ANNUAL MONITORING REPORT
2014

Prepared for:

Lower Minnesota River Watershed District

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Lower Minnesota River Watershed District

SCOTT Soil & Water Conservation District

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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 2014 and previous monitoring seasons. The monitoring work plan for 2014 included 3 temperature logging locations on Eagle Creek, 1 continuous water monitoring station on Eagle Creek (operated in conjunction with Metropolitan Council Environmental Services (MCES) Watershed Outlet Monitoring Program (WOMP)), 18 observation wells located in the Savage Fen area, and 1 water monitoring station on the Inlet to Dean Lake (DLI).

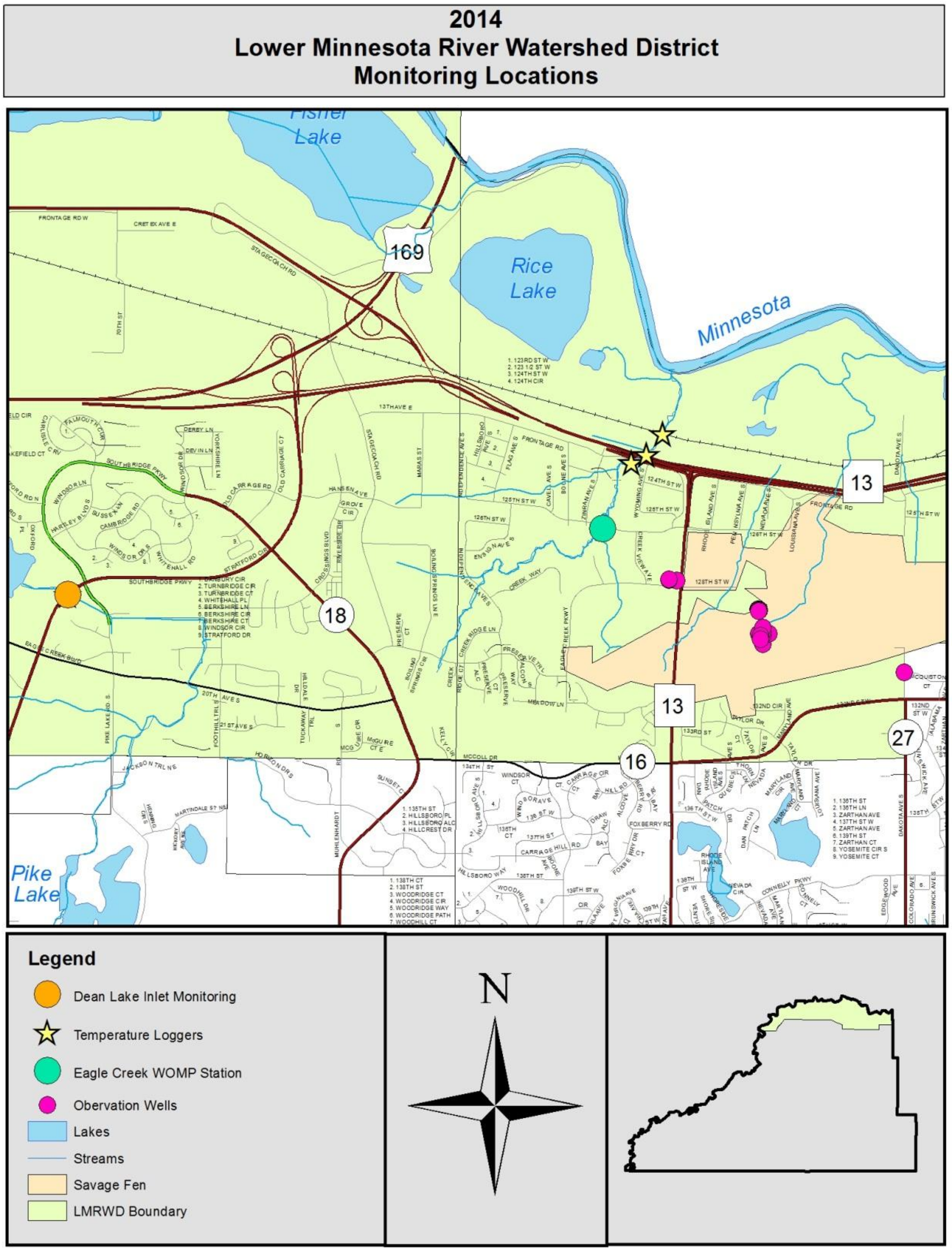

Figure 1. Monitoring Location Map

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 of Eagle Creek, a DNR 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 by Bonestroo in June of 2006 (Figure 2), 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. The loggers record continuous temperature data in 15-minute intervals. Scott Soil and Water Conservation District (SWCD) contracts with the LMRWD to collect and report the temperature data. Rainfall data used for this report is taken from the Shakopee Mdewakanton Sioux Community (SMSC) rain gauge located in Shakopee.

Results

Under most conditions, temperature results track atmospheric temperatures. During winter months, the downstream water is cooler because it is exposed to cold air longer than upstream water. During summer months, the downstream water is warmer because it is exposed to warm air longer.

Figure 2. Location of temperature loggers and WOMP station.

During warm summer days, water temperatures occasionally exceeded the optimal range for trout, but for only a few hours at a time. This is likely due to warmer air temperatures (Figure 3 and **Figure 5**). Noticeable warming of water temperatures downstream of highway 101 occured following some rain events. The upstream logger did not respond as drastically (Figure 4). This downstream warming may be caused by warm stormwater from the pond located between Highway 101 and the railroad tracks discharging into the stream after a storm event. The downstream temperature logger is located approximately 30 feet downstream of this input. This pond holds water which is likely warmed by a combination of solar energy and storm water inflow from the area south of Hwy 101. Large amounts of warm water may be released during rain events as the pond fills and overflows. An investigation was conducted on August 19, 2009 during a 2-inch rain event at numerous temperature monitoring locations on Eagle Creek upstream and downstream of the pond tributary, including the tributary itself. The temperature of Eagle Creek rises almost 2°C directly after the tributary discharges into Eagle Creek. The tributary water is almost 5°C higher than Eagle Creek. According to this study, temperature spikes appear to be due less from direct Highway 101 runoff, but rather more significantly, a combination of the warm ponded water, runoff from Highway 101, and an increase of water volume leaving 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. 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.

In the spring of 2014 the midstream temperature logger experienced a malfunction. Upon discovery, the unit was brought inside to be examined and was unable to be placed back in the stream until August. The Eagle Creek watershed recorded record flooding in June, during this time the flooded Minnesota River backed up into Eagle Creek. Temperature loggers recorded lower than normal temperatures during this time.

Conclusions and Recommendations

A streambank improvement project was implemented in the spring of 2013 by the Minnesota Department of Natural Resources. Approximately 2705 linear feet of streambank was narrowed to improve Trout habitat upstream of the temperature loggers, along the West Branch of Eagle Creek. This stretch of stream was previously wide, shallow and sunny which created potential temperature increases that are harmful to Brown Trout. By continuing monitoring efforts, the opportunity exists to track the influence of the upstream habitat improvements as well as the effects of the stormwater holding pond downstream of Highway 101.

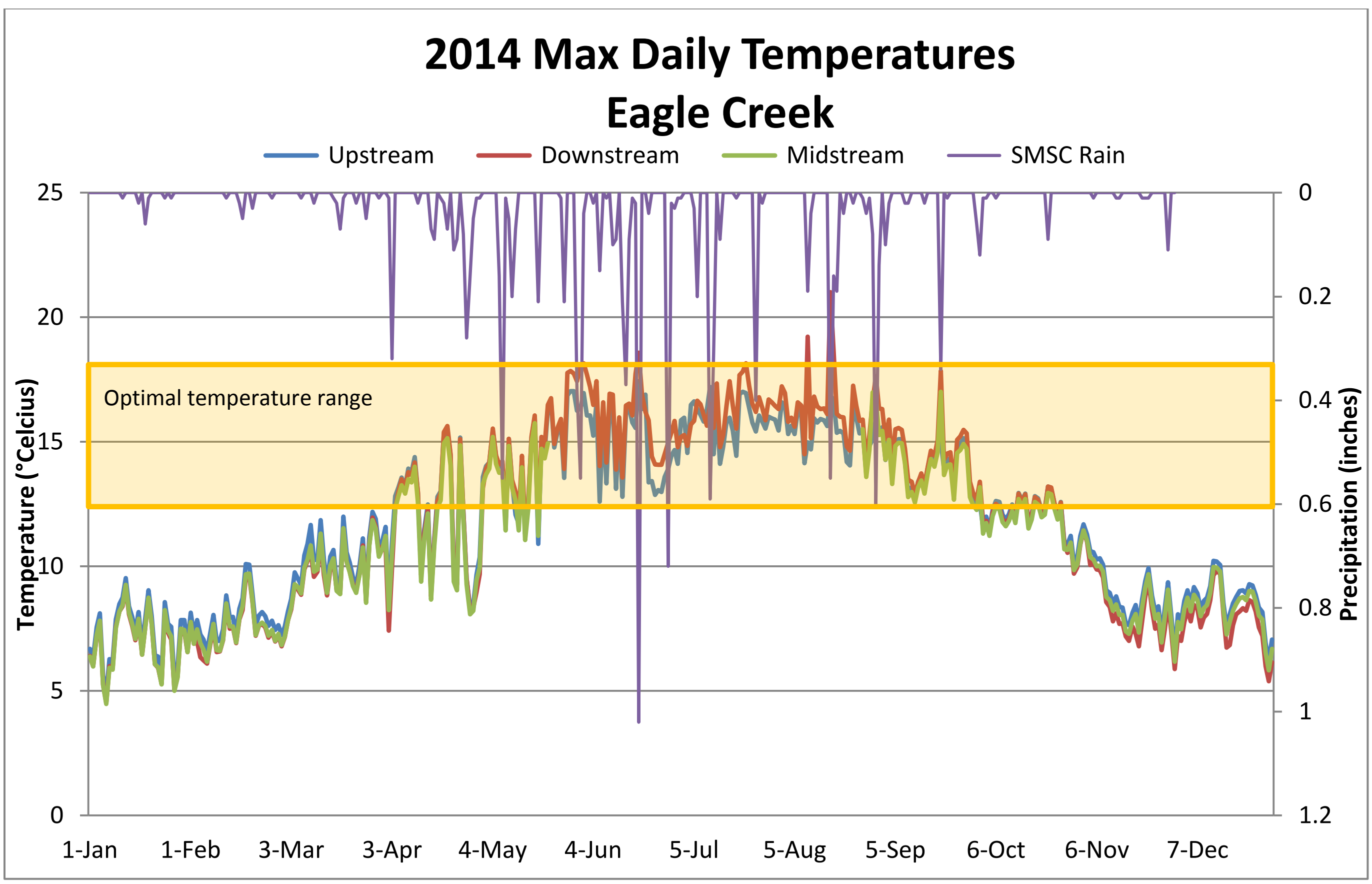

Figure 3. 2014 Maximum daily temperatures.

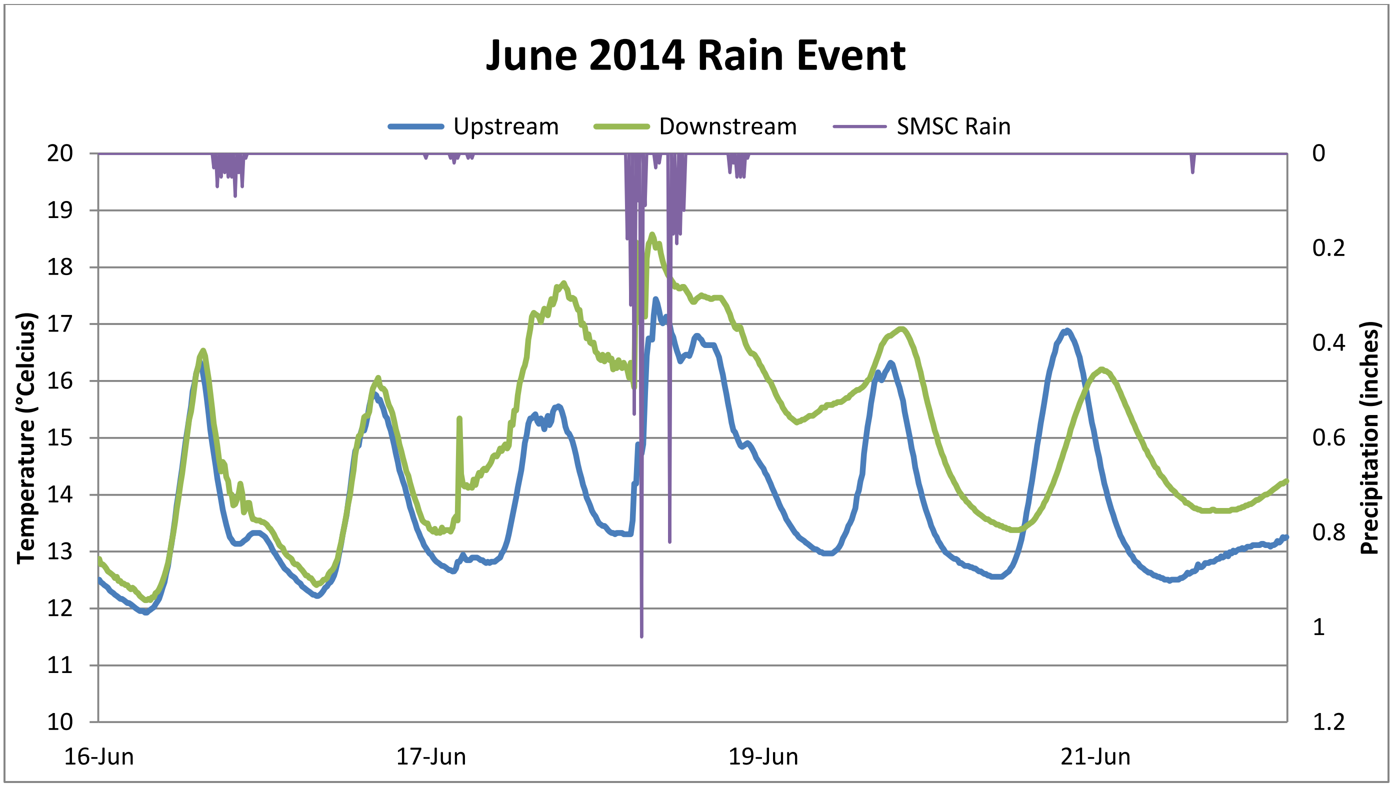

Figure 4. Eagle Creek rain event.

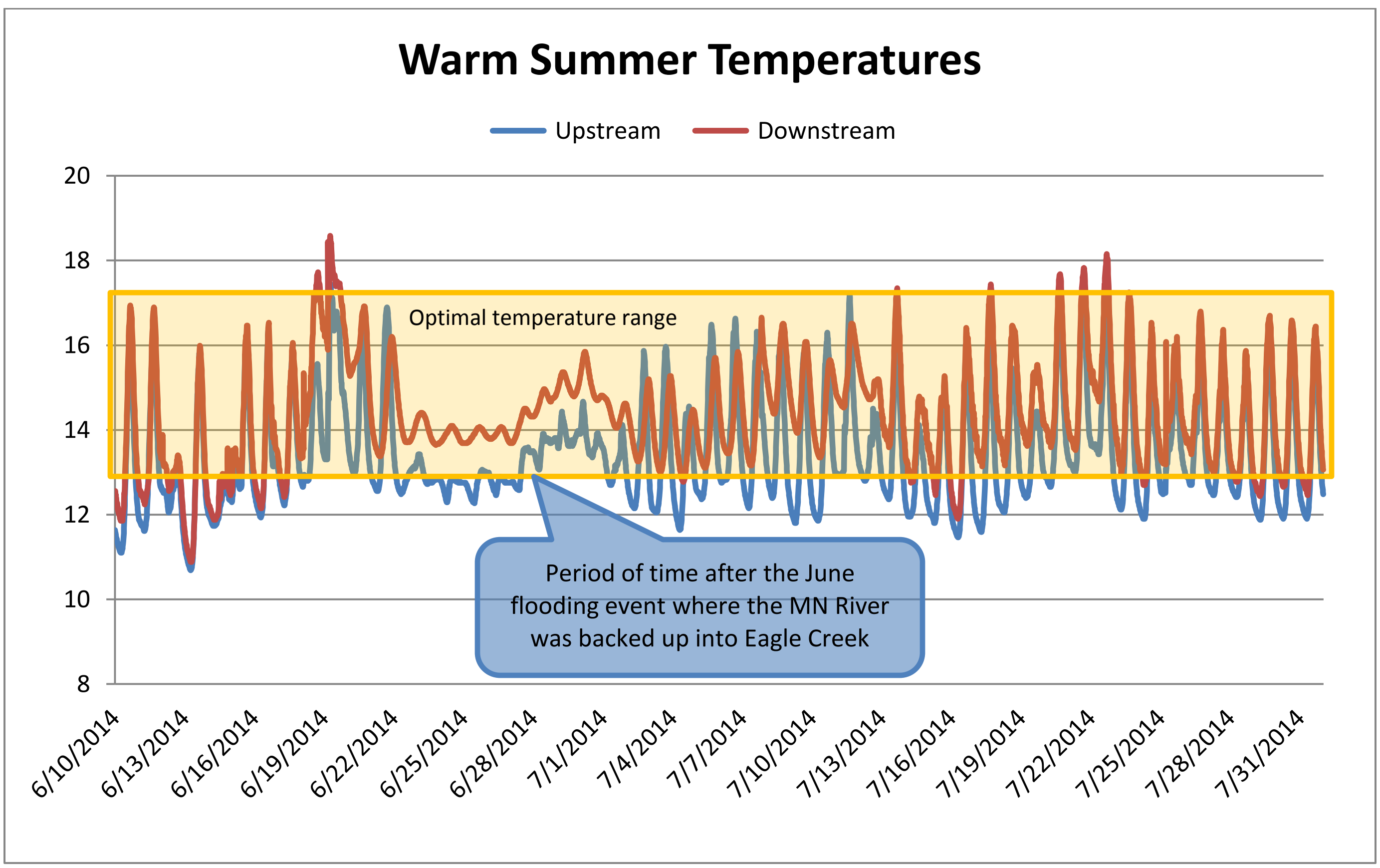

Figure 5. Warm summer temperatures.

II. Watershed Outlet Monitoring Program

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 stormwater 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.

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 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	2014 Precipitation* (inches)	30 year precipitation average**
January	0.83	0.73
February	1.100	0.62
March	0.880	1.73
April	6.33	2.53
May	3.71	3.69
June	12.55	4.64
July	4.03	3.49
August	3.13	5.05
September	1.5	3.41
October	1.07	2.47
November	0.44	1.64
December	1.080	0.95
Total	**36.65**	**30.95**

*Precipitation data obtained from volunteer rain gauge monitor in Prior Lake.
** The 30 year average (normal) is from 1981-2010, National Climatic Data Center, Station: 214176 JORDAN 1 S, MN.
http://www1.ncdc.noaa.gov/pub/data/normals/1981-2010/products/station/USC00214176.normals.text

Methods

Sampling

Samples are collected and analyzed for multiple parameters (
Table 2) 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. Composite samples are collected automatically during rainfall or snowmelt events using an automated sampler and datalogger. The sampler starts collecting water when the stream level (stage) rises above a predetermined activation stage set in the datalogger program. It continues to take a sample each time a fixed volume of water has passed the station. After 48 samples have been collected or the water level has dropped below the activation stage, the sampler automatically shuts off. This composite event sample is then brought to the lab for analysis. Four composite samples and eleven base flow grab samples were collected in 2014.

Due to a short holding time for analysis (eight hours), *E. Coli* samples are not able to be analyzed directly from the composite sample. Instead, four separate *E. Coli* grab samples were taken directly from the stream when collecting composite samples and are included in the hydrograph as grab samples (Figure 6).

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, 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

Many parameters are recorded continuously at the Eagle Creek WOMP station including stage, flow, conductivity, precipitation, and stream temperature. Water quality samples are collected monthly during base flow conditions and also during storm events. Monitoring data suggests that Eagle Creek consistently meets state water quality standards and ecoregion means[1], with the exception of bacteria, turbidity, and suspended solids (Table 1
Table 2). 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 higher bacteria, sediment, and turbidity levels than observed in summer months (Figure 7, Figure , Figure 8, and Figure 9). There was also a one-time dissolved oxygen measurement below the 7 mg/L standard (6.88 mg/L on 7/22/14)

[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.

The *Escherichia coli* standard is applicable from April 1 – October 31 and is exceeded when greater than 10% of the samples exceed 1260 Colony Forming Units per 100 ml (CFU's) *or* the geometric mean of no fewer than five samples in a calendar month exceed 126 CFUs. None of the samples exceeded 1260 CFU's from April through October (Figure 8). However, the geometric mean of the previous five *E. coli samples* exceeded 126 CFU's for June and September (Figure 9).

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. This year, Eagle Creek exceeded 10 mg/L in 9 of 15 (60%) lab samples (Figure 7). All of the TSS exceedances were sampled during events or winter months.

It is important to note that conclusions based on monitoring data for Eagle Creek are influenced (i.e. biased) by the relative percentage of samples collected during and immediately after storm events. For instance, 4 of the 15 (27%) samples were collected during events, and 60% of samples exceeded TSS standards. This bias is a result of the monitoring protocols specifically used at the Eagle Creek station. As stated, these protocols were designed to enable the Metropolitan Council to calculate pollutant loads to the Minnesota River. In order to assign load values, it is best to collect many storm event samples. Different protocols are typically used for assessing whether or not a particular water body meets state water quality standards. Therefore, caution must be used when attempting to characterize the condition of Eagle Creek based on data collected through this project.

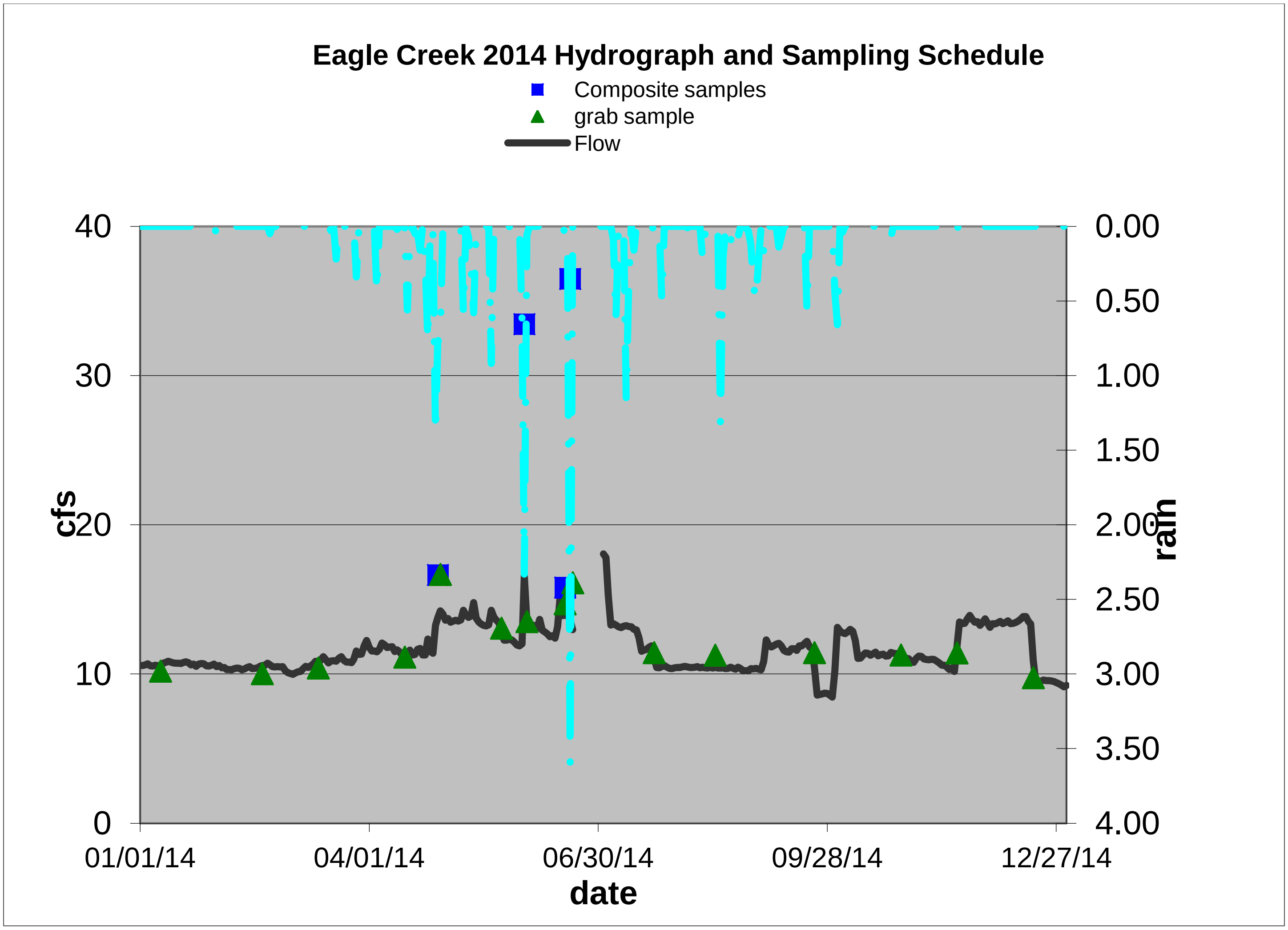

Figure 6: Flow, Precipitation, and Sample Schedule. Data is preliminary. Graph courtesy of MCES.

Table 2. Water quality preliminary results. Red, bolded text indicates exceedance of the state standard or NCHF ecoregion mean.

Parameter	MIN	25th %	AVG	75th %	MAX	Samples	Notes
Chloride (mg/L)	24.6	43.3	44.4	47.4	71.7	15	State standard = 230 mg/L
Conductivity (mMHOs)	447	640	626	654	672	17	
pH	7.06	7.52	7.69	7.88	8.36	12	
Total Alkalinity (mg/L)	176	259	255	272	283	15	No standard. 20 - 200 mg/L typical. Less than 10 mg/L indicate poor buffer capacity.
Hardness (mg/L)	300	309	318	324	336	10	
Calcium (mg/L)	71.3	76.7	78.7	82.5	82.9	3	
Magnesium (mg/L)	24.9	26.8	27.5	28.9	29.0	3	
Sulfate, Dissolved (mg/L)	14.7	20.2	21.6	23.3	30.3	14	
Dissolved Oxygen (mg/L)	6.88	8.14	8.60	9.24	9.54	11	State standard = 7 mg/L
COD (mg/L)	5	9	19	19	74	15	
E. coli Bacteria Count (CFU/100ml)	5	30	367	178	2420	13	State standard = 126 CFU/100ml as geometric mean
Chlorophyll-a	1.0	1.3	2.8	3.0	7.4	11	

(ug/L)							
Total Kjeldahl Nitrogen (mg/L)	0.15	0.24	0.46	0.48	1.80	12	
Ammonia (mg/L)	0.02	0.03	0.05	0.07	0.10	15	
Nitrate (mg/L)	0.08	0.11	0.14	0.15	0.29	15	Ecoregion mean = 0.04-0.26 mg/L
Nitrite (mg/L)	0.03	0.03	0.03	0.03	0.03	15	Ecoregion mean = 0.04-0.26 mg/L
Total Phosphorus (mg/L)	0.020	0.027	0.067	0.085	0.271	12	Ecoregion mean = 0.13 mg/L. EPA recommends < 0.1 mg/L.
Total Dissolved Phosphorus (mg/L)	0.02	0.02	0.02	0.02	0.03	15	
Ortho Phosphorus, Dissolved (mg/L)	0.01	0.01	0.01	0.01	0.02	14	
Total Suspended Solids (mg/L)	3	5	35	31	226	15	New standard = 10 mg/L
Volatile Suspended Solids (mg/L)	1	2	8	9	46	15	
Total Organic Carbon (mg/L)	2.4	2.8	3.6	3.9	7.7	15	
Transparency (cm)	14	63	78	100	100	15	
Lab Turbidity (NTRU)	5	6	17	16	75	15	Turbidity standard replaced by TSS
Field Turbidity (FNU)	0.0	4.4	14.1	18.8	64.9	12	Turbidity standard replaced by TSS

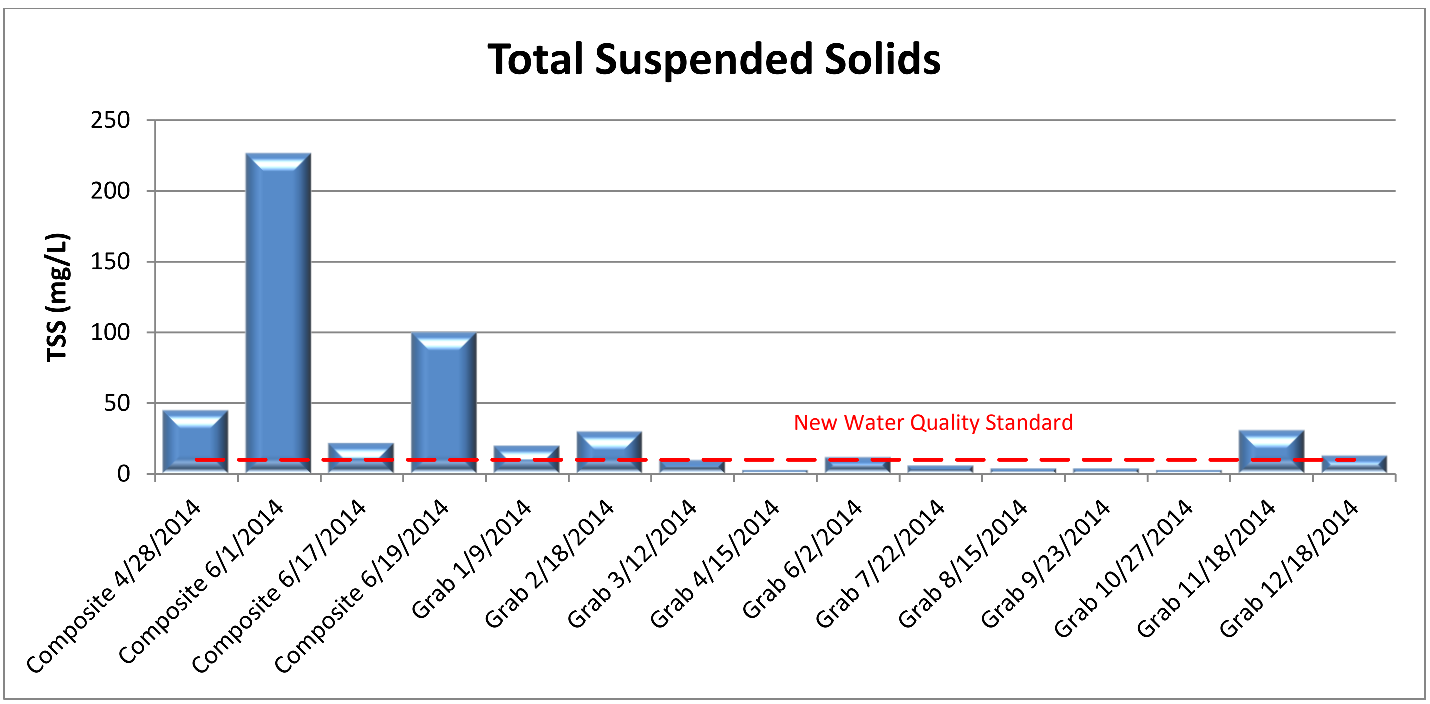

Figure 7. Total Suspended Solids. New TSS State Standard for Class 2A Waters = 10 mg/L with no more than 10% exceedance.

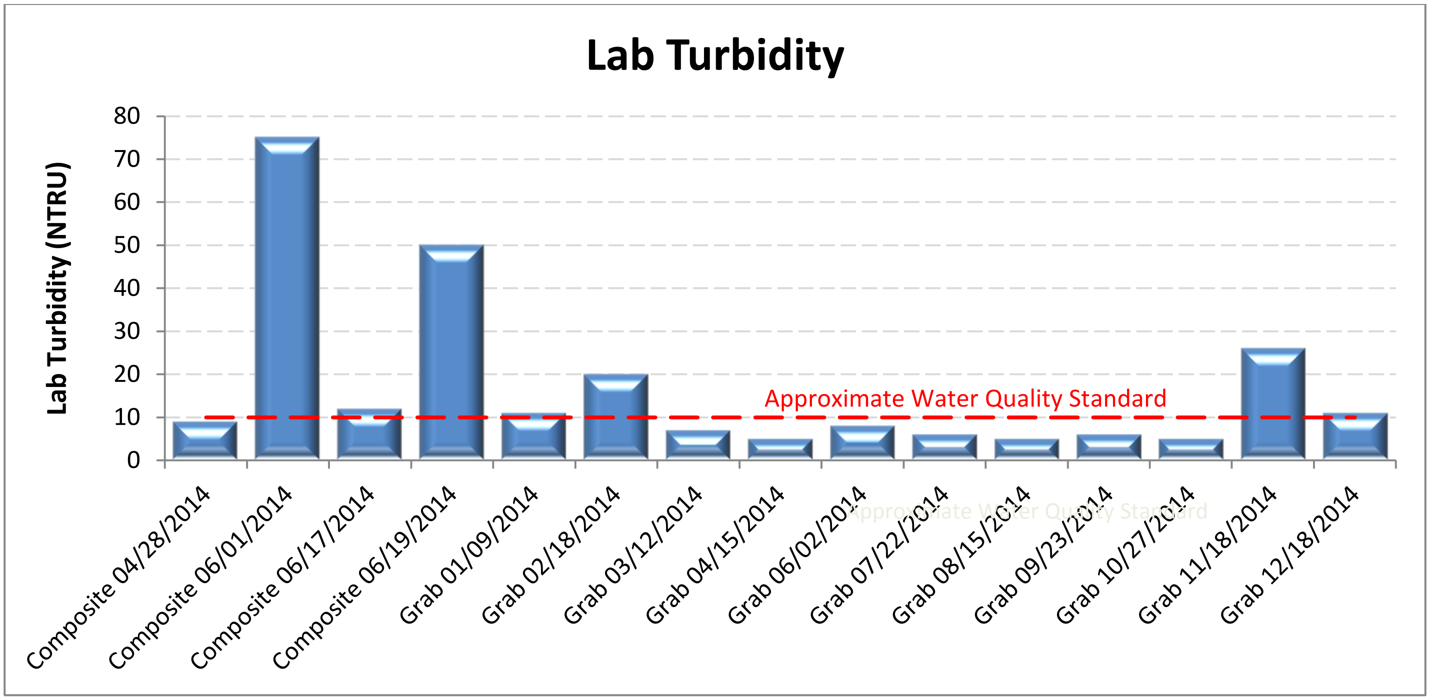

Figure 8. Lab Turbidity**.** The orange line indicates an approximate of the previous turbidity standard. Because turbidity was measured in Nephelometric Turbidity Ratio Units (NTRU), rather than Nephelometric Turbidity Units (NTU), the standard of 10 NTU's could not directly apply. Turbidity standards have been replaced by TSS starting in 2015.

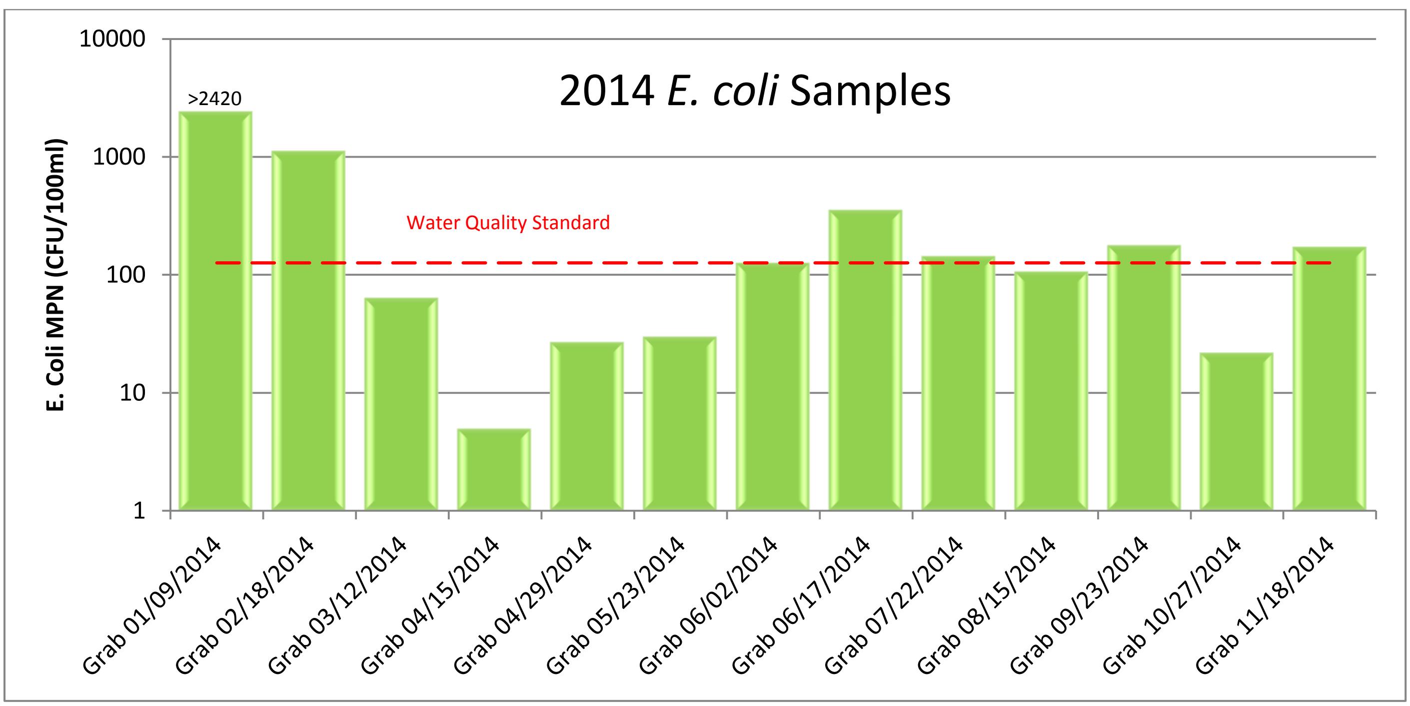

Figure 8. *E. coli* in 2014 samples. E. coli state standard for class 2A waters is not to exceed 126 organisms/100 ml as a geometric mean of not less than 5 samples representative of conditions within any calendar month. Nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 organisms per 100 ml. The standard applies only between April 1 and October 31.

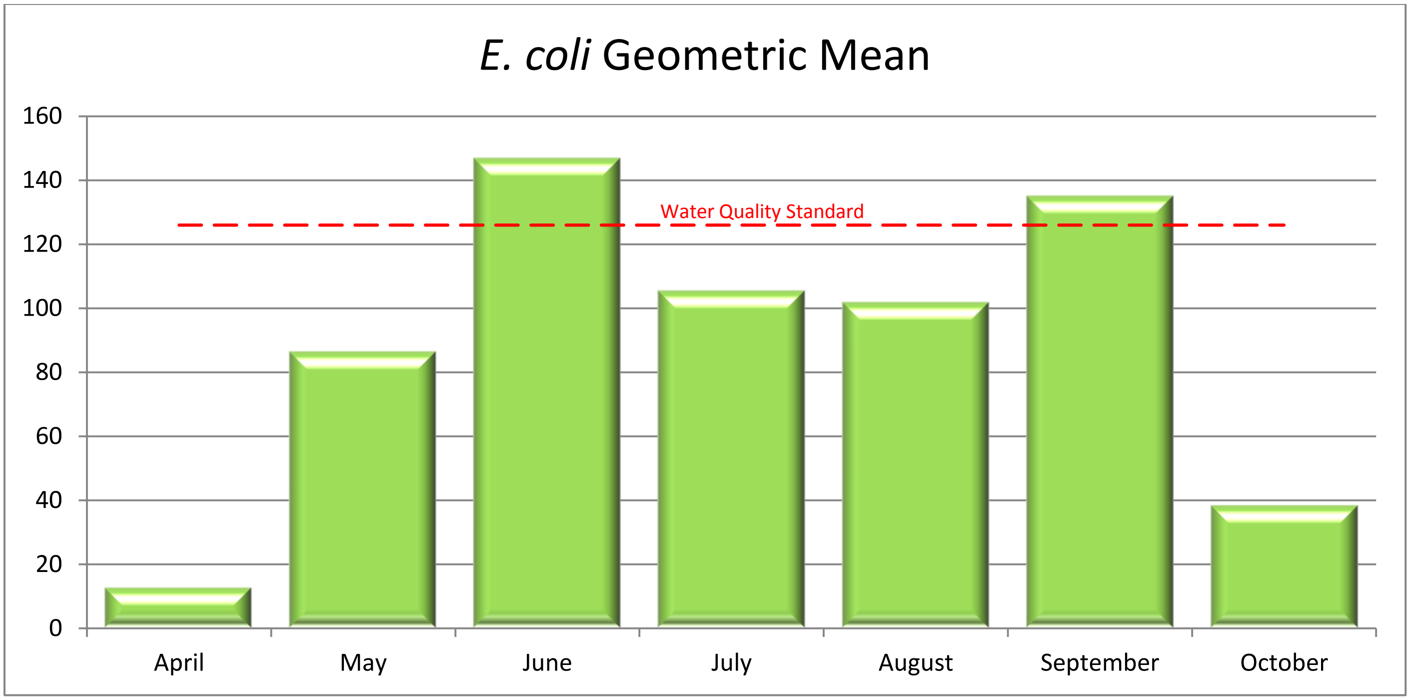

Figure 9. Geometric mean of *E. coli* at Eagle Creek. The geometric mean was calculated using the last 5 samples taken within any given month. Samples date back to 2010 for months August through October, 2011 for July, and 2012 for April through June. *E. coli* state standard for class 2A waters is not 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. While no individual measurement exceeds 1,260, June and September exceed the chronic 126 standard.

III. Dean Lake Inlet Monitoring

Dean Lake is identified as a priority management area by the LMRWD. It was placed on the Minnesota Pollution Control Agency's (MPCA) 303 (d) list of impaired waters in 2006. It is impaired for Aquatic Recreation due to excess nutrients causing eutrophication. In an effort to gather more data, the LMRWD has contracted with Scott SWCD 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. Scott SWCD also monitors water quality downstream of Dean Lake through a surface water assessment grant from MPCA. This downstream site is part of the "watershed restoration and protection strategy" (WRAPS) process of assessing major watersheds in Minnesota. Prior Lake Spring Lake Watershed District is contracting Scott SWCD to expand its 2015 monitoring of Dean Lake Inlet to include soluble reactive phosphorus and six *E. coli* samples.

Methods

In-stream field measurements of dissolved oxygen, temperature, turbidity, pH and conductivity were taken using a Hach MS5 Multiprobe Sonde. Field transparency was measured with a secchi tube. In 2014, 1 snowmelt, 15 base and 4 event grab samples were collected totaling 20 samples. Samples were collected on a biweekly schedule, with additional event grab samples taken after rain events. In order to develop a rating curve used to calculate discharge, flow and stream stage measurements were taken at the monitoring site.

Results

The first year of monitoring data suggest that the inlet to Dean Lake meets water quality standards in most cases with the exception of Nitrates and TSS. See results in table 3.

Table 3. Red, bolded text indicates exceedance of the state standard or NCHF ecoregion mean.

Parameter	MIN	25TH %	AVG	75TH %	MAX	MEDIAN	SAMPLES	Notes
Chloride (mg/L)	38.80	45.03	51.69	55.90	73.80	49.55	22	State standard = 230 mg/L.
Nitrate (mg/L)	0.06	0.13	0.41	0.64	1.34	0.19	22	Ecoregion mean = 0.04-0.26 mg/L
Nitrite (mg/L)	0.03	0.03	0.03	0.03	0.03	0.03	22	Ecoregion mean = 0.04-0.26 mg/L
Dissolved Phosphorus, Filtered (mg/L)	0.01	0.02	0.04	0.05	0.10	0.03	22	
Suspended Solids (mg/L)	2.00	6.25	12.95	17.00	37.00	11.00	22	New Standard Class 2B = 30 mg/L
Total Kjeldahl Nitrogen (mg/L)	0.49	0.92	1.03	1.10	1.60	0.98	22	
Total Phosphorus (mg/L)	0.04	0.06	0.09	0.09	0.17	0.08	22	State standard is 0.1 mg/L.
Lab Turbidity (NTRU)	2.00	5.25	8.64	9.75	27.00	6.00	22	
Volatile Suspended Solids (mg/L)	1.00	2.00	3.36	4.00	7.00	3.00	22	

III. Well Monitoring

In 2005 the LMRWD contracted with Scott Soil and Water Conservation District to collect groundwater measurements from 12 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://climate.umn.edu/ground_water_level/.

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

Scott SWCD monitors 12 wells in the Savage Fen and four Eagle Creek wells just outside of the Fen monthly from April to November (figure 11). The water level fluctuates throughout the year and many of the wells record water levels above ground.

In 2010 the Savage Post Office and Fire Department were constructed near the bluff wellheads and as a result, the wellheads were reconstructed and placed below the street, accessible by a manhole cover. The bluff wells were not read in 2011 or 2012 as a result of the construction. In May of 2013, SWCD monitoring staff along with MN DNR Hydrologist Michael MacDonald and City of Savage Utility Services Superintendent Michael Klimers toured the groundwater wells in the Savage area to discuss changes and repairs that were needed. As a result of the meeting, the bluff wells were monitored again in 2013 and 2014 by the SWCD with the assistance of City of Savage staff that coordinated the opening of manhole covers monthly for readings.

In addition, four wells are monitored in the Eagle Creek portion of Savage Fen (figure 13). The cap on well # 4 became stuck half way through the 2014 season and measurements for August, September, and October were missed for that well.

Results

Savage Fen water levels followed a seasonal pattern with a slight decrease in midsummer and then increase in the fall (figure 11). Average Savage Fen well levels in 2014 were slightly lower (0.19 feet) than in 2013 but the trend since 2010 seems flat (figure 12). The 2014 Eagle Creek well levels decreased sharply from June to July and then stabilized through fall (figure 13). Eagle Creek average well water depth decreased from 2010 to 2012 and then increased through 2014 to the highest levels over the past five years (figure 14).

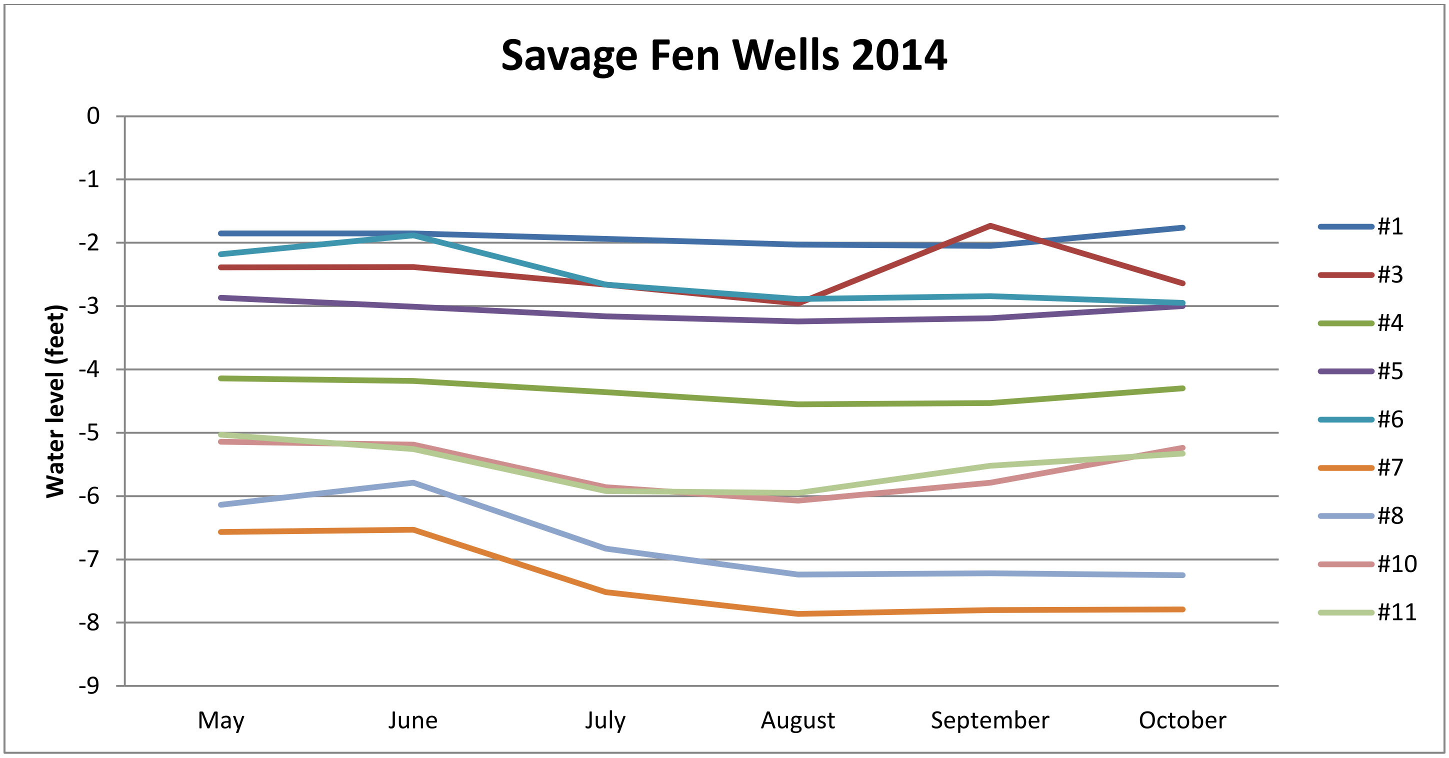

Figure 11. Savage Fen wells (2014). One measurement was taken during each month for each well. The water level is reported in relation to ground level.

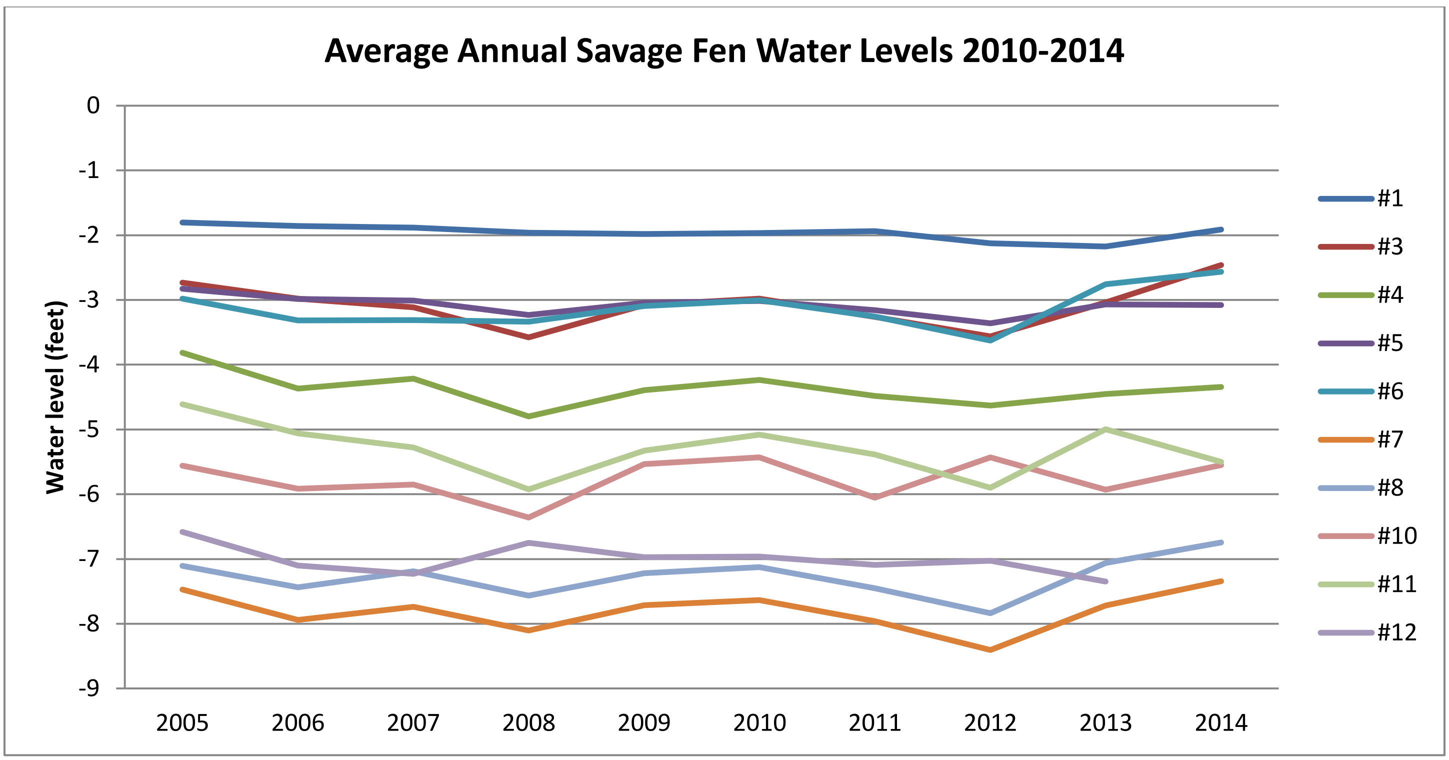

Figure 12. Average annual water level in Savage Fen wells (2005-2014). Averages include all observations in a calendar year. Water levels are reported in relation to ground level.

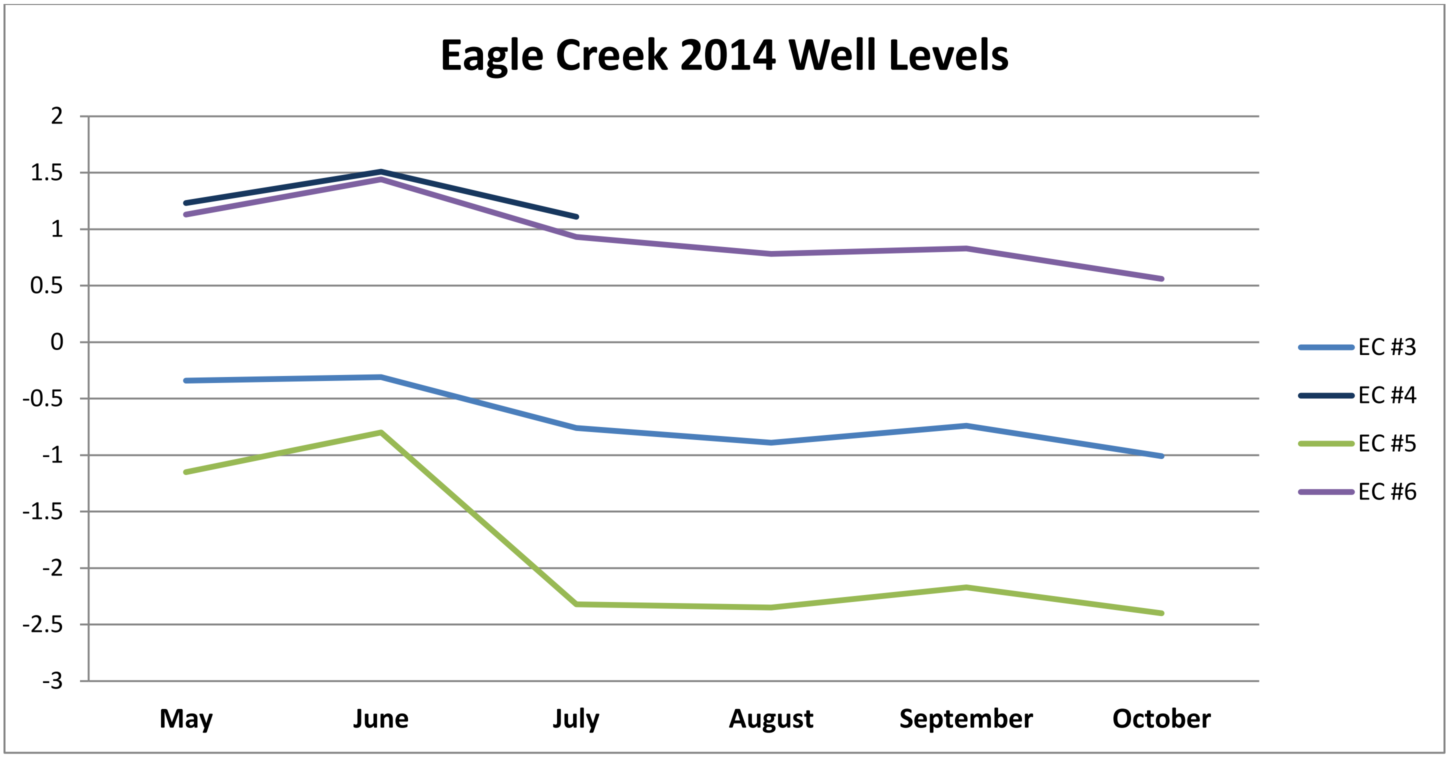

Figure 13. Eagle Creek 2014 well water levels. One measurement was taken in each month for each well. Water levels are reported in relation to ground level.

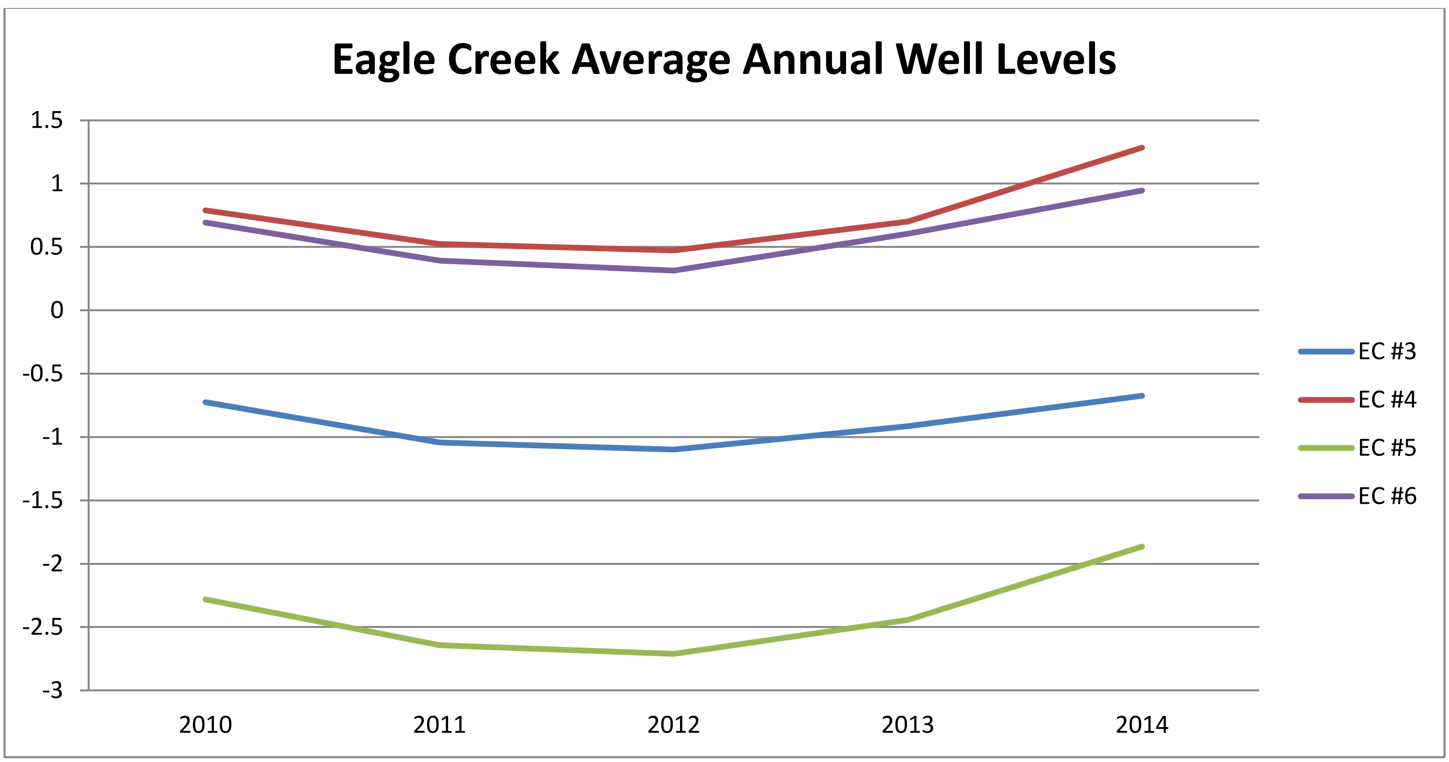

Figure 14. Average annual Eagle Creek well levels (2010-2014). Averages include all observations in a calendar year. Water levels are reported in relation to ground level.