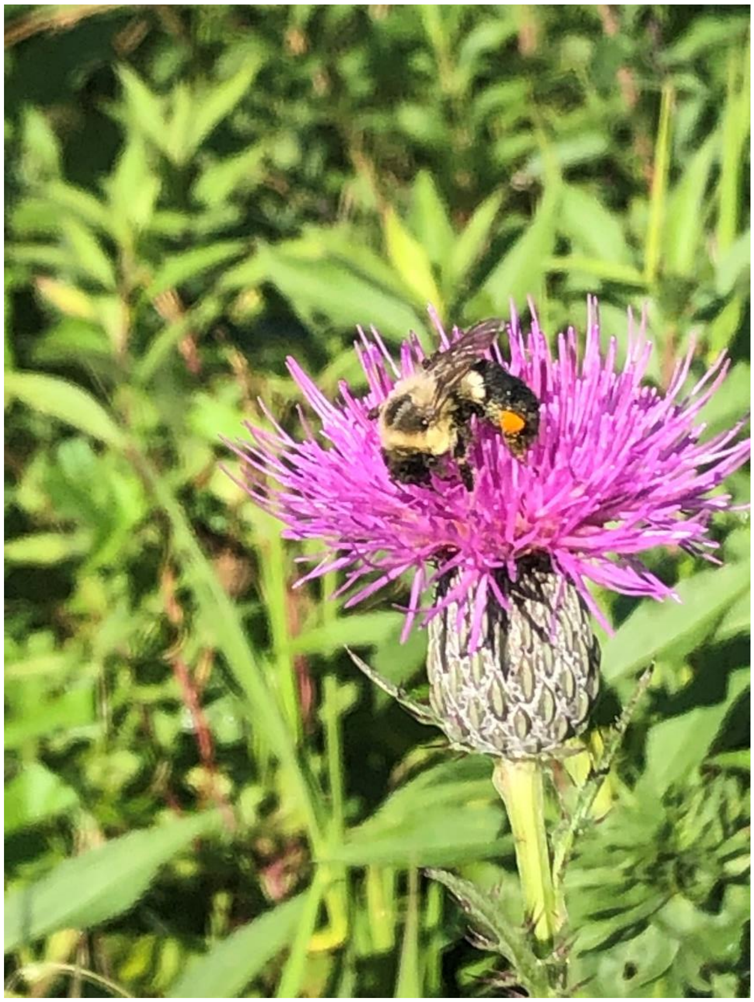
ANNUAL MONITORING REPORT
2020



Savage Fen bee

Prepared for:

Lower Minnesota River Watershed District

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LOWER MINNESOTA RIVER
WATERSHED DISTRICT

SCOTT
SWCD

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Introduction

This report focuses on the summary and comparison of water resources data collected by Scott Soil and Water Conservation District (SWCD) from 2020 and previous monitoring seasons. Like previous years, the monitoring work plan for 2020 included three water temperature logging locations in Eagle Creek and three around the watershed connected to Eagle Creek. One continuous water monitoring station in Eagle Creek (operated in conjunction with Metropolitan Council Environmental Services (MCES) Watershed Outlet Monitoring Program (WOMP). Ground water monitoring at 17 observation wells located in the Savage Fen and surrounding area. Along with one water monitoring station on the inlet to Dean Lake (DLI). The locations of the 2020 monitoring activities are seen in Figure 1. For staff safety, a pause from all monitoring activities was observed from the end of March to the middle of May due to increased COVID-19 cases around Minnesota.

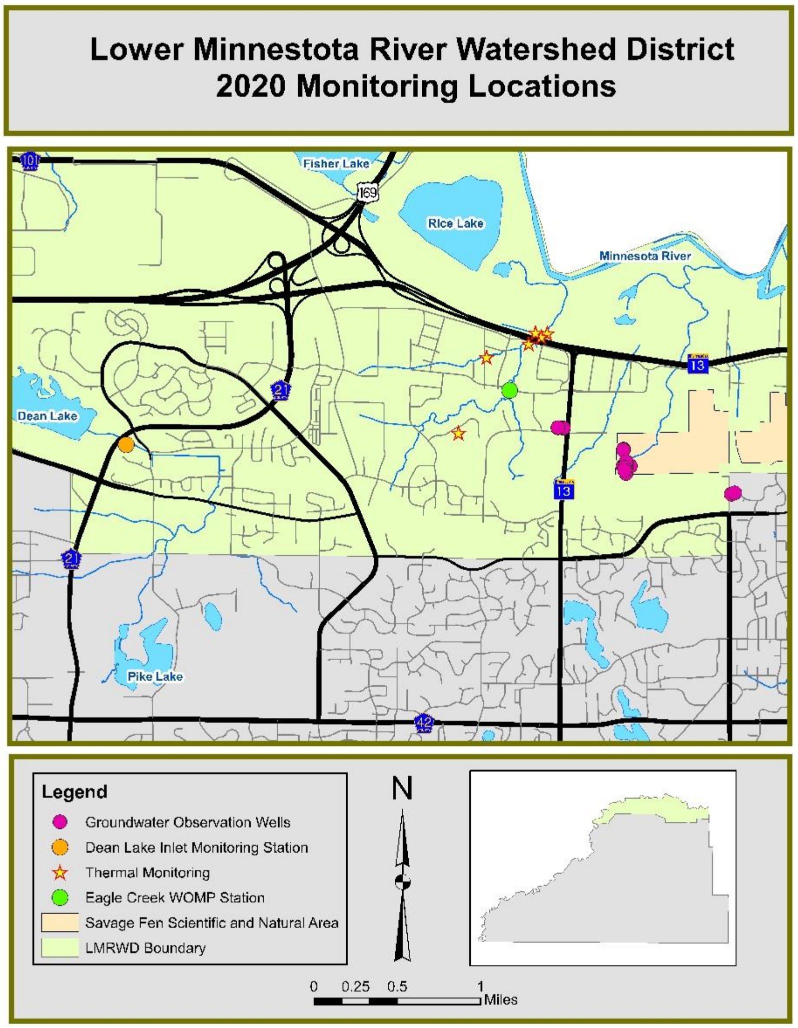

Figure 1. Monitoring locations around the Scott County portion of the Lower Minnesota River Watershed District for the 2020 monitoring season.

I. Thermal Monitoring

This study was initiated by the Lower Minnesota River Watershed District (LMRWD) to evaluate the impact storm water runoff from Highway 101 has on temperatures in Eagle Creek, a Minnesota Department of Natural Resources (MNDNR) designated trout stream. Brown Trout are very sensitive to temperature as it impacts growth rate, habitat, and food resources. The optimal temperature range for adult brown trout is approximately 12.4 – 17.6° Celsius (Bell, 2006).

Methods

Temperature loggers were placed upstream and downstream of Highway 101 in June of 2006 and have been recording stream temperature since that time. In October 2012, a midstream logger was placed just upstream of a pond tributary to monitor its impact on stream temperatures. Three additional loggers (Hwy 101 logger, Schroeders Park logger and the Creek Way logger) have been placed on the outlets of the ponds adjacent to Eagle Creek in late July of 2018 (Figure 2). The goal of the additional pond loggers is monitor water temperatures leaving the ponds and help identify potential warm thermal sources contributing to the creek. All the loggers record continuous temperature data in 15-minute intervals. Scott SWCD contracted with the LMRWD to collect and report the instream temperature data. Rainfall data used for this report is taken from the KMNSAVAG31 wunderground station located approximately three miles East South East of the Eagle Creek WOMP monitoring station (https://www.wunderground.com/dashboard/pws/KMNSAVAG31).

Results

Under most conditions, stream temperatures trend with atmospheric temperatures. The downstream logger shows a deviation from the midstream and upstream loggers during both the winter and summer. A combination of atmospheric temperatures and the inflow of cold and warm water from the inlet near the Hwy 101 logger would influence the deviation.

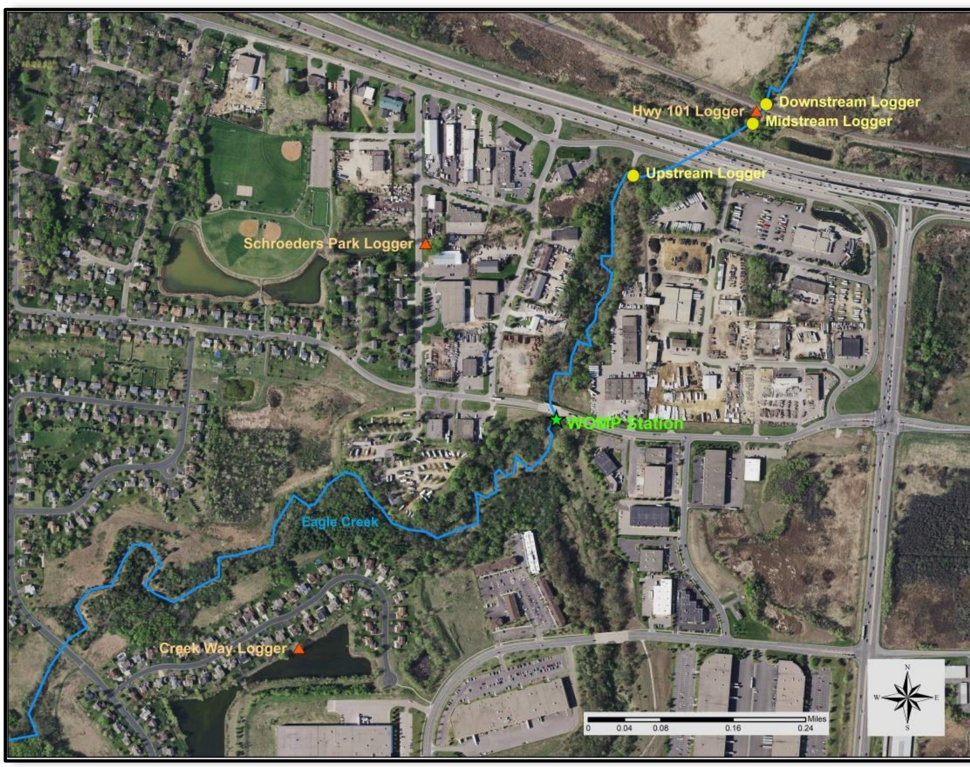

Figure 2. Location of temperature loggers and WOMP station. The new 2018 loggers are represented by the orange triangles. No temperature logger exists at the WOMP station.

Similar to other years, the upstream logger continues to be the warmest during the winter and coolest in the summer of the three Eagle Creek loggers. The downstream logger shows an opposite trend as it is the warmest in the summer and coolest in the winter (Figure 3). During warm summer days, water temperatures occasionally exceeded the optimal range for trout but for only a few hours at a time (Figure 4). The maximum daily temperatures exceeded the optimal range 30 and 6 times for the downstream and upstream loggers respectively. The midstream logger was lost during the peak summer temperatures so it is unkown of how often that section exceeded the optimal range. A noticable seperation in water temperatures is noticed after rain events. It appears that the downstream loggers tend to peak higher and for an extended period of time when compared with the upstream logger. This is likely due to surface runnoff from the stormwater inlets under Hwy 101 and increased side channel flow from the inlet at the Hwy 101 logger location. The midstream logger has been replaced and moved to the outlet end of the Hwy 101 culvert in the main Eagle Creek channel, roughly 170ft upstream of the previous midstream logger location.

The additional three loggers at the Creek Way pond outlet, Shroeder's park outlet and the Hwy 101 pond inlet are not a part of the spring fed Eagle Creek main channel. They are more reactive to atmospheric temperature fluctuations (Figure 5). The Creek Way pond logger tracks very close to average air temperatures, except for a few times in early and late 2020. Shroeder's park and Hwy 101 loggers track very close to one another, with the exception to the Spring of 2020 where the flooding likely kept the Hwy 101 logger cooler than normal. Looking at how these ponds influence the main channnel of Eagle Creek, it is likely that the Hwy 101 pond inlet has some influence to rising temperatures at the downstream logger as the largest seperation in temperatures between the upstream and downstream logger is observed after the Hwy 101 logger temperatures surpase the main channel temperatures (Figure 6). Fluctuations are also observed with the atmospheric temperatures and rain events.

Discussion

Similar to previous years, all of the loggers responded to atmospheric and tributary influences as seen in the past. Minimal flooding in the spring did not appear to have any significant impacts to stream temperatures. A seasonably dry 2020 offered as stark comparison to the unseasonably high precipitation rates in 2019. The precipitation events create instantaneous spikes in temperature, while a lack of preciptation creates longer more sustained spikes that are likely due to warmer air temperatures. The downstream and upstream loggers both showed spikes in maximum daily temperatures outside the opitimal range for the Brown Trout, and the total number of spikes increased by 19 between all of the loggers when compared with 2019 data.

The pond loggers tracked well with average air temperatures. It is difficult to dicerne if the Creek Way logger had any water interactions, except for snow melt, as the logger tracked well with atmoshperic temperatures all year. The Hwy 101 pond logger tracked diurnally with the downstream and midstream loggers. It remained cooler than the main channel in the winter and warmer in the summers. It likely has some influence on the downstream logger temperatures as a noticable seperation is observed between the midstream and downstream loggers after the Hwy 101 logger temperatures surpase the main channel temperatures. This is similar to the results found in the brief investigation in 2009.

An investigation was conducted on August 19, 2009 during a 2-inch rain event at numerous temperature monitoring locations on Eagle Creek. Termperatures were recorded upstream and downstream of the pond tributary and in the tributary itself. The temperature of Eagle Creek rose almost 2°C directly after the tributary discharged into Eagle Creek. The tributary was almost 5°C higher than Eagle Creek. According to that study, temperature spikes in Eagle Creek appear to be from large volumes of solar heated pondwater and warm surface runoff dishcarhging from the pond. The temperature of the pond may not actually increase during storm events, but rather the volume of water discharging into Eagle Creek is perhaps the stronger influence on temperature rise. This greatly exceeds the small increase in temperature that typically occurs during dry periods that could be attributed to atmospheric warming of the stream. The addition of the thermal loggers at the outlets of the ponds adjacent to the creek will provide a longer record of the actual influence of temperature increases from the ponds. Even though the temperature exceeds the optimal range for trout by only a few degrees and for only a short period, these rapid temperature increases could be stressful to fish.

The state water quality standard for Class 2A waters maintain there shall be “no material increase” in temperature.

Being a groundwater fed stream, the stream temperatures often track with ambient temperatures but the groundwater keeps the stream warmer in cold months and cooler in warm months. Other factors that show influence to fluctuating Eagle Creek temperatures are atmospheric temperatures, Spring flooding, and precipitation events. All of the loggers generally track with seasonal air temperatures in the Spring with the main channel loggers have a more diluted effect, likely due to flooding influences. Flooding usually occurs as early as March and can last up to June. This can artificially increase or surpress temperature fluctuations during these periods. Finally, precipitation events are seen to have impacts to the logger temperatures, especially in the midstream and downstream loggers. These loggers have the greatest potential for influence from highway runoff and pond overflow discharge.

Continually monitoring of Eagle Creek and the adjacent ponds will allow the tracking of temperature shifts. It also allows for historical background for past and future restoration projects, similar to the MNDNR habitat improvement project in 2013. An unexpected geomorphic shift occurred in the streambed during 2020 which created sediment build up and deep pools between the Hwy 101 culvert and the downstream logger. This shift either burried or displaced the midstream logger causing a gap in data for the summer. The creek is very sandy and unstable in this section and it is no surprise that the stream channel could change in this fasion, but it was surprising the rate of this change with no significant hydrogeologic influences observed throughout the year. A new midstream logger was attached to the culvert on the downstream end of the Hwy 101 culvert to ensure and stream channel alterations do not cause this issue again.

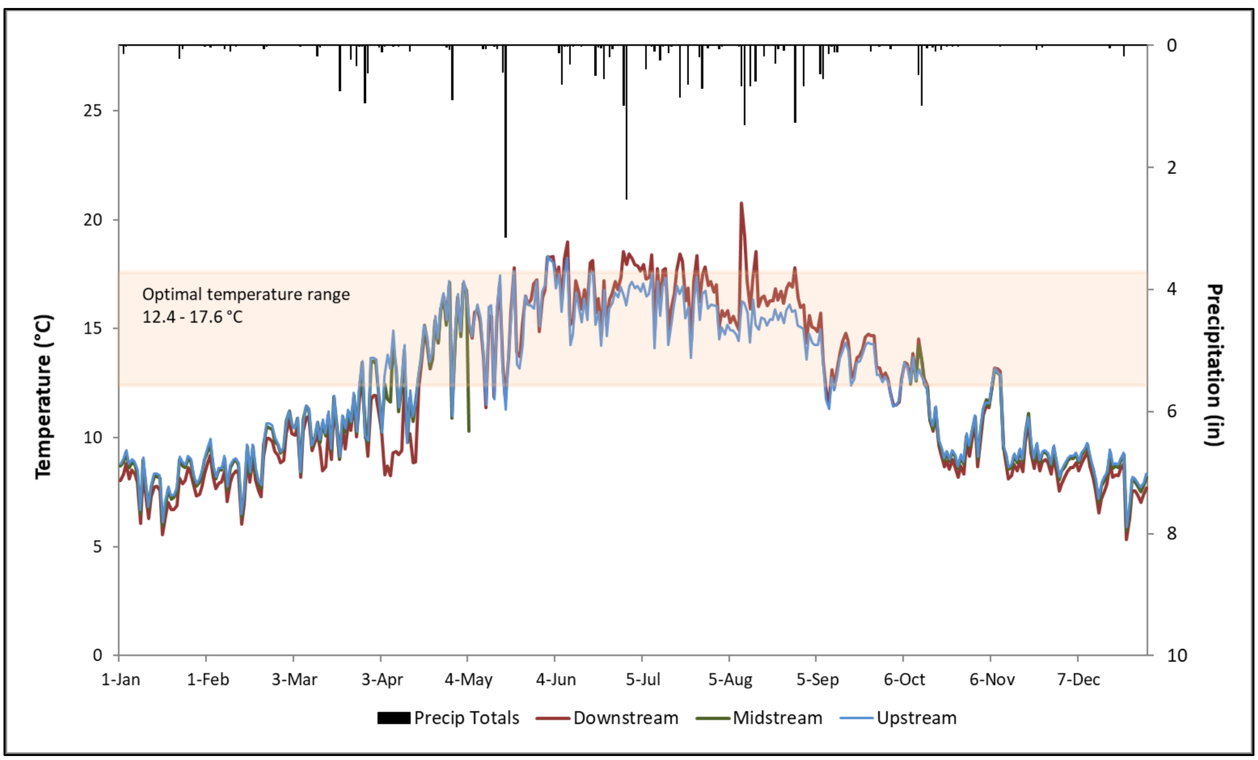

Figure 3. 2020 Maximum daily water temperatures in Eagle Creek.

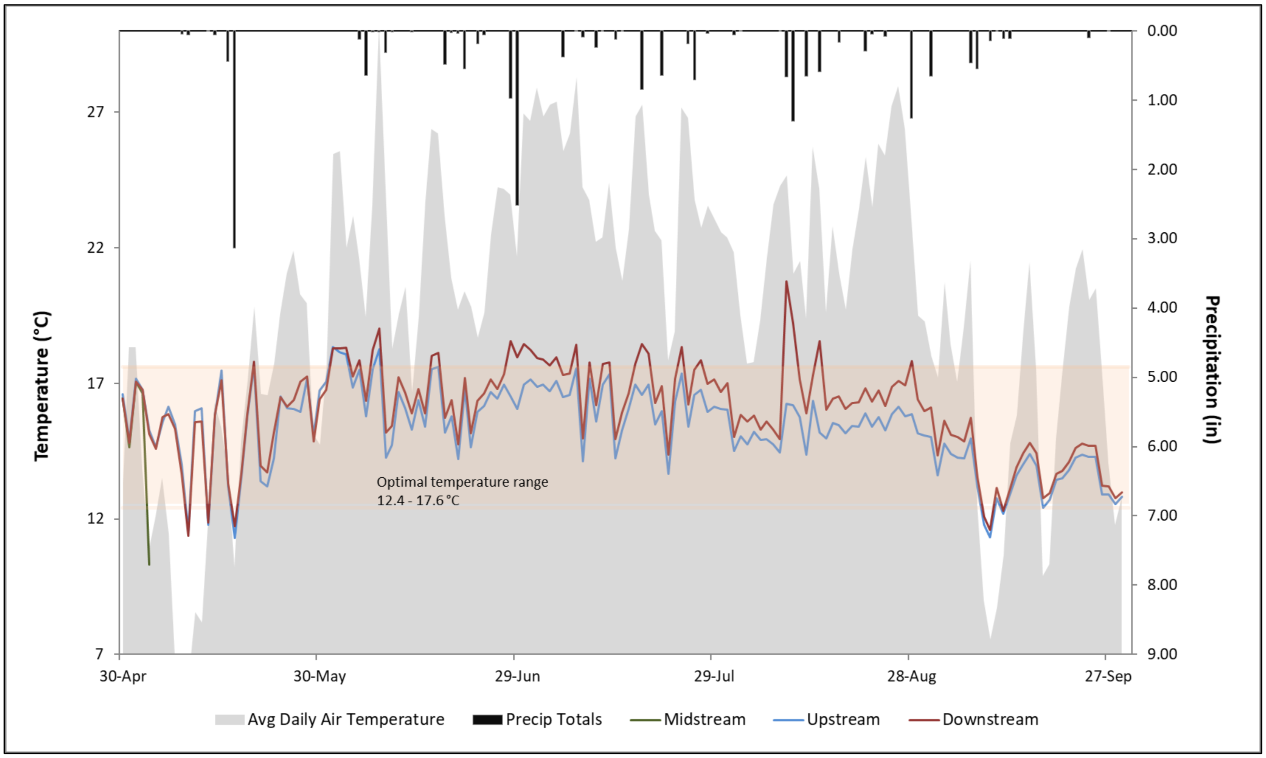

Figure 4. Maximum daily temperatures for the 2020 summer.

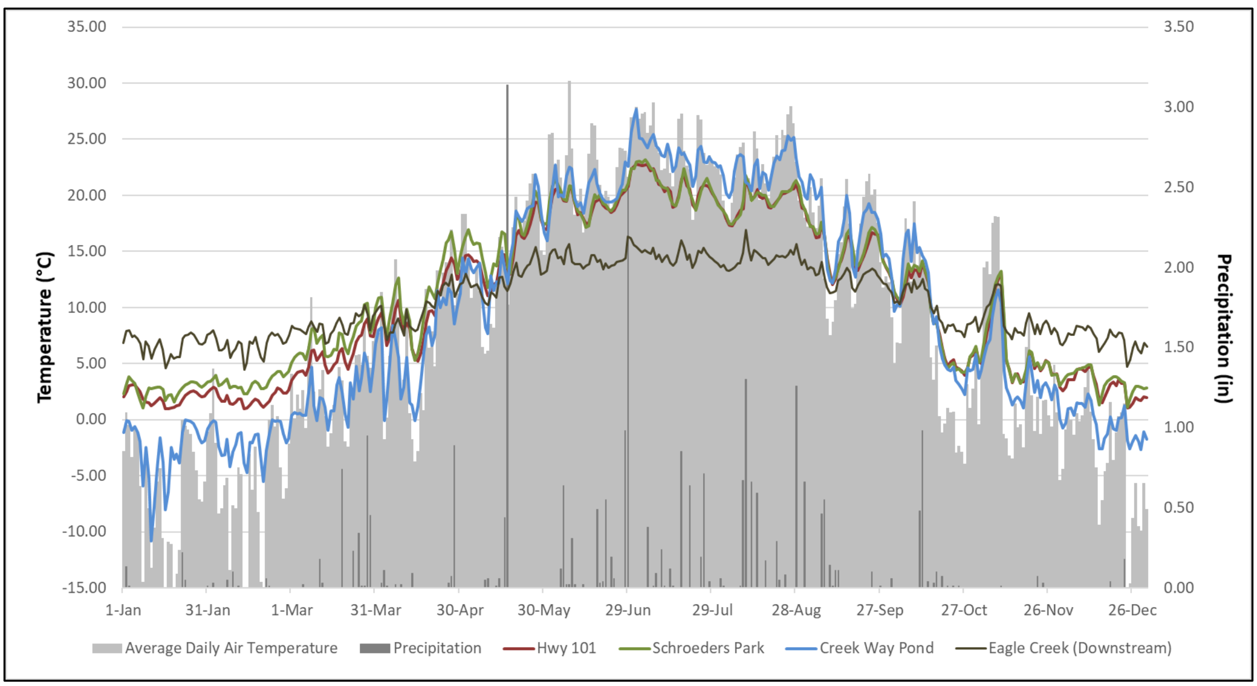

Figure 5. Pond outlet loggers 2020 average daily water temperatures. The Eagle Creek (Downstream) logger is shown for reference.

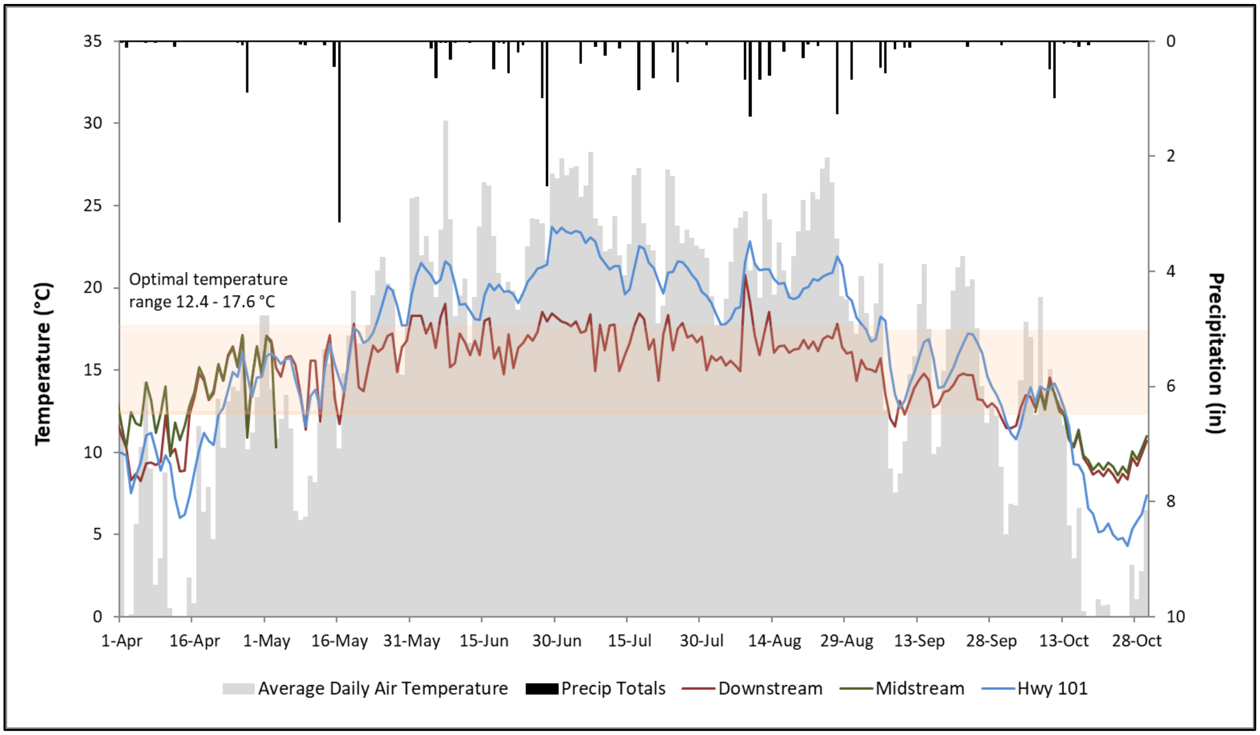

Figure 6. Comparison of 2020 water temperatures at the Hwy 101 pond and Eagle Creek upstream and downstream of pond confluence.

II. Eagle Creek Monitoring

Eagle Creek is a Class 2A self-reproducing trout stream, a unique water resource in the metropolitan area. The Creek originates at the Boiling Springs (an area considered sacred by the Mdewakanton Sioux Community) and outlets into the Minnesota River. Significant measures have been taken over the past couple of decades to prevent degradation of Eagle Creek, including diverting storm water from the stream, the establishment of a 200-foot natural vegetative buffer along each side of the bank, and most recently in 2013, a habitat improvement project along the west branch of Eagle Creek. These and other steps have helped to significantly minimize impacts from this rapidly growing suburban area.

Watershed Outlet Monitoring Program (WOMP)

The Eagle Creek monitoring station began in 1999 as part of the Metropolitan Council's Watershed Outlet Monitoring Program (WOMP). This program was designed and is currently managed by the Metropolitan Council, for the primary purpose of improving the ability to calculate pollutant loads to the Minnesota River. The Lower Minnesota River Watershed District (LMRWD) is the local funding partner for this station, and contracts with the Scott Soil and Water Conservation District (SWCD) to perform field-monitoring activities. The monitoring station is located in the City of Savage near Highway 13 and Highway 101, approximately 0.8 miles upstream of the confluence with the Minnesota River.

The following water quality and flow data is preliminary and is subject to change until the Metropolitan Council submits the final report for this period.

Table 1. Precipitation near Eagle Creek WOMP Station.

Month	2020 Precipitation Jordan* (inches)	2020 Precipitation Savage** (inches)	30 Year Record ***		
			Average	Minimum	Maximum
January	0.74	0.42	0.83	0.08	4.00
February	0.79	0.26	0.85	T	2.18
March	3.15	2.96	1.75	0.34	4.26
April	1.57	1.27	2.96	0.42	7.51
May	4.54	3.76	4.52	1.08	11.08
June	5.16	6.01	5.40	2.10	12.30
July	3.54	3.29	4.17	0.87	8.48
August	3.70	5.81	4.96	1.11	10.86
September	1.96	1.49	2.87	0.21	6.88
October	2.75	1.79	2.65	0.52	5.83
November	1.11	0.11	1.55	T	4.99
December	0.97	0.22	1.21	T	3.40
Total	**29.98**	**27.39**	**34.26**	**21.93 (2000)**	**41.99 (2019)**

* Precipitation data obtained from the NOAA Jordan 1SSW site.
** Precipitation data obtained from wunderground station KMNSAVAG31
*** The 30 year average (normal) is from 1990-2020, NOAA National Weather Service Forecast Office: site Jordan 1SSW Minimum annual average is from 2000 and maximum is from 2019. Records indicated with a "T" represent a trace of precipitation.
https://www.wunderground.com/dashboard/pws/KMNSAVAG31
https://w2.weather.gov/climate/xmacis.php?wfo=mpx

Methods

Sampling

Many parameters are recorded continuously at the Eagle Creek WOMP station including stage, velocity, conductivity, precipitation, and stream temperature. Samples are collected and analyzed for multiple parameters (Table 5) during base flow conditions and storm events. Base flow samples are taken monthly during periods of time unaffected by rainfall or snowmelt events. Samples are taken directly from the stream and then transported to the Metropolitan Council Environmental Services Laboratory (lab) for analysis. The station is set with a composite sampler to collect a number of samples during peak flow events, but during 2020 the Metropolitan Council staff was still trying to fine tune the equipment's collection capabilities. The goal is to capture the water quality at or near the peak of the hydrograph. The event samples are treated similar to base flow samples and the grab samples are brought to the lab for analysis. The site was visited, and samples were collected twenty-six times during the 2020 monitoring season, a couple of the composite samples were collected during the season.

Flow

There are two means of measuring stage and flow at the WOMP station: a WaterLOG bubbler system and Sontek Argonaut Shallow Water (SW) system. The bubbler system has been used since 1999 to measure stage. To determine the amount of flow related to stage, flow measurements are taken manually by MCES staff with a flow meter while the creek is at different stages and a rating curve is developed. With this data, a stage-flow relationship can be applied to the datalogger program, which then calculates continuous flow values as determined by the measured stage.

The Sontek Argonaut-SW was installed by the Metropolitan Council in 2008. This equipment calculates instantaneous flow based on the cross section area, stage, and velocity of the water. This equipment was determined necessary because of occasional backwater conditions caused by beaver dams or flooding of the Minnesota River. The bubbler system is not able to determine that the water is moving slower, so it automatically calculates higher flow as the stage rises. The Argonaut is able to adjust the flow as velocity changes, making the flow values more accurate during backwater conditions.

Results

The range of sampled water quality parameters are reported in table 3. The minimum, 25th percentile, median, mean, 75th percentile and maximum values are reported along with any state standard or comparable ecoregion range or mean for comparison purposes. Individual TSS and E. coli samples are plotted in figures 8 and 10 respectively. The 5 year trend of monthly TSS values and monthly geometric mean of all E. coli samples taken over the past 10 years are reported in figure 9 and 11 respectively.

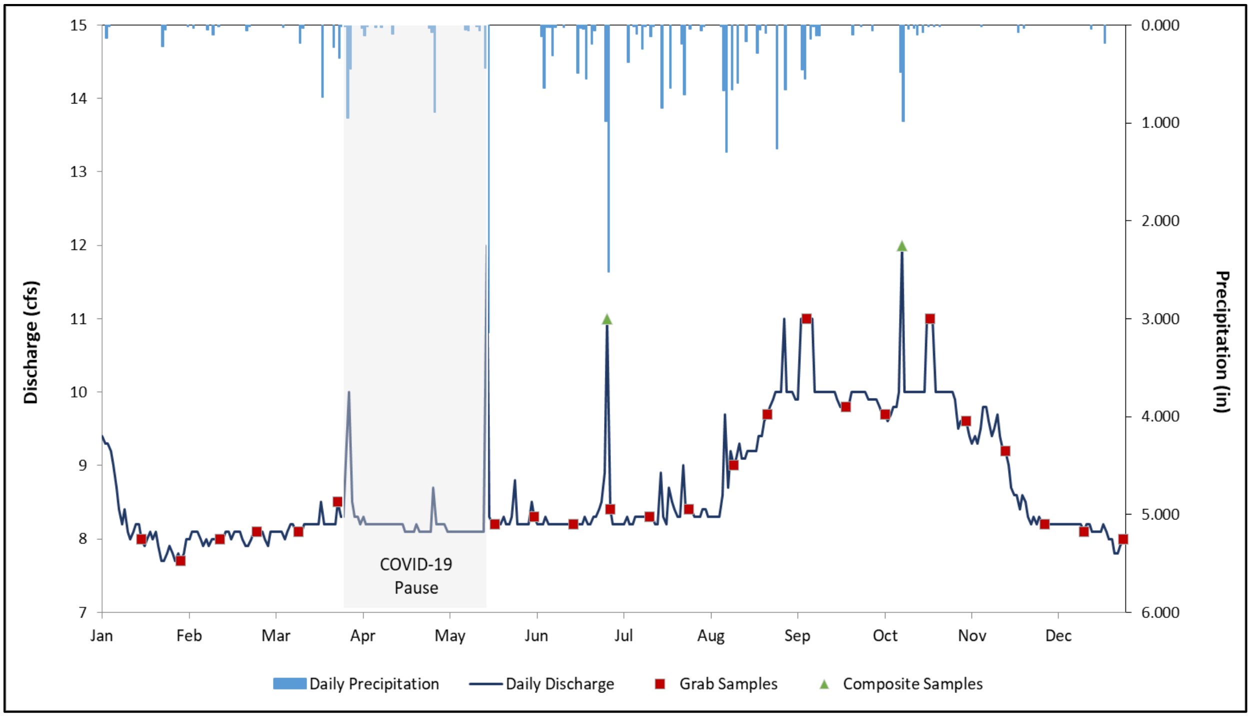

Figure 7. 2020 Eagle Creek WOMP discharge, precipitation, and samples collected. Discharge data is provided by METC and is preliminary. A shift is likely needed from early August to late November to bring the observed hump down to actual discharge levels.

Table 2. 2020 *In situ* water quality measurements taken by YSI EXO 1 multi-probe mini sonde during 2020 sampling.

Parameter	Min	25th %	Median	Avg	75th%	Max	N	Notes
Temp (deg C)	6.99	7.66	9.87	10.14	12.48	14.48	25	
DO (mg/L)	7.39	7.91	8.61	8.52	9.07	9.54	25	Standard = > 7 mg/L
pH (Units)	7.46	7.62	7.70	7.67	7.73	7.85	25	Standard = 6.5-8.5
Conductivity (umho/cm)	617.5	672.0	681.2	675.8	683.5	691.5	25	

Table 3. 2020 Water quality preliminary lab results. Red text indicates exceedance of the state standard or NCHF ecoregion mean.

Parameter	Min	25th %	Median	Avg	75th%	Max	N	Notes
Alkalinity (mg/L_CaCO3)	267	267	273	271	274	274	3	No standard, 20-200 mg/L typical
Chloride (mg/L)	41.0	50.1	51.7	51.3	53.5	56.4	26	Standard = 230 mg/L
Hardness (mg/L_CaCO3)	319.0	319.0	334.0	330.0	337.0	337.0	3	
Ammonia (mg/L)	0.03	0.06	0.06	0.07	0.07	0.11	27	
Sulfate (mg/L)	17.8	17.8	18.8	18.8	19.9	19.9	3	
Nitrate (mg/L)	0.20	0.20	0.20	0.22	0.24	0.37	26	Ecoregion mean = 0.04-0.26 mg/L
Nitrite (mg/L)	0.06	0.06	0.06	0.06	0.06	0.06	26	Ecoregion mean = 0.04-0.26 mg/L
Total Kjeldahl Nitrogen (mg/L)	0.11	0.22	0.27	0.35	0.39	1.70	26	
Total Phosphorus filtered (mg/L)	0.020	0.020	0.020	0.022	0.020	0.051	26	Ecoregion mean = 0.06-0.15 mg/L EPA recommends < 0.1 mg/L
Total Phosphorus unfiltered (mg/L)	0.020	0.020	0.033	0.057	0.068	0.283	26	Ecoregion mean = 0.06-0.15 mg/L EPA recommends < 0.1 mg/L
Ortho Phosphate (mg/L)	0.005	0.008	0.010	0.009	0.010	0.017	25	
Total Organic Carbon (mg/L)	1.9	1.9	2.1	2.1	2.2	2.2	3	
Suspended Solids (mg/L)	1	3	8	18	19	176	26	Ecoregion mean = 4.8-16 mg/L Standard = 10 mg/L
Volatile Suspended Solids (mg/L)	1	1	3	5	6	50	26	
E. Coli (#/100ml)	5	43	59	219	167	1986	26	Standard = 126 CFU/100ml as geometric mean

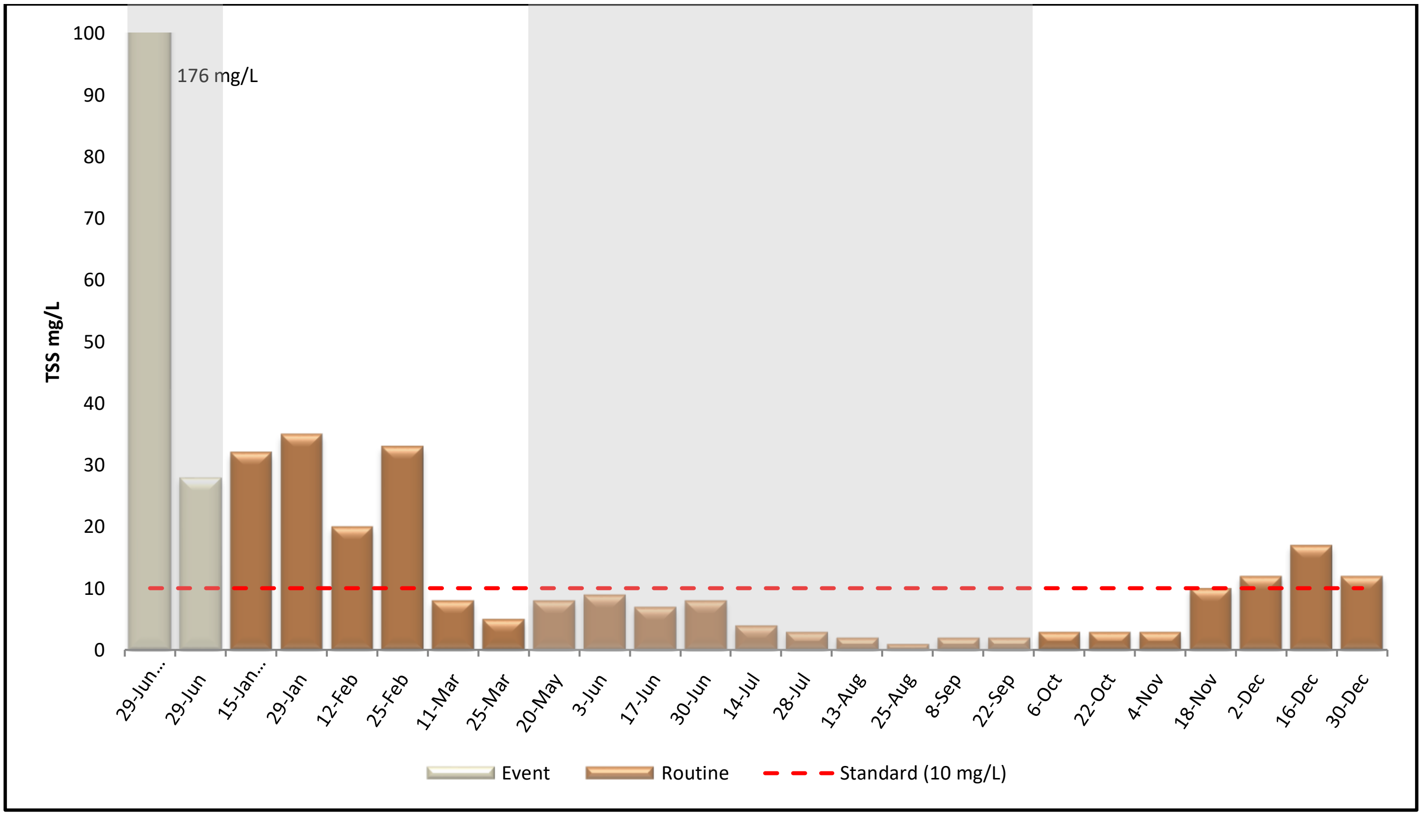

Figure 8. Total Suspended Solids (2020). State Standard for Class 2A Waters = 10 mg/L with no more than 10% exceedance between 1 April and 30 September (indicated by the red dashed line and the shaded areas in the graph).

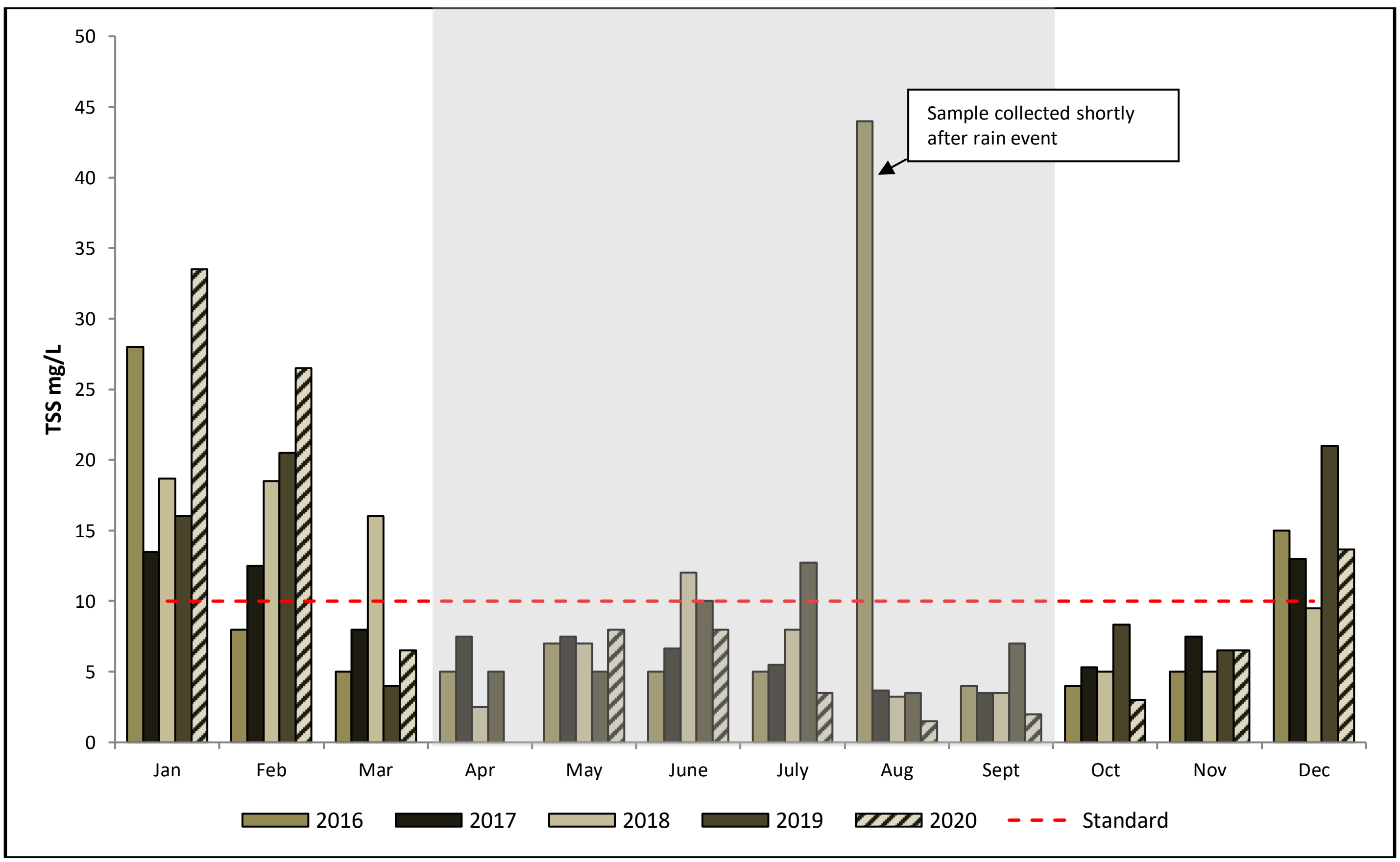

Figure 9. Total suspended solid monthly average over the last 5 years for non-event samples. The state standard is 10mg/L indicated by the dashed red line. No more than 10% exceedance shall occur between 1 April and 30 September (shaded area).

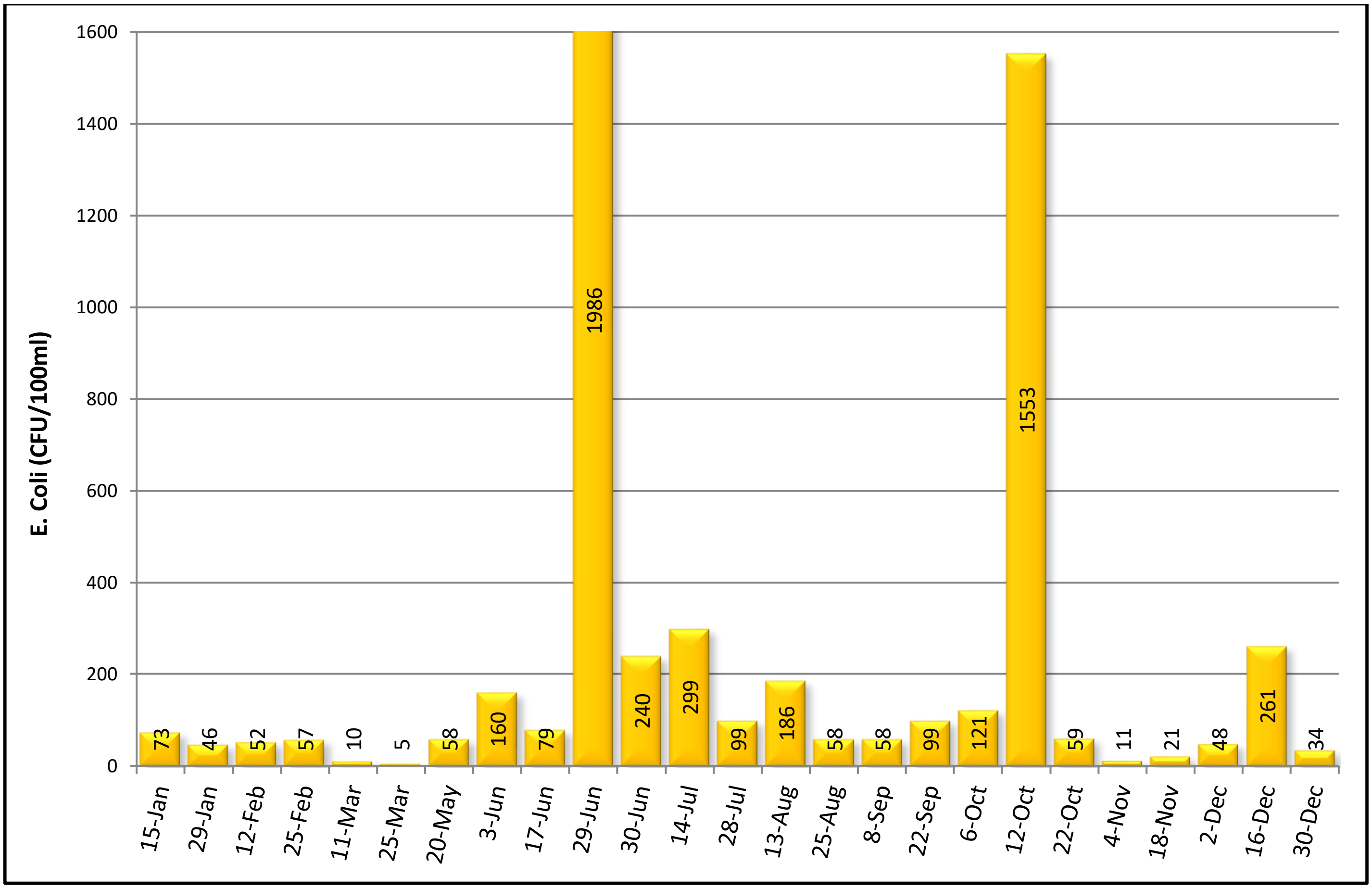

Figure 10. *E. coli* samples (2020). *E. coli* state standard for class 2A waters is not to exceed 126 organisms/100 ml as a geometric mean of not less than 5 samples representative of conditions within any calendar month. Nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 organisms per 100 ml. The standard applies only between April 1 and October 31.

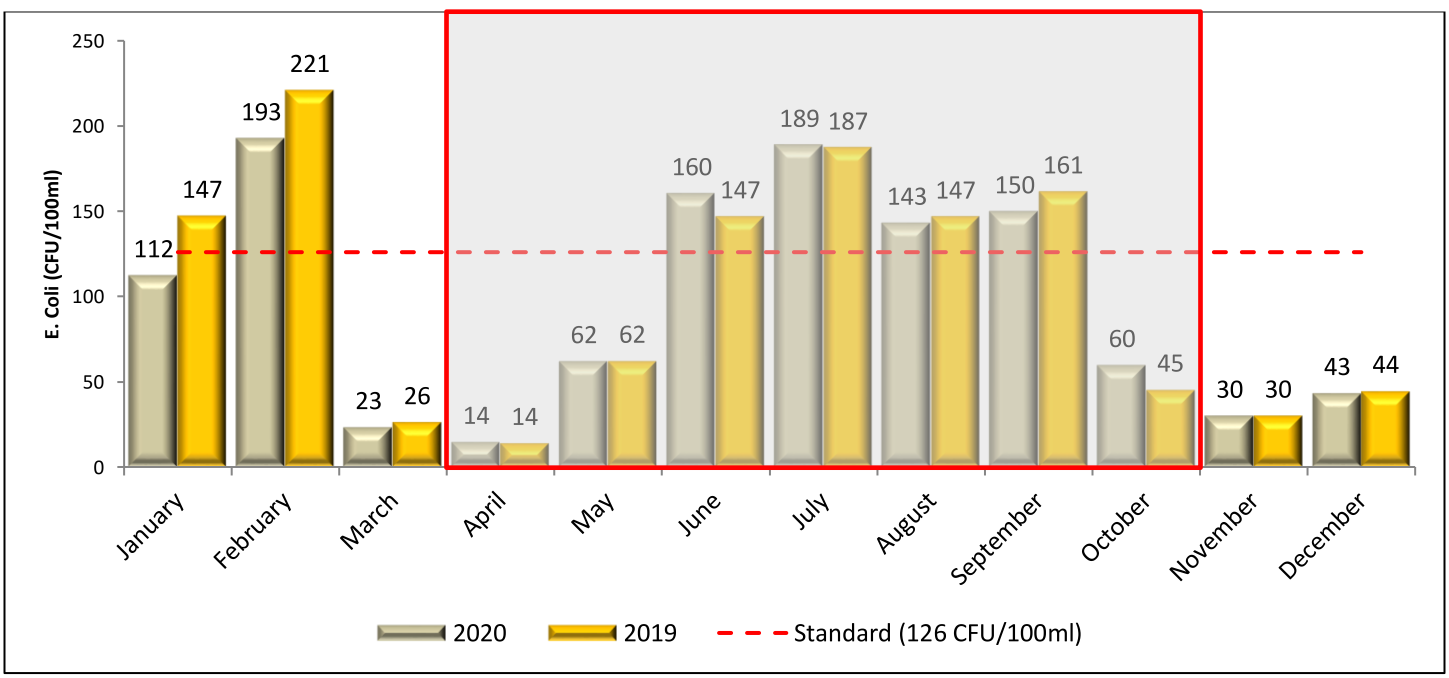

Figure 11. Geometric mean of *E. coli* at Eagle Creek. The geometric mean was calculated using all samples over the past 10 years (2010-2020) for any given month. *E. coli* state standard for class 2A waters is not to exceed 126 organisms/100 ml as a geometric mean of not less than 5 samples representative of conditions within any calendar month. Nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 organisms per 100 ml. The standard applies only between April 1 and October 31.

Discussion
In general, the monitoring data suggests that Eagle Creek consistently meets state water quality standards and ecoregion means[1], with the exceptions being bacteria and suspended solids (Figure 8, Figure 11 and Table 3). The elevated levels of these parameters in winter is characteristic of this stream due to the fact that Eagle Creek is spring fed and does not freeze over in the winter. The open water attracts a large number of waterfowl, which results in historically higher bacteria, sediment, and turbidity levels than observed in summer months. Elevated levels during the summer are a result of continual waterfowl use and runoff from significant rain events.

The *E. coli* standard is applicable from April 1 – October 31 and is exceeded when greater than 10% of the samples exceed 1260 Colony Forming Units (CFU) per 100 ml *or* the geometric mean of no fewer than five samples in a calendar month exceed 126 CFUs. Two samples exceeded 1260 CFU's from April through October, one in June and another in October (Figure 10). Additionally, the geometric mean of the previous ten years of *E. coli* samples resulted in the exceedance of 126 CFU's for June thru September (Figure 14). February also exceeded the 126 CFU threshold leaving seven months below the standard. Compared to 2019, six months showed a lower geometric mean, three months stayed the same and three months increased by an average of 10 CFU's.

The previous state turbidity standard was replaced with a Total Suspended Solids (TSS) standard. The new TSS standard for Class 2A waters state that no more than 10% of samples shall exceed 10 mg/L between April 1 and September 30. This year, Eagle Creek exceeded 10 mg/L in 9 of 25 (36%) lab samples during the 2020 monitoring season (Figure 8). For all of the samples collected from April thru September, 2 of 13 (16.7%) exceeded the state standard. Both samples that exceeded the standard were collected during "event" based sampling. The other seven exceeding samples were during the winter months when waterfowl is constantly seen using the body of water.

III. Dean Lake Inlet Monitoring

Dean Lake Inlet was once on the Minnesota Pollution Control Agency (MPCA) 303 (d) list of impaired waters from 2006-2016. It was impaired for Aquatic Recreation due to excess nutrients causing eutrophication. In 2016 the body of water was re-assessed and reclassified as a wetland in the MPCA's Lower Minnesota River Watershed Monitoring and Assessment Report of June 2017. Although the reclassification removes the body of water from the 303 (d) list the nutrient loading still remains. Scott SWCD continues to provide monitoring data on the inlet to Dean Lake to document nutrient loading. The monitoring site is located where CR21 passes over the Prior Lake Outlet Channel to the southeast of Dean Lake. The SWCD monitors water chemistry and continuous stage and flow at this location. This site has been monitored from 2014 to present.

Methods
In-stream field measurements of dissolved oxygen, temperature, turbidity, pH, and conductivity were taken using an YSI EXO 1 multiparameter Sonde. Field transparency is measured with a 1 meter secchi tube. Bi-weekly scheduled samples and additional event grab samples taken after rain events are taken while the stream channel is open (March-November). In 2020, 17 base grab samples and 4 event grab samples were collected totaling 21 samples. In addition to water quality samples, a total of four periodic flow

[1] There are seven ecoregions in Minnesota. Ecoregions are classified by geographic areas with similar plant communities, land use, soil, and geology. Eagle Creek is located in the North Central Hardwood Forest (NCHF) ecoregion. Each ecoregion has unique water quality goals as determined by historical monitoring of representative and minimally impacted reference streams within that ecoregion.

measurements were taken in 2020. These measurements are used and in conjunction with flow measurements taken over the previous years to develop a discharge rating curve. This rating curve is applied to the continuous 15 minute stage measurements collected by Campbell Scientific SR50 Ultrasonic Distance Sensor and CR1000 data logger to calculate continuous discharge data at the site (Figure 15).

Results

The 2020 monitoring data suggest that the inlet to Dean Lake meets MN water quality standards for all measurable categories, but it fell out of ecoregion mean and EPA recommendations for phosphorus, nitrate and suspended solids (Table 4). Historically, the inlet has seen spikes in nitrate and phosphorus. During the 2020 sampling season the total unfiltered phosphorus fell beyond the EPA recommended level 14% of the time and measured below and above the Ecoregion mean 52% and 5% of the time respectively. This is a 5% drop in EPA exceedance and Ecoregion highs compared to 2019. The nitrates only exceeded the Ecoregion high 38% of the time, up 24% from 2019. Similar to 2019 the nitrate levels never fell below the standards. Finally, the suspended solids was at or exceeded the state standard 38% of the time and went above the Ecoregion high 10% of the time. This was down 33% and 23% when compared to 2019 data.

Table 4. 2020 water quality data from Dean Lake Inlet. Red, bolded text indicates exceedance of the state standard or North Central Hardwood Forest ecoregion mean.

Parameter	Min	25th %	Median	Avg	75th%	Max	N	Notes
Chloride (mg/L)	25.00	51.8	57.5	55.2	58.9	64.7	21	Standard = 230 mg/L
Nitrate (mg/L)	0.20	0.20	0.20	0.33	**0.50**	**0.73**	21	Ecoregion mean = 0.04-0.26 mg/L
Nitrite (mg/L)	0.06	0.06	0.06	0.06	0.06	0.06	21	Ecoregion mean = 0.04-0.26 mg/L
Total Kjeldahl Nitrogen (mg/L)	0.41	0.56	0.73	0.71	0.85	0.92	21	
Total Phosphorus filtered (mg/L)	0.020	0.020	0.020	0.025	0.029	0.047	21	Ecoregion mean = 0.06-0.15 mg/L EPA recommends < 0.1 mg/L
Total Phosphorus unfiltered (mg/L)	0.020	0.042	0.058	0.065	0.086	**0.162**	21	Ecoregion mean = 0.06-0.15 mg/L EPA recommends < 0.1 mg/L
Lab Turbidity (NTRU)	2	4	5	5	7	13	21	
Suspended Solids (mg/L)	3	4	7	9	13	**22**	21	Ecoregion mean = 4.8-16 mg/L Standard = 30 mg/L
Volatile Suspended Solids (mg/L)	1	2	2	3	4	5	21	

Table 5. 2020 *In situ* water quality measurements taken by a YSI EXO1 multi-probe mini sonde for Dean Lake Inlet.

Parameter	Min	25th %	Median	Avg	75th%	Max	N	Notes
Temperature (°C)	2.53	10.75	14.52	15.22	10.75	24.84	21	
Dissolve Oxygen (mg/L)	6.21	6.75	7.79	8.53	9.80	13.75	21	
pH (Units)	7.02	7.31	7.77	7.65	7.92	8.08	21	
Conductivity (umho/cm)	434.2	471.4	494.3	573.5	692.2	981.2	21	

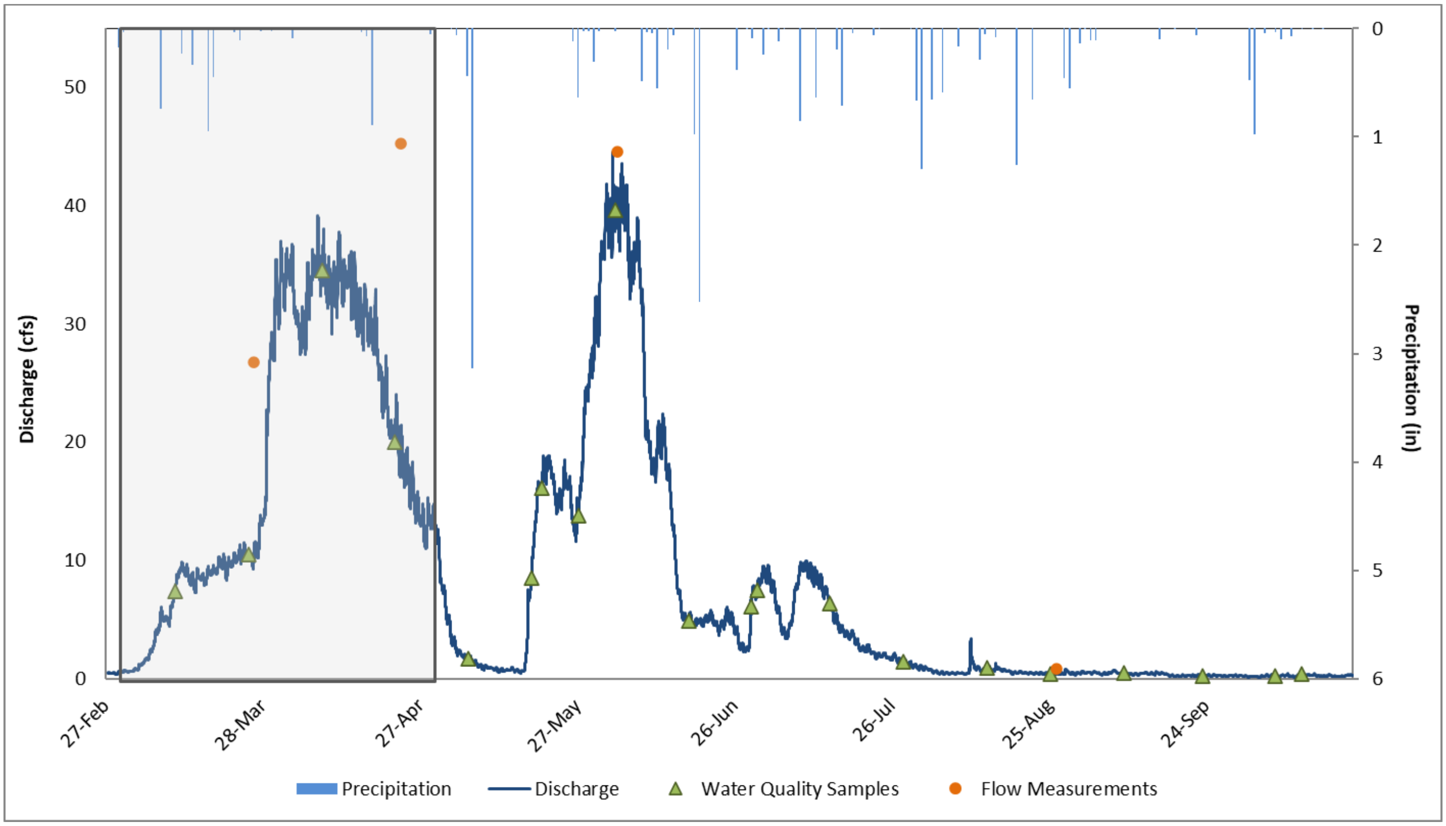

Figure 12. Dean Lake Inlet discharge, precipitation, flow measurements, and water quality samples collected (2020). Shaded areas are when the Prior Lake low flow outlet channel was open. Event samples were taken on 5/18, 5/27, 6/29 and 10/12.

Discussion

The discharge at the Inlet mostly trended with precipitation and atmospheric trends. Due to the dry season, the Prior Lake outlet channel was only open during the beginning of the season. A second spike was observed in late May after the Prior Lake Spring Lake Watershed District (PLSLWD) staff cleared a significant amount of vegetation from Prior Lakes outlet channel. Even though Dean Lake is now considered a wetland, it is still prudent to compare annual water quality results to its previous standards to track any water quality improvements or degradations at the site. Minnesota still requires that the quality of wetlands be maintained even if it does not follow previously identified lake standards. Most of the water quality parameters at the Dean Lake Inlet are within the recommended standards and ecoregion averages. In most cases those parameters that exceeded standards were down when compared with 2019. With all of the exceeding parameters, most exceedance is occurring after precipitation events, droughts, or seasonally influence. Monitoring these levels should continue to track any potential increases or decreases in these levels. Although Dean Lake Inlet is no longer on the 303 (d) list because of its reclassification, it is important to track the amount of nutrients at the site to maintain historical data and track nutrient loading downstream.

IV. Well Monitoring

In 2005 the LMRWD contracted with Scott Soil and Water Conservation District to collect groundwater measurements from 13 wells in the Savage Fen, 4 wells in the Eagle Creek area and 2 Bluff wells. The data from these recordings is used to assess groundwater resources, determine long-term trends and interpret the impacts of pumping and climate. The wells in the Savage Fen were installed by the DNR to monitor development effects and water usage from the City of Savage on the water level in the Fen. All well data is entered into the DNR's groundwater level database and can be accessed at http://www.dnr.state.mn.us/waters/cgm/index.html.

The MNDNR continually assesses the validity and necessity of monitoring wells around the state. In 2018 the bluff wells sealed, and the MNDNR is currently investigating the need for the Eagle Creek wells and a few of the Savage Fen wells.

Savage Fen Area Wells

The Savage Fen is a rare wetland complex at the base of the north-facing bluffs in the Minnesota River Valley, the largest calcareous fen of its kind in Minnesota. A plant community of wet, seepage sites with an internal flow of groundwater rich in calcium, magnesium bicarbonates and sulfates result in a thick peat base that is able to support a unique diversity of plants. More than 200 various plant species have been found in the Savage Fen, some of which are rare.

Methods

The Scott SWCD is contracted to monitor 13 wells in the Savage Fen monthly between April and October. The water levels in the Fens fluctuate throughout the year and the artesian wells record water levels above ground level. Due to COVID-19 restrictions, the MNDNR did not open the two artesian wells (70027 & 70026). Eleven wells are reported in this annual report (Figure 14). In addition, four wells are monitored in the Eagle Creek portion of Savage Fen on the other side of highway 13 (Figure 19).

The SWCD had monitored two additional wells in the Savage Bluff area. In 2010 the Savage Post Office and Fire Department was constructed near the bluff wellheads and as a result, the wellheads were reconstructed and placed below the street, accessible beneath a manhole cover. The SWCD did not read these two wells in 2011 or 2012 as a result of the construction. In 2013, the SWCD resumed monitoring these wells with the City of Savage staff providing access. The Bluff wells were sealed during the 2019 season and are no longer accessible. There are two MNDNR observation wells (70024 & 70025) are roughly 300ft southwest of the bluff wells that will continue to monitor groundwater levels in that area.

In total, the SWCD recorded 105 water level measurements in 2020 from 15 wells for LMRWD.

Results

The Savage Fen water levels showed a small consistent drop in water levels throughout the 2020 monitoring season (Figure 13). Overall, the average Savage Fen water levels for 2020 decreased 1.07 feet throughout the year, with some wells dropping more than others (Figure 15, 16 &17). Historically, the Fens have shown signs of fluctuation, and besides a dip in 2012 the water levels have shown a general sign of increase. This year the wells levels decreased with an average 0.29 foot drop in water levels over the last 10 years (Figure 14). The 2020 Eagle Creek well levels generally showed a decrease throughout the year with all the wells averaging a 0.85ft drop throughout the year (Figure 19). The wells were 0.03ft lower on average when compared to the 10 year average. This was due to the fact that EC3 and EC5 were 0.26 and 0.05ft lower than the average and EC4 and EC6 were 0.16 and 0.01ft higher than the average, respectively. This is evident as the EC3 and EC5 wells show a downward trend over the last 10 years, while EC4 and EC6 show an upward trend (Figure 20). In 2020 all the Savage Fen wells showed a decrease in water levels when compared with 2019 and most (except for SF1, SF3 and SF12) decreased over the 10 year average (Figure 18). Most of the Eagle Creek wells decreased in water levels when compared with 2019 data, with EC3 and EC5 also showing a decrease when compared with 10 year averages (Figure 21).

All figures in this section are reported in depth to water (DTW) which is a product of the wells measuring point elevation minus the elevation of the recorded observed elevation.

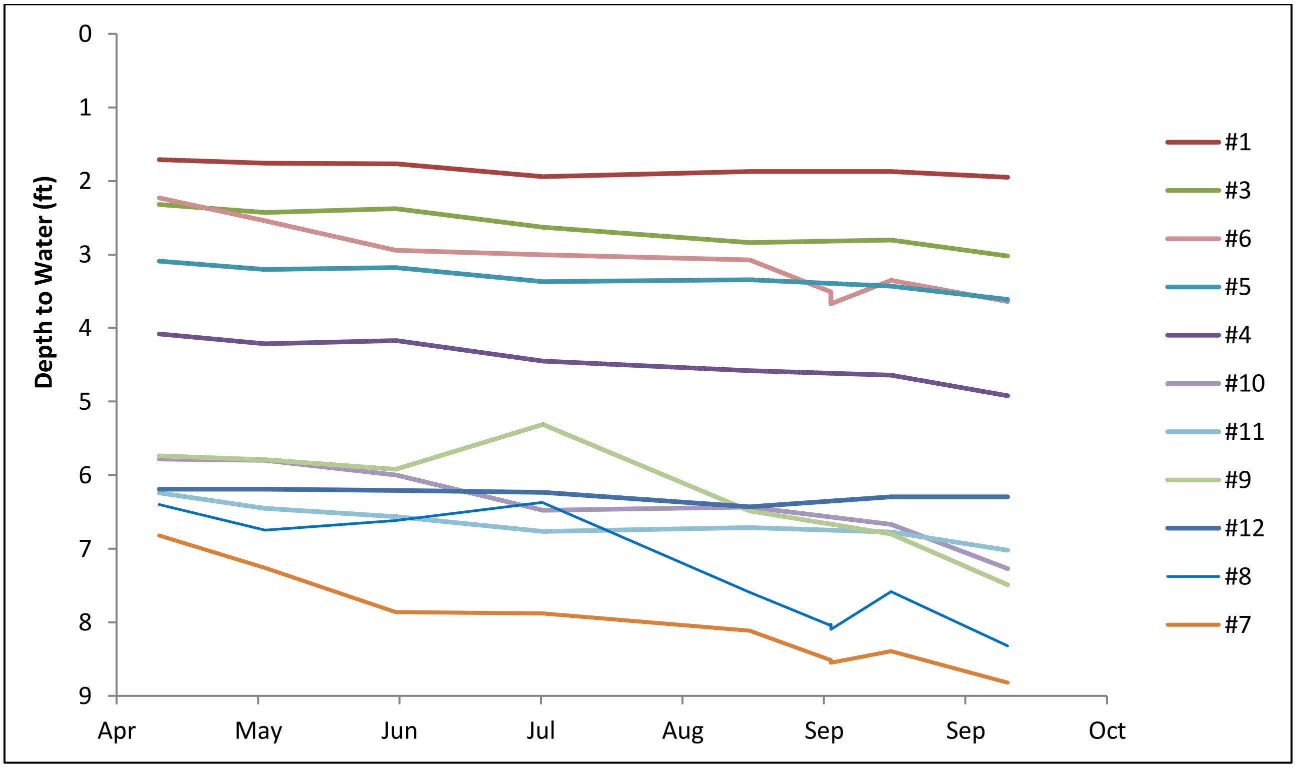

Figure 13. Savage Fen Wells (2020).

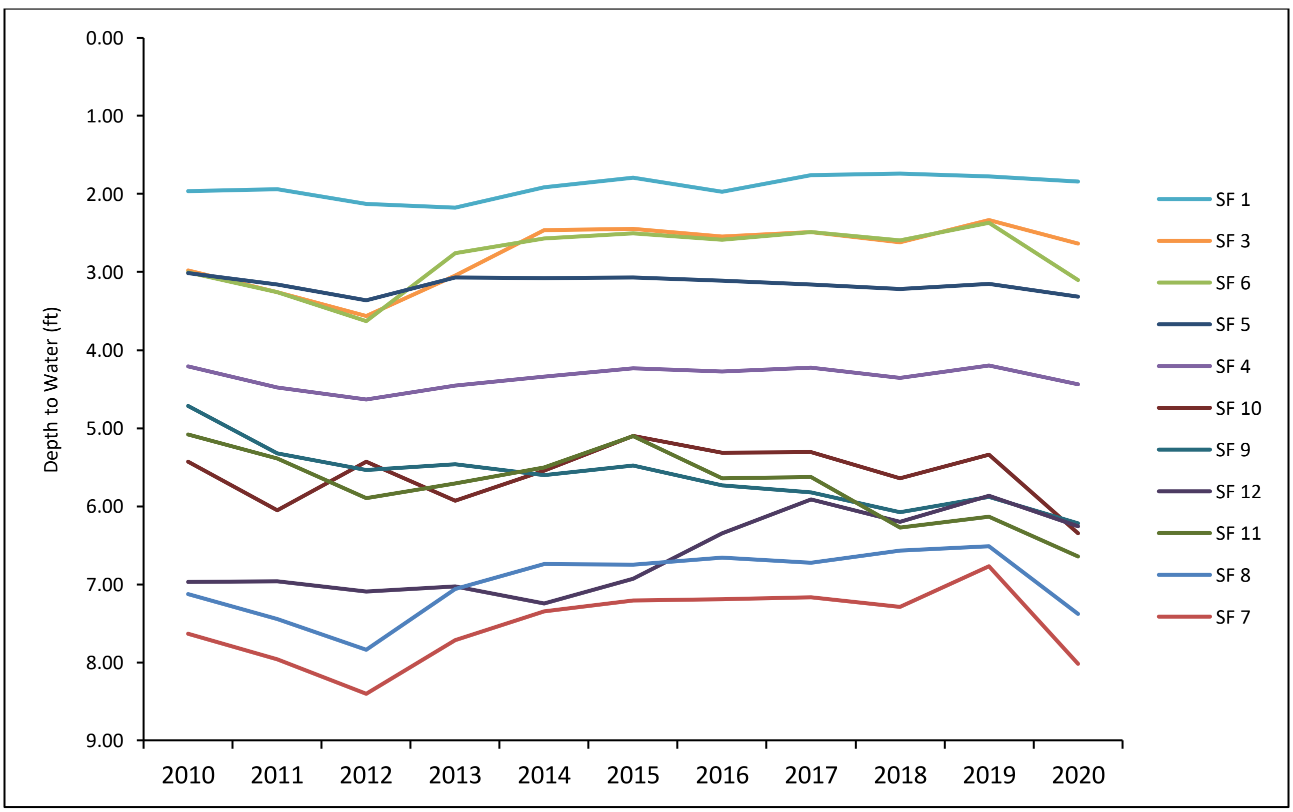

Figure 14. Average annual water level in Savage Fen wells (2010-2020). Averages include all observations in a calendar year.

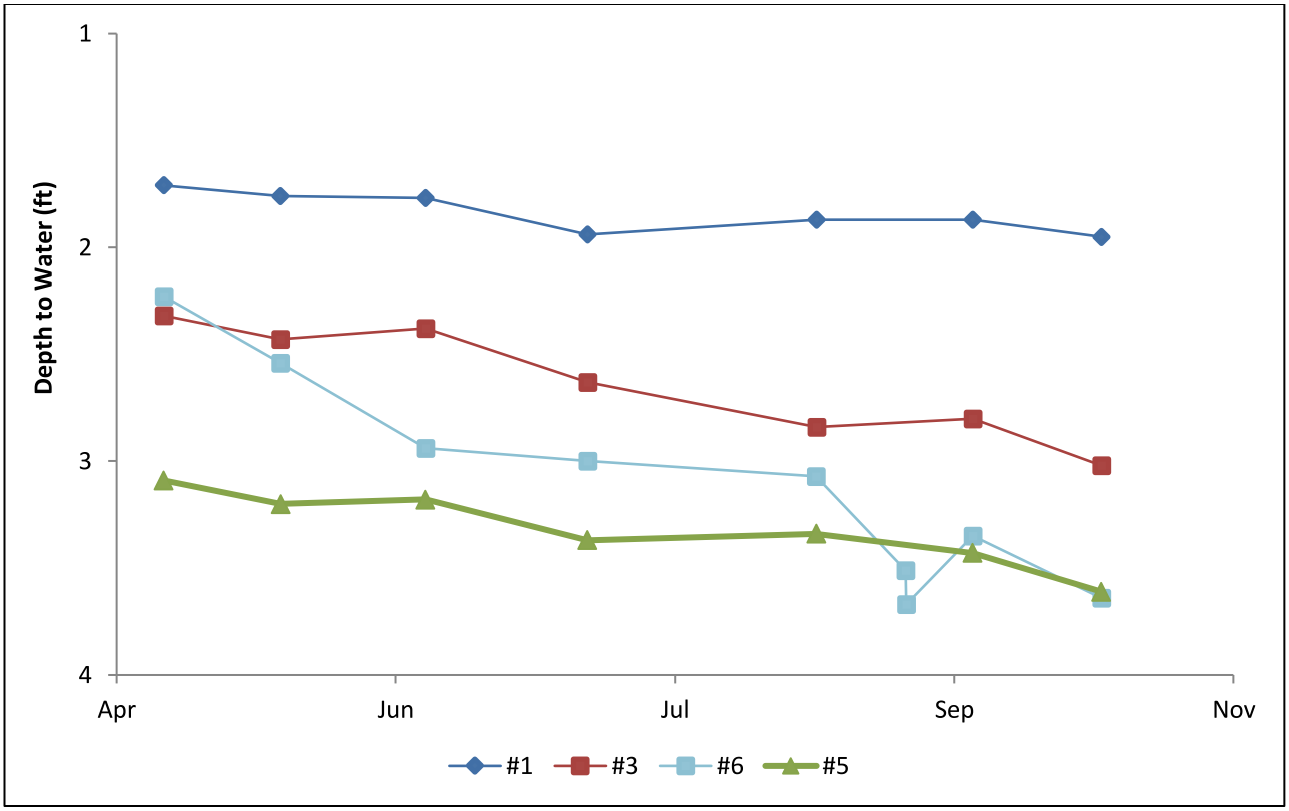

Figure 15. The four Savage Fen wells with the lowest depth-to-water (DTW) values (2020).

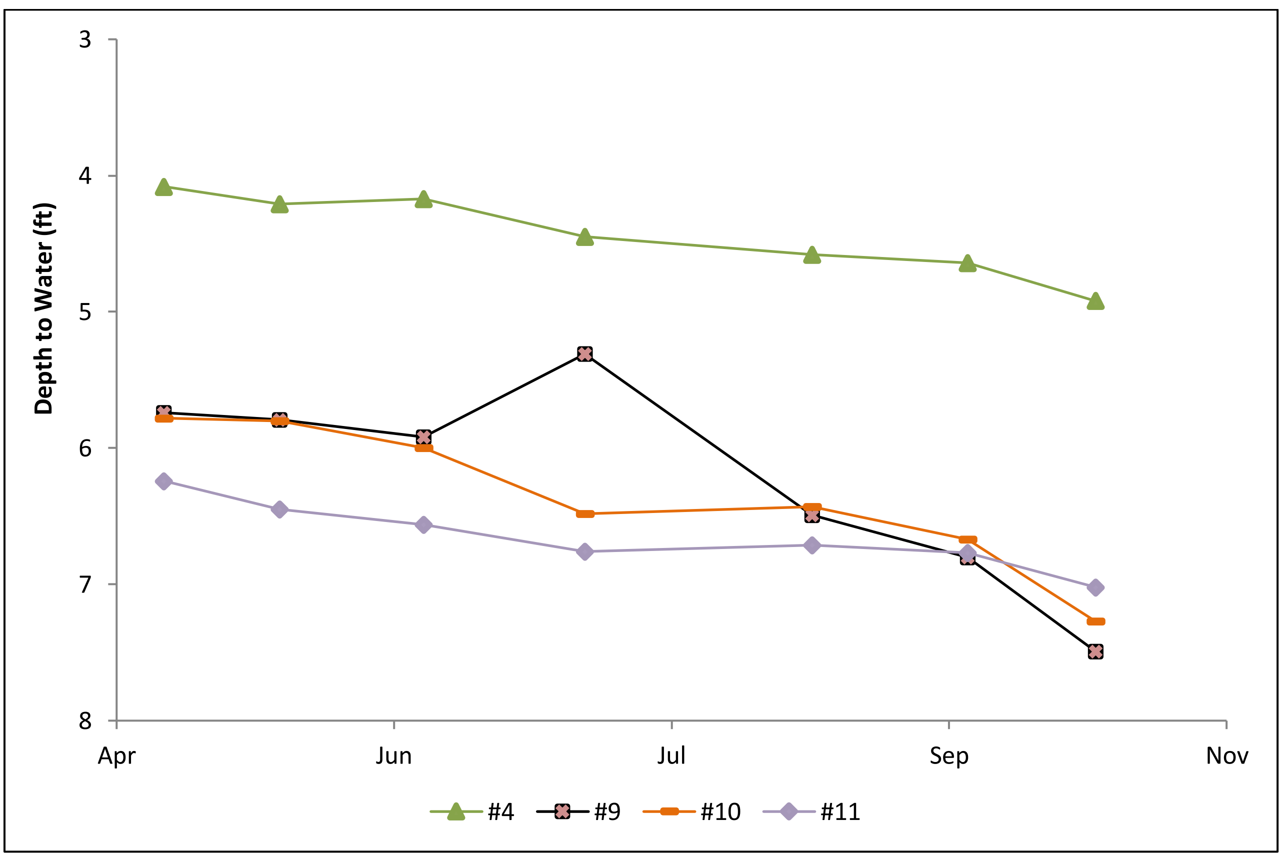

Figure 16. The four Savage Fen wells with the mid-level depth-to-water (DTW) values (2020).

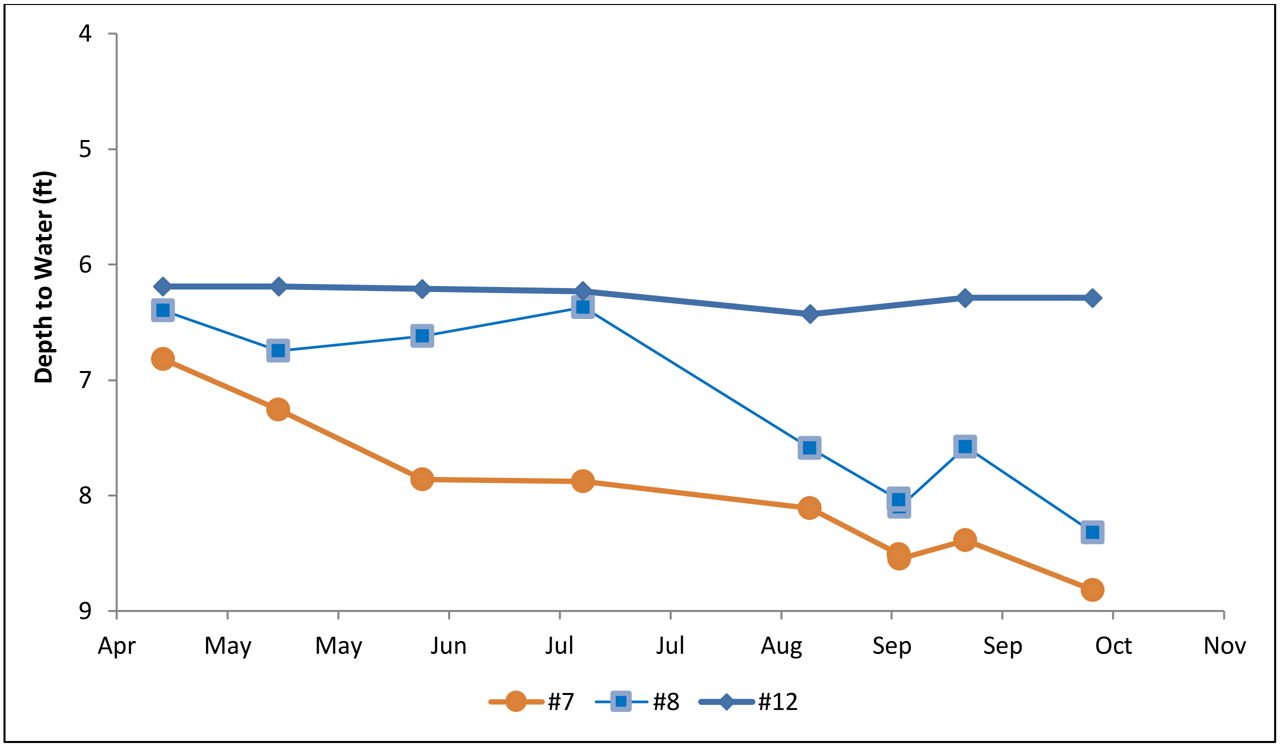

Figure 17. The three Savage Fen wells with the highest depth-to-water (DTW) values (2020).

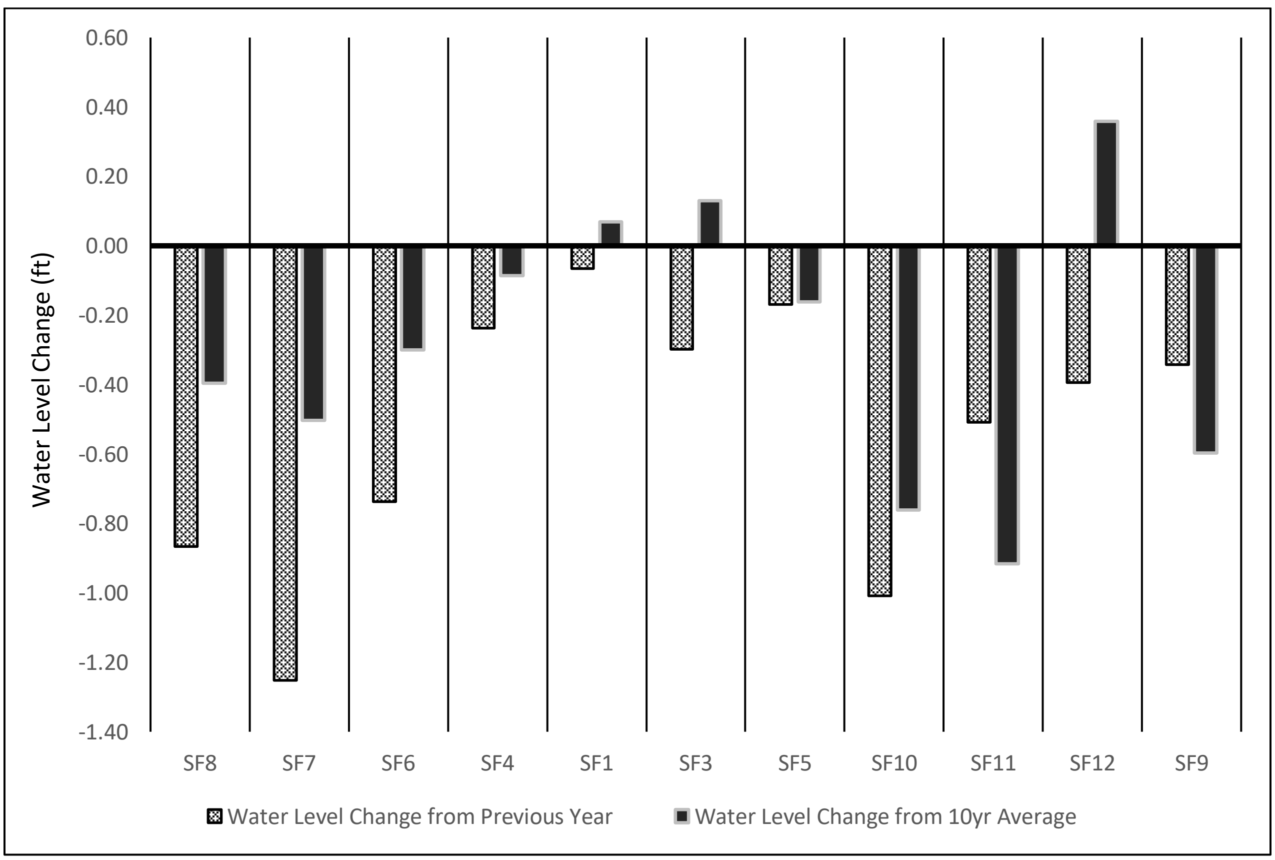

Figure 18. The water level changes at each Savage Fen well when compared with the previous year and the 10yr average depth to water. Average 2020 depth to water levels were used to compare with average 2019 values and 10yr historical averages.

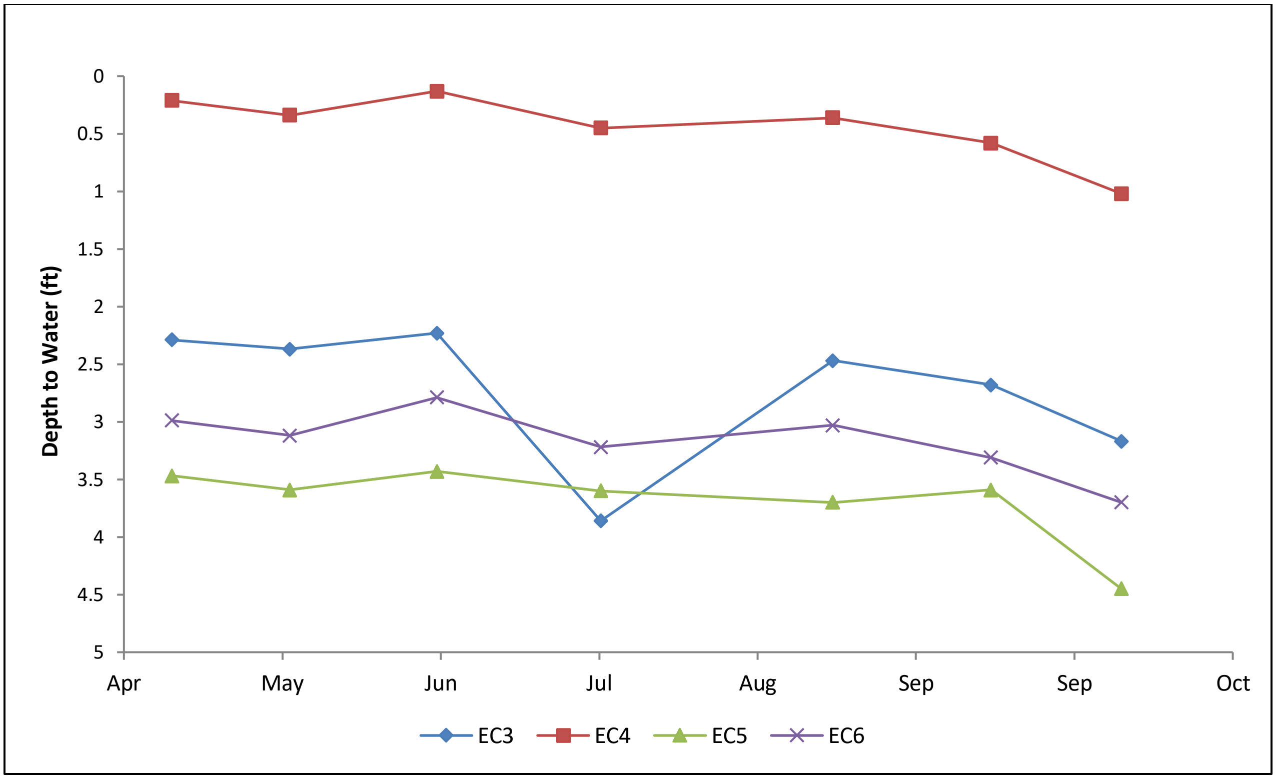

Figure 19. Eagle Creek well measurements for 2020.

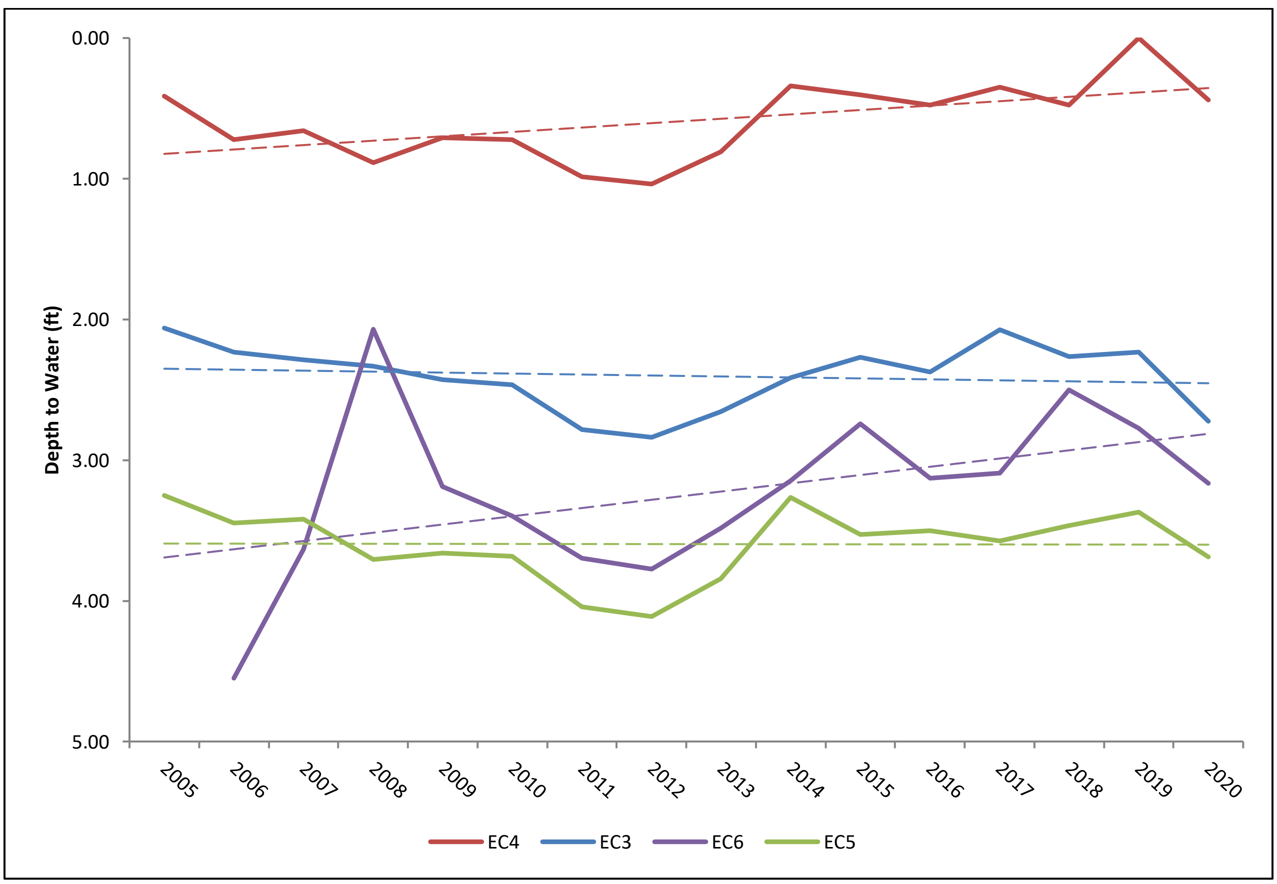

Figure 20. Eagle Creek historical trends. Values are yearly averages and include all values taken within the year.

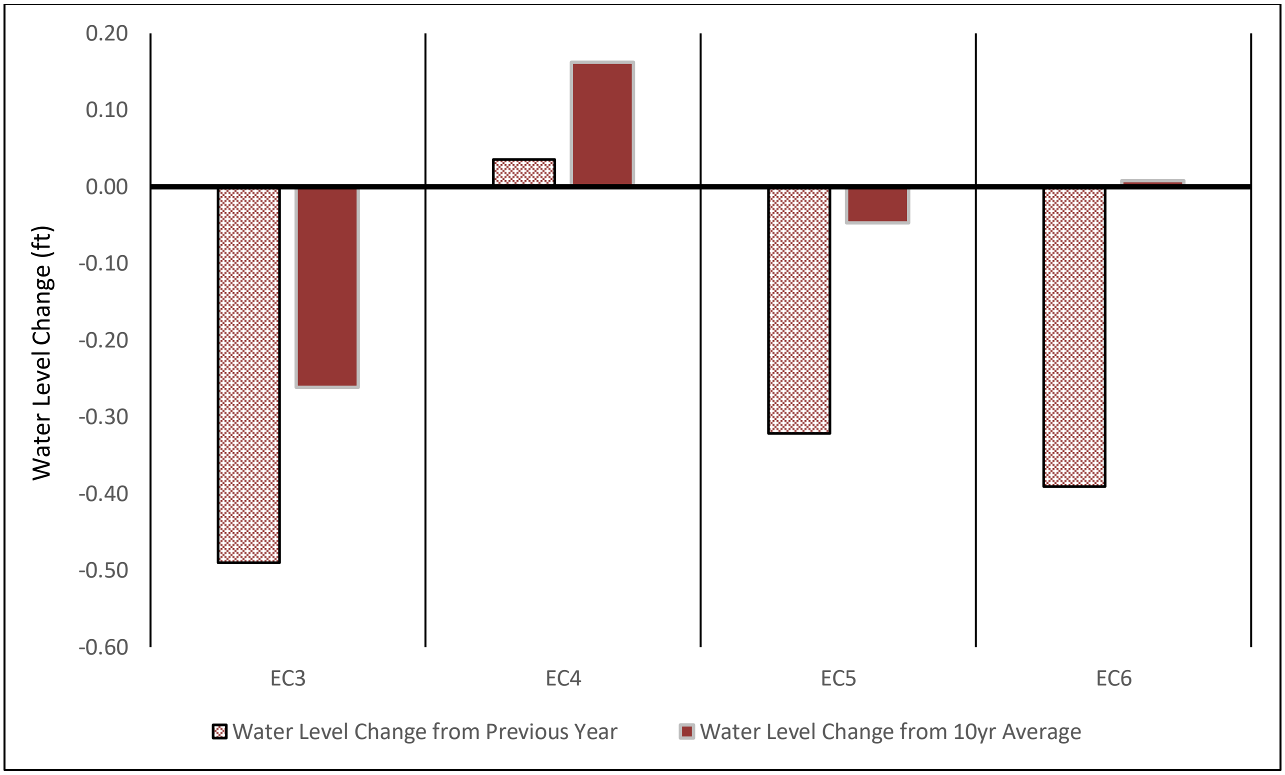

Figure 21: The water level changes at each Eagle Creek well when compared with the previous year and the 10yr average depth to water. Average 2020 depth to water levels were used to compare with average 2019 values and 10yr historical averages. No 2019 data was available during the 2019 season for EC4, the well was overtopped or frozen throughout the season. The 2018 averages were used for the EC4 annual comparison.

Discussion

A seasonably dry 2020 led to a decrease in water levels in all of the monitored wells. Although lower seasonal precipitation values can show a change in surface wells, decreased groundwater levels can amplify the lower levels in all the wells. A continual annual increase in the wells from 2012 allowed for the drop in 2020 without having significant implications to historical groundwater levels. There are many factors that can impact groundwater levels in northern Scott County. Seasonally, the amount of snowpack and precipitation throughout the year will determine recharge levels and rates. Other factors like groundwater consumption and surface water re-direction will also impact groundwater levels. Looking forward to the 2021 monitoring season, the MNDNR is considering sealing the Eagle Creek wells and a few of the Savage Fen wells. Depending on their monitoring needs some wells may be limited to the number of measurements available. Continual monitoring of all the available wells in the LMRWD area will provide information on groundwater levels that can provide information on the impacts of water usage and recharge capabilities.

V. References

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