The State of the Streams

A Summary of 2022

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Ennis, Montana – June 1st, 2023

MADISON CONSERVATION DISTRICT

Executive Summary

Our Summer 2022 season was a huge success. 2022 Big Sky Watershed Corps (BSWC) Member Raeya Gordon led the weekly data collection efforts with our team of volunteers and facilitated our third annual *Tributary Blitz* event. She has also been leading our efforts to increase data quality and transparency with the help of this year's BSWC Member, Sudha Petluri, and our long-time partner and local expert, Dr. Adam Sigler with Montana State University – Extension Water Quality. 2023 BSWC Member Sudha Petluri will be leading this upcoming year's Madison Stream Team Monitoring Efforts.

2021 yielded a drought of unprecedented magnitude. In Madison County we received some of the lowest rainfall on record during early and mid-summer. As a case in point, we received 0.78 inches of rain in Ennis for June and July, but the long-term average is 3.50 inches. This was the lowest recorded in the past 75 years of National Weather Service data collection. We also experienced one of the hottest summers on record. For instance, June and July yielded 30 days with temperatures above 90º F in Ennis. Since 1988, the average has been 10 days and the prior record was 21 days.

2022 brought some welcomed relief from these severe drought conditions and 2023 is off to a good start for making more progress in alleviating these drought conditions. 2022 total precipitation in May well exceeded the average of 1.91 inches at a rate of 4.12 inches, nearing the all-time record for May 1980 of 4.51 inches, while the total for June and July was near average at 2.74 inches. 2023 is also off to a good start with the first three months (January-March) of total precipitation being above the average of 1.45 at a rate of 2.26.

South West Montana faced significant challenges in 2021 related to drought. Working lands suffered due to lack of water and forage for livestock for the second growing season in a row. The 2021 fire season was severe, with multiple wildfires in the area and an abundance of smoke. Additionally, many streams exhibited record low flows and higher temperatures than normal. By August 2021, most of our county was categorized as D4 "Exceptional Drought," the nation's highest form of drought (Image 1).

Fortunately, August 2021 was cooler and wetter than normal, but the subsequent winter and spring did not lift us from drought conditions. Although April-June of 2022 was much cooler and wetter than normal, we remained in D2 "Severe Drought" due to the residual effects of the prior two years of drought. The soils were very thirsty continued to soak up the abundance of short-term water in our local ecosystem. Fortunately, this trend of above average precipitation continued for the rest of the 2022 calendar year and we ended the year with 3 inches more of precipitation than the yearly average for the Madison Valley. This brought most of Madison County's drought level down to D0 "Abnormally Dry." The most recent map released on May 23, 2023, has most of the county listed as "Drought Neutral," while half of the Madison Valley remains listed as D0 "Abnormally Dry."

As with most things, long-term trends are the true indicator of environmental conditions and trends. We'll continue to work with stakeholders to monitor the health of our streams, improve Best Management Practices, and restore sections of water that have the potential to improve long-term drought conditions in our area. Thanks for your continued support.

Kind regards, Colin Threlkeld and Sudha Petluri.

Chapters and Sections

Chapter 1

Annual MST Monitoring Data, Visualization, and Interpretation

The 2022 Sampling season consisted of two major parts: the regular monitoring of South Meadow Creek, Moore Creek, and Jack Creek (Map 1), and the third annual Tributary Blitz of sixteen important streams. The Madison Stream Team volunteers were essential in completing these monitoring efforts, and without them the season would not have been possible.

In the last year MCD has made efforts to look through historic data, do quality control, and work towards making all MST data publicly available on Montana State University's Data Hub. Additionally, MCD has been uploading current and historic MST data to MT-eWQX, the Department of Environmental Quality's database. Dr. Adam Sigler and his team from MSU have provided significant help with both of these efforts. His Guidance and expertise have informed MCD each step of the way. We have also received immense support from Deanna Tarum and Abbie Ebert at MT DEQ, who have been a valuable resource while navigating MT-eWQX. For more information about the MSU Data Hub and MT-eWQX, see Image 2 in the appendix.

Discussion of Parameters

Water quality monitoring is a good avenue for examining stream health and can indicate when something is off balance or needs attention. The scientific terms used to talk about water quality can be difficult to understand and are not always explained in terms of real-world impacts. The Madison Stream Team monitors water quality indicators such as turbidity, pH, conductivity, and Dissolved Oxygen. While having this data is important, it's not nearly as useful without an understanding of what these measurements say about the water.

Turbidity is a measure of how much suspended sediment is in the water. The clearer the water, the lower the turbidity. There is a natural fluctuation of turbidity throughout the season. During high flows and spring runoff, turbidity is high because of sediment running into the stream and powerful flows releasing sediment from the stream bottom and banks. When there is exposed soil without vegetation, it is highly susceptible to erosion and will likely lead to increased turbidity in nearby streams. Too much suspended sediment in streams can be detrimental to fish health for multiple reasons. When the water is turbid, sediment can bury and suffocate fish eggs and larvae, make it difficult for fish to find food, and it can clog their gills making it difficult to breathe. High turbidity can also impact aquatic plants by preventing sunlight from reaching the stream bottom, and disrupt irrigation infrastructure by clogging pumps and nozzles

pH is a measurement of a liquid's basic or acidic quality. A pH of 7 is neutral, while a pH of less than seven indicates acidity and higher than 7 indicates a base. Although seven is neutral, there is a range of acceptable pH measurements for healthy streams, and in fact that range can vary depending on the natural conditions of the stream. The acceptable range for pH in streams is considered to be about 6.5-8.5 by the US EPA. A pH measurement outside of this range is an indicator that something is out of balance and it could be due to pollution. pH is important because it determines how soluble nutrients, minerals, and metals are in the water. In more acidic water harmful metals are more soluble and therefore more toxic to organisms living in the stream because they're more easily absorbed. Aquatic organisms have a range of pH that they can withstand, so excessively high or low pH can decrease species diversity. Notably, the scale is logarithmic so an 8 is 10X more basic than a 7.

Conductivity is the ability of water to carry an electrical current. Things that increase this ability are salts, phosphorus, nitrogen, metals etc. We use conductivity as a way to measure the abundance of these dissolved elements in a stream. A high conductivity can indicate pollution from road salt, excessive fertilizer, or runoff from urban landscapes. Conductivity can also change based on water temperature, which is important to remember when interpreting data.

Dissolved Oxygen (DO) is the amount of oxygen dissolved in the water and available to aquatic species. Oxygen enters the water from the air and from aquatic plants. A healthy diversity of stream structure with riffles encourages water and air mixing and increases dissolved oxygen. Aquatic organisms can't survive without dissolved oxygen, so it's important to notice if DO levels are declining. One common cause of low DO is algal blooms. Microorganisms decomposing the algae rapidly consume oxygen and create an imbalance in the system. Algal blooms occur when there are excess nutrients in the water, allowing algae growth to increase rapidly. Another contributing factor is temperature. Warmer water holds less oxygen, and warmer streams are also more susceptible to algal blooms. Dissolved oxygen is extremely important to monitor as it is a good indicator of a stream's ability to support life.

The natural range of each of these water quality measurements can vary depending on geographic area, land use, and the surrounding conditions. With consistent water quality data, trends over time can be monitored. Ideally, remedies can be implemented to address any issues that are identified via monitoring.

*2022 BSWC Member installing staff gauge (Raeya Gordon)

Methods
The regular monitoring of South Meadow Creek, Moore Creek, and Jack Creek included water quality, quantity, and photo monitoring. Several water quality parameters were measured using a multi-meter (pH, conductivity, dissolved oxygen, and temperature). The multi-meter was calibrated the morning before each sampling event and regularly maintained. Two turbidity samples were taken at each site and a turbidity meter was used to take three readings of each sample. The data reported reflects the average of all six readings. Water quantity was estimated using a flow meter. The estimated flow is calculated based on the width of the stream and the depth and water velocity at intervals across the stream channel. The data set, figures, and MST infographic can be found in the appendix at the end of this document.

In addition to regular weekly monitoring, a datalogger located at each sample site collected hourly air temperature, water temperature, and water stage through the sampling season (May-October). The maximum average water temperature from each day was used to visualize stream temperature in relation to a trout threshold. The threshold for water temperature used is 73°F because that is the temperature at which trout experience extreme stress.

Discharge was calculated using several discharge estimates taken during regular monitoring to build a rating curve that calculates discharge based on the stage of the stream as reported by the datalogger at each station. The rating curve was used to calculate hourly discharge based on the hourly stage data. The stage point measurement was used instead of the stage average to stay consistent across monitoring stations because some stations did not report average.

**JCP-SSR data logger monitoring station*

South Meadow Creek, Moore Creek, and Jack Creek

South Meadow Creek: South Meadow Creek begins in the Tobacco Root Mountains and flows easterly to the confluence with Ennis Lake. It has been monitored since 2010 and two sites were included in the 2022 data collection- SM-WEIR and SM-EDC.

SM-EDC experienced the highest temperatures of any site. From mid-July to mid-September the water temperatures were consistently above the 73˚F threshold for trout tolerance (Figure 1). High water temperatures were likely due to high air temperatures, low flows, and lack of vegetation cover. After spring runoff, SM-EDC experienced low flows of 0-1.5cfs throughout the summer (Figure 2). SM-WEIR did not surpass the trout threshold of 73˚F (Figure 3). SM-WEIR is upstream of SM-EDC and has dense vegetation that provides shade and temperature regulation. The SM-WEIR discharge reflects spring runoff and a steep increase in mid-August (Figure 4). The Discharge trend at SM-WEIR does not reflect the trend seen at SM-EDC, likely because South Meadow is used for irrigation and there are several water users between the two sites.

Specific Conductivity, dissolved oxygen, and turbidity were within normal ranges for both SM-EDC and SM-WEIR. SM-EDC had elevated pH readings of 9.17 on August 4th, and 9 on August 19th (Figure 8).

Moore Creek: Moore Creek begins in the southern end of the Tobacco Root Mountains in United States Forest Service public lands and quickly enters private ranchlands. It continues to drop elevation and flow easterly for approximately 10 miles until it runs through the town of Ennis and begins to flow more northerly. Prior to town there is at least one significant natural waterfall, at least two significant in-stream reservoirs, and a large ditch (Valley Garden) that crosses the stream and at times spills irrigation water into the stream. In town, it experiences a mix of high-quality riparian habitat as well as major concrete and metal infrastructure. Downstream of town, it enters a large portion of the greater Madison valley floor and wetland complex prior to connecting with Ennis Lake (Reservoir). It has been monitored since 2010, and two sites were included in the 2022 data collection- MC-RD and MC-HOME.

Both MC-HOME and MC-RD have TruTrackers to monitor temperature and stream discharge hourly. The water temperature at both the MC-HOME and MC-RD remained below the trout threshold of 73˚F (Figures 9 & 11). The discharge at both sites peaked on May 30th and October 23rd (Figures 10 & 12). This could be due to a precipitation event, or changes in waterflow related to irrigation.

MC-HOME showed slightly elevated turbidity readings at the beginning of June, which coincides with runoff. Conductivity and pH were within normal ranges for both monitoring locations (Table 2). Dissolved Oxygen concentrations were slightly low at MC-Home on June 30th, July 15th, and August 4th, and at MC-RD on August 4th.

Jack Creek: Jack Creek originates in the high country between two units of National Wilderness. From within the boundaries of an area of major human development (Big Sky and Moonlight

Area), it flows westerly through the Madison Range, multiple canyons and a significant gravel road prior to spilling onto the Madison Valley floor. There are a number of diversions and at least one spring that influences the creek prior to its confluence with the Madison River. Jack Creek has been included in the monitoring program since 2006 and 3 sites were included in the 2022 data collection- JCP-SSR, JCP-CYN, and JCP-JCR.

The 2022-2023 season was the third season that winter baseflow sampling was conducted on Jack Creek, where samples are collected and analyzed for nitrate-nitrite (Figure 25). The purpose of this analysis is to evaluate whether the development patterns in the headwaters of Jack Creek are impacting the stream. During winter baseflow conditions, nitrate-nitrite samples are collected to provide a snapshot of conditions on Jack Creek without outside environmental inputs from things such as runoff. This year samples were only collected at the JCP-SSR site due to complications. Nitrate-nitrate levels were lower than last year (Figure 28).

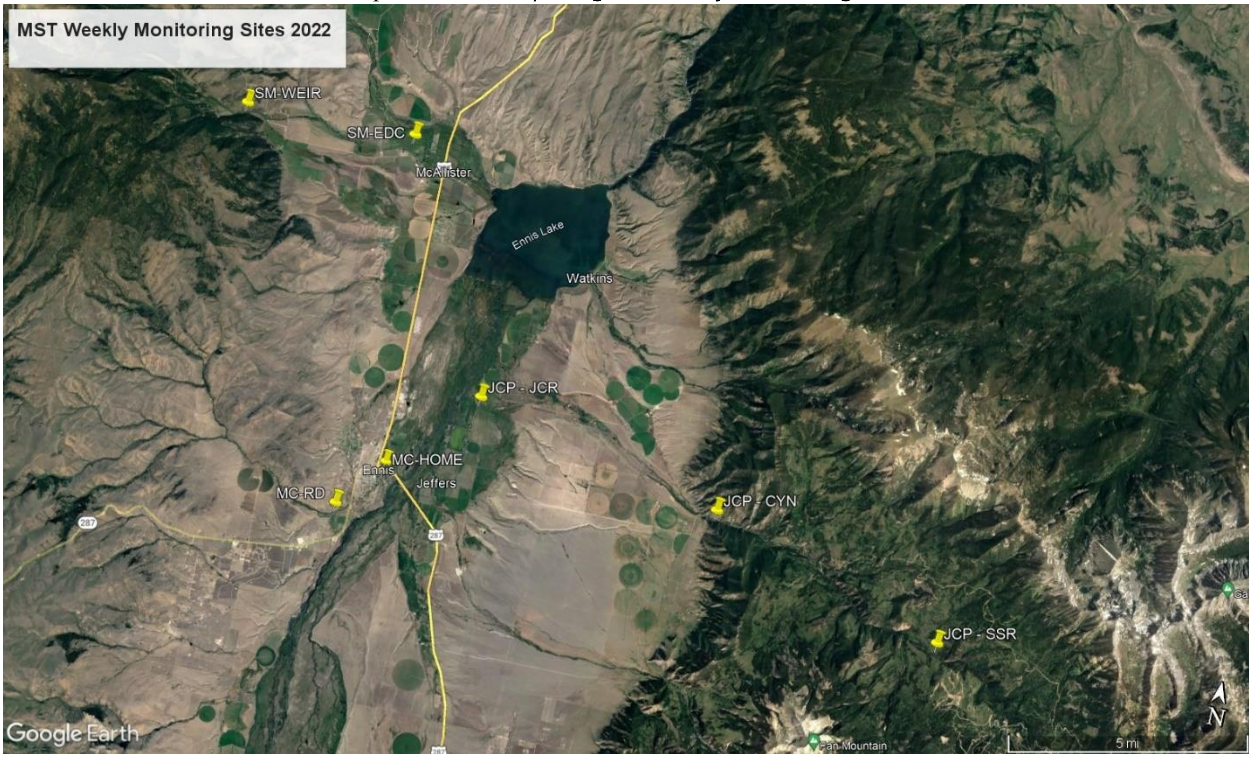
Data from the TruTracker stationed at JCP-JCR was collected in 2022. Despite high temperatures throughout June and July, the water temperature at JCP-JCR never exceeded the trout threshold and remained steady throughout the season (Figure 17). Discharge peaks at the beginning of June with Spring Runoff, then steadily decreases throughout the rest of the season (Figure 18). The discharge at JCP-JCR was greater this year than in the previous 3 years.

Campbell Scientific dataloggers were stationed at JCP-CYN and JCP-SSR and data was collected in 2022. Temperature and discharge measurements were collected by hand on a regular basis, in addition to hourly data from a data logger. This data has not been analyzed since 2018, but will be analyzed in 2023.

The JCP-SSR station was removed in October 2022 due to bridge reconstruction at the site. A datalogger will not be installed at this site in 2023 due to pending construction of the bridge.

Turbidity, conductivity, and dissolved oxygen readings for all three sites were within a normal range. JCP-JCR had an elevated pH reading of 8.65 on July 14th, and JCP-CYN had a slightly elevated pH reading of 8.59 on September 21st (Figure 22).

Map 1. Locations for regular weekly monitoring 2022



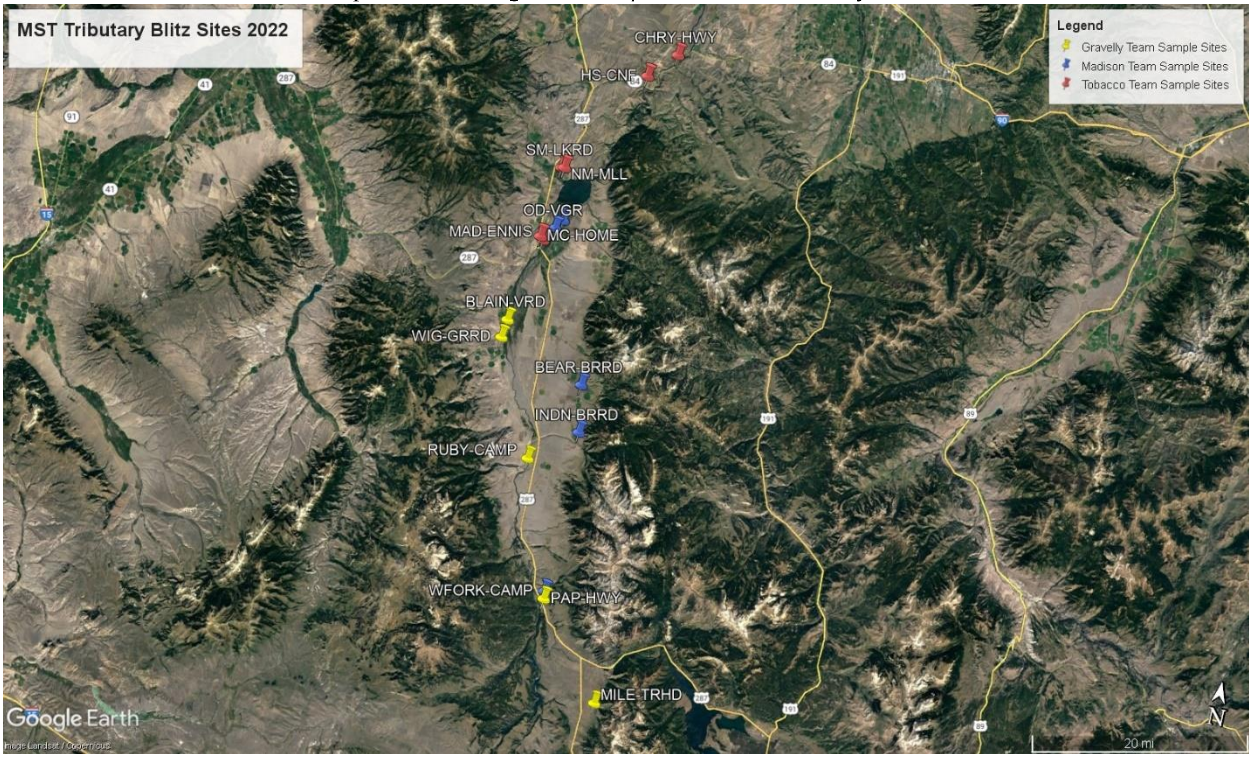
Tributary Blitz

The third annual Tributary Blitz was held August 24th, 2022. The Blitz is a one-day sampling event during which volunteers monitor sixteen important tributaries of the Madison River (Map 2). This is a form of Synoptic Sampling, which takes place over a short window of time and removes the variables that change day to day. From one day to the next the conditions in a river can change dramatically, depending on weather and temperature. By completing all of the sampling in one day, the blitz provides a representative snapshot of the Madison Tributaries. As the Tributary Blitz continues over time, we will be able to use these snapshots to evaluate trends and monitor change.

The 2022 event was made possible by the participation of the Madison Stream Team volunteers. A group of ten participants gathered early that morning and reviewed sampling methods before splitting into three teams, each tackling tributaries originating in a different mountain range: Tobacco, Madison, and Gravelly. Each team used a multi-meter to monitor water temperature, Dissolved Oxygen, conductivity, and pH. Turbidity samples were taken at each site and MCD's turbidity meter was used to evaluate the samples in their modest lab. Several nutrient samples were taken at each site and sent to Energy Labs for analysis. These samples included Total Persulfate Nitrogen (TPN), Nitrate-Nitrite, Total Phosphorus, and Dissolved Orthophosphate, all of which are important indicators of water quality. Hot Springs Creek and Moore Creek had Total Phosphorus levels above the DEQ recognized threshold of 0.03 mg/L (Figure 26). Blaine Spring Creek, Moore Creek, South Meadow Creek, and Wigwam Creek had Total Nitrogen levels above the DEQ recognized threshold of 0.30mg/L (Figure 23). Because there is natural variation of the nutrient levels in water, the Total Phosphorus and Total Nitrogen thresholds were determined based on eco-region and time of year. The thresholds used in this report reflect the Middle Rockies eco-region from July 1st to September 30th, as determined by DEQ.

*MST volunteer and MCD staff member (Colin Threlkeld) collecting water samples during 2022 Tributary Blitz.

Map 2. Monitoring Location for the 2022 Tributary Blitz.



Chapter 2

Stream Restoration

<u>*Lower Jack Creek*</u>

The Madison Conservation District completed this project in partnership with Trout Unlimited, Trout and Salmon Foundation, Northwestern Energy, Montana Watershed Coordination Council, R.E. Miller and Sons, Montana Conservation Corps, Montana DNRC, and Montana Fish, Wildlife and Parks (FWP). It would not have been possible without the landowners, The Madison Valley Ranch and Fasules Family. The final planting of the Lower Jack Creek restoration project was completed in 2020, after several years of geoengineering.

In 2021 regular monitoring and watering of the site was done to insure successful establishment of the Cottonwood and Willow plantings. Every cottonwood planted in 2020 has survived, and watering will continue if drought persists. Due to extreme drought and low flows, many of the willow cuttings had difficulty accessing water and had a low success rate. In the coming season we will continue to control weeds, browsing pressure, and support the establishment of woody riparian vegetation through reinforcing wildlife exclusionary fencing.

*Large bend on part of Lower Jack Creek Restoration. Note the spillover of high water onto banks that soaked into the riparian area and provided water for soil recharge and establishing plants during the project's first year.

*Cottonwood planting from 2020 at the Lower Jack Creek Restoration in 2021

Lower Moore Creek

This project seeks to restore degraded and historically channelized conditions on a segment of lower Moore Creek near the confluence with the Madison River (Ennis Lake/Res.). The work will improve near-stream and instream wildlife habitat by re-connecting with and utilizing historic stream channels and re-establishing floodplain connectivity, sinuosity, a riparian plant community, and reducing sediment inputs by stabilizing eroding banks and preventing further stream incision and erosion. It will also help mediate elevated stream temperatures recognized by the Department of Environmental Quality's Total Maximum Daily Load reports (TMDL). Notably, this site is located in valuable wildlife habitat given its proximity to the confluence with the mainstem, and geographic context within the productive and diverse river valley bottom. Species of interest that we would anticipate benefitting from this project include resident and migratory avian species (Trumpeter Swan, Wilson's Snipe, etc.), amphibians, and reptiles.

In addition, the landowners are concurrently working with NRCS and MCD to generate riparian pastures to ensure high quality management of cattle within sensitive streamside habitat on their property.

Due to increased interest from partners and adjacent landowners, this project now encompasses a 4.4 miles long stretch of Lower Moore Creek from the town of Ennis to the Valley Garden Ranch property. Here, the MCD facilitated project will link up with another restoration project also in the planning phases to achieve restoration of Lower Moore Creek from the town of Ennis to its confluence with the mainstem of the Madison River at Fletcher Channel. This project will be a large multi-phase undertaking over the coming years and will require the cooperation of many partner agencies/organizations and landowners. We hope to begin phase 1 of this project in 2023/2024.

*Satellite imagery clearly indicates the channelized section of this valuable tributary stream.

Chapter 3

Natural Streambed and Land Preservation Act (The 310 Law) Projects

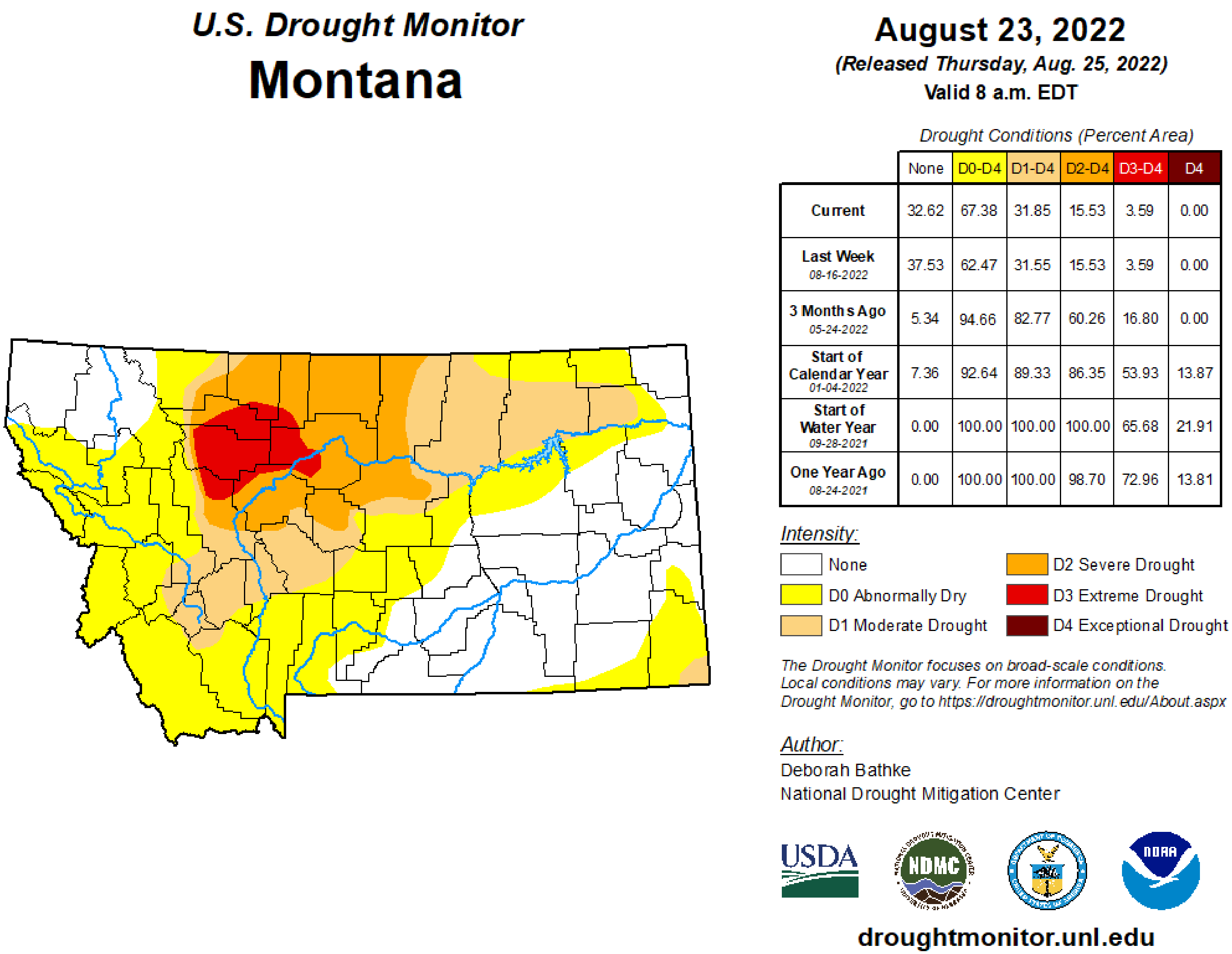
Since 1975, conservation districts in the state of Montana have been championing the Natural Streambed and Land Preservation Act, commonly known as “310 Law”. The associated permitting process is required when any private party is proposing to conduct work in or near a perennial stream. These are unique opportunities to be afield with local landowners to discuss the proposed work and potential impacts. The state’s Fisheries Biologist is also present for most field inspections and recommendations to the MCD Board of Supervisors. Our board is comprised of 7 members of the public, and they make the final decision on whether a permit is jurisdictional, approved, modified, or denied. About 80% of the permitted projects were “other” (culverts, bridges, restoration, etc.), and the remaining were related to “agricultural projects” (points of diversion, etc.) (Table 1). The updated list of 310 permits in 2022 is on the Madison Conservation District website.

Table 1. 310 permit applications in 2022.

Decision/Type	AG RELATED	FORESTRY RELATED	MINING RELATED	OTHER (URBAN, UTILITIES, ROADS)	TOTAL
Approved as Proposed	4			14	18
Approved with Modifications				7	7
Denied	1			1	2
Withdrawn/Not a Project/Canceled				3	3
Emergencies				2	2
Complaints	1				1
Arbitrations					0
Total	6	0	0	27	33

Appendix

Image 1. Drought monitor map from August 23rd, 2022, the week of the 2022 Tributary Blitz.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	32.62	67.38	31.85	15.53	3.59	0.00
Last Week 08-16-2022	37.53	62.47	31.55	15.53	3.59	0.00
3 Months Ago 05-24-2022	5.34	94.66	82.77	60.26	16.80	0.00
Start of Calendar Year 01-04-2022	7.36	92.64	89.33	86.35	53.93	13.87
Start of Water Year 09-28-2021	0.00	100.00	100.00	100.00	65.68	21.91
One Year Ago 08-24-2021	0.00	100.00	100.00	98.70	72.96	13.81

Image 2. MT-eWQX and Data Hub Summary.

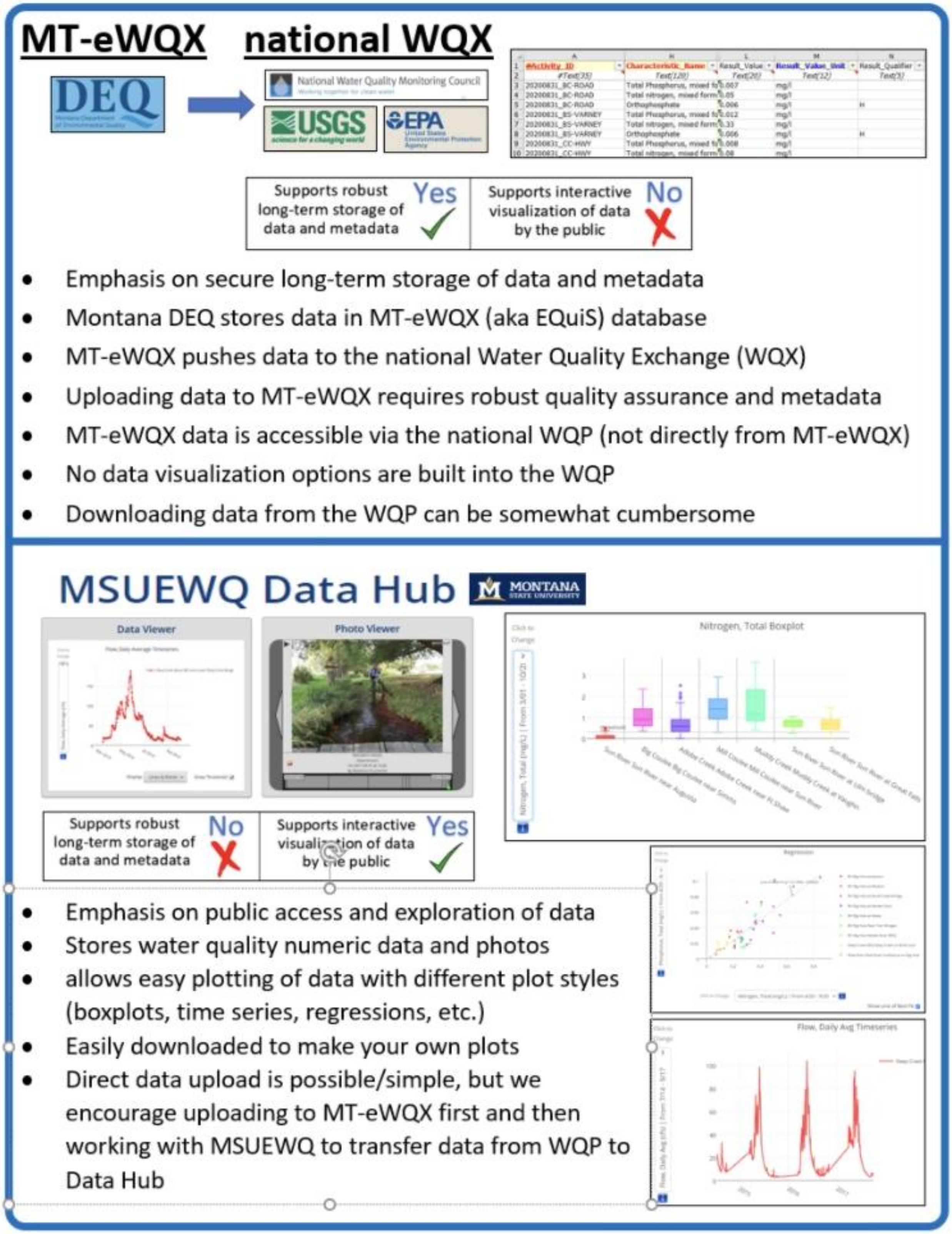


Table 2. Field data from regularly weekly monitoring in 2022

Station	Date	Air Temp (°C)	Water Temp (°C)	Specific Cond. (µs/cm^2)	Electrical Cond. (µs/cm)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	pH	Visual Turbidity	Turbidity Average (NTU)	Stream Flow (cfs)	Stage (ft)	Cloud Cover	Precip	Past Precip
SM-EDC	5/10/2022	9.5	11.24	165	122	113.1	10.36	7.8	turbid	N/A	1.9488	N/A	25-75%	none	light
SM-WEIR	5/10/2022	8.5	5.66	123	77	112.6	11.81	7.22	slight	N/A	4.606	N/A	5-25%	none	light
MC-HOME	5/11/2022	14	9.55	264	186	96.8	9.25	8.28	turbid	3.66	2.824	N/A	5-75%	none	none
JCP-JCR	5/13/2022	14.5	6.84	276	181	83.7	8.49	8.22	turbid	7.56	32.223	1.15	25-75%	none	light
JCP-CYN	5/13/2022	10	5.05	209	130	77.7	8.26	8.1	turbid	10.17	35.752	N/A	25-75%	none	light
MC-RD	5/16/2022	14	7.91	256	173	76.2	7.51	7.7	turbid	5.67	2.7906	1.45	25-75%	none	light
SM-EDC	5/25/2022	17	10.28	114	82	113.6	10.66	8.53	slight	1.24	0.155	0.2	25-75%	none	none
MC-HOME	5/25/2022	20	12.13	307	232	114	10.07	8.42	turbid	6.31	1.107	N/A	25-75%	none	none
MC-RD	5/25/2022	21	10.19	306	219	109.9	10.32	8.2	turbid	5.08	0.601	0.95	25-75%	none	none
SM-WEIR	5/25/2022	14	4.38	92	57	102.9	11.16	7.87	slight	1.36	5.157	0.5	25-75%	none	none
MC-HOME	6/2/2022	N/A	12.44	325	179	118.9	10.63	7.92	turbid	17.82	5.312	2.08	25-75%	none	none
MC-HOME	6/9/2022	20	12.75	265	204	100.6	8.95	8.12	turbid	8.52	1.768	1.78	5-25%	none	none
MC-RD	6/9/2022	20	12.54	263	201	100.9	9	8.04	turbid	8.31	1.834	1.28	5-25%	none	none
SM-EDC	6/9/2022	21	9.38	86	60	106.8	10.27	7.95	slight	5.91	8.177	0.62	25-75%	none	none
SM-WEIR	6/9/2022	14.5	4.25	57	34	107.9	11.77	7.78	clear	2.53	26.37	1.45	5-25%	none	none
JCP-JCR	6/17/2022	31	7.55	194	128	105.5	10.48	8.38	opaque	66.57	N/A	2.54	5-75%	none	none
JCP-CYN	6/17/2022	26	5.73	153	97	105.5	10.97	8.22	opaque	48.57	N/A	N/A	5-75%	none	none
SM-EDC	6/23/2022	19	9.66	74	53	105.8	10.08	8.14	slight	4.10	15.521	0.85	<5%	none	none
SM-WEIR	6/23/2022	19	5.92	50	32	102.3	10.7	8.08	slight	2.24	45.622	1.62	<5%	none	none
JCP-CYN	6/30/2022	N/A	5.8	162	104	101.1	10.66	8.49	turbid	7.25			<5%	none	none
MC-RD	6/30/2022	N/A	13.21	336	261	96	8.46	8.48	slight	4.77	0.97	0.88	<5%	none	none
JCP-JCR	6/30/2022	N/A	7.94	181	122	102.4	10.22	8.35	turbid	8.68	119.764	1.9	<5%	none	none

MC-HOME	6/30/2022	N/A	13.02	318	246	89.7	7.49	8.32	slight	5.86	0.483	1.57	<5%	none	none
JCP-JCR	7/14/2022	41	16.11	255	211	122	10.12	8.65	turbid	3.90	48.359	1.45	5-25%	none	light
JCP-SSR	7/14/2022	28	9.98	155	109	106.3	10.14	8.44	clear	2.00	12.414	N/A	5-25%	none	light
JCP-CYN	7/14/2022	32	8.7	186	129	112	10.97	8.4	slight	2.40	75.741	N/A	5-25%	none	light
MC-MCRD	7/15/2022	26.5	15.24	286	233	98.1	8.28	8.34	slight	1.49	0.775	0.82	75-100%	none	moderate
SM-EDC	7/15/2022	26	14.13	97	77	107.3	9.29	8.28	slight	2.90	5.579	0.46	75-100%	none	moderate
MC-HOME	7/15/2022	24	15.67	329	270	88.1	7.73	8.21	turbid	3.82	0.465	1.56	75-100%	none	moderate
SM-WEIR	7/15/2022	28	11.63	66	49	103.7	9.5	8.08	clear	1.26	18.73	1	5-75%	none	moderate
SM-EDC	7/21/2022	29	14.28	95	76	119.5	10.23	8.54	clear	1.69	1.097	0.22	<5%	none	none
MC-MCRD	7/21/2022	33	14.05	360	285	110	9.53	8.44	slight	3.38	0.355	0.68	>5%	none	none
MC-HOME	7/21/2022	30	14.81	322	259	94.6	8.14	8.25	slight	8.39	0.047	N/A	>5%	none	none
SM-WEIR	7/21/2022	27	10.09	65	46	138	13.17	8.01	clear	1.52	13.159	0.82	<5%	none	none
JC-JCR	7/28/2022	32	18.46	260	227	123.4	9.76	8.51	clear	2.35	22.621	1.21	5-25%	none	none
JC-CYN	7/28/2022	25	9.35	199	140	104.6	10.11	8.22	clear	2.42	60.843		<5%	none	none
SM-EDC	8/4/2022	34	19.38	117	104	109.2	8.4	9.17	clear	0.56	N/A	0.06	25-75%	light	none
MC-MCRD	8/4/2022	33	16.12	435	362	94.7	7.72	8.45	clear	1.61	0.304	0.68	25-75%	none	none
SM-WEIR	8/4/2022	N/A	14.5	86	68	96.7	8.25	8.27	clear	1.47	6.887	0.59	25-75%	none	light
MC-HOME	8/4/2022	33	16.52	379	317	83.3	6.8	8.1	turbid	19.62	0	1.34	5-25%	none	none
JC-CYN	8/11/2022	N/A	12.32	202	153	101.3	9.16	8.4	clear	2.41	36.053	N/A	5-25%	none	light
JC-JCR	8/11/2022	N/A	17.02	280	237	114.8	9.36	8.35	clear	1.88	18.028	1.12	5-25%	none	light
JC-SSR	8/11/2022	N/A	10.36	192	138	98.9	9.36	8.15	clear	1.20	3.608	N/A	25-75%	none	light
SM-EDC	8/19/2022	28	16.41	108	90	123.5	10.15	9	clear	0.77	N/A	0.01	<5%	none	none
MC-HOME	8/19/2022	25	14.83	390	314	95.5	8.13	8.14	Slight	2.70	N/A	1.38	<5%	none	none
SM-WEIR	8/19/2022	27	12.85	64	49	102.7	9.14	7.97	clear	1.75	17.55	1.12	5-25%	none	none

MC-MCRD	8/19/2022	27	13.61	438	342	99.8	8.52	N/A	clear	1.37	N/A	0.66	<5%	none	none
JC-CYN	9/14/2022	17	9.5	215	151	105.9	10.08	8.44	clear	0.95	24.192	N/A	25-75%	none	moderate
JC-JCR	9/14/2022	19.5	12.74	294	226	110.2	9.71	8.2	clear	1.94	11.860	1.02	25-75%	none	light
JC-SSR	9/14/2022	14.5	7.73	219	147	102.7	10.21	8.08	clear	2.92	1.774	N/A	75-100%	none	moderate
JC-CYN	9/21/2022	N/A	9.57	206	145	109	10.45	8.59	clear	0.84	21.178	N/A	5-75%	none	none
JC-JCR	9/21/2022	N/A	12.82	285	219	114.8	10.23	8.46	clear	2.13	10.240	1.02	25-75%	none	none
JC-SSR	9/21/2022	16	7.55	208	139	112.1	11.26	8.31	clear	0.83	1.636	N/A	5-25%	none	none
SM-EDC	9/29/2022	22.5	11.31	124	92	114.2	10.53	8.49	clear	0.43	1.041	0.2	75-100%	none	none
MC-MCRD	9/29/2022	22	11.09	442	324	98.8	9.12	8.21	clear	0.28	0.311	0.71	75-100%	none	none
SM-WEIR	9/29/2022	18	8.56	114	79	115.4	11.3	7.78	clear	0.46	3.771	0.36	75-100%	none	none
MC-HOME	9/29/2022	N/A	N/A	N/A	N/A	N/A	N/A	N/A	clear	0.77	0.053	1.42	75-100%	none	none
JC-CYN	10/14/2022	6	N/A	N/A	N/A	N/A	N/A	N/A	clear	0.86	17.546	N/A	<5%	none	none
JC-JCR	10/14/2022	15	N/A	N/A	N/A	N/A	N/A	N/A	clear	1.13	14.336	N/A	<5%	none	none

Figure 1. Daily maximum water and air temperatures in 2022 at SM-EDC

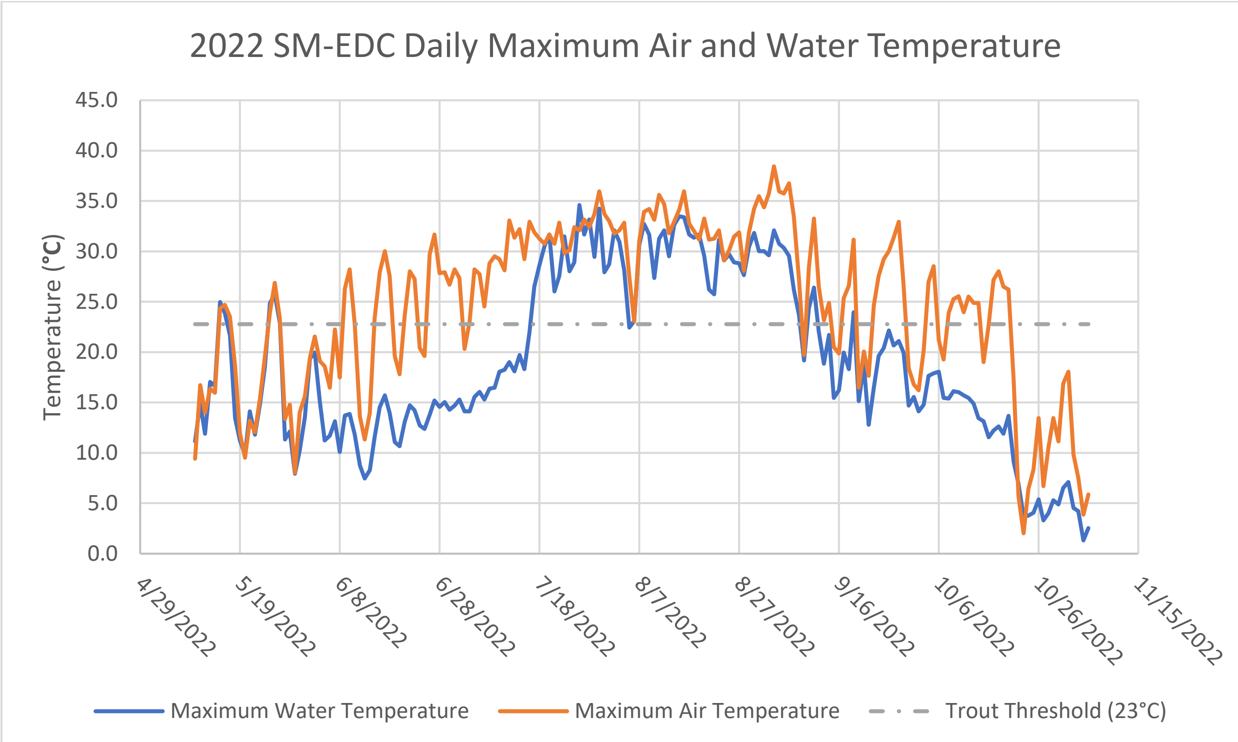


Figure 2. Hourly discharge calculated from TruTrack data and estimates in 2022 at SM-EDC.

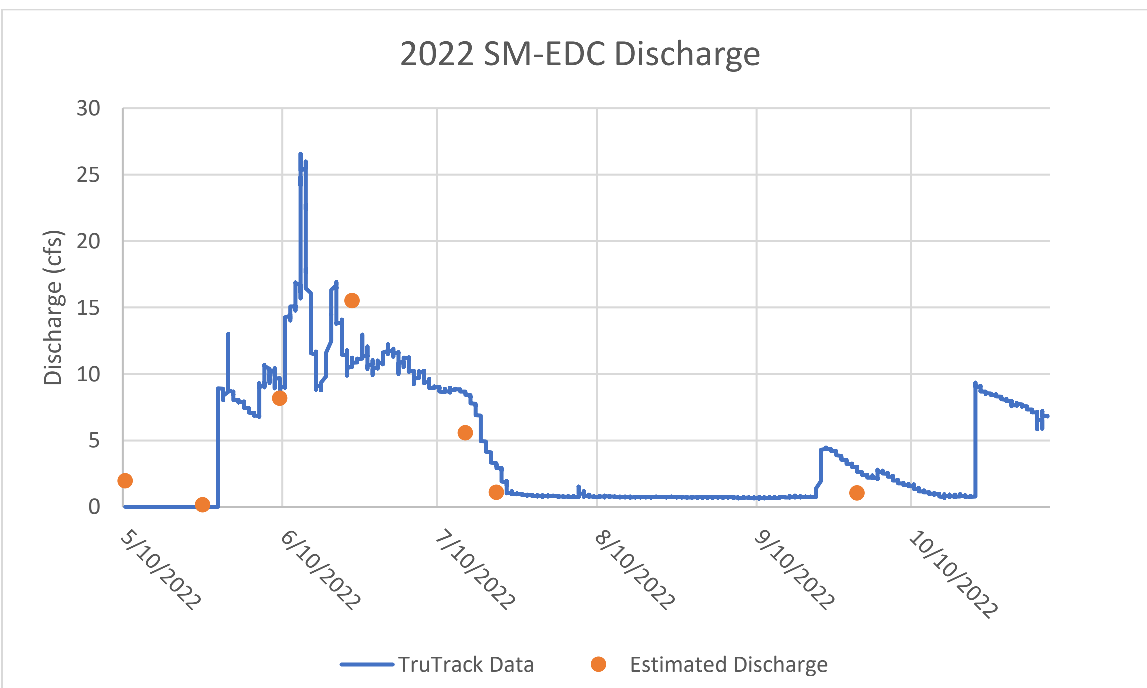


Figure 3. Daily maximum water and air temperatures in 2022 at SM-WEIR.

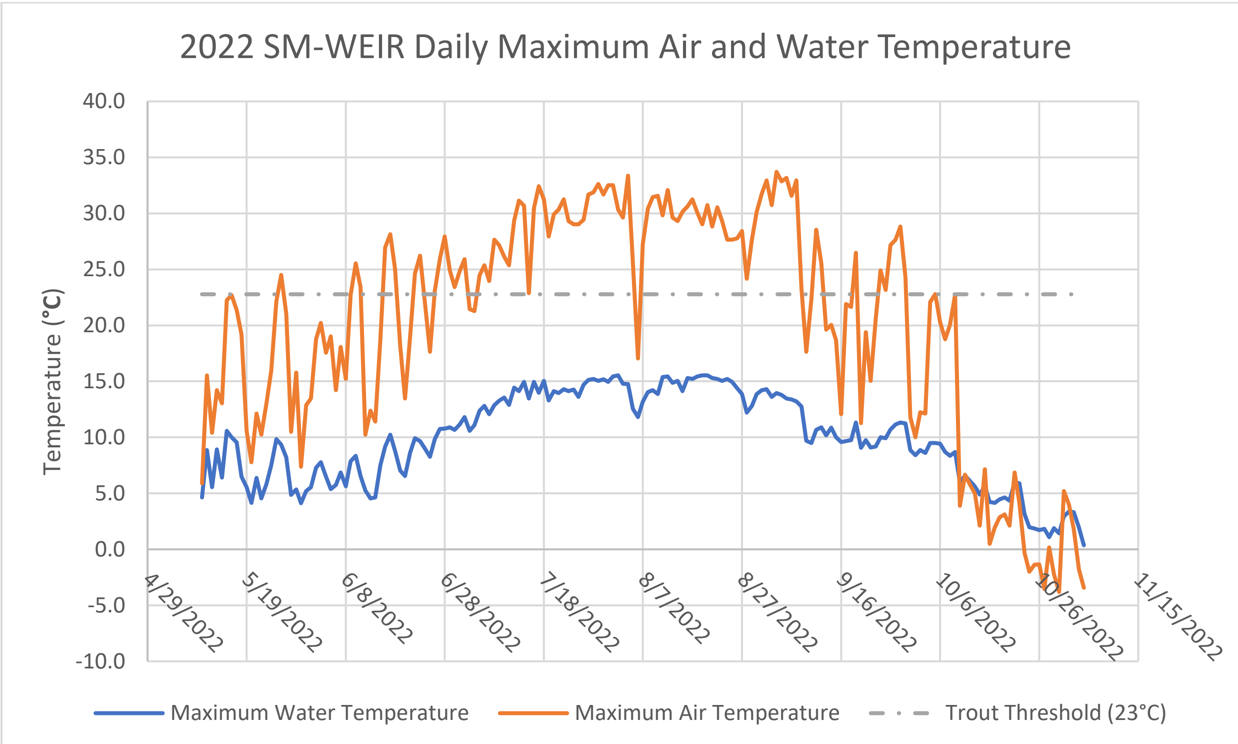


Figure 4. Hourly discharge calculated from TruTrack data and estimates in 2022 at SM-WEIR.

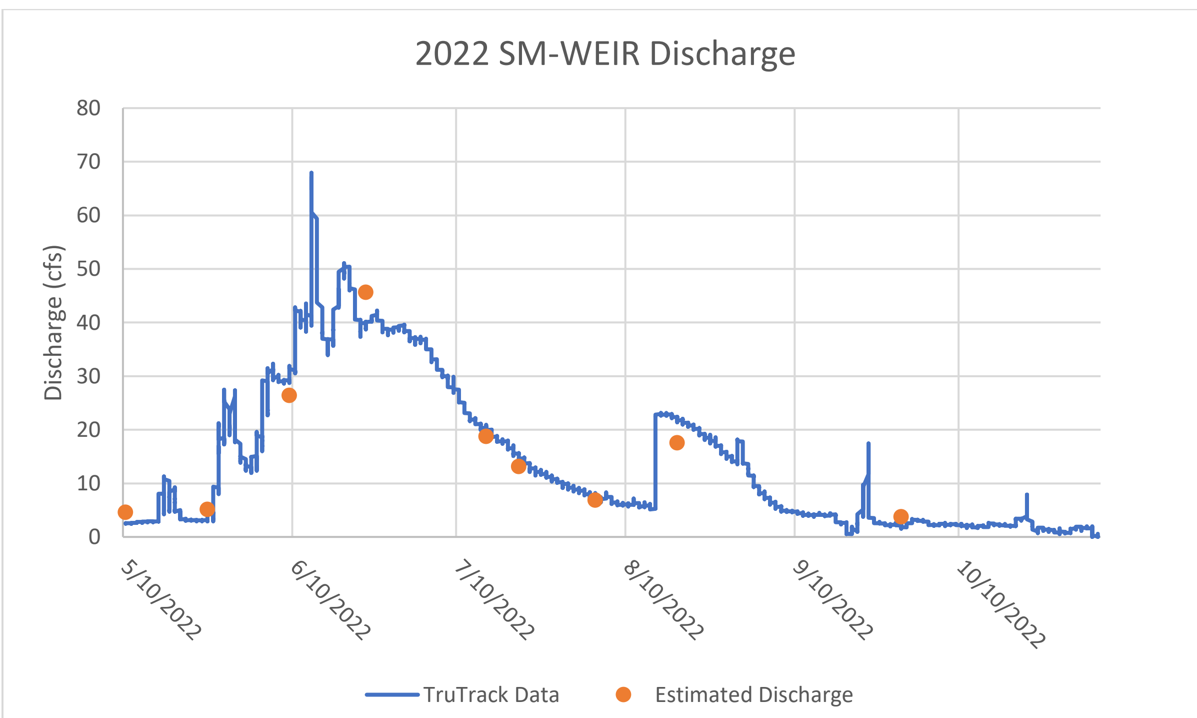


Figure 5. Turbidity data in 2022 at SM-EDC and SM-WEIR.

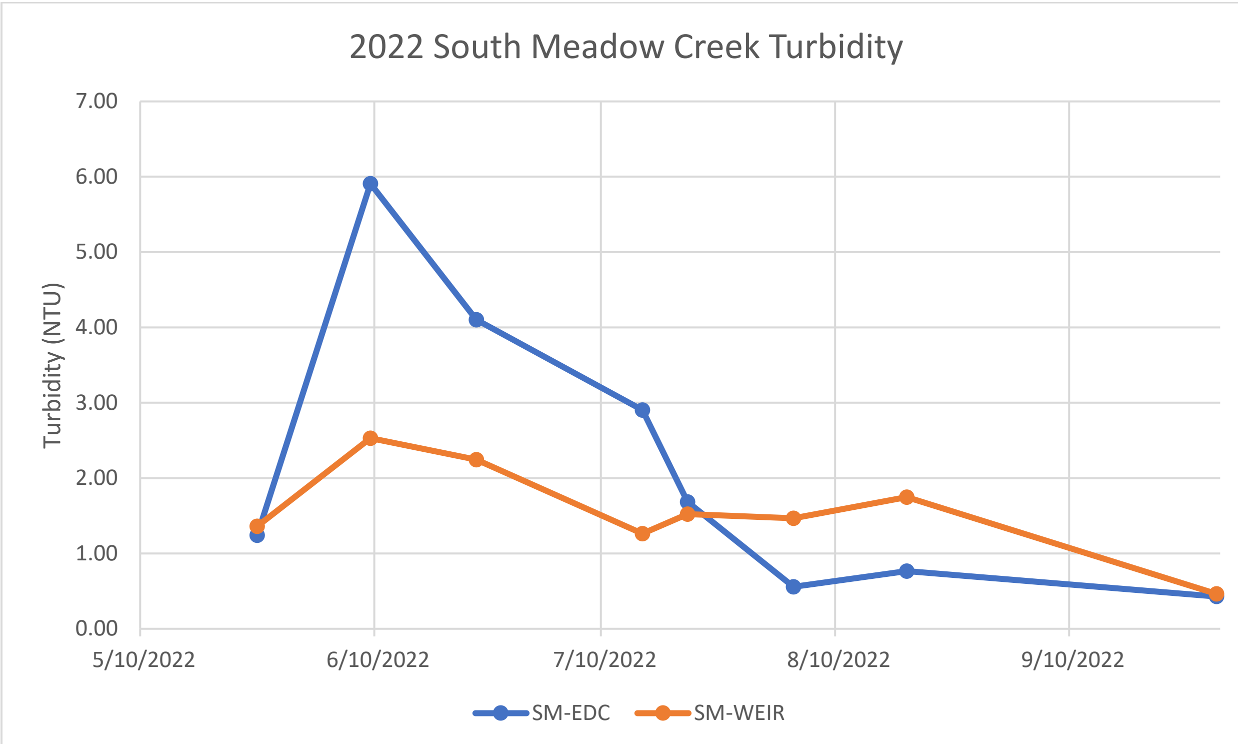


Figure 6. Dissolved Oxygen (%) in 2022 at SM-EDC and SM-WEIR.

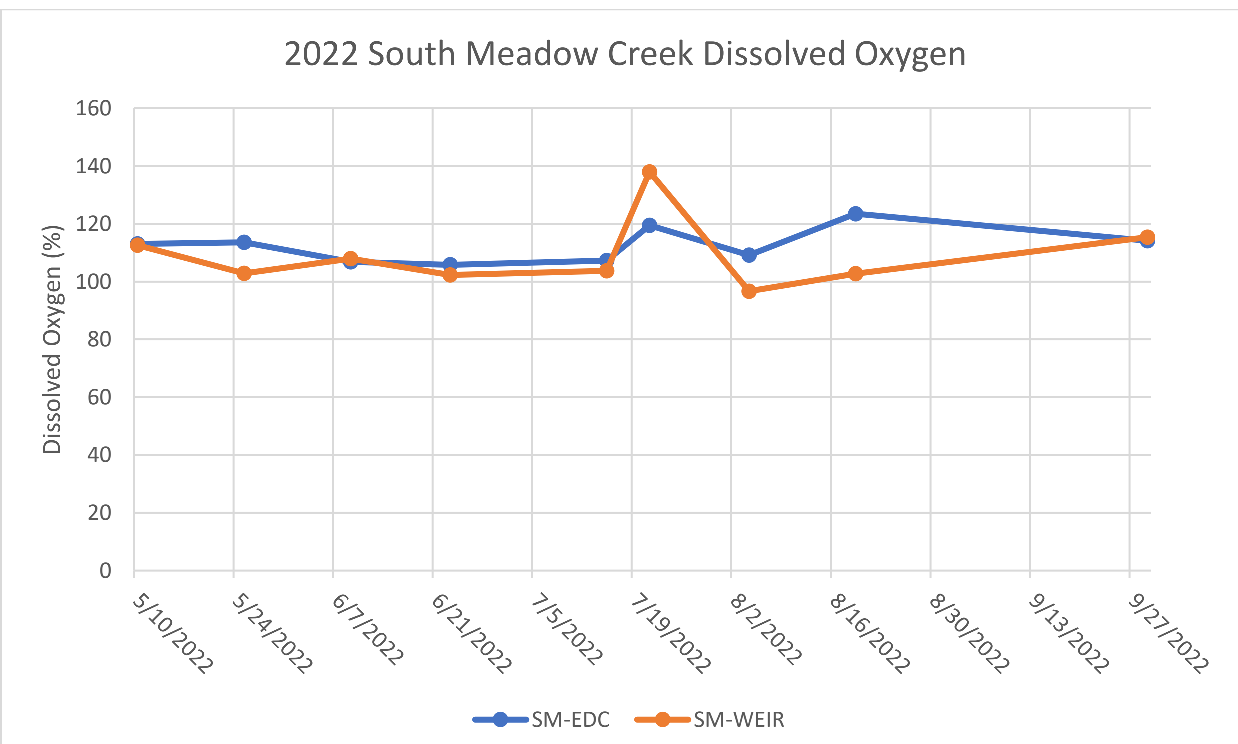


Figure 7. Specific Conductivity in 2022 at SM-EDC and SM-WEIR.

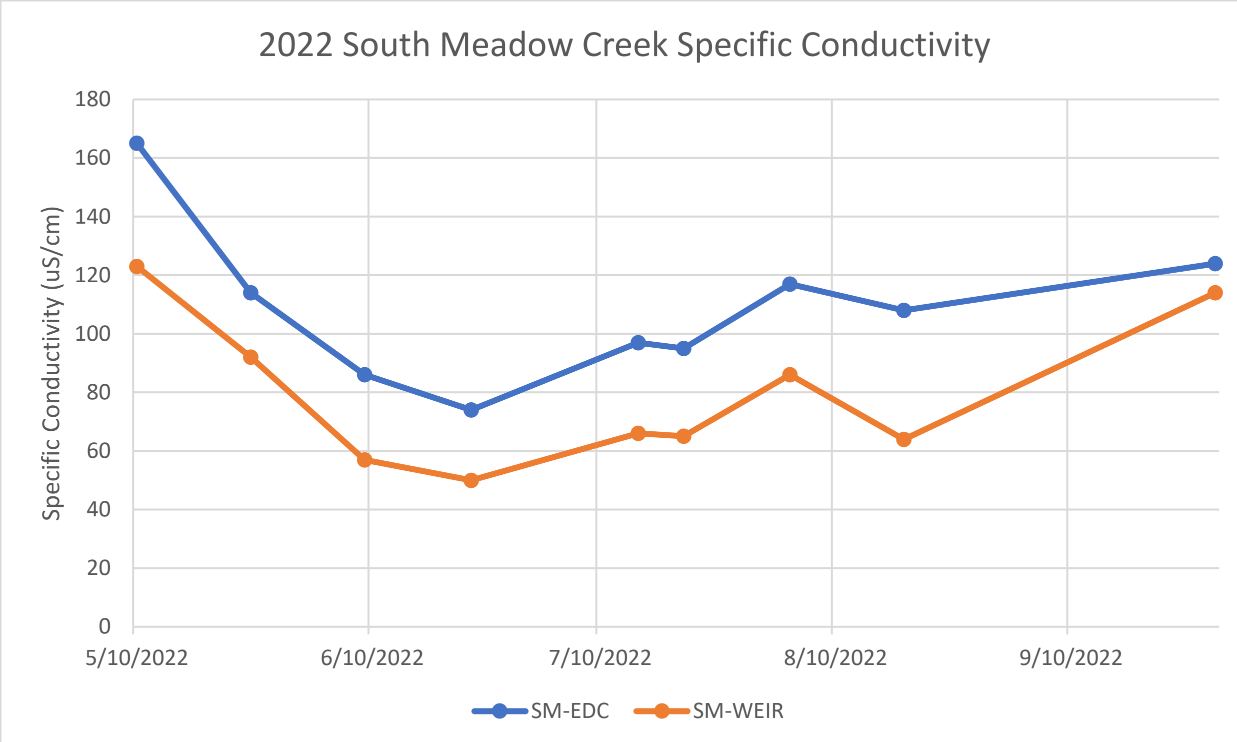


Figure 8. pH data in 2022 at SM-ED and SM-WEIR.

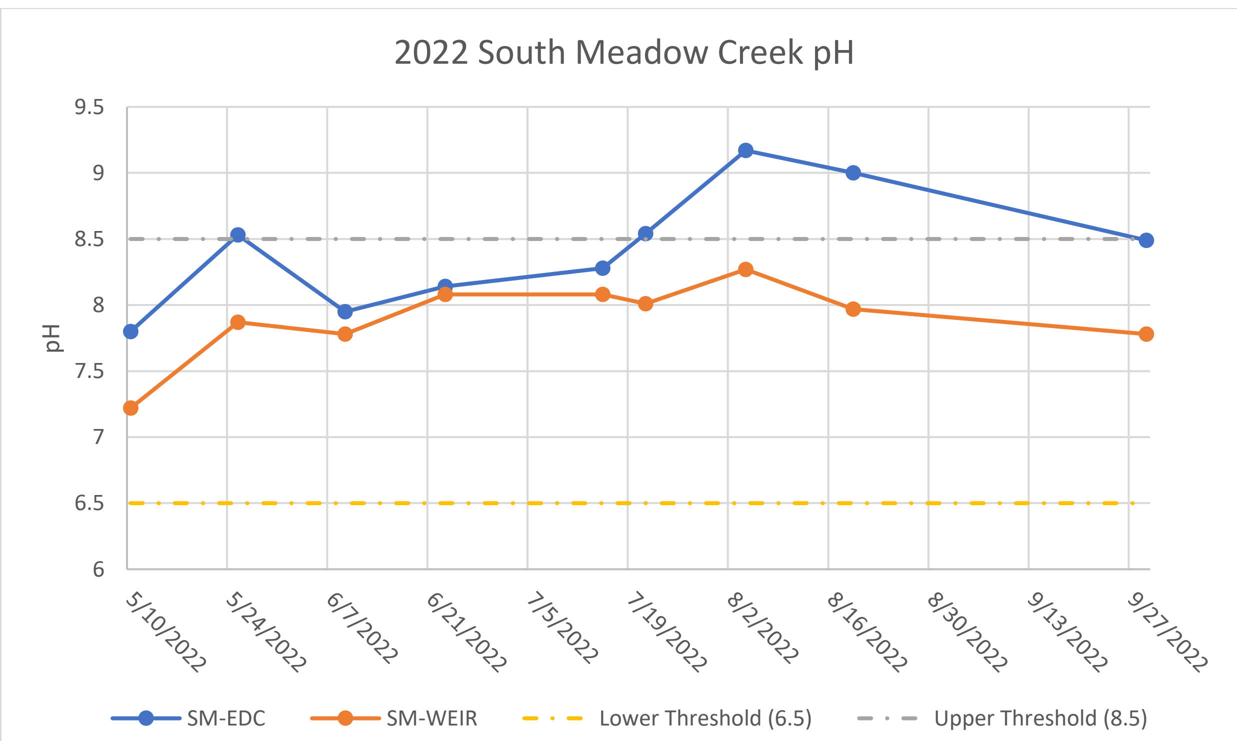


Figure 9. Daily maximum water and air temperatures in 2022 at MC-HOME.

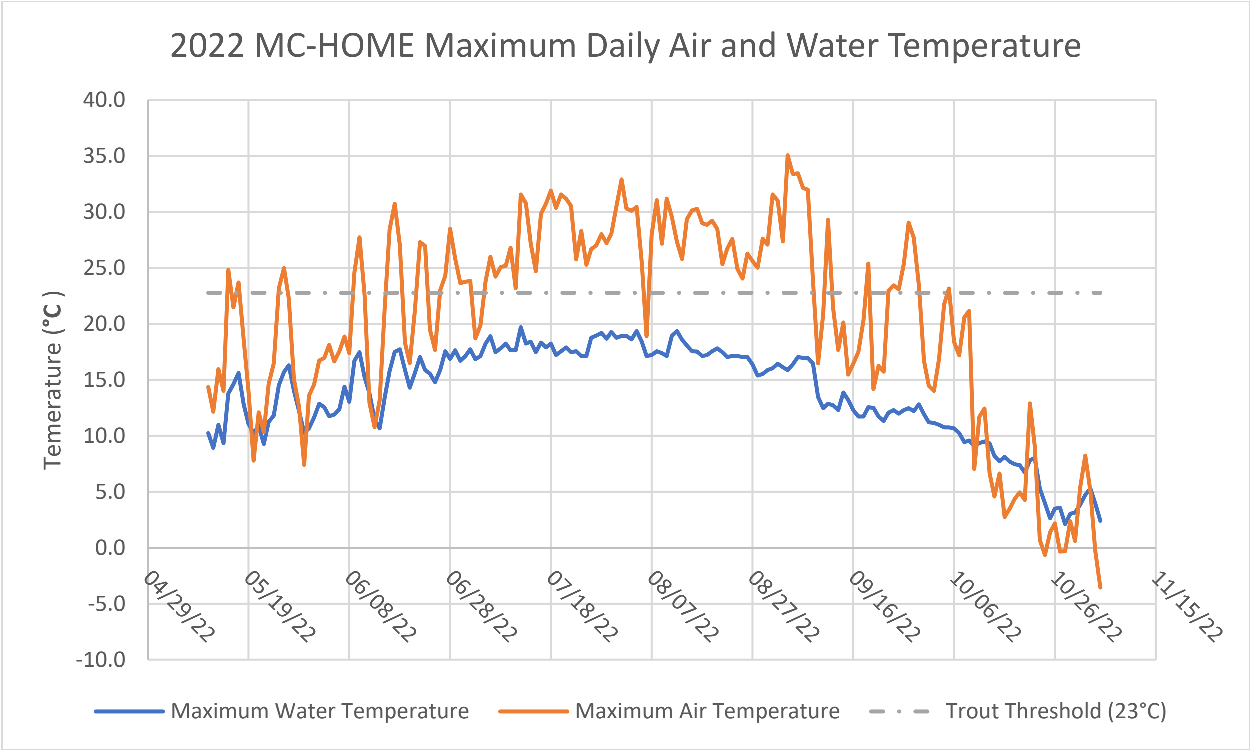


Figure 10. Hourly discharge calculated from TruTrack data and estimates in 2022 at MC-HOME.

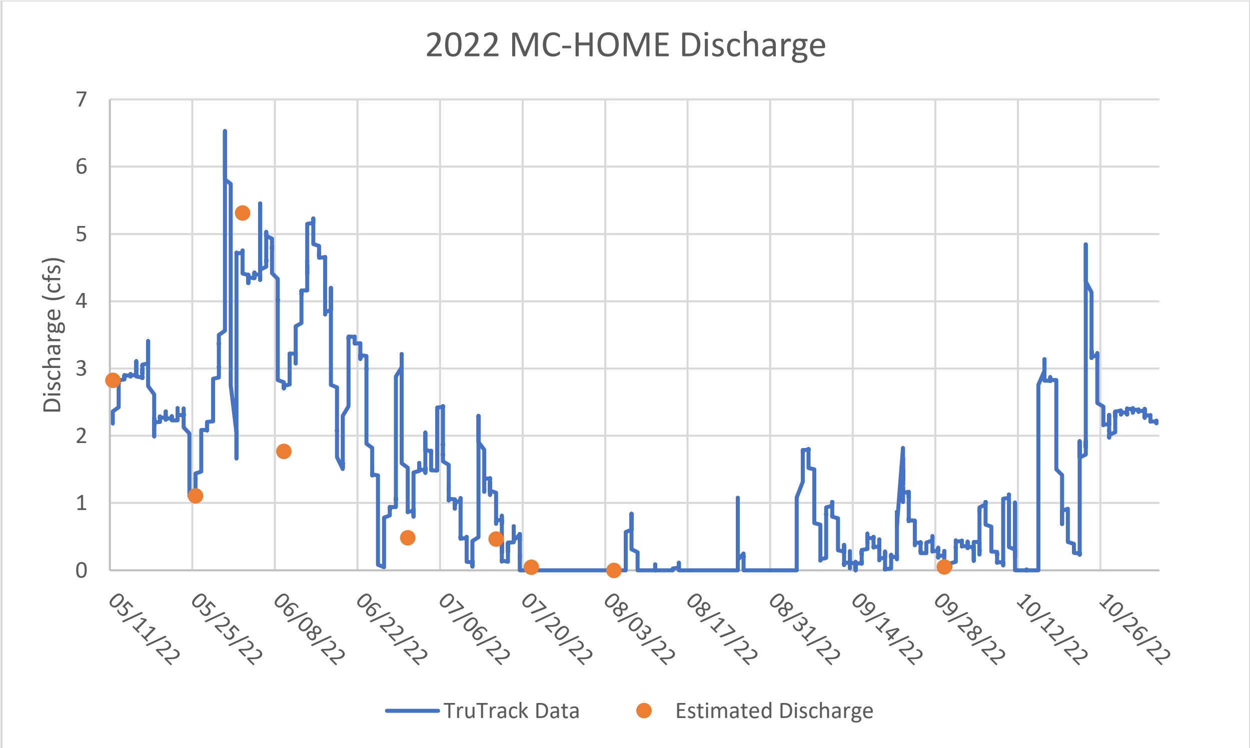


Figure 11. Daily maximum water and air temperatures in 2022 at MC-RD.

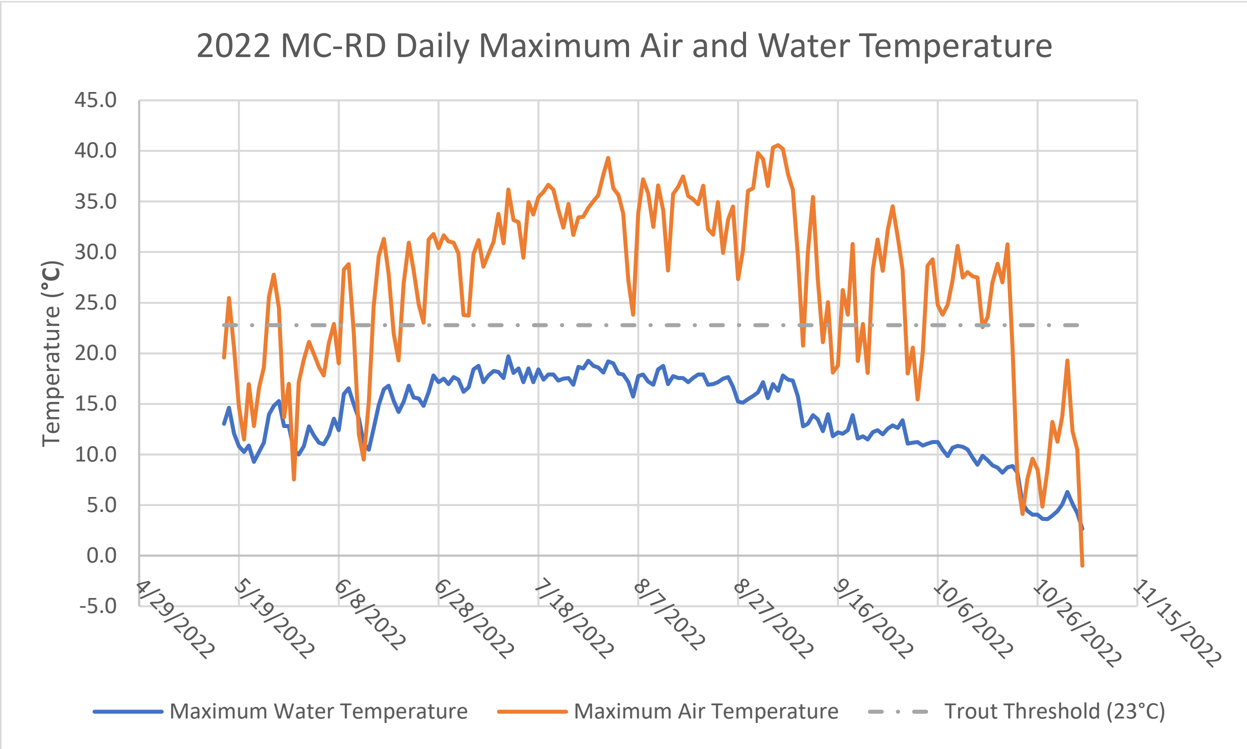


Figure 12. Hourly discharge calculated from TruTrack data and estimates in 2022 at MC-RD

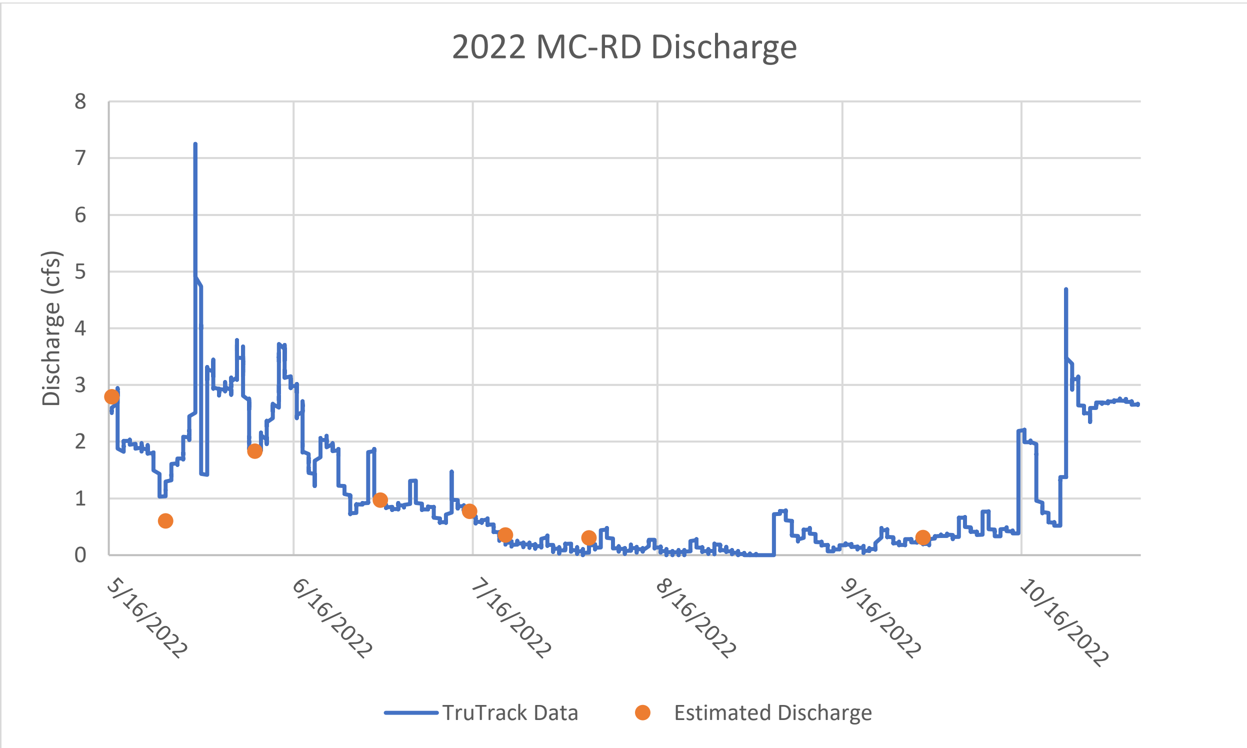


Figure 13. Turbidity data in 2022 at MC-HOME and MC-RD.

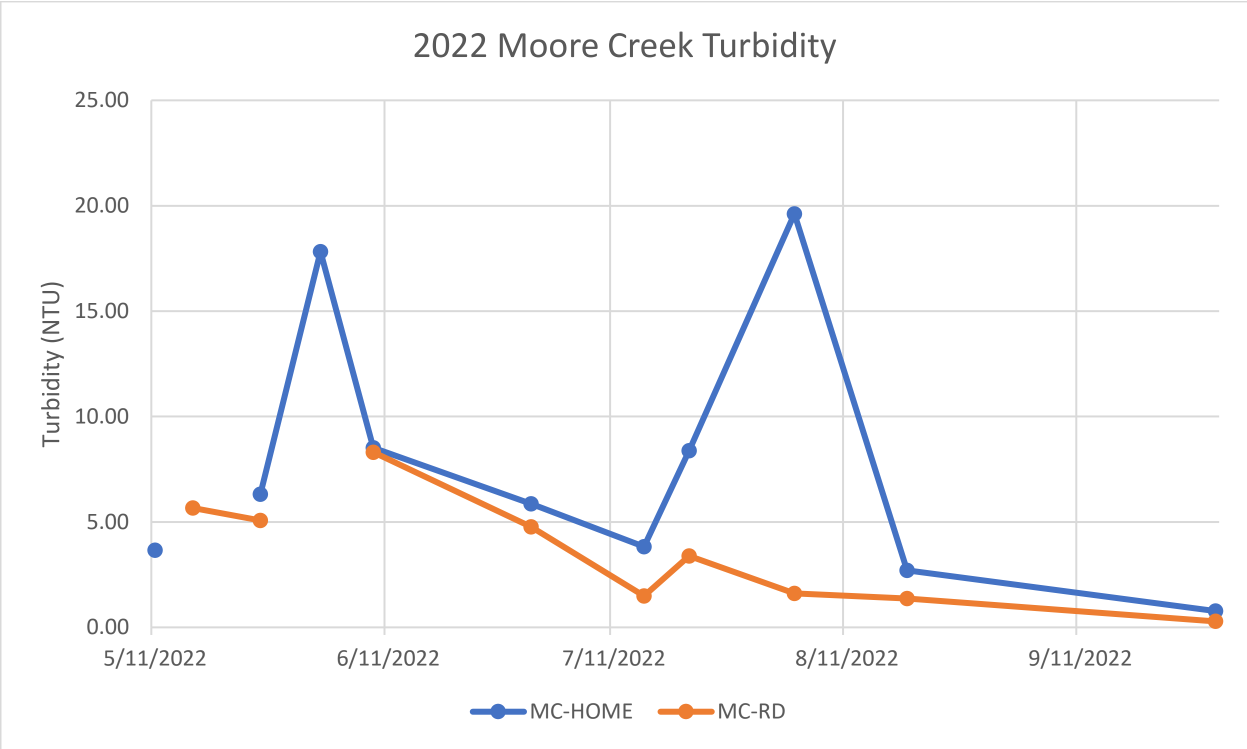


Figure 14. Specific Conductivity data in 2022 at MC-HOME and MC-RD.

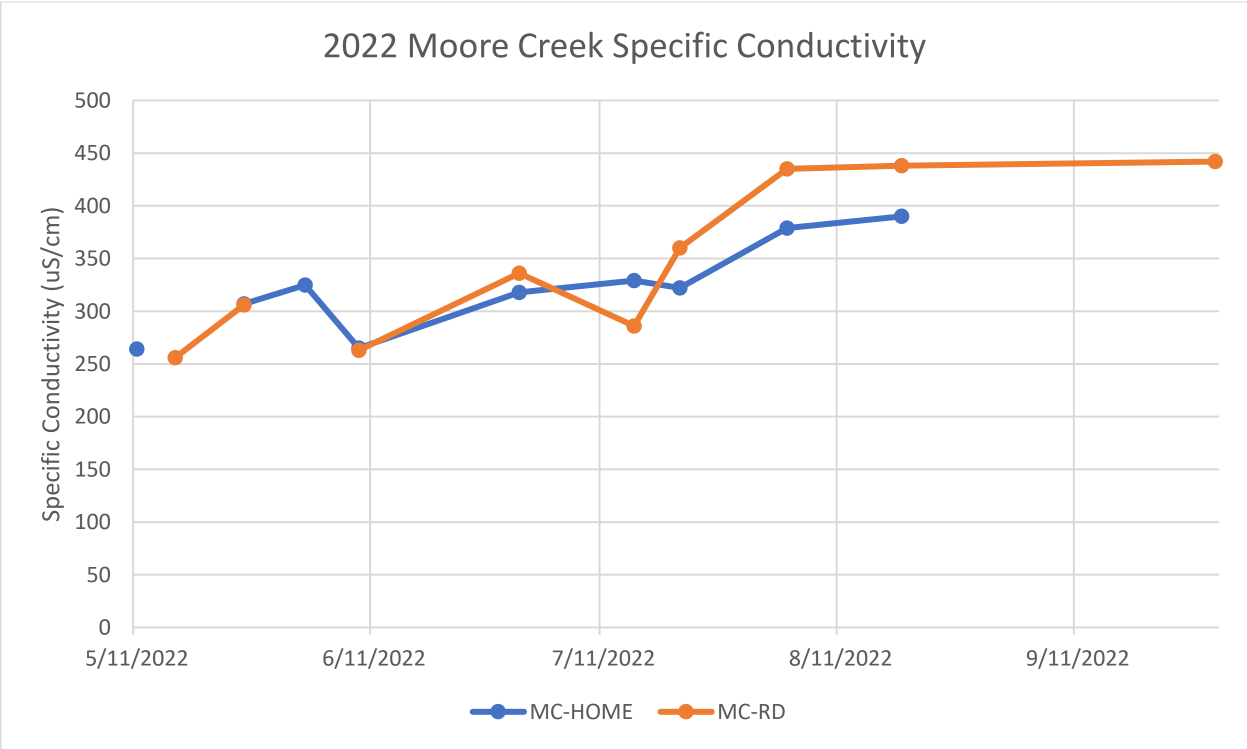


Figure 15. Dissolved Oxygen (%) data in 2022 at MC-HOME and MC-RD.

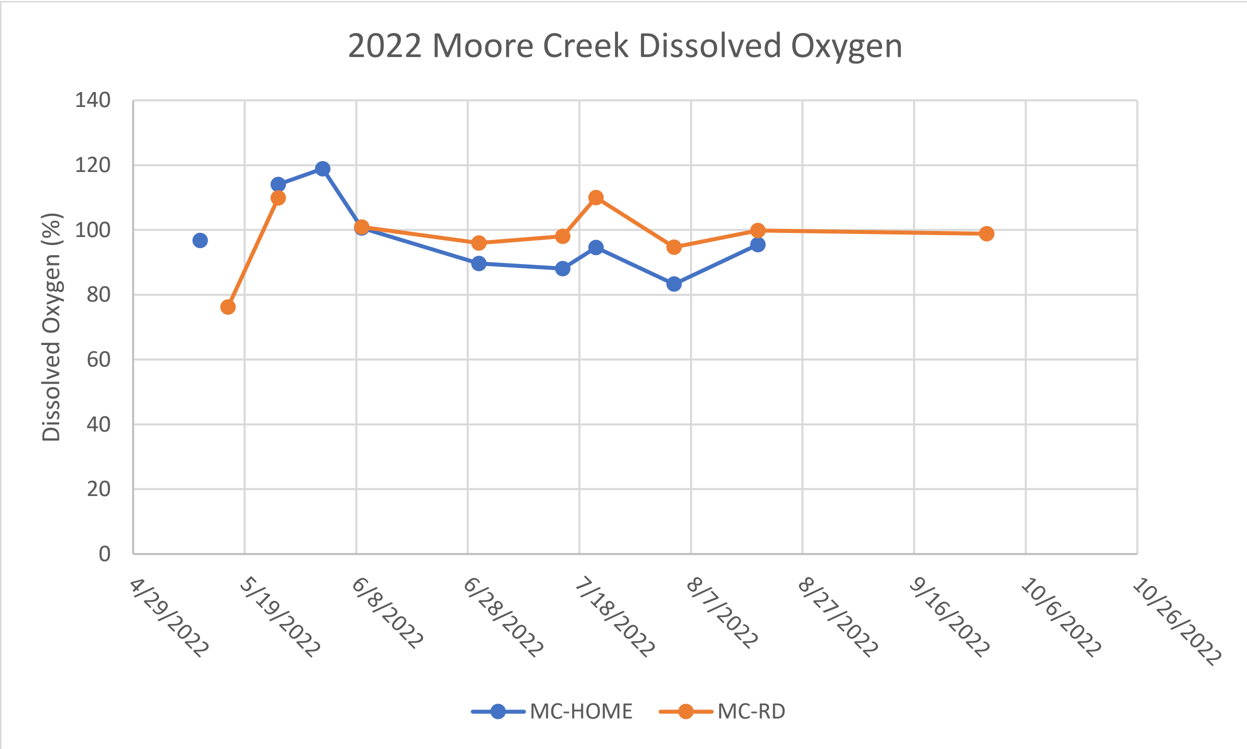


Figure 16. pH data in 2022 at MC-HOME and MC-RD

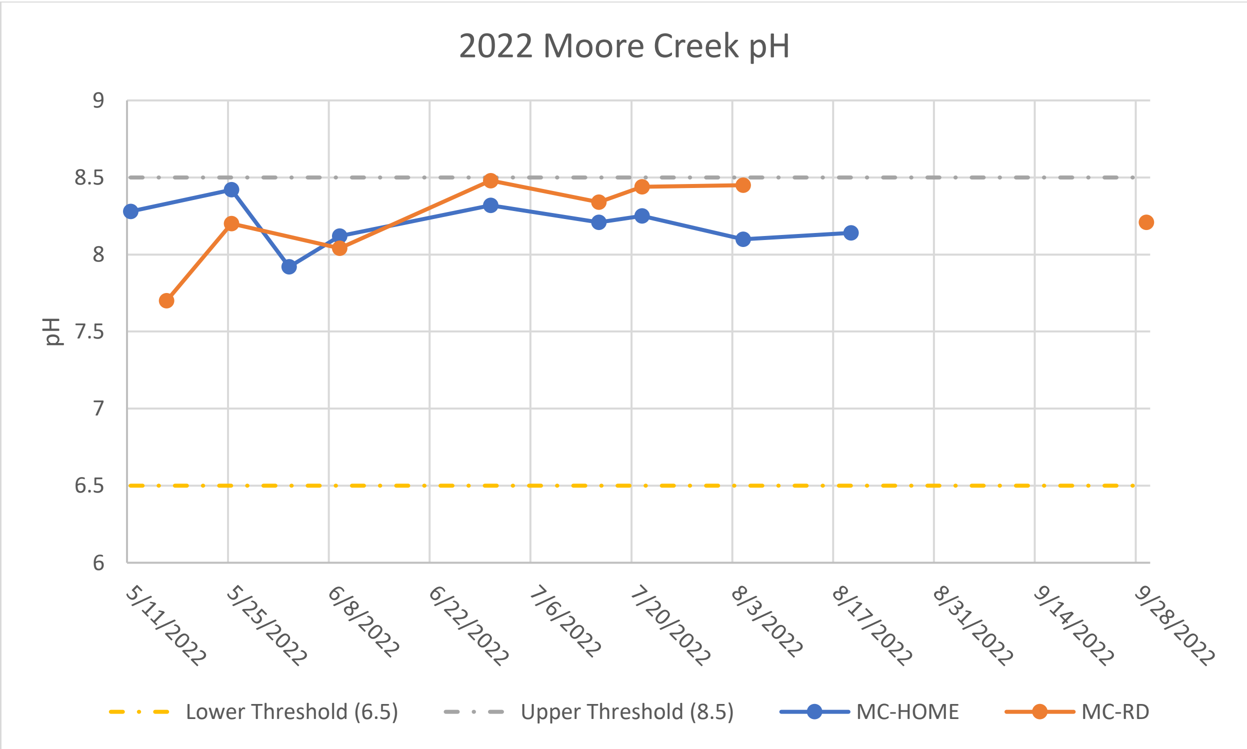


Figure 17. Daily maximum water and air temperatures in 2022 at JCP-JCR

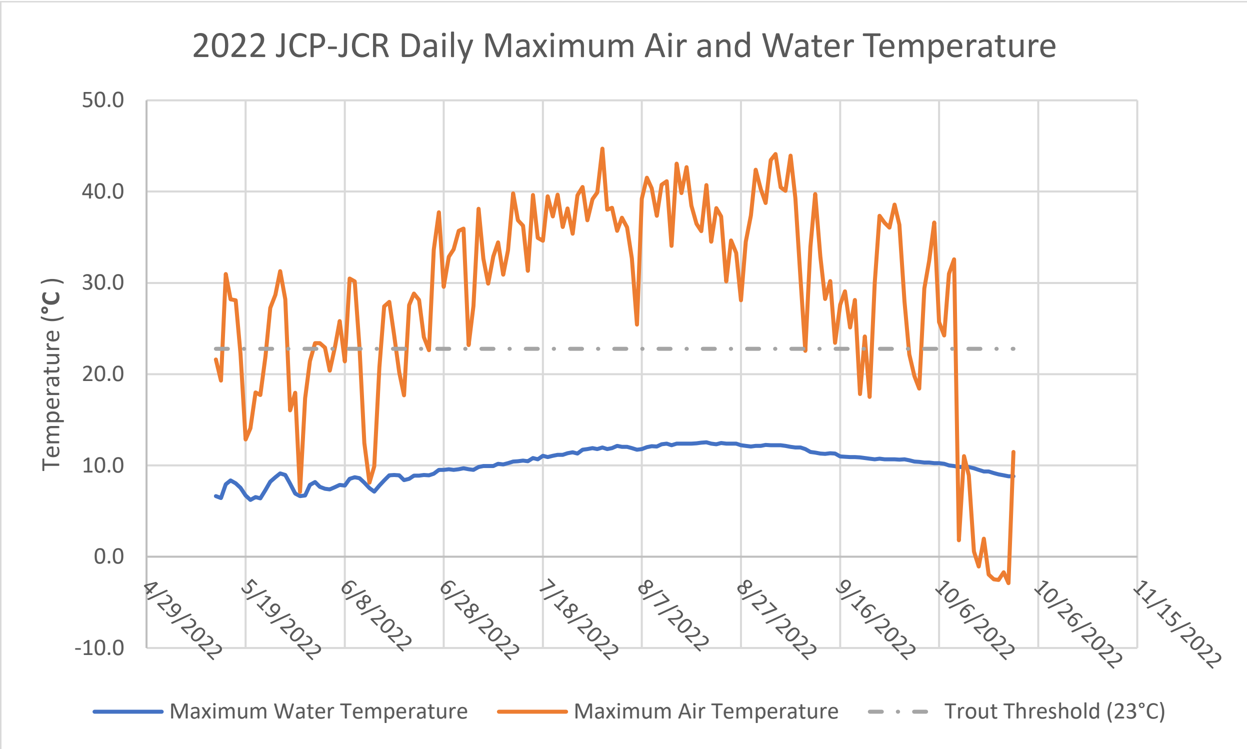


Figure 18. Hourly discharge calculated from TruTrack data and estimates in 2022 at JCP-JCR

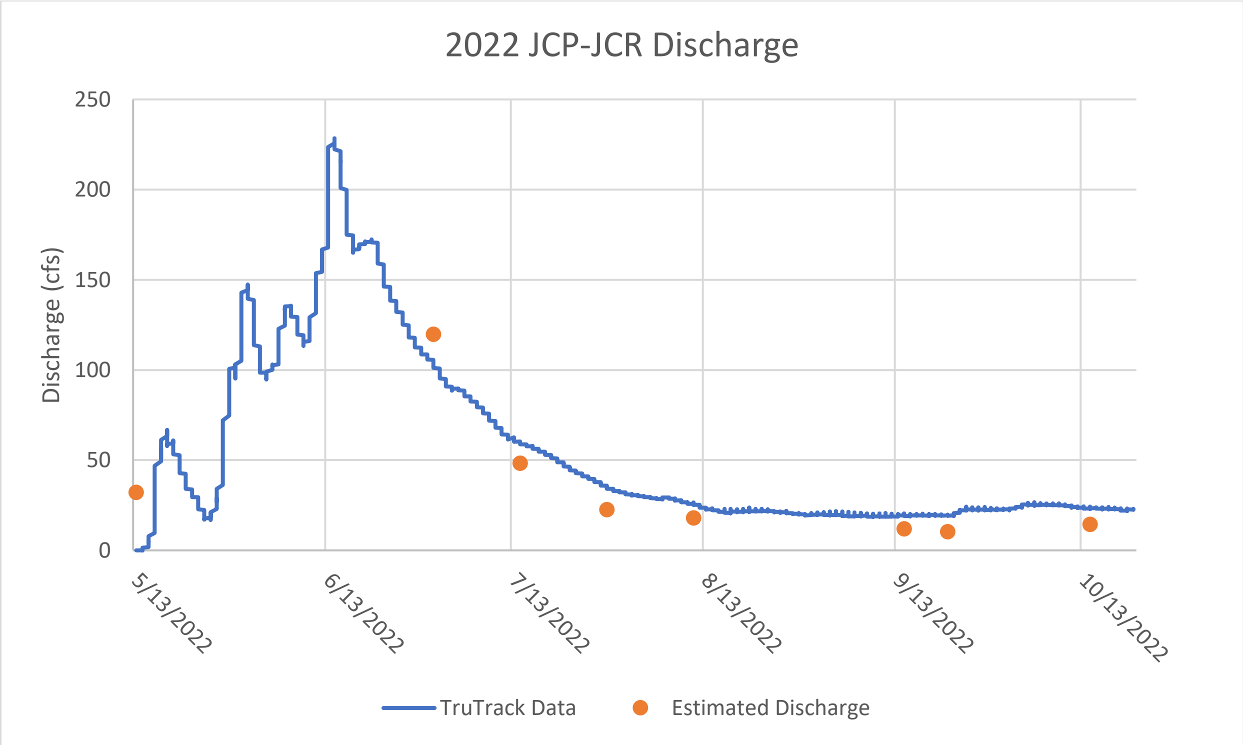


Figure 19. Turbidity data in 2022 at JCP-CYN, JCP-JCR, and JCP-SSR.

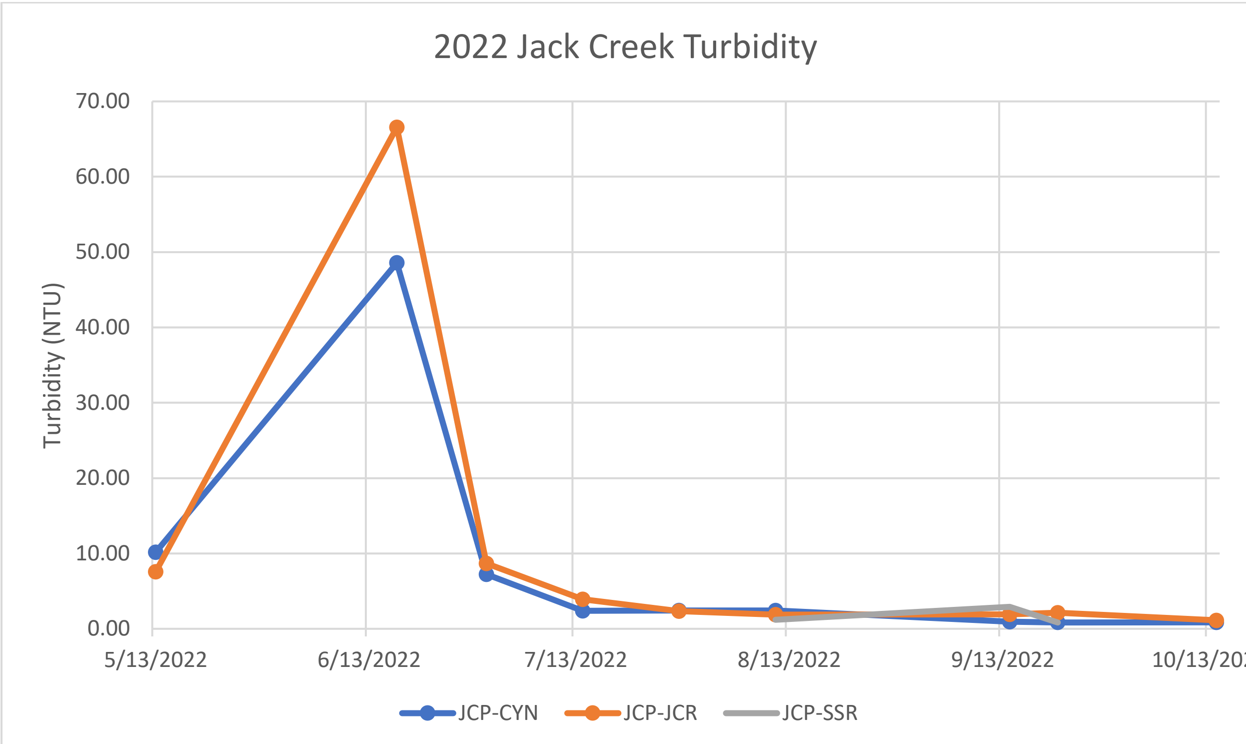


Figure 20. Specific Conductivity in 2022 at JCP-CYN, JCP-JCR, and JCP-SSR.

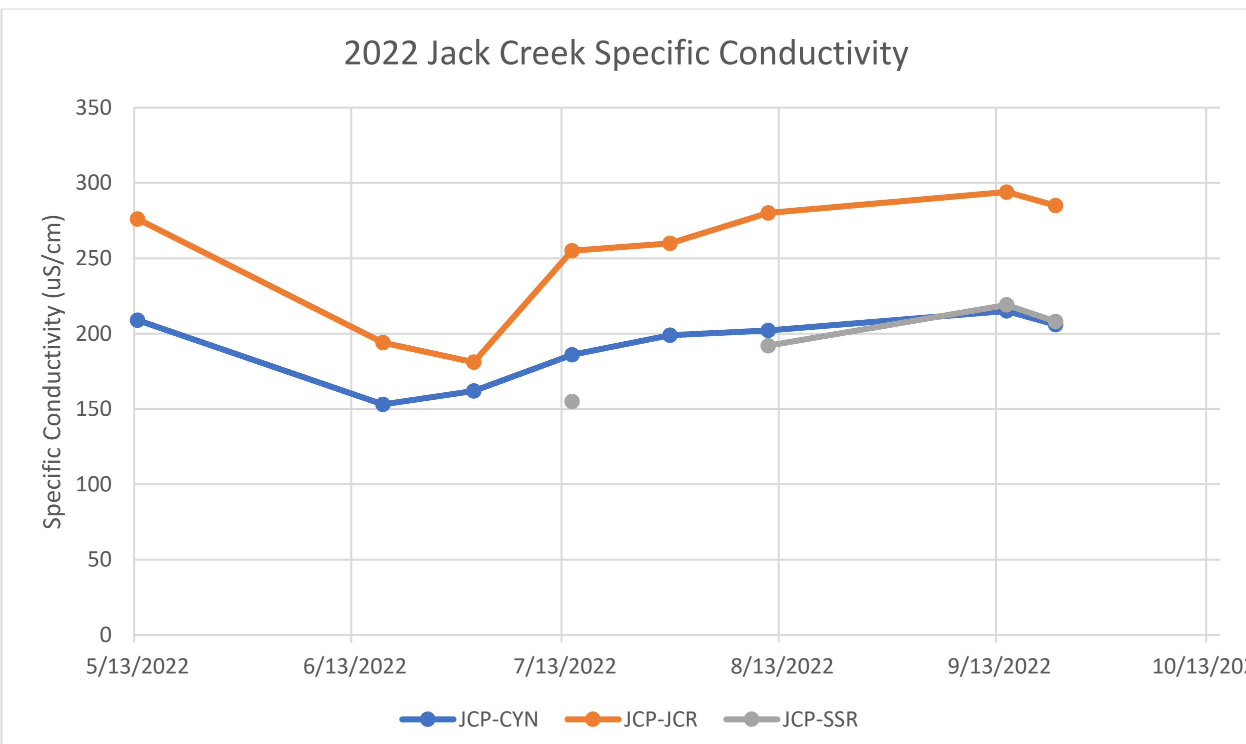


Figure 21. Dissolved Oxygen (%) in 2022 at JCP-CYN, JCP-JCR, and JCP-SSR.

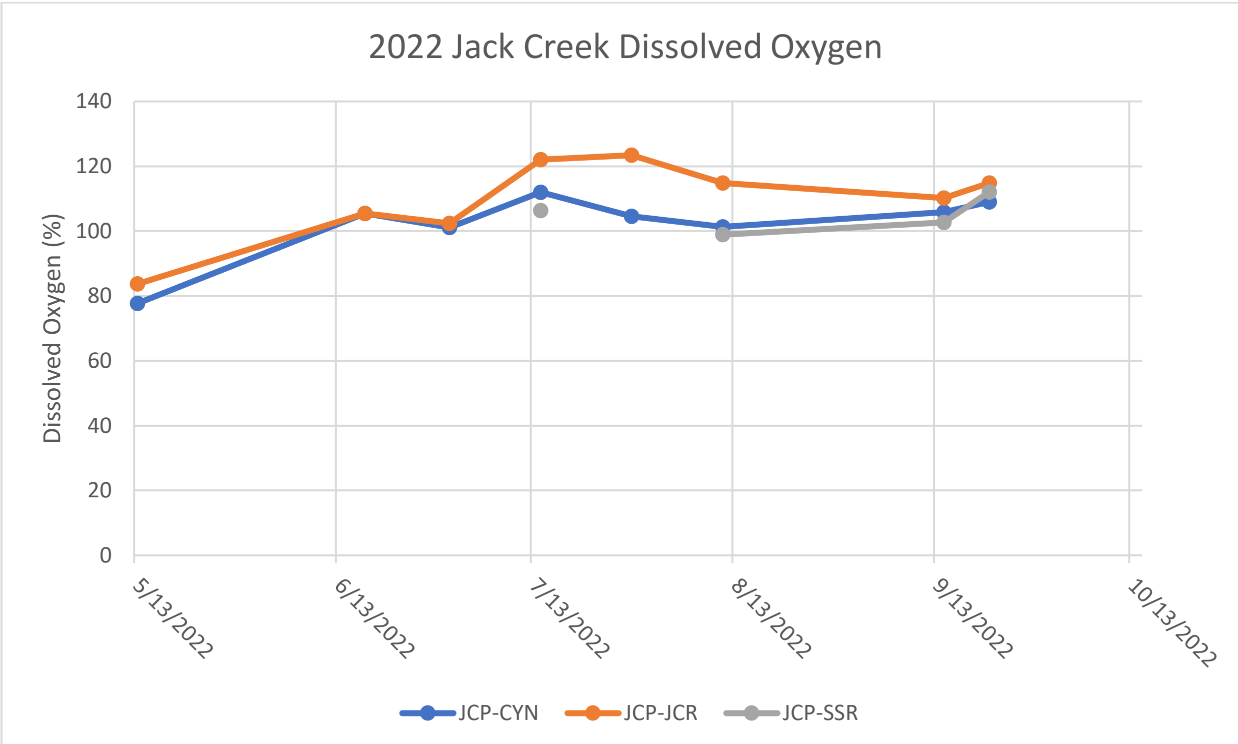


Figure 22. pH data in 2022 at JCP-CYN, JCP-JCR, and JCP-SSR.

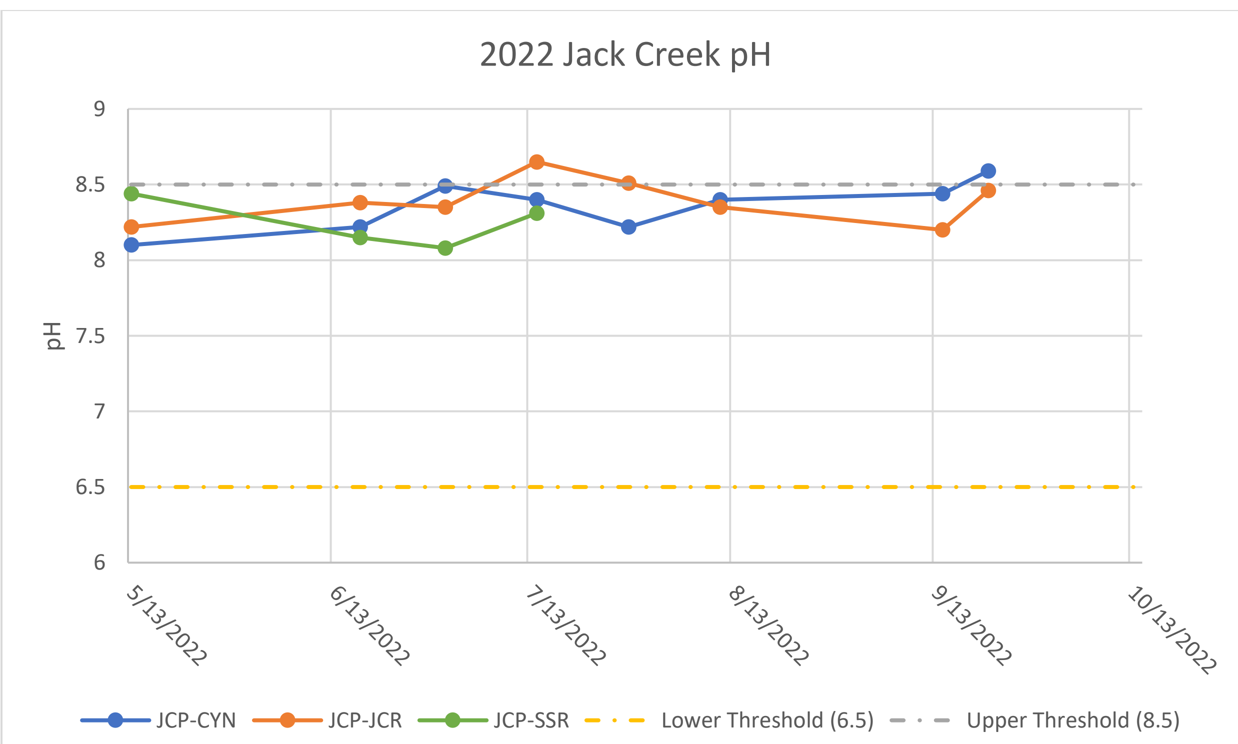


Figure 23. 2022 Tributary Blitz Total Nitrogen Concentration with Department of Environmental Quality threshold for the Middle Rockies eco-region (Total Nitrogen = 0.30mg/L).

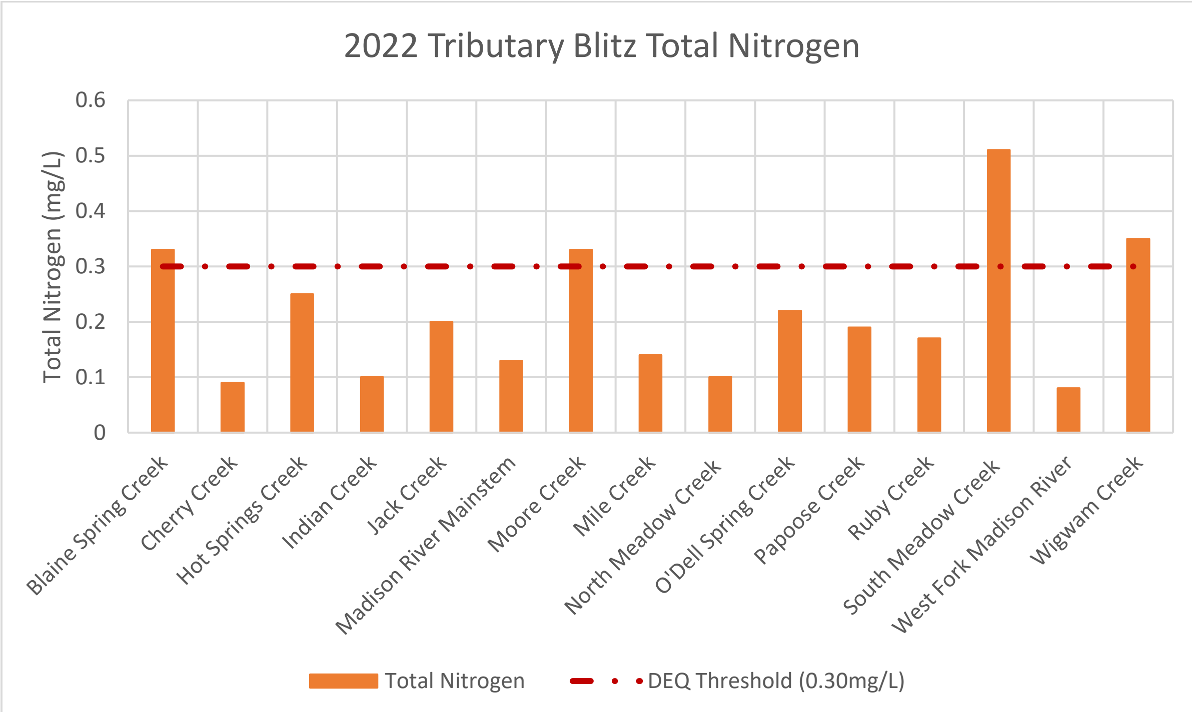


Figure 24. 2020-2022 Tributary Blitz Total Nitrogen Concentration Data with Department of Environmental Quality threshold for the Middle Rockies eco-region (Total Nitrogen = 0.30mg/L).

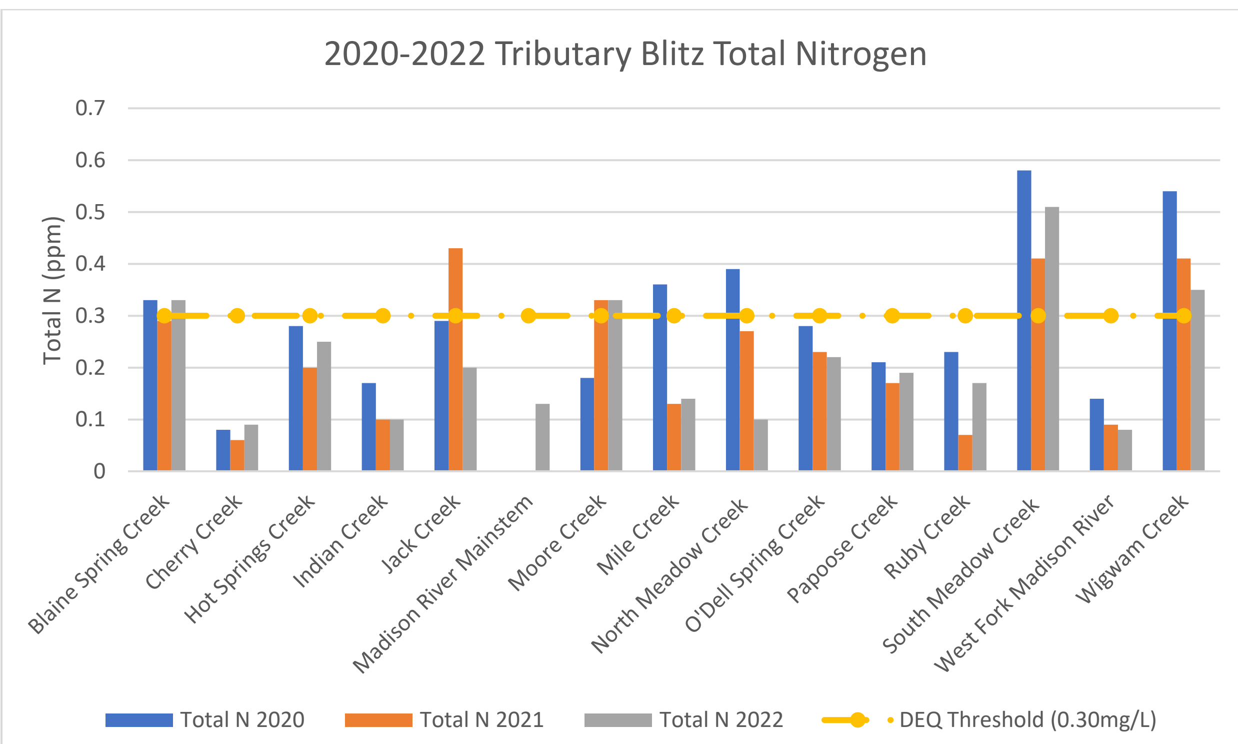


Figure 25. 2022 Tributary Blitz Nitrate-Nitrite Concentration with threshold (0.10mg/L).

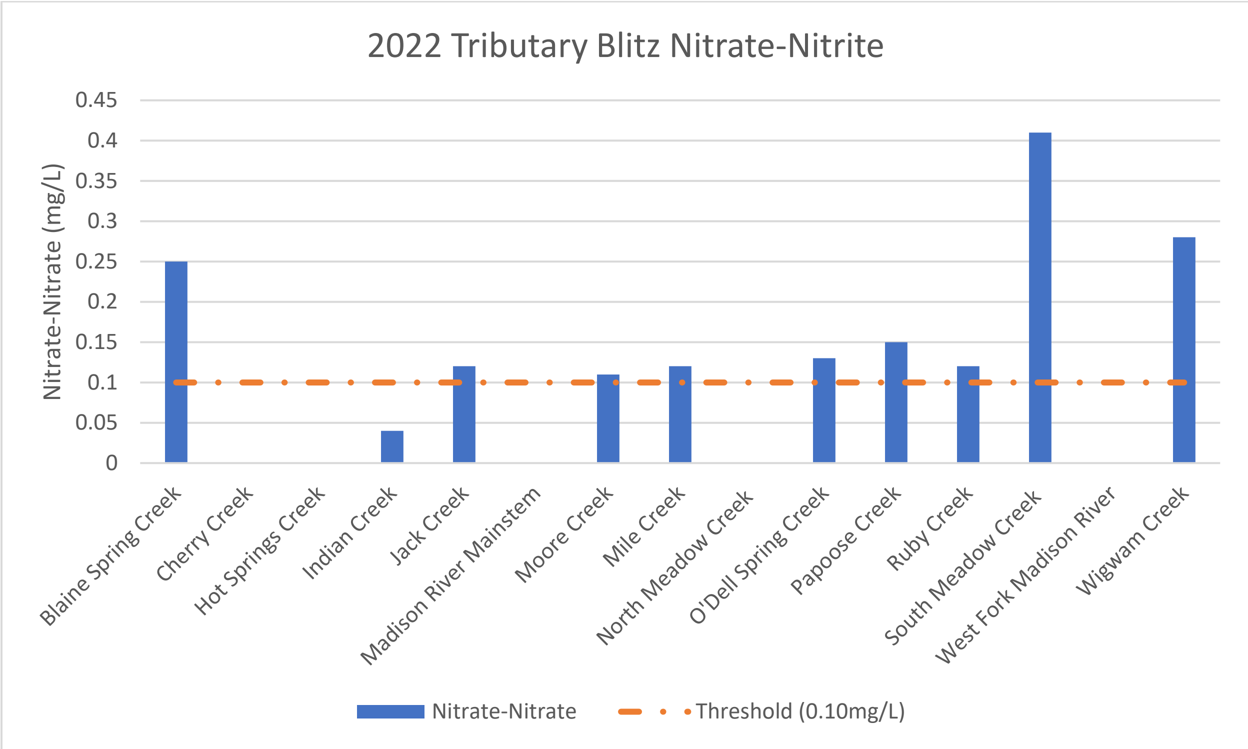


Figure 26. 2022 Tributary Blitz Total Phosphorous Concentration with Department of Environmental Quality threshold for the Middle Rockies eco-region (Total Phosphorous = 0.03mg/L).

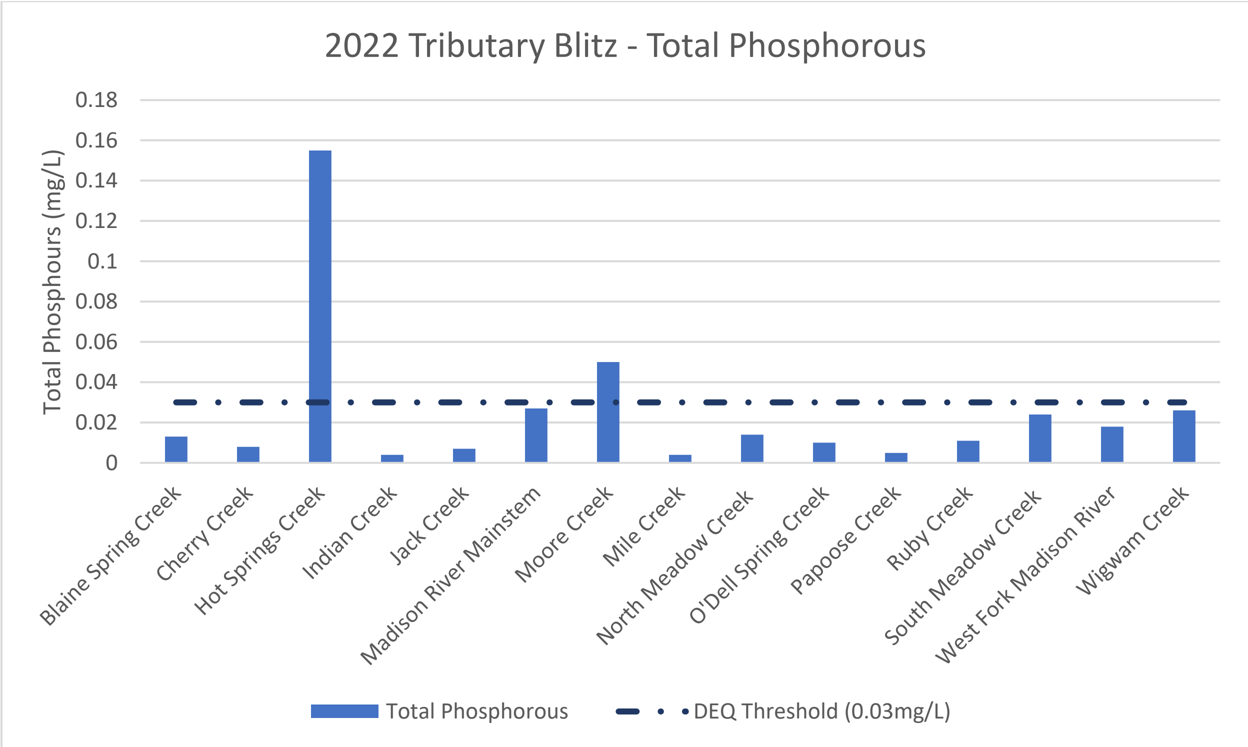


Figure 27. 2020-2022 Tributary Blitz Total Phosphorous Concentration with Department of Environmental Quality threshold for the Middle Rockies eco-region (Total Phosphorous = 0.03mg/L).

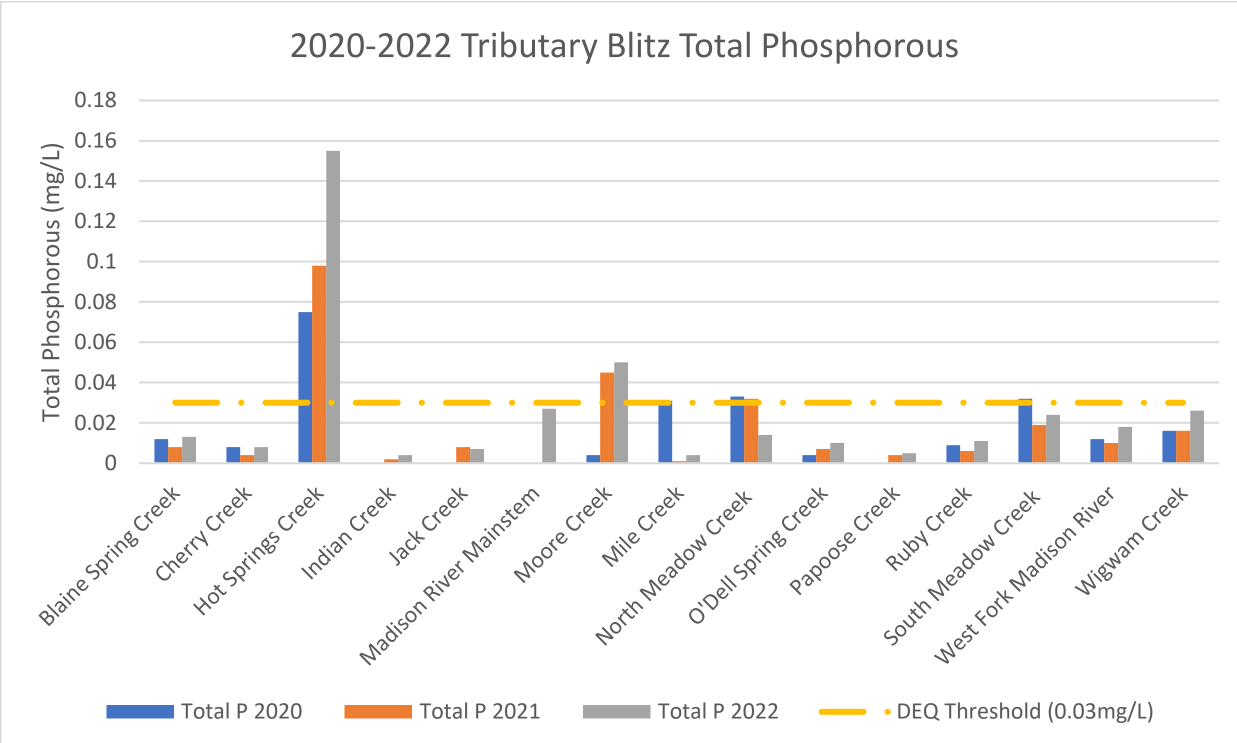


Figure 28. 2021-2023 Jack Creek Winter/Low-Flow Sampling Nitrate-Nitrite Concentration.