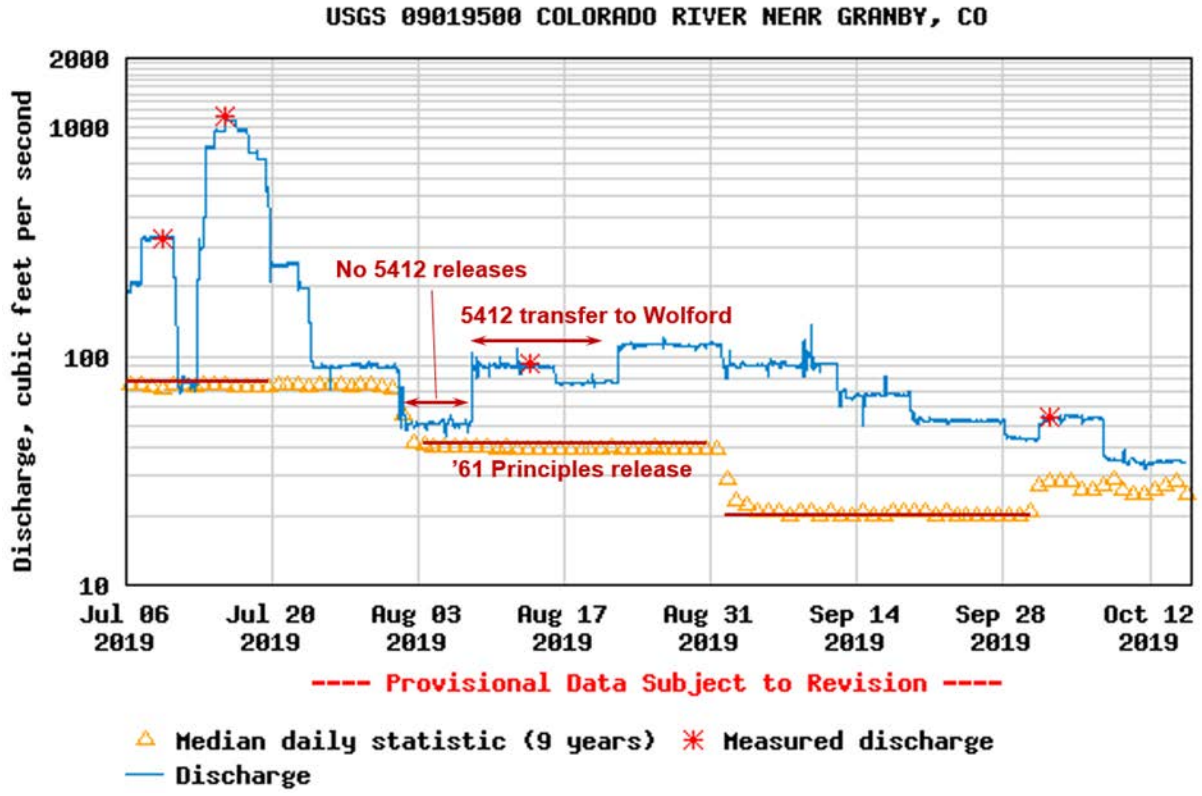


Figure 17: USGS Steamflow Colorado River near Granby

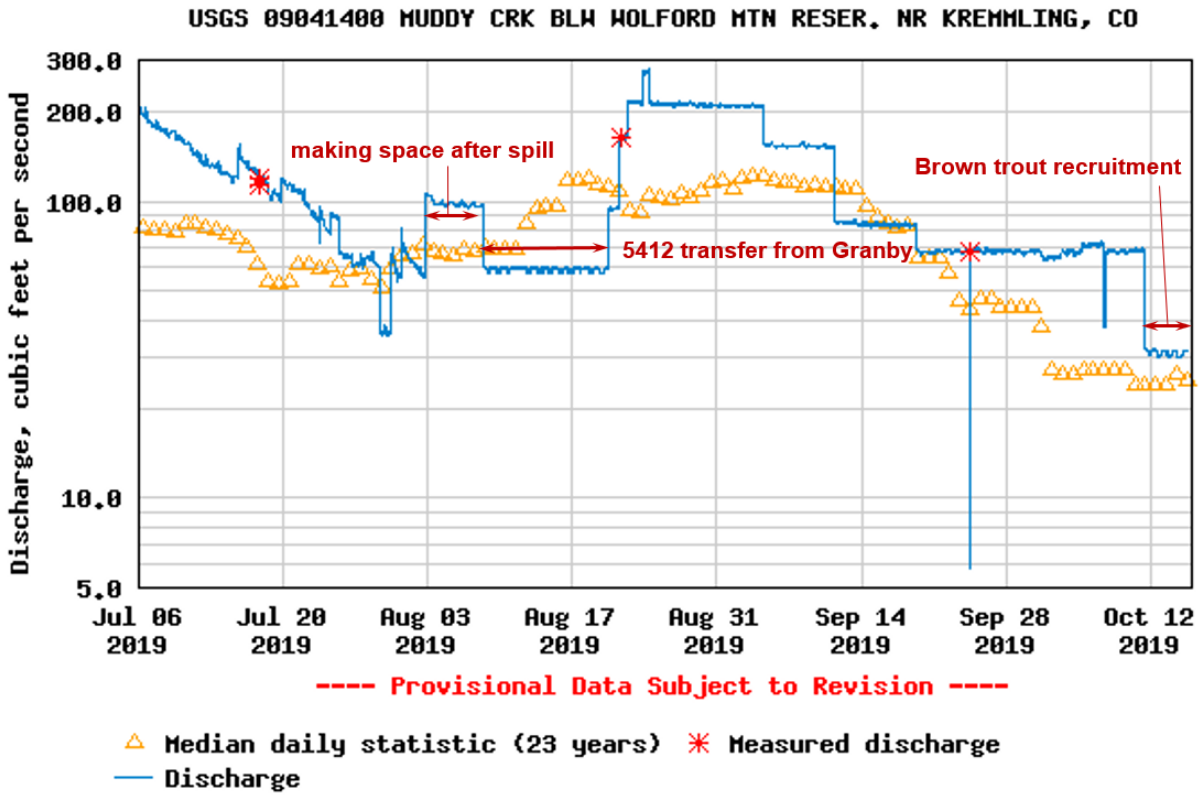


Figure 18: USGS Steamflow Muddy Creek below Wolford Reservoir

Grand Lake Clarity and Operations in the Three Lakes

Grand Lake Adaptive Management was again a success in 2019. A later than average spring runoff resulted in extended inflows into the Three Lakes. Throughout the July 1 to September 11 clarity season, Reclamation planned Adams Tunnel diversions to follow a pattern of 300 cfs on Sunday/Monday, and 500+ cfs from Tuesday through Saturday as flows allowed (**Figure 19**). 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 and Grand Lake to be diverted through the Adams Tunnel. Clarity goal qualifiers (3.8 meter average, and 2.5 meter minimum Secchi depth from July 1 – September 11) in Grand Lake were met this year with a season running average of 4.8 meters and a minimum of 4.0 meters. 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 are still being evaluated.

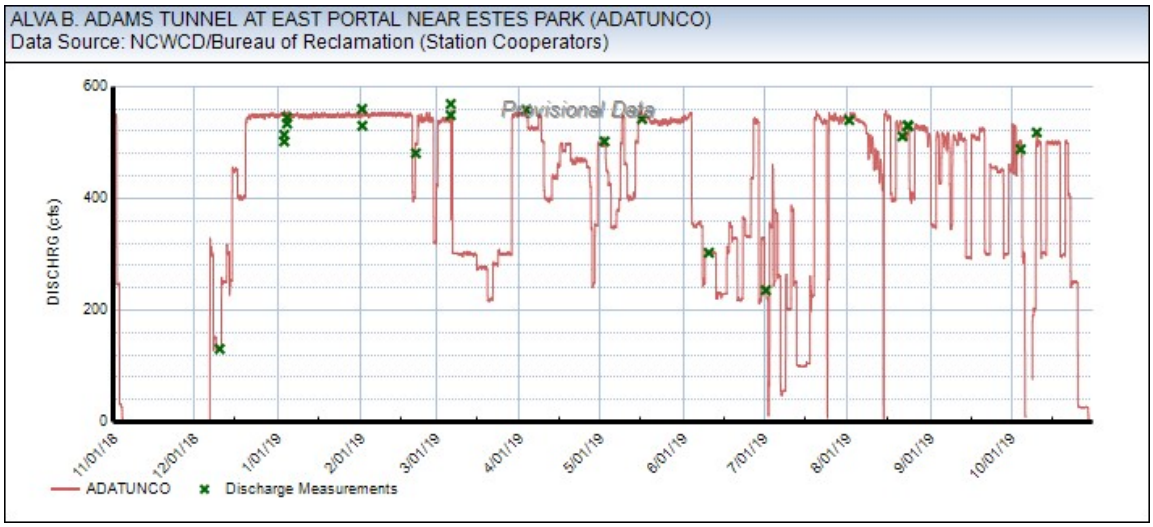


Figure 19: 2019 Adams Tunnel Diversions

The 2019 flow regime in the Lower Colorado River as shown in **Figure 20** reflects the ongoing highly variable climatology and hydrologic uncertainty in the Colorado River basin. LBD operations in 2018 and 2019 as documented in weekly Operations Subcommittee teleconference call notes and Annual Operations Reports reflect the full range of challenges to be expected in future years.

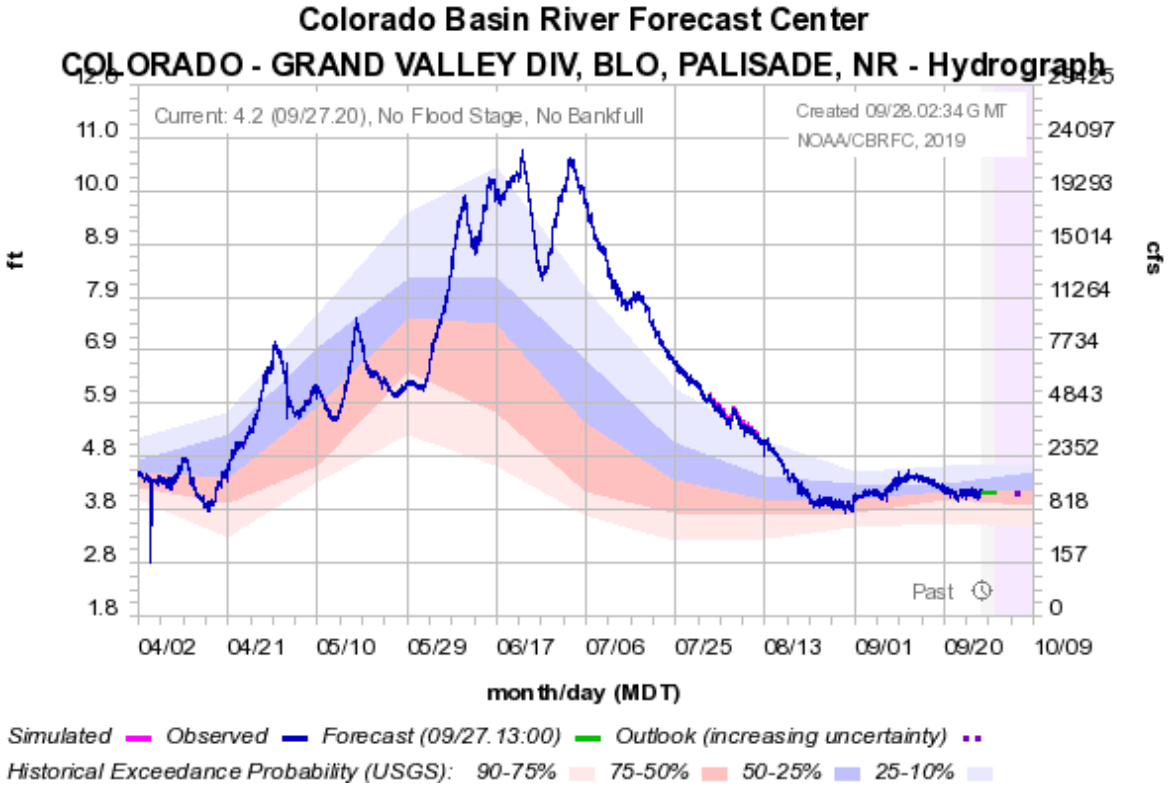
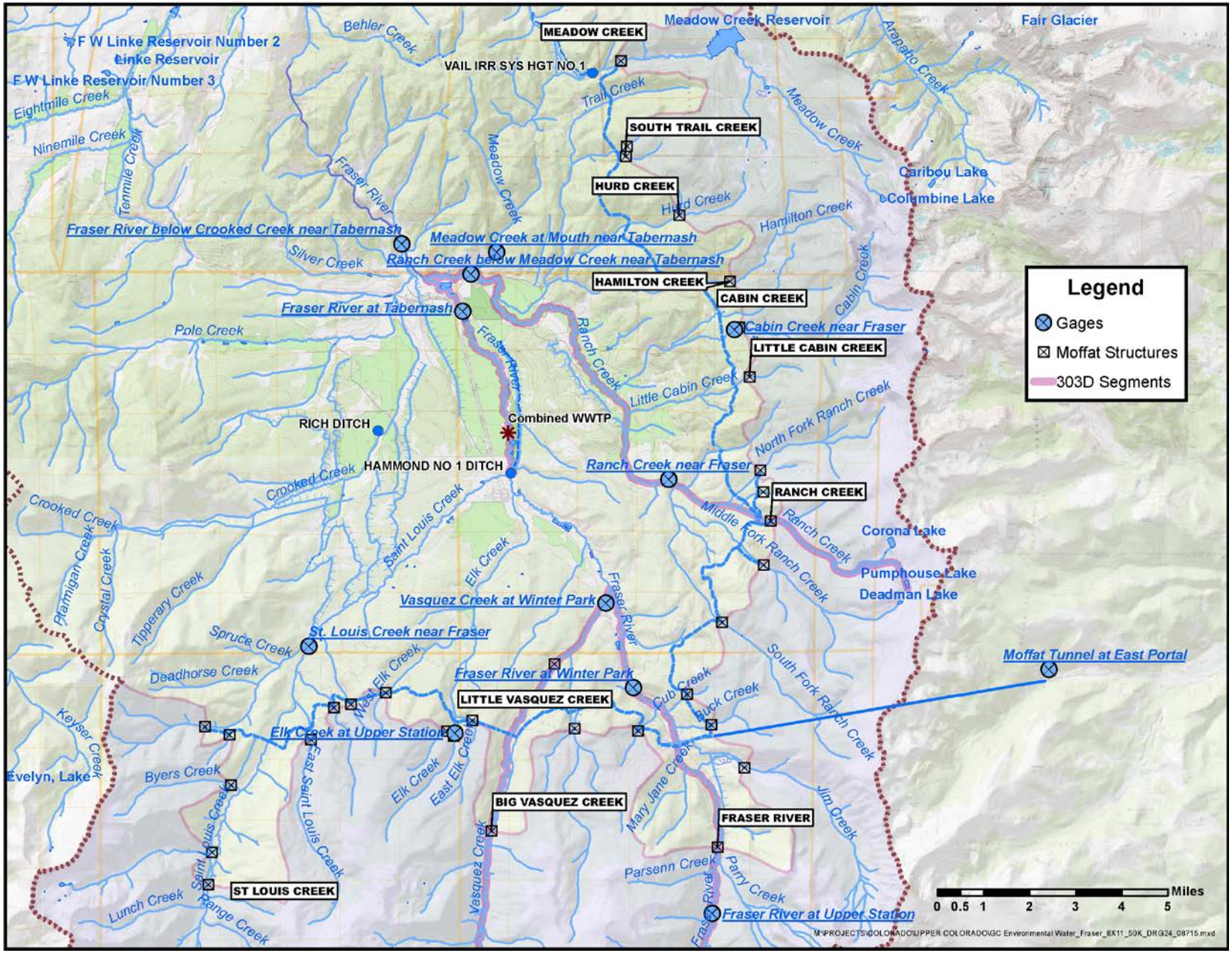
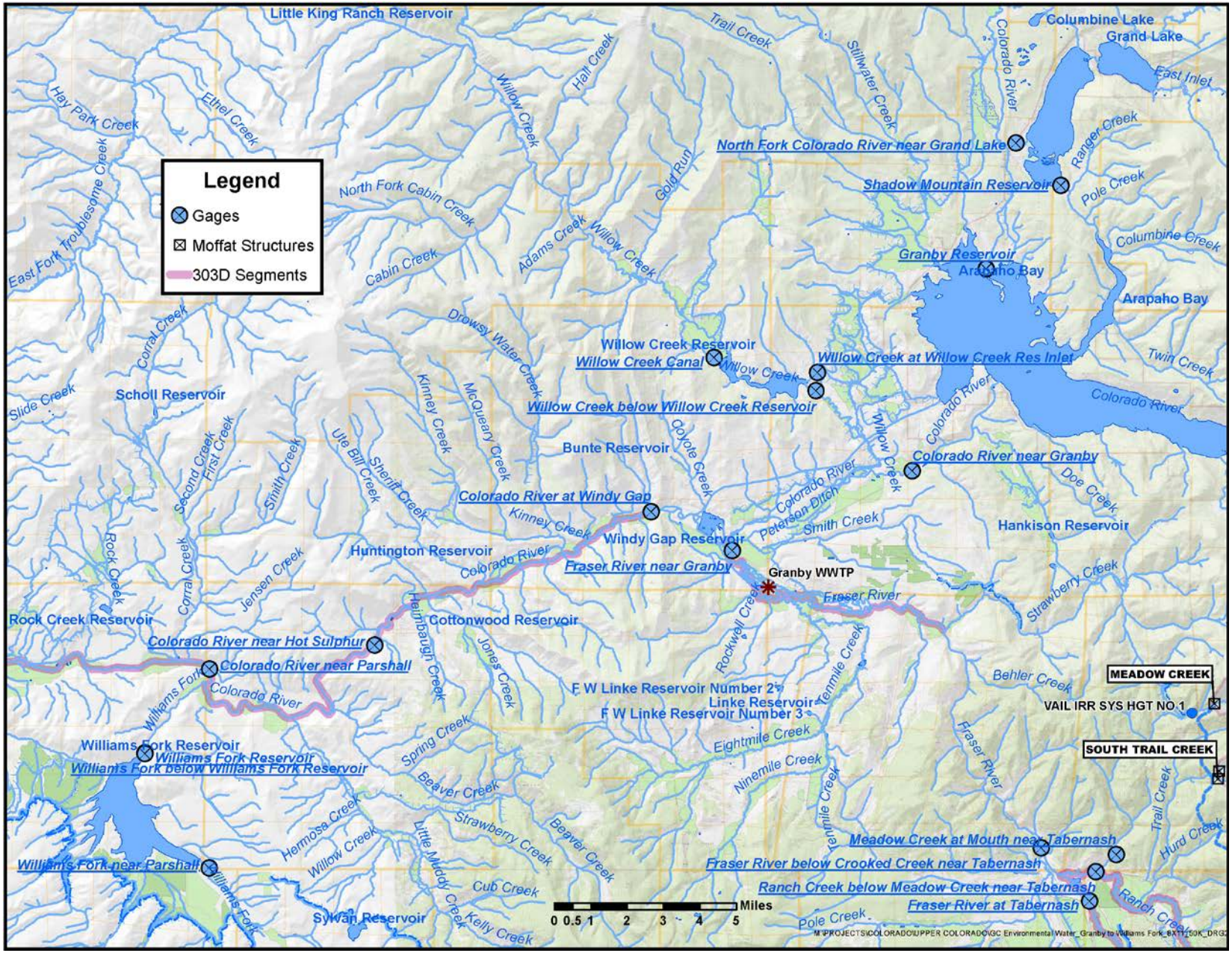


Figure 20: 2019 Colorado River below Palisade Streamflow

Attachment A: Map of Fraser River Collection System



Attachment B: Map of Colorado River from Granby Reservoir to Williams Fork



Attachment C

LBD Water Sources and Quantities Offering Flexibility

1. Moffat Collection System Voluntary/Enhancement Water

- 1,000 af environmental bypass
- Surplus water not needed in a given year by Denver Water

2. Northern/Subdistrict Water

- Grand County's Water Supply
    - Variable Supply - 3.8% of Windy Gap Pumping in excess of 15,000 af, up to 1,500 af
    - MPWCD transfer water – Potential August 1 transfer equal to unused portion of Middle Park's Annual Water Supply (up to 2,300 af) from prior Windy Gap accounting year (only half of the unused water available for transfer prior to completion of Chimney Hollow Reservoir)
    - End of year pumping if Subdistrict pumping complete, must pay power costs for pumping (DW allocated $1M pumping fund)
    - Storage capacity:
        - Before Chimney Hollow completion – 7,500 af, if unused capacity available
        - After Chimney Hollow completion - 4,500 af in Granby Reservoir, if unused capacity available, with ability to share MPWCD's storage if both agree
- MPWCD's Water Supply
    - Variable Supply - 3.8% of Windy Gap Pumping in excess of 15,000 af, up to 1,500 af (estimated long-term average yield of 700 af)
    - Storage capacity of 3,000 af in Granby Reservoir, if unused capacity available

3. Endangered Fish Water

- 5,412.5 af for endangered fish. US Fish and Wildlife Service (FWS) can call for this water. The water may be released from Granby after August 1st during wet years, and exchanged into Green Mountain, Williams Fork and/or Wolford Reservoir, until FWS asks for the release to the 15-mile reach. Releases depend on the type of hydrologic

year and the targeted streamflow in the Colorado River in the 15-mile reach. These releases are coordinated with Grand County and other interested parties during the HUP calls, benefiting the stream segment below Granby Reservoir. The typical release schedule aids in maintaining a 75 cfs flow at USGS Granby gage from Aug 1 through mid-September

4. Williams Fork Reservoir Storage

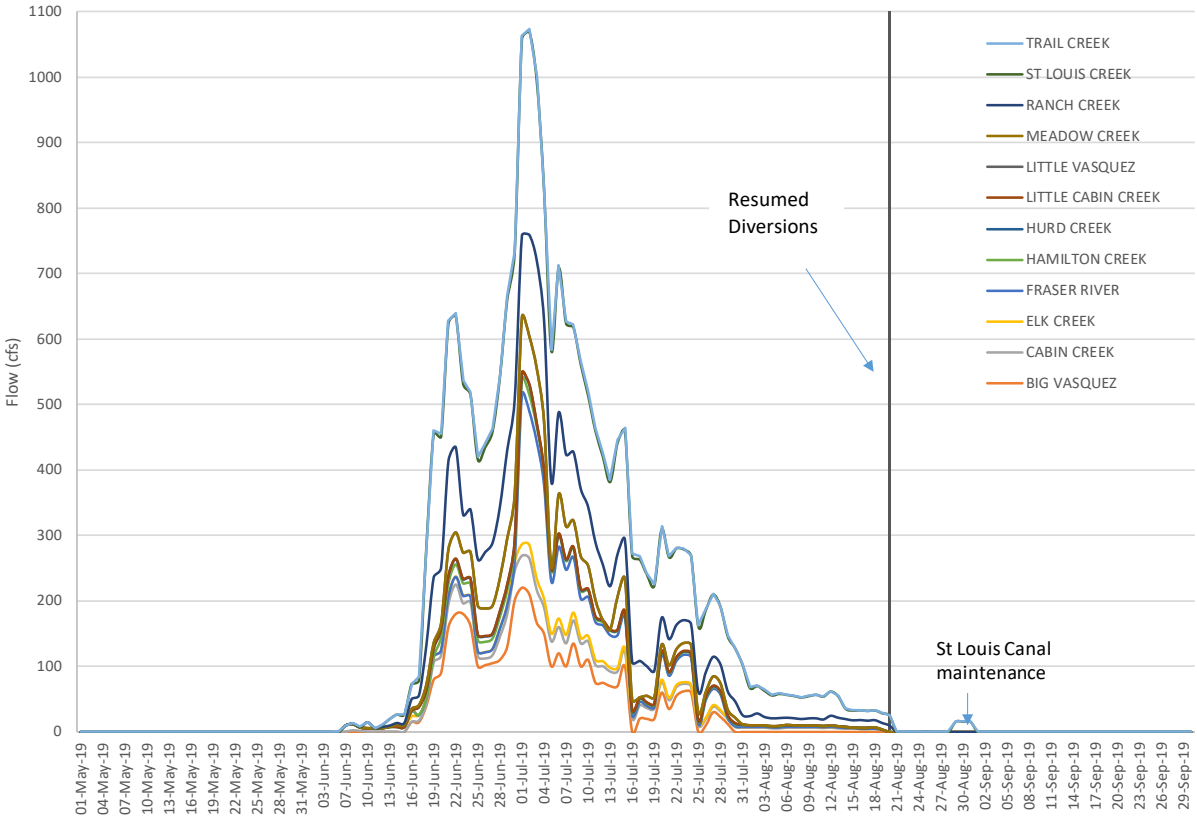
- 1,000 af environmental water (CRCA) stored when 1,000 af environmental water is bypassed during a mainstem Colorado River Call. 2,500 af maximum carryover, first to spill, notification of anticipated spill

Attachment D

Denver Water Learning By Doing Operations
2019 Summary of Denver Water's Water Releases to Benefit the Fraser River Basin

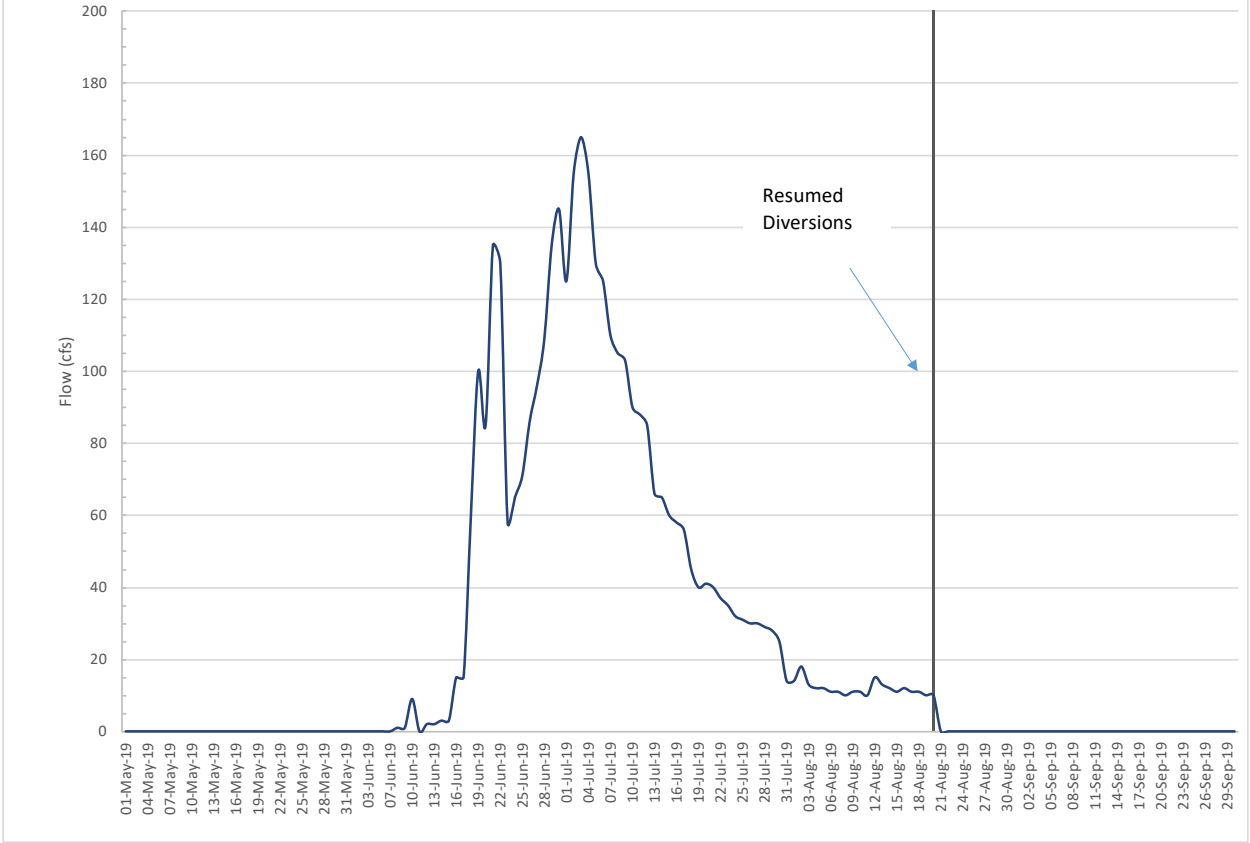
The first Learning by Doing (LBD) operations call of 2019 was held on May 21st and focused on expected Denver Water spring operations and forecasted spills (un-diverted flow). Cool and wet conditions were present and persisted into June, which delayed runoff for about a month. The Moffat Collection System stopped diverting Ranch Creek, Trail Creek and St. Louis Creek diversions on June 8, 2019 (Figure 1). Based on recommendations from LBD, Denver Water continued diversions from the Williams Fork River Basin in order to divert less and provide more water in the Fraser River Basin. Over the next few weeks in June, more flows went un-diverted at Denver Water's diversions, releasing water to the streams. These un-diverted flows were due to a wet spring, which increased available water on the West and East slopes of Denver Water's collection system. For example, native flows on South Boulder Creek allowed Denver Water to store or divert 7,642 acre-feet (AF) of water from South Boulder Creek and Ralston Creek. This resulted in 1,959 AF stored at Gross Reservoir, 5,683 AF diverted directly to Moffat Treatment Plant from South Boulder Creek, and 597 AF was diverted to storage or to the Moffat Treatment Plant from Ralston Creek. By July 1st, Gross and Ralston Reservoirs were close to full and Moffat Tunnel flows were reduced to prevent those Reservoirs from spilling.

Figure 1. Moffat Collection System un-diverted Flow – 2019.



Conditions dried out quickly and Denver Water reduced releases to the river in late July to maintain Reservoir levels at Gross and Ralston Reservoirs. Based on recommendations from LBD, Denver Water diverted water from the Upper Williams Fork and continued to bypass water on St. Louis and Ranch Creeks. While this reduced the amount of water available for hydropower at Williams Fork Reservoir, Denver Water concurred that the extra flows requested by LBD provided an environmental benefit to St. Louis and Ranch Creeks. As conditions began to dry out and stream flows dropped off in late summer, Denver Water started diverting more water at each diversion and by August 20th, the Moffat Collection System was diverting all the water available (except for required bypass flows and water needed for senior water rights). Between June 8th and August 20th, approximately 42,000 AF of water was bypassed (un-diverted) from the Moffat Collection System. During this time period, the LBD operations subcommittee was in communication with Denver Water and providing input on where un-diverted flows should occur. Figure 2 shows the un-diverted flows on Ranch Creek.

Figure 2. Main Ranch Creek un-diverted flow – 2019.



Denver Water coordinated water operations to accommodate two construction projects in 2019. The first was the replacement of the overhead portion of the Vasquez Siphon (Siphon 1) over the Fraser River and the second was a tie-in on the Jim Creek Canal by Winter Park Water and Sanitation (Jim Creek tie-in). The Vasquez Siphon Project was completed in 2019 but the second project (Jim Creek tie-in) was delayed.

When planning for the 2019 runoff and summer operations in the early spring, Denver Water was concerned that the snowpack and the two construction projects would impact its ability to fill Gross and Ralston Reservoirs. The runoff was projected to be average and diversions would be limited during the runoff period due to the construction projects. Therefore, Denver Water made the decision that no voluntary water releases would be made in 2019.

The Vasquez Siphon Project limited the amount of water that could be diverted from the Upper Williams Fork, St. Louis Creek, and Vasquez systems to around 275 cubic feet per second (cfs). The Project started in late April and lasted into early November. Due to a wet and cool spring, flows in South Boulder and Ralston Creeks were above normal allowing Denver Water to store native South Boulder Creek water in Gross Reservoir and Ralston Creek water in Ralston Reservoir. In turn, this allowed Denver Water to divert less water from the Moffat Collection System and subsequently, the Vasquez Siphon Project limitation of 275 cfs was not a factor in Denver Water operations.

A short, unplanned maintenance project to repair some concrete in the St. Louis Canal occurred between August 29th and August 31st and provided about 100 AF (16 cfs for 3 days) of additional flows to St. Louis Creek (Table 1).

Table 1. 2019 Summary of Denver Water's Construction-Related Water Releases (No voluntary environmental water releases were made in 2019).

Dates	Duration	DW Diversion Location	Total Amount of Water Bypassed (AF)*
Aug 29-31	3 days	St. Louis Creek	100
TOTAL			**100**

*Does not include USFS-required bypass flows at Denver Water's diversions

FLUSHING FLOWS

The Grand County Mitigation and Enhancement Coordination Plan (MECP), U.S. Forest Service (USFS) Off-license Agreement, and Section 404 Permit for the Moffat Project all have flushing flow requirements. In 2019, these flows were met or exceeded at all locations (see table "Attachment 1 – 2019 Flushing Flow Monitoring Report"). In 2018, all but one stream (Cabin Creek) met or exceeded recommended flushing flow requirements. A comparison to past years' data collected since 2018 is shown in the table "Cumulative Flushing Flow Monitoring Report" in Attachment 2.

FRASER SEDIMENT POND

Denver Water, Colorado Department of Transportation (CDOT), and Grand County entered into a participation agreement to remove accumulated sediment from the Fraser River Diversion structure in 2011 (DW Contract 500441). Table 2 shows sediment removal at this location for each year since 2013 which was the first year of sediment removal activities.

Table 2. Truck Loads and Amount of Sediment (Tons) removed each year from the Fraser River Diversion.

Year	Truck Loads	Sediment Removed (Tons)
2013	68	680
2014	69	690
2015	55	550
2016	37	370
2017	32	320
2018	29	290
2019[1]	33	330
Total	**323**	**3,230**

1 – Data from 2019 is provisional

2018 DENVER WATER DIVERSIONS

In the future, bypass water will be available every year for LBD to use. The graph and table shown in Attachments 3(a) and (b) depict Denver Water diversions based on gaged flows in the Moffat Collection System for 2018. Compiling this information is time consuming, so 2019 flows will be provided in next year's annual report. However, this historic information can be useful to LBD in order to plan where additional bypass water may be available as it shows where in the Moffat Collection System Denver Water diverted water for a given year. A summary of 2018 Denver Water diversions is shown in Table 3. For detailed information, refer to Attachments 3(a) and (b).

Table 3. Moffat Collection System 2018 Diversions (based on canal gages).

Location	Total Volume Diverted 7/1/2018-9/30/2018 (AF)	July Average Daily Diversion Rate (cfs)	August Average Daily Diversion Rate (cfs)	September Average Daily Diversion Rate (cfs)
Jones Pass to Vasquez Creek	1,827	18	7	4
Vasquez Diversion	1,859	17	7	7
St. Louis Creek to Elk Creek Diversion	2,123	25	7	2
Little Vasquez and Cooper Creek Diversions	911	9	3	3
Meadow Creek Direct Diversion	0	0	0	0
Meadow Creek Storage Release	2,598	0	15	28
Trail Creek to Little Cabin Creek Diversion	0	0	0	0
North Ranch to Buck Creek Diversion	1,198	12	4	4
Fraser River and Jim Creek Diversions	977	9	6	1

Attachment 1 – 2019 Flushing Flow Monitoring Report.

Fraser and Upper Williams Fork River Basins

ANNUAL FLUSHING FLOW MONITORING - 2019

2019 Year Type: **WET**

Waterbody	Measuring Location	Flushing Flow Mean Daily Discharge (cfs)	Dates Flow was at or above Flushing Flow Target	Flushing Flow (mean daily flow) Achieved for a Minimum of 72 Hours?
Fraser River Basin				
Fraser River at Winter Park	USGS 0902400	80	6/29-7/7	YES
Vasquez Creek at DW Diversion	broad-crested weir on diversion	50	6/19-7/15, 7/22-7/24	YES
Ranch Creek near Fraser	USGS 09032000	40	6/18-7/20	YES
Cabin Creek near Fraser	USGS 09032100	40	6/20-6/22, 6/30-7/4	YES
St. Louis Creek near Fraser	USGS 09026500	70	6/8-7/31	YES
Williams Fork River Basin				
Steelman Creek	Williams Fork below Steelman Creek - USGS 09035500	At least 35 cfs	7/1-7/9 (above 140 cfs no diversions)	YES
Bobtail Creek		At least 80 cfs	7/1-7/9 (above 140 cfs no diversions)	YES
McQueary Creek		At least 25 cfs	7/1-7/9 (above 140 cfs no diversions)	YES

Attachment 2 – Cumulative Flushing Flow Monitoring Report.

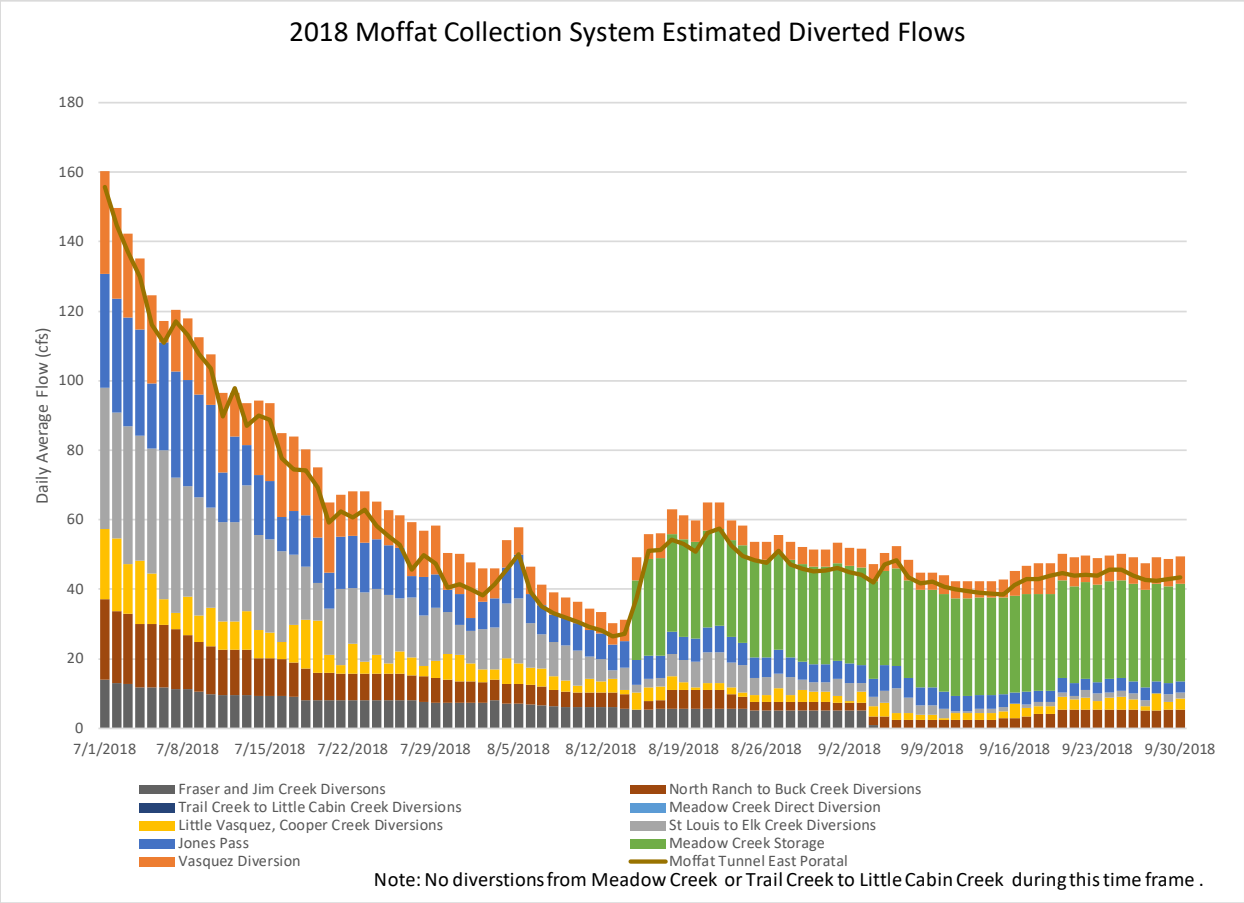
Fraser and Upper Williams Fork River Basins

FLUSHING FLOW MONITORING (2018-2019)

Cumulative Reporting (Target: 3 out of 10 years)

Waterbody	Flushing Flow Mean Daily Discharge (cfs)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Summary
		Flushing Flow Achieved?											
Year Type		Dry	Wet										
		Fraser River Basin											
Fraser River at Winter Park	80	YES	YES										2 of 2 years
Vasquez Creek at DW Diversion	50	YES	YES										2 of 2 years
Ranch Creek near Fraser	40	YES	YES										2 of 2 years
Cabin Creek near Fraser	40	NO	YES										1 of 2 years
St. Louis Creek near Fraser	70	YES	YES										2 of 2 years
		Williams Fork River Basin											
Steelman Creek	At least 35	YES	YES										2 of 2 years
Bobtail Creek	At least 80	YES	YES										2 of 2 years
McQueary Creek	At least 25	YES	YES										2 of 2 years

Attachment 3(a) – Daily Denver Water Diversions from several locations in the Moffat Collection System (July 1, 2018 to September 30, 2018).



Note: No diverstions from Meadow Creek or Trail Creek to Little Cabin Creek during this time frame .

Attachment 3(b) – Daily Denver Water Diversions from several locations in the Moffat Collection System (July 1, 2018 to September 30, 2018).

Date	Jones Pass	Vasquez Creek	St. Louis Creek to Elk Creek	Little Vasquez, Cooper Creeks	Meadow Creek Direct	Meadow Creek Storage Release	Trail Creek to Little Cabin Creek	North Ranch to Buck Creek	Fraser River and Jim Creek	East Portal Moffat Tunnel
7/1/2018	33	30	41	20	0	0	0	23	14	156
7/2/2018	33	26	36	21	0	0	0	21	13	145
7/3/2018	31	24	40	14	0	0	0	20	13	137
7/4/2018	30	20	36	18	0	0	0	18	12	130
7/5/2018	19	25	36	15	0	0	0	18	12	116
7/6/2018	31	6	43	8	0	0	0	18	12	111
7/7/2018	30	18	39	5	0	0	0	17	11	117
7/8/2018	30	18	32	11	0	0	0	16	11	113
7/9/2018	30	16	34	8	0	0	0	14	11	108
7/10/2018	30	14	29	11	0	0	0	14	10	103
7/11/2018	14	23	29	8	0	0	0	13	10	90
7/12/2018	25	13	29	8	0	0	0	13	10	98
7/13/2018	11	12	36	11	0	0	0	13	10	87
7/14/2018	17	21	27	8	0	0	0	11	9	90
7/15/2018	17	23	27	7	0	0	0	11	9	89
7/16/2018	10	24	26	5	0	0	0	11	9	78
7/17/2018	13	21	20	11	0	0	0	10	9	75
7/18/2018	15	19	15	14	0	0	0	9	8	74
7/19/2018	13	20	11	15	0	0	0	8	8	69
7/20/2018	10	20	14	5	0	0	0	8	8	59
7/21/2018	15	12	22	3	0	0	0	8	8	62
7/22/2018	15	13	16	9	0	0	0	8	8	61
7/23/2018	14	15	20	4	0	0	0	8	8	63
7/24/2018	14	11	19	6	0	0	0	8	8	58
7/25/2018	14	10	20	3	0	0	0	8	8	55
7/26/2018	14	9	15	7	0	0	0	8	8	53
7/27/2018	6	15	17	5	0	0	0	7	8	46
7/28/2018	11	13	15	3	0	0	0	7	8	50
7/29/2018	9	14	15	5	0	0	0	7	7	47
7/30/2018	6	11	12	8	0	0	0	7	7	41
7/31/2018	9	11	9	8	0	0	0	6	7	41
8/1/2018	4	16	9	5	0	0	0	6	7	40
8/2/2018	8	10	11	4	0	0	0	6	7	38
8/3/2018	8	9	12	3	0	0	0	6	8	42
8/4/2018	10	8	16	8	0	0	0	6	7	46
8/5/2018	13	8	19	6	0	0	0	6	7	50
8/6/2018	8	8	13	5	0	0	0	6	7	39

Attachment 3(b) – Daily Denver Water Diversions from several locations in the Moffat Collection System (July 1, 2018 to September 30, 2018).

Date	Jones Pass	Vasquez Creek	St. Louis Creek to Elk Creek	Little Vasquez, Cooper Creeks	Meadow Creek Direct	Meadow Creek Storage Release	Trail Creek to Little Cabin Creek	North Ranch to Buck Creek	Fraser River and Jim Creek	East Portal Moffat Tunnel
8/7/2018	8	6	10	5	0	0	0	5	7	35
8/8/2018	8	6	10	4	0	0	0	5	6	33
8/9/2018	8	6	10	3	0	0	0	4	6	32
8/10/2018	8	6	10	2	0	0	0	4	6	31
8/11/2018	7	6	6	4	0	0	0	4	6	29
8/12/2018	7	6	6	3	0	0	0	4	6	28
8/13/2018	7	6	2	4	0	0	0	4	6	26
8/14/2018	7	6	6	1	0	0	0	4	6	27
8/15/2018	7	7	2	5	0	23	0	0	5	37
8/16/2018	7	7	2	4	0	28	0	2	5	51
8/17/2018	7	7	2	4	0	28	0	2	6	51
8/18/2018	7	7	6	4	0	28	0	5	6	54
8/19/2018	7	7	6	2	0	28	0	5	6	53
8/20/2018	7	6	7	1	0	28	0	5	6	51
8/21/2018	7	8	9	2	0	28	0	5	6	56
8/22/2018	7	8	9	2	0	28	0	5	6	57
8/23/2018	7	5	7	2	0	28	0	4	6	52
8/24/2018	7	6	8	1	0	28	0	4	6	50
8/25/2018	6	5	5	2	0	28	0	2	5	48
8/26/2018	6	5	5	2	0	28	0	2	5	48
8/27/2018	7	5	4	4	0	28	0	2	5	51
8/28/2018	6	5	5	2	0	28	0	2	5	47
8/29/2018	5	5	3	4	0	28	0	2	5	46
8/30/2018	5	5	3	3	0	28	0	2	5	45
8/31/2018	5	5	3	3	0	28	0	2	5	45
9/1/2018	5	6	5	2	0	28	0	2	5	46
9/2/2018	6	5	5	1	0	28	0	2	5	45
9/3/2018	5	5	2	3	0	28	0	2	5	44
9/4/2018	5	5	3	3	0	28	0	2	1	42
9/5/2018	7	5	3	4	0	27	0	3	0	47
9/6/2018	7	6	7	2	0	28	0	2	0	48
9/7/2018	6	6	4	2	0	28	0	2	0	43
9/8/2018	5	5	3	1	0	28	0	2	0	42
9/9/2018	5	5	3	1	0	28	0	2	0	42
9/10/2018	5	5	3	1	0	28	0	2	0	41
9/11/2018	4	5	0	2	0	28	0	2	0	40
9/12/2018	4	5	0	2	0	28	0	2	0	39
9/13/2018	4	5	1	2	0	28	0	2	0	39

Attachment 3(b) – Daily Denver Water Diversions from several locations in the Moffat Collection System (July 1, 2018 to September 30, 2018).

Date	Jones Pass	Vasquez Creek	St. Louis Creek to Elk Creek	Little Vasquez, Cooper Creeks	Meadow Creek Direct	Meadow Creek Storage Release	Trail Creek to Little Cabin Creek	North Ranch to Buck Creek	Fraser River and Jim Creek	East Portal Moffat Tunnel
9/14/2018	4	5	1	2	0	28	0	2	0	39
9/15/2018	4	5	1	2	0	28	0	3	0	39
9/16/2018	3	7	0	4	0	28	0	3	0	41
9/17/2018	4	8	1	2	0	28	0	4	0	43
9/18/2018	3	9	1	2	0	28	0	4	0	43
9/19/2018	3	9	1	2	0	28	0	4	0	44
9/20/2018	4	8	1	4	0	28	0	5	0	45
9/21/2018	4	8	1	3	0	28	0	5	0	44
9/22/2018	3	8	2	4	0	28	0	5	0	44
9/23/2018	3	8	2	3	0	28	0	5	0	44
9/24/2018	4	8	1	4	0	28	0	5	0	46
9/25/2018	4	8	2	4	0	28	0	5	0	46
9/26/2018	4	8	2	3	0	28	0	5	0	44
9/27/2018	4	8	2	1	0	28	0	5	0	43
9/28/2018	4	8	0	5	0	28	0	5	0	42
9/29/2018	3	8	2	2	0	28	0	5	0	43
9/30/2018	3	8	2	3	0	28	0	5	0	43