

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
WATER RESOURCES DIVISION
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STAFF REPORT

Bacterial Monitoring Results for Michigan Rivers and Streams: 2020

1 Introduction

Staff from the Michigan Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division (WRD), and its contractors, collected samples from 113 sites on rivers and streams throughout the Lower Peninsula of Michigan and 14 sites in the Upper Peninsula of Michigan in 2020 (Figure 1; site locations are described in Appendix 1). Samples from these sites were analyzed for *E. coli* on a weekly basis, for 1-5 weeks, and results are shown in Appendix 2. Site locations and data summaries can be viewed on EGLE's interactive map, accessible through Michigan.gov/EcoliTMDL (click on the image of the map and visit the “*E. coli* Monitoring” tab). Monitoring objectives were to:

1. Assess the current status and condition of individual waters of the state and determine whether the Total Body Contact (TBC) and Partial Body Contact (PBC) designated uses are being met. Michigan is committed to assessing the waters of the state to determine the attainment status of the designated uses. All data will be considered in the upcoming 2022 Clean Water Act Sections 303(d) and 305(b) lists.
2. Conduct microbial source tracking (MST) in impaired priority waters.
3. Obtain screening level dissolved oxygen (D.O.) and Total Dissolved Solids (TDS) measurements, as well as conductivity, turbidity, temperature, and pH data to assist in interpretation of water quality data.

2 Water Quality Standards (WQS)

2.1 *E. coli*

Michigan's designated use rule states that all water bodies shall be protected for TBC recreation from May 1 through October 31 and PBC recreation year-round (Rule 100 [R 323.1100] of the Part 4 Rules, WQS, promulgated pursuant to Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended). To maintain these designated uses, Michigan has established ambient *E. coli* WQS in Rule 62 of the Part 4 Rules.

E. coli is a type of bacteria (single cell organism) that is used as an indicator of the presence of fecal contamination in surface water, such as lakes, streams, and wetlands. Ensuring that waters meet the *E. coli* WQS also ensures that other disease-causing microorganisms (pathogens) are kept below harmful levels. Pathogens in a stream or lake can infect humans through ingestion or skin contact, resulting in diseases such as gastroenteritis, giardia, hepatitis, or cholera.

The WQS of 130 *E. coli* per 100 milliliters (mL) as a 30-day geometric mean, and 300 *E. coli* per 100 mL as a daily maximum are established to protect the TBC use from May 1 through October 31. To protect the PBC use (year-round), 1,000 *E. coli* per 100 mL as a daily maximum is used.

2.2 D.O.

D.O. minimum WQS are described in R 323.1064 of the Part 4 Rules and rely upon the coldwater and warmwater fishery designations set forth in the 1997 Michigan Department of Natural Resources (MDNR) Directors Order DFI-101.97 (MDNR, 1997). In surface waters of the state designated to protect coldwater fish, the D.O. shall not fall below a minimum of 7 milligrams per liter (mg/L). In the remainder of streams, the WQS is a minimum of 5 mg/L, to protect warmwater fish species. D.O. results (with violations of the minimum WQS highlighted) and the coldwater or warmwater designations are found in Appendix 3. D.O. is lowest before sunrise because plants and microorganisms respire (and do not photosynthesize) throughout the night using up oxygen. Photosynthesis begins at sunrise releasing and replenishing oxygen.

3 **Sampling Methods**

3.1 *E. coli*

Each *E. coli* sampling event consisted of 3 samples taken at representative locations within a defined sampling area. In a flowing water body, these locations are referred to as left, center, and right. The center sample was collected in the spatial center of the stream, the right sample was collected midway between the center and the right bank, and the left sample was collected midway between the center location and the left bank. Care was taken to ensure that all samples were collected in the moving portion of the stream, avoiding stagnant areas near the banks, debris dams, or pilings. Samples were collected directly from the stream, just below the surface, into sterile wide-mouthed polypropylene bottles. Collection occurred using a sampler lowered from the bridge by a rope or by wading in and sampling upstream of the body. Care was exercised to avoid the surface microlayer of water and bottom sediment layer, both of which may be enriched in bacteria and not representative of the water column. Clean latex gloves were worn and replaced after sample collection at each site.

Field blanks were collected at a minimum of once per sampling date (target rate of 5 percent), by filling a sample bottle with deionized water in the field at a randomly selected site. Duplicates were taken by collecting a larger volume of sample and pouring alternately between the sample bottle and the duplicate bottle (target rate of 10 percent of events). At randomly selected events and sites, duplicates were collected for the left, center, and right samples at the same sampling event (date and location). For example, the first sampling event at Site 1 was randomly selected for quality control sampling, and duplicates were collected for left, center, and right samples resulting in 6 samples (L, C, R, L^{dup}, C^{dup}, and R^{dup}). These sample results were used to calculate a daily geometric mean (DGM) to be used in comparison with the daily TBC WQS, and the duplicate results were used to calculate a geometric mean for quality assurance (DGM^{dup}). Samples were submitted to the analytical laboratory within the 6-hour bacterial hold time and chain-of-custody was maintained at all times.

Precipitation data for the 24 hours and 48 hours prior to each sampling event are recorded in Appendix 2, and graphed in Appendix 5, and were obtained from nearby weather stations (Michigan State University (MSU) Extension, 2021). Where possible, the relative water level was determined at each sampling event by measuring the distance in centimeters from a set point on the bridge or culvert to the surface of the river using a weighted metal tape (Appendices 4 and 5) (Figure 2).

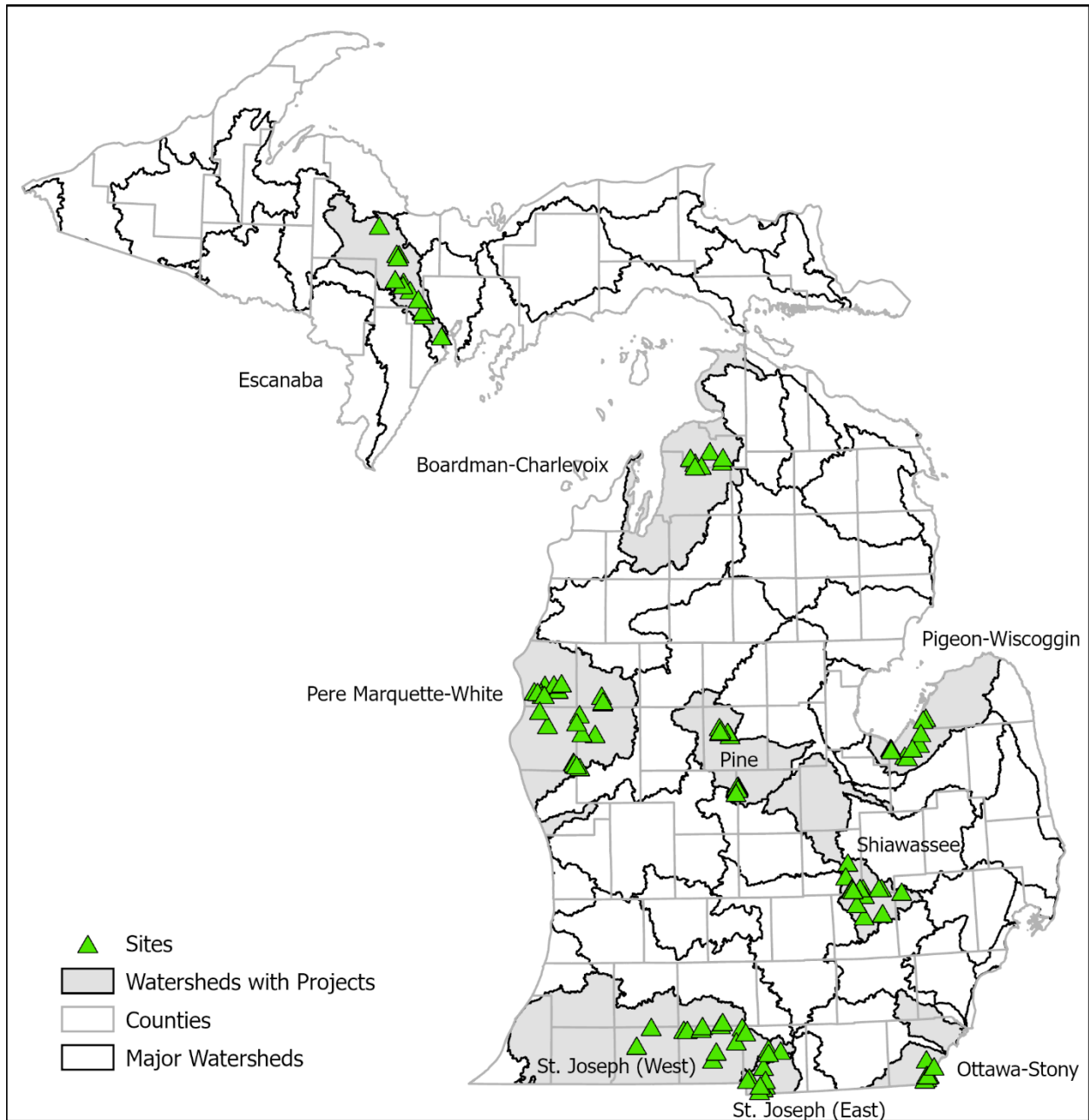


Figure 1. Site locations for *E. coli* and D.O. monitoring in 2020.



Figure 2. Mark on culvert for determining the relative water level. Measurements are from this point to the water's surface and were recorded on each sampling visit.

3.2 MST

For the source tracking studies, samples were collected using different methods. For the Escanaba, Boardman Charlevoix, Ottawa-Stony, and Pere Marquette testing, an MST sample volume (200 mL) was collected from the center portion of the stream, and an additional 100 mL of that sample was analyzed for *E. coli*. The MST portion was filtered and frozen according to the MSU laboratory's standard operating procedures, then shipped to the laboratory on dry ice. For the Shiawassee study, a large sample volume was collected from the center portion of the stream in a sterile bottle (1 L) and 100 mL was poured off to be analyzed for *E. coli*. The remaining volume was then taken directly to the MSU laboratory where MSU staff filtered and froze them according to their protocol. Chain-of-custody was always maintained for all MST samples. The following markers were used:

Marker	Type	Literature Source
<i>Bacteroides thetaiotaomicron</i> (<i>B. theta</i>)	Human	Yampara-Iquise et al., 2008
HF183 (<i>Bacteroidales</i>)	Human	USEPA, 2019
CowM2	Bovine	Shanks et al., 2008
Pig-2-Bac (<i>Bacteroidales</i> 16S rRNA)	Porcine	Mieszkin et al., 2009

3.3 D.O. and Other Parameters

Field water quality parameter measurements were recorded weekly during *E. coli* sample collection using a YSI EXO Multiparameter Water Quality Sonde. Parameters included: D.O., conductivity, turbidity, temperature and pH (not all parameters were collected at all events). The sondes were calibrated weekly following the manufacturer's instructions. Sondes were calibrated for D.O. prior to sampling each day, and other parameters were calibrated once weekly. The D.O. measurements collected during this study were collected between 6:00 a.m. and 1:30 p.m., thereby missing the most critical time for D.O. depletion (just prior to sunrise). Results are contained in Appendix 3.

4 Interpretation of *E. coli* and MST Results

Many environmental factors may affect the concentrations of *E. coli* in surface water, including precipitation, flow, settling of *E. coli* through the water column (particularly in a lake or impoundment), and the mortality of *E. coli* due to the passage of time or exposure to sunlight, proximity to sources, etc. In trying to determine sources of *E. coli* to a sampling site, it is helpful to look at results in the context of precipitation prior to sampling (shown in Appendix 2). When *E. coli* concentrations are high regardless of the weather conditions, the sources may be

different from a location where *E. coli* is only high following rainfall. The results in Appendix 2 are color-coded to indicate TBC and PBC WQS exceedances, as described in Section 2.1.

Dry weather exceedances, or exceedances during low flows, indicate a constant source of *E. coli* is impacting the site, such as failing septic systems, illicit sanitary connections, livestock or wildlife congregating in the water, or shallow groundwater contamination.

Wet weather exceedances, or exceedances during high flows, indicate that the source is flushed into water bodies during precipitation events or inundated during flooding. Examples of wet weather sources include urban or rural storm water, runoff from agricultural fields or pastures, illicit sanitary connections to storm drains or field tiles, accumulated waste (animal or human) in storm drains or on the ground surface, or pet or wildlife waste on lawns or parks.

To assist in determining the sources of *E. coli* to water bodies, MST analysis was conducted for selected sites and projects (Appendix 4). The presence of a host-specific genetic source tracking marker (either human, bovine, or porcine) indicates the presence of a potential source of that type in the sample.

There are a few considerations when interpreting MST data:

1. Deoxyribonucleic acid (DNA), used in MST, may survive wastewater treatment and composting processes. DNA may appear in the sample, while the source bacteria are dead. It is important to consider the presence of wastewater treatment facilities upstream of sites, which would not contribute significantly to live *E. coli* (if in compliance with their permit) but could contribute human MST markers.
2. The MST genetic targets are based on host-specific *Bacteroides* or *Bacteroidales* bacteria, which are very different from *E. coli*. Specificity of each marker is discussed below:
 - Human Markers: Mieszkin (2009) found HF183 was 100% specific to human feces. In a study of human sewage, Aslan and Rose (2013) found *B. theta* had 97% specificity, and HF183 had 71% specificity.
 - Bovine Marker: 100% specificity for CowM2 marker to bovines was found in Shanks et al. (2010), Raith et al. (2013), and Odagiri et al. (2015). However, Shanks et al. (2011) found that bovine bacterial communities vary highly by feedlot and diet, with animals fed a higher percent grain in their diets having less microbial diversity in their feces. The amount of CowM2 in cow feces has been shown to be less in calves (Shanks et al., 2014), which make up about 16.7% of the Michigan cattle population (USDA, 2021).
 - Porcine Marker: Pig-2-Bac (*Bacteroidales* 16S rRNA) has been shown to be 100% specific to pig feces in several studies (Mieszkin et al., 2009; Heaney, 2015; and Xu et al, 2020). However, false positives (less than 100% specificity to pigs) may be possible, with a Peruvian study finding false positives in dog and goat feces (Schiaffino et al., 2020) and a Spanish study finding cross reaction with cattle and poultry (Gómez-Doñate et al., 2016), possibly attributed to regional genetic differences.
3. Persistence: DNA degrades over time, once the host cell is dead. The decay occurs at variable rates due to many factors, including the taxa of the MST target; sunlight; substrate where the bacteria are residing (water vs. sediment); and ambient temperature (Murphy, 2018). For example, DNA may persist up to 6 times longer in freshwater sediments than in the water column above (Kim, 2015). The detection of a marker with a short persistence time indicates more recent pollution by the host animal. The absence of a marker may indicate that it has decomposed to the point of non-detection, even when *E. coli* levels are still high. The persistence and specificity of the markers used in this study are summarized as follows:
 - Human markers: *B. theta* dies almost immediately on exposure to the environment and degrades quickly at summer surface water temperatures. Ballesté and Blanch (2010) found that *B. theta* was 90% non-detectable after 12-15 hours in the spring-summer in

non-sterile river water. HF183, from human specific *Bacteroidales*, is likely slightly more persistent than *B. theta*; 90% non-detectable after 1.05 days in the summer with some still detectable at 2 days (Ballesté et al, 2018). While the time it takes for DNA to degrade by 90% from starting concentrations (known as the T90) is short with these human markers, it is possible that they could be still be detectable for much longer if the initial concentration in the source feces and surface water is high, or if environmental conditions are favorable. Temperature, sunlight, and competition with native bacterial communities have an impact on persistence.

- Bovine marker: Although it is known that CowM2 persists at detectable levels for at least 6 days under controlled outdoor conditions (Korajkic et al., 2019), no T90 data was available.
 - Porcine marker: Porcine specific *Bacteroidales* has been shown to be considerably more persistent than the human *Bacteroides* and *Bacteroidales* markers, with a T90 of up to 10 days in river water (Marti et al., 2011).
4. A non-detect result does not rule out the host animal as a source in the upstream areas. MST markers may not be detected due to decomposition (lack of persistence), dilution below detection levels, the presence of compounds in the sample which inhibit the detection using qPCR techniques (known as 'inhibition'), or the complete absence of the target marker in the sample (a true negative).
 5. Weather at the time the sample was collected, and location of known sources (such as National Pollutant Discharge Elimination System discharges) are important considerations in determining potential sources.
 6. Knowledge of the *E. coli* concentration at the time of sampling assists in interpreting results. Higher bacterial concentrations could be more likely to yield a positive detection, while low bacterial densities would be more likely to result in a non-detect. Additionally, if *E. coli* levels were below the daily maximum TBC WQS, EGLE typically chose not to analyze the source tracking samples.
 7. A false negative occurs when the target marker is not found in the sample (the result is non-detect), but the marker is present. It is not possible to know if a negative result indicates the source is absent from the sample, or if the marker is not detectable due to inhibition, decomposition, or other reason.

5 Quality Control

5.1 Goals

The goals for quality assurance and quality control sampling were:

- Blanks – Field blanks should not contain detectable levels of *E. coli*. The detection level for *E. coli* in surface water is <10 *E. coli* per 100 mL. The target for the number of field blanks collected is 5% of total samples or a minimum of 1 field blank per trip.
- Duplicates - If both the DGM and the DGM^{dup} for a randomly selected event fall below 300 *E. coli* per 100 mL (attainment with the TBC WQS), or conversely, both are more than or equal to 300 *E. coli* per 100 mL (nonattainment with the TBC WQS), then the data are considered acceptable. When the DGM and DGM^{dup} would result in a different attainment decision, then the results of duplicate analyses should be used to calculate a relative percent difference (RPD) between the DGM and DGM^{dup}. The target for the RPD is ≤50 percent. The target for the number of duplicate samples is 10% of samples collected.

5.2 Quality Control Results

The results for quality assurance and quality control in this study were as follows:

- Blanks – All field blanks contained less than 10 *E. coli* per 100 mL (reporting level). Blanks were collected at the minimum of 1 per trip (4.4%).

- Duplicates - Of the 568 sampling events, 52 sampling events (9.2 percent) were randomly selected for duplicate sample collection. The DGM and DGM^{dup} resulted in the same TBC attainment status decision at all of the selected events; therefore, the quality control goal was met. The use of RPD calculations for quality control was not necessary; but, for informational purposes, the average RPD was 16%.

6 Conclusions

6.1 Monitoring Objectives 1 and 2

6.1.1 General Information

Water levels relative to a fixed point (relative water levels) were measured at most sites. Measurements are listed in Appendix 2 and displayed in Appendix 6. The lowest water level recorded at each site was the baseline measurement (represented as 0) in the Appendices and relative water level change is calculated as the difference between baseline and each event measurement (e.g., the water levels at the East Branch Escanaba River at Iron Street, on July 2, 2020, were 3 centimeters above baseline, which occurred 1 week later on July 8, 2020). Water levels at some sites were very stable (less than 3 cm change throughout the study); therefore, water level relationships for some sites are not shown in Appendix 6.

A positive relationship indicates that high flow issues are impacting these sites, such as urban storm water or tiles and ditches flowing during times of high water table. High flow events were not captured in all of the 5-week studies. Conversely, increasing *E. coli* concentrations with decreasing water levels (a negative relationship) reveals impacts from dry weather and low flow sources such as illicit connections, failing septic systems, or livestock with direct access to the water body.

6.1.2 Watershed Summaries:

The following are summaries by watershed, accompanied by a table of results color coded to indicate value relative to other events (Tables 2-4 and 7-14). Cells with warmer colors (red) indicate *E. coli* results above the median of all data (white cells). Cooler colors (blues) indicate results below the median. Data are summarized by weekly averages and the 30-day geometric mean to allow spatial and temporal visualization of results. The relationship between flow and *E. coli* concentrations, weather information, and MST results are also summarized in each of the watershed summaries below.

a. Escanaba (14 sites)

In the Escanaba watershed, only Squaw Creek (Site ID 210241) exceeded the DGM and 30-day geometric mean TBC WQS (Table 1 and 2). Squaw Creek exceeded the daily TBC WQS on the first 3 events and concentrations remained remarkably stable following the rain event of 0.78 inches prior to the July 15 event (Appendix 5) despite a large increase in water level. MST was conducted on samples from July 9 and 15, and results indicate that human and bovine sources are likely contributing fecal matter to the stream (Appendix 4).

Water levels at some sites fluctuated widely (Appendix 2). Warner Creek (520381) water levels were steady through most of the study but dropped by 64 centimeters (cm) between the last 2 monitoring events. Beaver activity on Warner Creek is evident in satellite aerial images and is the likely reason for the sudden change. The July 15 rain event caused water levels throughout the study area to increase by 20-44 cm.

A relatively strong positive relationship between *E. coli* concentrations and flow (higher flows having higher *E. coli*) was found at Reno Creek (210329) and West Branch Escanaba (520561), although these sites met all applicable *E. coli* WQS (Appendix 6). A strong negative relationship between *E. coli* and flow (lower flows having higher *E. coli*) was found at Little West Branch

Escanaba River (520463) (Appendix 6). No *E. coli* exceedances were recorded at this site, but this strong relationship indicates a constant source of *E. coli* is contributing. D.O. concentrations in the Little West Branch Escanaba River were below the coldwater fishery WQS consistently (Appendix 3).

The July 2, 8, 15, and 23 sampling events were collected following significant rainfall events. While levels were below the standard at all sites except Squaw Creek, the *E. coli* concentrations did increase at some of the sites in response to the rain (Appendices 2 and 4); particularly Sawmill Creek (520259) and Reno Creek (210329).

Table 1. E. coli DGM, 30-day geometric means, and weekly averages for the Escanaba and tributaries. A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	1-Jul	9-Jul	15-Jul*	23-Jul*	30-Jul	30-Day Geometric Mean
Escanaba R - County 420 21st Rd	84	42	49	31	37	46
Escanaba R - Robing Rd	9	12	28	3	20	11
Hunters Br - Boney Falls H Rd	44	59	59	16	20	34
Reno Cr - County 420 21st Rd	124	170	217	108	59	124
Sawmill Cr - Escanaba R Rd	89	58	232	79	40	82
Squaw Cr - Saint Nicholas 31st Rd	735	751	755	162	180	414
Swimming Hole Cr - Escanaba River Rd	58					
Un-Named Cr - Homestead Rd	43					
Weekly Average	148	182	223	67	60	

Table 2. E. coli DGM, 30-day geometric means, and weekly averages for the Escanaba and tributaries. A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	2-Jul*	8-Jul*	17-Jul	24-Jul	29-Jul	30-Day Geometric Mean
E Br Escanaba R - Iron St	37	39	25	58	60	42
Escanaba R - Power Line Ln	48	78	40	20	48	43
Little W Br Escanaba R - Little West Rd	112	147	67	50	16	61
Middle Br Escanaba R - M35	16	16	7	26	16	15
W Br Escanaba R - County Road 557	26	34	64	55	63	46
Warner Cr - M35	88	216	193	112	76	126
Weekly Average	55	88	66	53	46	

b. St. Joseph (West) – Lake Michigan Drainage (16 sites)

Two sites in this watershed met all applicable *E. coli* WQS; Portage River at South Fisher Lake Road (750292) and Coldwater River at Union City Road (120260) (Table 3). An additional site, Lehr Lake Inlet (120256) met the daily TBC on all events but exceeded the 30-day TBC WQS. The Lehr Lake Inlet site also routinely exceeded the threshold for TDS (Appendix 3).

Two sites exceeded the daily maximum TBC WQS on all 5 events; Tekonsha Creek (130419) and Sand Creek (300315). As a result of the consistently high *E. coli*, Tekonsha and Sand Creeks had the highest 30-day geometric means of all the sites in this watershed. It should be noted that the lower *E. coli* concentrations in Table 3 could, in part, be due to lower water temperatures, which had fallen into the 40°F range by the end of that 5-week period.

A large rain event (1.92 inches) on the day prior to the September 8 event caused all monitored sites to exceed the PBC WQS (Table 4). Inadequate dilutions were used in the lab analysis of the Beebe Creek sites that day, resulting in >10,000 as a result for 1 or more of the samples at each site.

The following sites had a strong positive relationship of increasing *E. coli* concentrations with increasing water levels: Beebe Creek (both sites), Tekonsha Creek, Sand Creek, South Branch Hog Creek (120261), and the St. Joseph River (Pedestrian Bridge, 300320) (Appendix 6). Weaker negative relationships (decreased *E. coli* concentrations with increasing water levels) were observed in both Portage River sites and both Coldwater River sites, and the St Joseph River at 9 Mile (130305), indicating potential dilution of constant sources.

No D.O. issues were noted in this watershed (Appendix 3).

Table 3. E. coli DGM, 30-day geometric means, and weekly averages for sites in the St. Joseph (Lake Michigan). A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	29-Sep*	6-Oct	13-Oct*	19-Oct*	26-Oct	30-Day Geometric Mean
Coldwater R - E Fenn Rd	196	332	379	103	113	196
Coldwater R - Union City Rd	137	127	287	53	73	114
Lehr Lake Inlet - Mendon Rd	183	137	250	282	110	181
Portage R - YZ Ave	288	168	434	134	103	196
Portage R - S Fisher Lake Rd	179	86	87	78	58	90
Sauk R- Butters Ave	253	72	1,293	239	42	188
Spencer Cr - off Mendon Rd (M60)	519	434	510	243	123	321
St Joseph R - 9 Mile Rd	377	123	197	112	100	159
Weekly Average	266	185	429	155	90	

Table 4. E. coli DGM, 30-day geometric means, and weekly averages for sites in the St. Joseph (Lake Michigan). A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	24-Aug	31-Aug	8-Sep*	15-Sep	21-Sep	30-Day Geometric Mean
Beebe Cr - E Moore Rd	347	339	10,000	316	283	638
Beebe Cr - State Rd	678	529	11,191	742	1,411	1,333
S Br Hog Cr - Clarendon Rd	745	693	23,407	430	1,218	1,446
Sand Cr - W Litchfield Rd	606	968	9,453	619	1,260	1,340
St Joseph R - Pedestrian Bridge N of Fayette Rd	616	749	17,097	255	185	821
St Joseph R - S County Line Rd	216	192	3,723	160	202	346
St Joseph R - T Drn S	194	150	1,956	132	97	236
Tekonsha Cr - Old US 27 S	820	423	13,026	550	653	1,102
Weekly Average	528	505	11,232	401	664	

c. Pere Marquette-White (25 sites)

All sites in the Pere Marquette-White watershed exceeded the daily and 30-day geometric mean TBC WQS (Appendix 2, Table 5. *E. coli* DGM, 30-day geometric means, and weekly averages at Pere Marquette and Pentwater sites. A star next to the date indicates a monitoring event following a rain event of more than ¼ inch.

Site Description	14-Jul	21-Jul	28-Jul	4-Aug	11-Aug*	30-Day Geometric Mean
Baldwin R - M 37	148	359	145	135	222	187
Beaver Cr - Comstock Ave	132	197	443	380	336	272
Big S Br Pere Marquette R - Croswell Ave	162	165	92	194	887	211
Freeman Cr - Maple Island Ave	2,420	745	1,116	976	679	1,059
Middle Br Pere Marquette R - S James Rd	105	193	175	112	145	142
N Branch Pentwater R - N 96th Ave	227	263	419	326	3,627	494
Pere Marquette R - Dickinson Ave	211	182	115	547	275	232
S Br Pere Marquette R - W 76th St	136	246	136	2,420	135	272
S Branch Pentwater R - N 120th Ave	506	302	488	167	1,486	450
Weekly Average	450	295	348	584	866	

Table 65 and 6). A detailed study of Brayton Drain was conducted, which will be discussed separately from the rest of the Pere Marquette-White. The Pere Marquette-White did not have any recorded D.O. violations or TDS results above the threshold of 500 mg/L (Appendix 3).

Pere Marquette-White (excluding Brayton Drain): Several sites exceeded the PBC WQS more than once, including Freeman Creek (640183), Black River (530032), an unnamed tributary to the Pere Marquette (530273), and 3 sites in Swan Creek (530229, 530231 and 530294), (Appendix 2).

The most downstream site in this study, the mainstem Pere Marquette River at Scottsville Road (530027), exceeded the PBC WQS on August 12 after a rain event in the prior 48 hours.

Results from the Scottville Road site showed no relationship between water level and *E. coli* (Appendix 6); but rain events appear to have caused an increase in *E. coli* (Appendix 5), indicating pollution from storm-related runoff, and flushing from the more polluted tributaries such as the nearby Black River. Overall, sampling events with rain in the prior 48 hours tended to have the highest weekly averages (Table 5 and Table 6).

In this watershed, many sites showed a strong positive relationship of increasing *E. coli* with increasing water levels, including Baldwin River (430009), South Branch Pere Marquette River (430569), Big South Branch Pere Marquette River (620220), Pere Marquette River at Dickinson (620248), and the South and North Branch Pentwater River (640186 and 640205). Only Weldon Creek (530226) showed the opposite relationship (lower *E. coli* during higher water levels); the rest of the sites had weak or no relationship.

Table 5. E. coli DGM, 30-day geometric means, and weekly averages at Pere Marquette and Pentwater sites. A star next to the date indicates a monitoring event following a rain event of more than ¼ inch.

Site Description	14-Jul	21-Jul	28-Jul	4-Aug	11-Aug*	30-Day Geometric Mean
Baldwin R - M 37	148	359	145	135	222	187
Beaver Cr - Comstock Ave	132	197	443	380	336	272
Big S Br Pere Marquette R - Croswell Ave	162	165	92	194	887	211
Freeman Cr - Maple Island Ave	2,420	745	1,116	976	679	1,059
Middle Br Pere Marquette R - S James Rd	105	193	175	112	145	142
N Branch Pentwater R - N 96th Ave	227	263	419	326	3,627	494
Pere Marquette R - Dickinson Ave	211	182	115	547	275	232
S Br Pere Marquette R - W 76th St	136	246	136	2,420	135	272
S Branch Pentwater R - N 120th Ave	506	302	488	167	1,486	450
Weekly Average	450	295	348	584	866	

Table 6. E. coli DGM, 30-day geometric means, and weekly averages at Pere Marquette River sites. A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	16-Jul*	22-Jul	29-Jul*	5-Aug	12-Aug*	30-Day Geometric Mean
Big S Br Pere Marquette R - E Wilson	140	117	345	207	136	174
Black R - E 1st St	2,420	1,158	694	313	4,839	1,242
Lichte Cr - S Morton Rd	1,047	411	488	418	585	552
Pere Marquette R - S Scottville Rd	246	127	884	387	1,843	456
Swan Cr - W Chauvez Rd	1,270	1,464	2,420	995	3,268	1,710
Swan Cr - W Kinney Rd	1,008	579	2,420	652	2,421	1,174
Swan Cr (Trib to) - W Kinney Rd	1,056	1,455	1,312	946	2,010	1,308
Trib to Pere Marquette - W Chauvez Rd	1,894	958	2,016	1,298	1,348	1,450
Weldon Cr - M10	246	332	283	395	383	323
Weekly Average	1,036	733	1,207	623	1,870	

Brayton Creek: EGLE's 2017 study of the White River found excessive exceedances of the PBC WQS in Brayton Creek at Cleveland Road (Rippke, 2018); therefore, in 2020 a more detailed study was conducted to attempt to determine sources of pollution (Figure 3). None of the sites met the TBC or PBC WQS and the severity of the issue had not improved since 2017. Brayton Drain at East Wilke Road (640318) had the overall highest *E. coli* concentrations of all sites (Table 7).

A minor rainfall event (less than a ¼ inch) occurred in the 24 hours prior to sampling on July 20, with a major rain event (0.63 inches) occurring within 48 hours prior to the August 3 event. The August 3 event resulted in the highest *E. coli* averaged across all sites, likely due to storm-related runoff (Table 7 and Appendix 5). Minor precipitation occurred in the 48 hours prior to the August 10 event, leaving July 13 and 27 as the only true dry weather events. Five of the 7 sites exceeded the PBC WQS on the July 27 dry weather sampling event, indicating illicit discharges or another constant source.

The tributary at Maple Island Road (640355) had bovine MST detections on 4 of 5 events, 1 porcine detection, and 2 human detections (Figure 3, Appendix 4). This site was also the only tributary to show a strong positive relationship of increasing *E. coli* with increasing water levels (Appendix 6). Aerial images suggest livestock pastures may be located on this small tributary, and further upstream on Van Wagoner Road is an animal feeding operation (AFO). AFOs which meet certain qualifications, including the number of animal units above a certain threshold, require a permit and are called concentrated animal feeding operations (CAFO).

Aerial images upstream of the site on the tributary to Brayton Drain, East of 200th Avenue (640353) show an AFO where there may be unrestricted livestock access to the creek. Although the bovine marker was not detected here, cattle and other livestock cannot be ruled out since they are present and *E. coli* is high. Just downstream of the confluence of the tributary at Maple Island Road, Brayton Drain at East Wilke Road (640318) had a bovine detection at 1 of the 5 events, on August 10. Upstream of the site on Wilke Road, but downstream of Martin Lake, another AFO appears to have livestock with direct access to Brayton Drain. EGLE will further investigate these sites and work with other agencies to mitigate impacts.

Off of 32nd Street, upstream of Martin Lake, human markers were found 2 times at Bowman/Dragon (620343) and 3 times at Brayton Drain (620344). On 2 of those occasions at Brayton Drain, both human biomarkers were found during relatively dry conditions, strongly indicating that human sources were impacting the stream at that time. At Bowman/Dragon Drain, human markers were detected once during dry conditions and once following rain. Either illicit discharges or failing septic systems could be contributing to the continuously elevated *E. coli* and relatively common human *Bacteroides* detections. There are no sanitary sewer systems collecting and treating human waste in the Brayton Creek watershed, so all homes are relying on septic systems. EGLE generally has limited authority over failing septic systems and will report these findings to the local health department.

The bovine marker was detected once at each of the sites upstream of Martin Lake, specifically Bowman/Dragon and Brayton Drain off 32nd Street. On August 10, with no rain in the prior 24 hours, bovine marker was detected at 3 of the sites (Brayton Drain at Wilke and off 32nd Street, and the tributary at Maple Island Road). There are 2 dairy CAFOs in this watershed located upstream of Martin Lake: Northpoint Dairy-CAFO on Fitzgerald Street and JMax LLC-CAFO off of Green Street ([MiEnviro Database](#), accessed March 26, 2021). The porcine marker was also detected at the Bowman/Dragon on 2 events, 1 dry and 1 following less than ¼ inch of rainfall. In addition to the CAFOs, there are several AFOs that are not regulated by permit. Just south of the watershed are several more CAFOs, including a hog farm, which may land apply within the Brayton Drain watershed. The density of AFOs in this area is high, and the manure must be either land-applied to fields in the area, stockpiled, or

moved elsewhere. It is not known where or when the spreading is occurring for nonregulated AFOs, or if the fields are tiled for drainage. Older aerial images show that crops are spray irrigated in this area, which could cause manure to enter the creek from manure land-application fields even during dry weather.

Further downstream on the mainstem Brayton Creek, at Cleveland Road (640349) and east of 200th Avenue (640354), no detections of any markers were found despite *E. coli* being elevated. The shorter longevity of *Bacteroides* or dilution may explain the absence of these markers further downstream while it was detected upstream (*E. coli* generally survives much longer than *Bacteroides*).

Table 7. E. coli DGM, 30-day geometric means, and weekly averages at Brayton Drain sites. A star next to the date indicates a monitoring event following rain of more than ¼ inch in the prior 24 hours.

Site Description	13-Jul	20-Jul	27-Jul	3-Aug*	10-Aug	30-Day Geometric Mean
Bowman/Dragoon Drn - off 32nd St	4,531	2,396	996	2,231	468	1,624
Brayton Cr - Cleveland Rd	922	1,364	1,108	1,231	425	939
Brayton Drn - E of 200th Ave	775	1,587	1,491	1,302	540	1,052
Brayton Drn - E Wilke Rd	2,566	1,789	1,739	5,614	648	1,962
Brayton Drn - off 32nd St (above Bowman confluence)	854	1,762	1,041	8,108	720	1,556
Brayton Drn (Trib to) - E of 200th Ave	1,033	1,849	1,381	3,029	1,239	1,582
Brayton Drn (Trib to) - Maple Island Rd	513	475	420	1,579	712	649
Weekly Average	1,599	1,603	1,168	3,299	679	

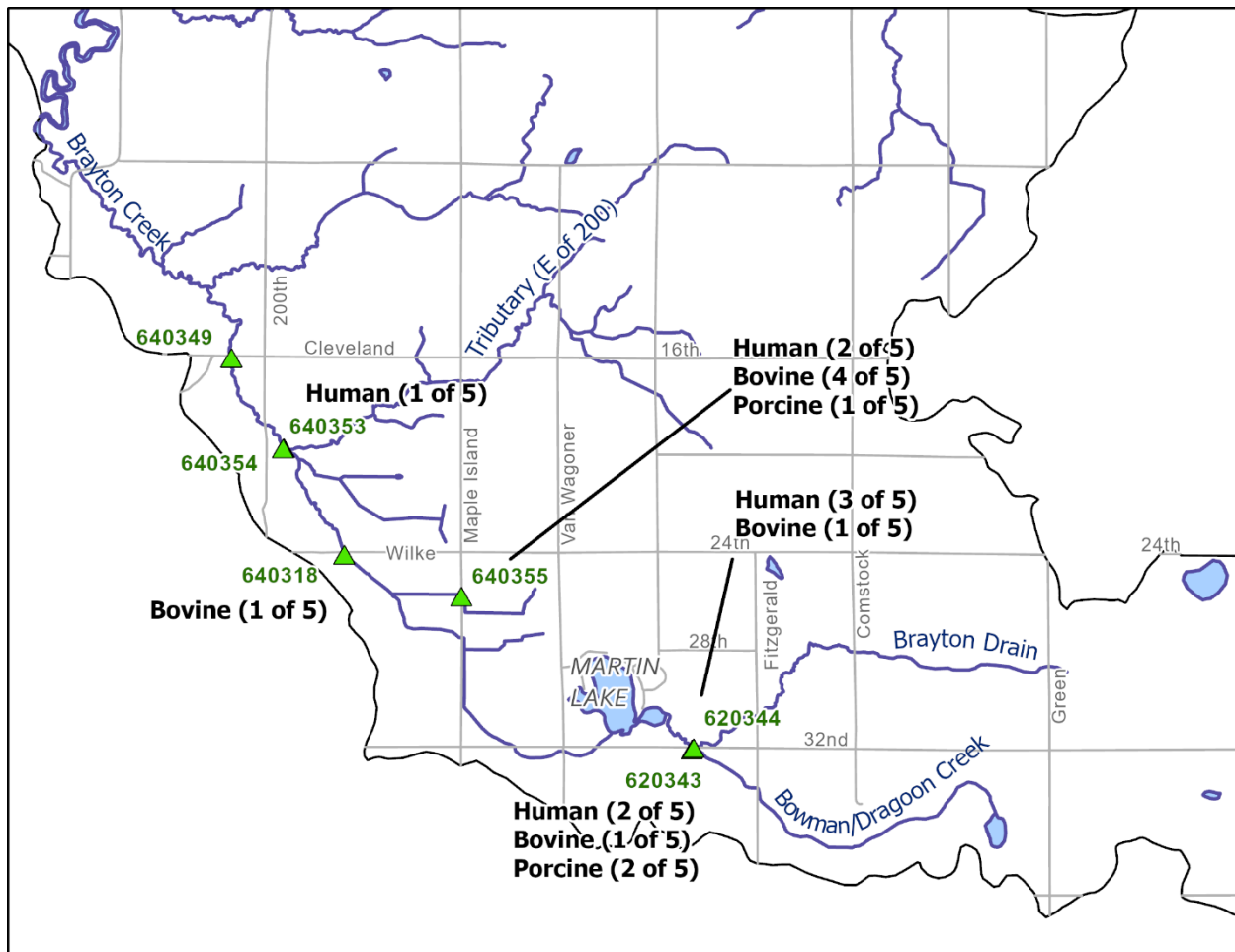


Figure 3. Map of Brayton Creek sites showing summaries of MST results (Appendix 4). MST summaries include the number of events where the markers were detected. Non-detectable MST results are not shown.

d. Boardman Charlevoix (8 sites)

Sites on the North Branch (150198) and South Branch (150187) of the Boyne River met all applicable *E. coli* WQS (Appendix 2). Within the 48 hours prior to the July 23 sampling event, a 1.73-inch rain event occurred, causing *E. coli* concentrations to rise throughout the study (Table 8, Appendix 5). The Jordan River (150010) and Deer Creek (150204) sites each had one daily TBC WQS exceedance following that rain event, but still met the 30-day TBC WQS. None of the sites exceeded the PBC WQS, despite the large rain event.

Almost all sites showed a relationship of increasing *E. coli* with increasing water levels, except for the Boyne River at South Lake Street (150100), which showed no relationship. Lake Charlevoix at Bridge Street (150056) and Birney Creek (150257) had weak relationships (Appendix 6).

MST was conducted for two events on samples from Birney Creek, but no markers were detected (Appendix 4). D.O. measurements were, for the most part, normal, though 1 event at the Jordan River and 1 event at the Boyne River at South Lake Street fell below the WQS to protect coldwater fishery. No elevated TDS measurements were found.

Table 8. *E. coli* DGM, 30-day geometric means, and weekly averages at Boardman Charlevoix sites. A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	15-Jul	23-Jul*	30-Jul	6-Aug	13-Aug	30-Day Geometric Mean
Birney Cr - Rogers Rd	637	713	216	176	212	326
Boyne R - S Lake St	166	248	175	188	207	195
Deer Cr - Pearsall Rd	110	478	51	37	80	96
Jordan R - Rogers Rd	57	339	42	42	39	66
Lake Charlevoix - Bridge St	110	507	214	257	402	262
Monroe Cr - M 66	184	828	226	136	77	205
N Br Boyne R - US 131	38	164	54	35	70	61
S Br Boyne R - Boyne Mountain Rd	58	139	57	37	18	50
Weekly Average	170	427	129	114	138	

e. Pigeon-Wiscoggin (10 sites)

Within the Pigeon-Wiscoggin watershed are several low gradient rivers that have been highly modified for drainage in this highly agricultural area of Saginaw Bay. For example, the Quanicassee River subwatershed has lost 97% of its pre-settlement wetland area (Fizzell, 2015).

At the time of this study, the water level of Lake Huron was near the recorded historic high ([ire.usace.army.mil/](http://re.usace.army.mil/)), potentially causing an influx of lake water to the lowest elevation sites. Flow was observed in the upstream direction at the Quanicassee River at Old State Road (West crossing; 790239) on June 15, July 6, and July 13. At the eastern crossing of Old State Road (790243), the Quanicassee River was noted as stagnant on all events. It is recommended therefore that this study be repeated when Lake Huron water levels are lower, to better evaluate the river with less influence from the lake.

Possibly attributable (at least partially) to either flow stagnation or lake water influence, the 2 sites on the Quanicassee River met all applicable *E. coli* WQS. The remainder of the sites exceeded the daily and 30-day geometric mean TBC WQS. Three sites exceeded the PBC WQS on the same hot and dry weather event (July 6); these were the 2 Wiscoggin Drain sites (790228 and 790240) and the unnamed tributary to Northwest Drain at North Kirk Road (790242). No significant rain occurred prior to sampling during this study (Table 9, Appendix 5).

Two sites showed a moderate trend of higher *E. coli* with lower water levels: Allen Drain (790244) and Northwest Drain at North Kirk Road (Appendix 6). Wiscoggin Drain at West Cass City Road (790228) had a very strong relationship, indicating a high likelihood of a constant source such as an illicit discharge, failing septs, or livestock with direct access. The unnamed tributary to Northwest Drain at North Vassar Road (790241), Quanicassee River (East crossing of Old State Road), and State Drain (320371) showed weak relationships of increasing *E. coli* with increasing water level (Appendix 6).

D.O. concentrations dipped below the warmwater fishery WQS at all sites except for Wiscoggin Drain at West Bay City Forestville Road (790240); this site was in a swiftly flowing riffle area, which may contribute to the higher D.O. In the Quanicassee River, the D.O. dropped to 0.61 mg/L, which was recorded during daylight and not at the most critical time of the day (before sunrise). July 6 had hot weather during sampling (80-89 F degree air temperature), which corresponded with a drop in the D.O., and a drought was occurring at the time. In fact,

between June 13 and July 6, only 0.15 inches of rainfall was recorded in nearby Fairgrove, Michigan (MSU Extension, 2021). No sonde measurements were collected on June 29 due to equipment failure.

Table 9. E. coli DGM, 30-day geometric means, and weekly averages at Pigeon-Wiscoggin sites.

Site Description	15-Jun	23-Jun	29-Jun	6-Jul	13-Jul	30-Day Geometric Mean
Allen Drn - N Ringle Rd	165	701	282	796	242	363
Columbia Drn - Lange Rd	119	409	470	107	200	218
Northwest Drn (Trib to) - N Kirk Rd	236	356	362	1,872	382	465
Northwest Drn (Trib to) - N Vassar Rd	209	426	110	109	395	211
Quanicassee R - Old State Rd - East	85	60	71	27	93	62
Quanicassee R - Old State Rd - West	6	18	14	9	25	13
State Drn - Sebewaing Rd	285	87	146	173	362	186
Trib to Quanicassee R - Akron/VanBuren				66		
Wiscoggin Drn - W Bay City Forestville Rd	297	544	779	2,530	506	694
Wiscoggin Drn - W Cass City Rd	475	891	1,733	2,445	553	998
Weekly Average	208	388	441	813	306	

f. Pine (14 sites)

The Coldwater River sites below the dam (West Bridge Street and Weidman Roads: 370178 and 370176) both met all applicable *E. coli* WQS, while the site above the lake exceeded the daily and 30-day TBC WQS (Woodruff Road - 370179). EGLE studies have found that this decrease below lakes and impoundments is typical likely due to the lake retention time causing prolonged exposure to sunlight, competition with other microorganisms, and settling contributing to bacterial mortality.

Except for the Coldwater River immediately below the dam (West Bridge Street) and the Coldwater River at Woodruff Road, all other sites had elevated *E. coli* on September 9 following a large rain event of 0.6 inches in the prior 48 hours (Appendix 5, Table 10). Five of the 8 sites exceeded the PBC WQS on that event. The Coldwater River at West Bridge Street was located above the confluence with Yonker Drain and would not be influenced by the water quality in the drain, which had very high *E. coli* on September 9. The Coldwater River at Weidman Road was impacted by the Yonker Drain at Bridge Street site, and any potential sources in the town of Weidman. Yonker Drain off Bridge Street (370177) was located slightly upstream and east of Yonker Drain at Bridge Street site (370181) and received some dilution from the lake and surrounding wetlands (Figure 4). This dilution likely resulted in the lower *E. coli* at the downstream site where it enters the Coldwater River. No 30-day geometric mean is available for the downstream Yonker Drain site, but a geometric mean of all available data is 255 *E. coli* per 100 mL, compared to 908 *E. coli* per 100 mL at the upstream site. In addition to having higher *E. coli*, Yonker Drain off Bridge Street was below the warmwater fishery D.O. WQS on all 5 monitoring events (Appendix 3).

The trend of increasing *E. coli* levels with increasing water levels was observed at Wagner Drain at North Vandecar Road (370172) and the unnamed tributary to Lake of the Hills (370180). Below the dam, the Coldwater River sites at West Bridge Street and Weidman Roads also showed a slight relationship of increased *E. coli* with increased water level, despite overall low

E. coli concentrations there. Upstream of the dam, no relationship between water level and *E. coli* was observed at Coldwater River at Woodruff Road, and water level could not be measured at either Yonker Drain site or at the Wagner Drain at Weidman Road (Appendix 6).

Wet weather sources appear important in the area, including potential illicit discharges (to storm sewers, field tiles, and ditches) and residential and agricultural runoff. Efforts are ongoing in the area to address any known illicit discharges from Beal City storm sewers by installing a sanitary sewer collection system. Discharges from Beal City to Wagner Drain were located between the upstream site (Weidman Road) and the downstream site at North Vandecar Road.

Wagner Drain at North Vandecar Road had high TDS throughout the study, which may be attributable to the known illicit discharges since the other Wagner Drain site upstream of the discharge (Weidman Road) did not have elevated TDS.

Four sites on the Pine River and 2 sites on County Drain 178, in the vicinity of Riverdale, were monitored for a single event (Appendix 2). None of the sites exceeded the daily TBC WQS. These sites will be monitored for a full 5 weeks in 2021, as resources allow.

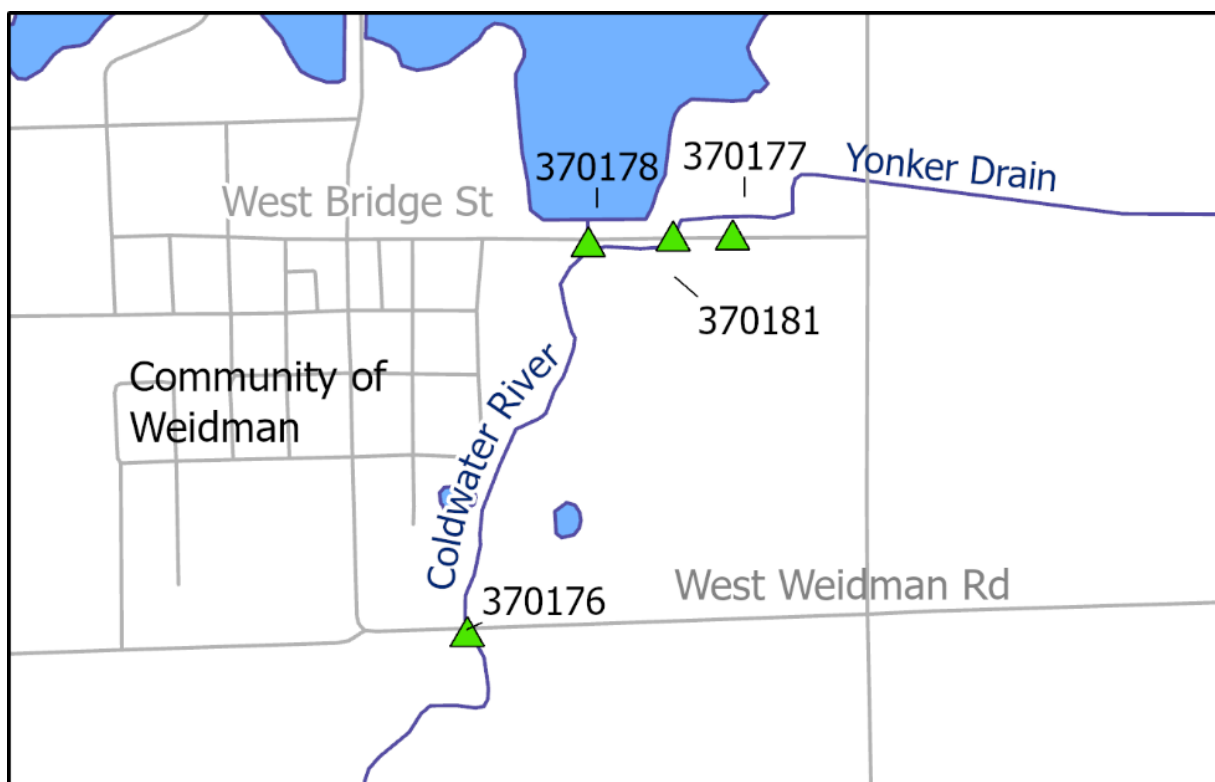


Figure 4. Locations of sites around the community of Weidman and downstream of Weidman Mill Pond.

Table 10. *E. coli* DGM, 30-day geometric means, and weekly averages at Pine River sites. A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	25-Aug	1-Sep	9-Sep*	16-Sep	22-Sep	30-Day Geometric Mean
Coldwater R - N Woodruff Rd (N Crossing)	479	490	429	309	199	362
Coldwater R - W Bridge St (West)	5	8	103	120	13	23
Coldwater R - W Weidman Rd	99	35	290	60	18	64
Lake of the Hills (Trib to) - W Rosebush Rd	427	317	1,036	337	363	444
Wagner Drn - N Vandecar Rd	294	339	1,189	294	305	403
Wagner Drn - W Weidman Rd	576	341	3,077	132	25	287
Yonker Drn (Trib to Coldwater) - Bridge St		128	2,502	138	97	
Yonker Drn (Trib to Coldwater) - off W Bridge St	719	538	20,132	263	301	908
Weekly Average	371	274	3,595	206	165	

g. Shiawassee (16 sites)

A detailed study of Rowley Creek (sometimes known as Kanouse Lake Drain) was conducted, which will be discussed separately from the rest of the Shiawassee sites.

Shiawassee (excluding Rowley Creek): Two sites on the Shiawassee River met all applicable *E. coli* WQS: Legrande Street (631311) and Bridge Street (250113). The Shiawassee River at Bridge Street was located immediately downstream of Lake Ponemah, Tupper Lake, and an impoundment of the river in Linden, Michigan. As noted in the discussion of the Pine River results (section f), rivers immediately downstream of lakes and impoundments tend to have low *E. coli*. The next site downstream on the river, at Hogan Road (250462), exceeded the 30-day geometric mean TBC WQS while also falling below the warmwater fisheries D.O. WQS on 4 of 5 events (Appendix 3). One possible contributor to the D.O. issue observed at Hogan Road is a sag caused by the lake and impoundment upstream, in addition to other point and nonpoint sources. The site at Legrande Street is also located below Stiffs Mill Pond and where the river is slow moving and flanked with riparian wetlands; with a 30-day geometric mean of 129 *E. coli* per 100 mL, it barely met the TBC WQS.

Both sites on North Ore Creek exceeded the daily TBC WQS on all 5 events while the site on East Clyde Road (470678) also exceeded the PBC WQS (Table 11. *E. coli* DGM, 30-day geometric means, and weekly averages at Shiawassee River sites. A star next to the date indicates a monitoring event following rain of more than ¼ inch.). Bogue Creek (470643) exceeded the PBC twice and the daily TBC WQS the remainder of the events. Sprague Creek at Byron Road (470677) exceeded the PBC WQS on all 5 events, indicating an elevated risk for bodily contact during wet and dry weather (Table 12).

Sites with a notable relationship of increasing *E. coli* with increasing water levels include: South Branch Shiawassee at Lovejoy Road (470663), North Ore Creek at Cullen Road (47680), Bogue Creek, Webb Drain (780095), and the Shiawassee at Exchange Road (780270) and Meier Road (250119). Interestingly, the only site showing the opposite pattern of higher *E. coli* at lower flows was Shiawassee at Bridge Street, which met all applicable *E. coli* WQS.

Table 11. *E. coli* DGM, 30-day geometric means, and weekly averages at Shiawassee River sites. A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	21-Jul*	28-Jul	4-Aug*	11-Aug	18-Aug	30-Day Geometric Mean
N Ore Cr - Cullen Rd	630	599	643	625	681	635
N Ore Cr (Trib to) - E Clyde Rd	1,700	459	661	736	752	778
S Br Shiawassee R - Lovejoy Rd	240	263	535	236	239	286
S Br Shiawassee R - S Byron Rd	187	209	293	158	223	209
Shiawassee R - Legrande St	156	112	198	78	132	129
Shiawassee R - Bridge St	7	74	6	6	65	16
Shiawassee R - Hogan Rd	182	214	280	247	152	210
Shiawassee R - Meier Rd	193	207	485	222	273	259
Weekly Average	412	286	387	289	315	

Table 12. *E. coli* DGM, 30-day geometric means, and weekly averages at Shiawassee and Rowley Creek sites. A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	20-Jul*	27-Jul	3-Aug*	10-Aug	17-Aug	30-Day Geometric Mean
Aginaw Lake Drn (Kanouse Dr) - Reed Rd (N)	1,124	1,374	1,090	1,822	812	1200
Bogue Cr - Marr Rd	995	814	1,526	645	2,004	1098
Euler Lake Drn - Reed Rd (S)	3,211	5,659	3,832	2,247	2,189	3213
Kanouse Lake Drn - E Beard Rd	1,232	1,817	4,238	1,829	2,147	2062
Rowley Cr (Kanouse Lake Drn)- Bath Rd	2,253	2,154	2,564	2,759	1,577	2222
Shiawassee R - Exchange Rd	136	80	438	157	167	165
Sprague Cr - Byron Rd	1,651	3,088	3,812	1,423	1,055	1963
Webb Drn - S Vernon Rd	474	270	1,698	1,662	469	701
Weekly Average	1,384	1,983	2,400	1,568	1,302	

Rowley Creek: Four sites in Rowley Creek (also known as Kanouse Drain) were studied in 2020, due to exceedances consistently above the PBC WQS in Rowley Creek at Bath Road (780201) recorded in 2015 (Rippke, 2016). EGLE's 2020 study found that Rowley Creek water quality had not improved. Euler Lake Drain (780272), Kanouse Lake Drain (780273), and Rowley Creek exceeded the PBC WQS on all 5 events; Aginaw Lake Drain (780271) exceeded the PBC WQS on 4 of the 5 events (Appendix 2). Only Rowley Creek at Bath Road showed a weak positive relationship between *E. coli* levels and water levels (Appendix 6). The remainder showed no relationship, which is not surprising due to relatively stable water levels and continuously high *E. coli* during this study.

MST was conducted at all 5 events at the tributary sites (Appendix 4, Figure 5). *E. coli* results combined with MST results indicate that Aginaw and Kanouse Lake Drains have persistent

human sources of fecal contamination, such as from illicit discharges of raw sewage or failing septic systems leaching into the surface waters. From aerial images, the Aginaw Lake Drain area appears to have been modified to promote the drainage of wetlands, with wetland cover still common in the headwaters. It is difficult to design and maintain septic system adsorption fields in areas with wetland soils and high water table, leading to the potential for sewage to leach into surface waters rather than deep into the ground as in a properly functioning system. EGLE generally has limited authority over failing septic systems and will report these findings to the local health department. MST results were less definitive at Euler Lake Drain, with human and porcine each detected once, on monitoring events that followed rain events. No markers were found during dry weather at Euler Drain; however, the *E. coli* concentrations remained elevated during dry weather indicating that constant sources are an issue.

There are no CAFOs in the area. But a hog AFO with an estimated 100 animals is located upstream of the Euler Lake Drain site on Beard Road, which is a potential source of the porcine *Bacteroides* marker. A relatively large bovine AFO is also located in the watershed on Reed Road, downstream of these sites, but the manure may be land-applied on fields throughout the area. No bovine markers were found in this study, but sources cannot be eliminated by the absence of a marker in samples (General Information 6.1.1). A large horse farm is located on Aginaw Lake Drain downstream of the Reed Road site, and upstream of the Rowley Creek at Bath Road Site.

There were no violations of the warmwater fishery D.O. WQS at these sites, and TDS generally remained below the 500 mg/L threshold (Appendix 3).

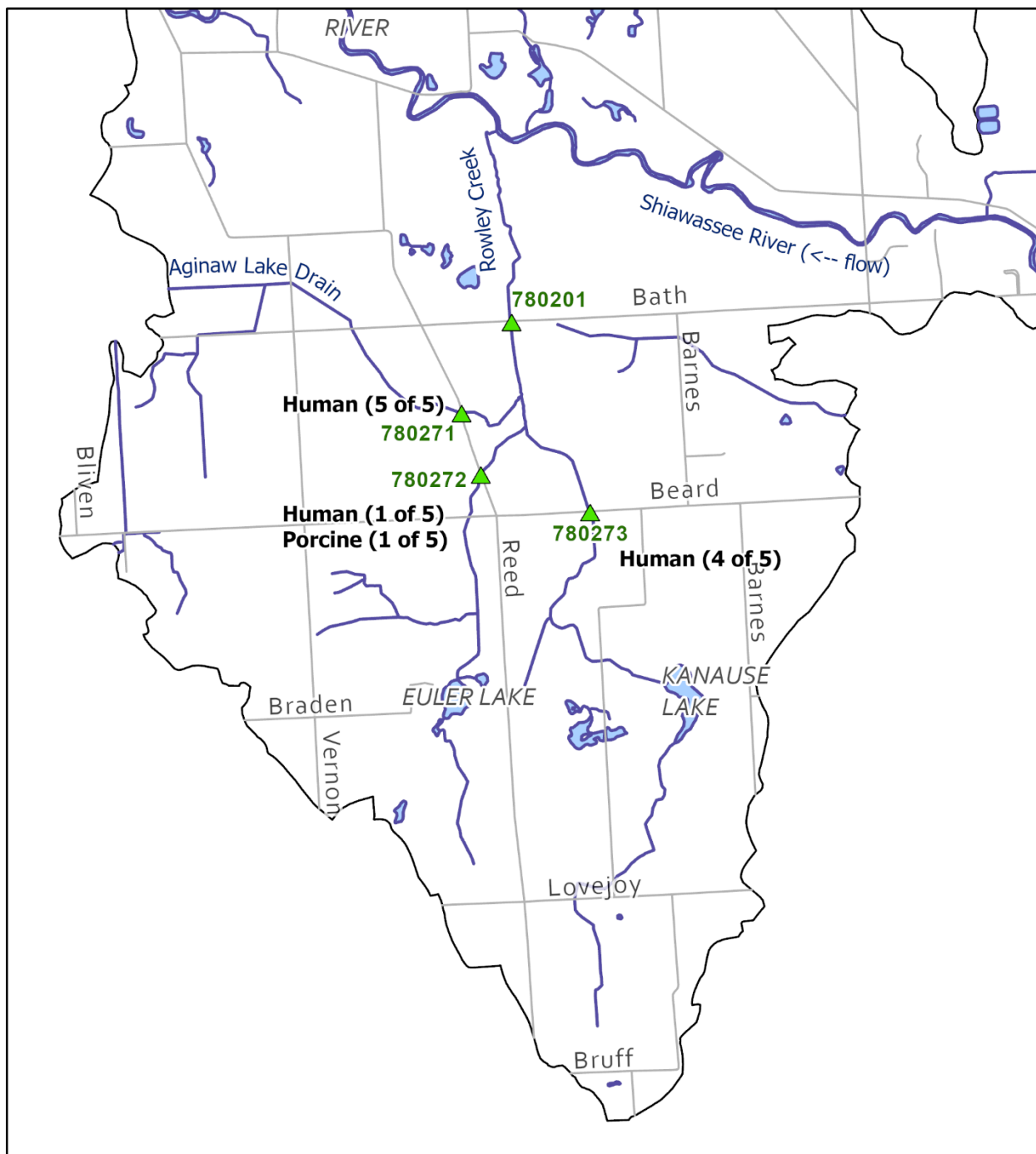


Figure 5. Locations of 3 sites upstream of the Rowley Creek site on Bath Road. MST results are summarized for each site; markers which were not detected are omitted from the summary.

h. Ottawa-Stony (7 sites).

In 2015, Bay Creek at Bay Creek Road (580451) exceeded the PBC WQS on 4 of 5 events (Rippke, 2016). In 2020, EGLE had planned to repeat this monitoring and investigate upstream on Bay Creek, including Yetter and Cousino Drains, in addition to several nearby waters that had not been assessed. Several sites were dry or not flowing normally at any of the 5 events in September through October (Yetter Drain, South Branch Otter Creek, and North Tenmile Creek). Likewise, 30-day geometric means could not be calculated at Cousino Drain (580645), Little Lake Creek (580584), or Otter Creek (580413) (Table 13). EGLE intends to study these

areas again, as resources allow, in the spring of 2021 when more flow is anticipated due to higher water table.

E. coli concentrations in Bay Creek at Bay Creek Road had improved dramatically from 2015, exceeding only the 30-day geometric mean TBC WQS. But the lack of flow and lower *E. coli* concentrations may be due to increased water levels of Lake Erie (dilution from intrusion by the lake) and may not be due to actual source remediation (no activities have been conducted as far as EGLE is aware). Very low D.O. was recorded frequently at this site (Appendix 3). Upstream on Bay Creek, relatively large amounts of the human marker (HF183) were found in most samples at Summit Street (580643) and Cousino Drain (580645), with *B. theta* also detected occasionally (Appendix 2).

Flat Creek (580642) *E. coli* results were particularly concerning; as high as 80,419 *E. coli* per 100 mL during dry weather. Flat Creek exceeded the PBC WQS on all 5 events (Appendix 2, Table 13). MST conducted on October 7, 14, and 21 found high amounts of the human markers, with both *B. theta* and HF183 found on October 7, providing strong evidence of human sewage. The upper part of Flat Creek is urban residential. Two porcine detections were found on both dry and wet weather events, in addition to bovine following wet weather. While the lower part of the Flat Creek watershed is agricultural, there are no obvious AFOs but there are some small hobby farms.

Lower water levels were associated with higher *E. coli* at Flat Creek and Bay Creek at Bay Creek Road (Appendix 6); suggesting that a constant source of fecal bacteria is being diluted, such as illicit discharges of raw sewage as indicated by the presence of human markers. In Muddy Creek (580646), higher *E. coli* was associated with higher water levels. Low D.O. and high TDS readings occurred at several of the sites in this watershed (Appendix 2).

Table 13. E. coli DGM, 30-day geometric means, and weekly averages at Ottawa Stony sites. A star next to the date indicates a monitoring event following rain of more than ¼ inch.

Site Description	24-Sep	30-Sep	7-Oct	14-Oct*	21-Oct*	30-Day Geometric Mean
Bay Cr - Bay Cr Rd	64	234	293	182	111	155
Bay Cr - Summit St	432	692	61	365	3,198	463
Cousino Drn - Vienna Rd	317	347			1,341	
Flat Cr - Dean Rd	12,606	24,196	80,419	10,098	1,916	13,655
Little Lake Cr - Suder Rd				1,073	1,433	
Muddy Cr - Cousino Rd	255	263	178	252	143	212
Otter Cr - Goutz Rd	26				12,188	
Weekly Average	2,283	5,146	20,238	2,394	2,904	

i. St. Joseph (East) – Lake Erie Drainage (9 Sites)

Sites on Austin Road were not accessible on June 16, resulting in a temporary site move 1 mile upstream on the same stream segments (to Camden Road). As a result, 30-day geometric means are not available for these sites.

Almost all sites exceeded the daily and 30-day geometric mean TBC WQS (Table 14). East Fork West Branch St. Joseph River at Card Road exceeded only the daily TBC WQS and met the 30-day geometric mean standard. The PBC WQS was exceeded on all 5 events at West

Fork West Branch at Long Lake Road (300314), and 4 events at Prouty Drain (300214). Turbidity measurements were high on June 30 at the Long Lake Road, corresponding with visible plumes of suspended sediment and elevated *E. coli* concentrations (Table 14).

The tributary to the East Fork West Branch at Austin Road (300312) was the only site to have high TDS (Appendix 3). The water in this tributary also was observed to have an unusual cloudiness and a slight sewage odor, indicating potential contamination from an illicit discharge.

Three sites on the East Fork West Branch had slight to moderate negative relationships between *E. coli* and water level (lower water levels having higher *E. coli*): both sites at Austin Road (300312 and 300313) and Card Road (300215). The remainder of the sites either had no relationship or water levels were not available. No significant rain occurred prior to sampling.

Table 14. *E. coli* DGM, 30-day geometric means, and weekly averages at St. Joseph sites.

Site Description	16-Jun	22-Jun	30-Jun	7-Jul	14-Jul	30-Day Geometric Mean
Carruthers Drn - W Montgomery Rd	534	312	316	427	192	337
E Fork W Br St Joseph R - Austin Rd		531	901	761	899	
E Fork W Br St Joseph R - Camden Rd	128					
E Fork W Br St Joseph R - Card Rd	50	106	65	388	203	122
Prouty Drn - Brott Rd	1,166	1,091	2,165	1,251	845	1,239
Trib to E Fork W Br St Joseph R - Austin Rd		1,114	786	806	3,297	
Trib to E Fork W Br St Joseph R - Camden Rd	1,898					
W Fork W Br St Joseph R - Long Lake Rd	1,929	2,296	6,980	2,583	1,469	2,593
W Fork W Br St Joseph Ri- Sampson Rd	322	538	625	538	695	527
Weekly Average	861	856	1,691	965	1,086	

6.2 Monitoring Objective 3

Field water quality data including turbidity, conductivity, calculated TDS, D.O., pH, and temperature are presented in Appendix 3.

The only sonde parameter that correlated well with *E. coli* concentration was turbidity (all data was transformed using natural log). Turbidity had a notable positive relationship with *E. coli* concentration (Pearson's correlation coefficient of 0.63, P value <0.001, n=268). Higher *E. coli* was generally associated with higher turbidity measurements (Figure 6). While turbidity cannot be used to predict whether *E. coli* is above the WQS because the relationship is not linear ($r^2=0.398$), it can be a visible indicator of river conditions likely to have high *E. coli*, particularly in streams that are observed frequently.

All pH measurements were within the expected range. D.O. met the applicable minimum WQS at most sites at the time of sampling (Appendix 3); however, because these events were instantaneous readings, it cannot be determined if the applicable fisheries designated use is being met. Because these measurements were not collected prior to sunrise, during the time

that is generally critical for low D.O., it is recommended that continuous D.O. studies be conducted at the sites listed in Table 15 as resources allow.

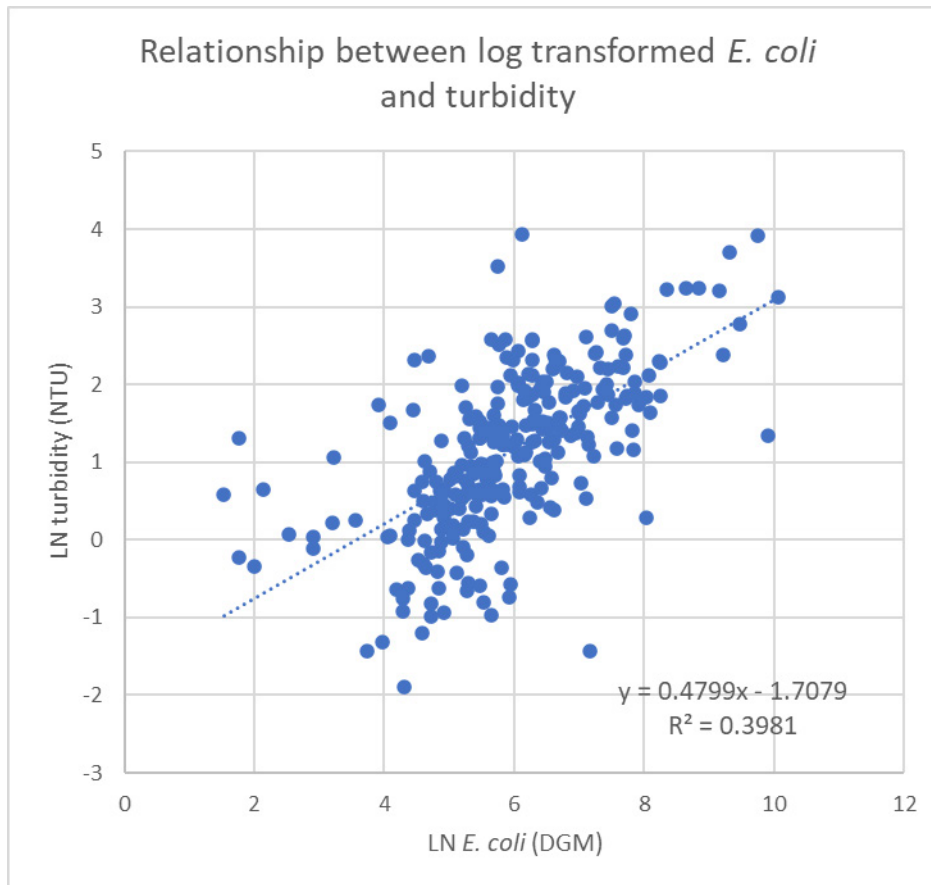


Figure 6. Relationship between Natural Log transformed daily geometric mean *E. coli* concentrations and stream turbidity ($R^2 = 0.40$, $r = 0.63$).

Michigan's TDS WQS states that TDS should not rise above 500 mg/L due to a controllable point source (R 323.1051). The standard is general and not component specific. Different components of TDS have different impacts on aquatic life, with chloride and sulfate being two of the most common and toxic components. A TDS value above 500 mg/L does not mean that the sites have chloride and sulfate values higher than the WQS; thus, the impact on aquatic life is unknown. The TDS components and associated source(s) at the sites in Table 15 may be natural (due to surficial geology or soils) but may also be attributed to development including road salt, road dust control, industrial discharges, illicit water softener discharges, or other pollutants. It is recommended that monitoring for lab analysis of TDS, chloride, and sulfate be conducted at the sites listed in Table 16, as resources allow.

Table 15. Summary of instantaneous D.O. WQS violations for coldwater (CW) and warmwater (WW) streams in this study.

Watershed	Site ID	Site description	CW or WW	Instantaneous Violations (count)
Boardman Charlevoix	150010	Jordan R - Rogers Rd	CW	1
	150100	Boyne R - S Lake St	CW	1
Shiawassee	250462	Shiawassee R - Hogan Rd	WW	4
St. Joseph	300215	E Fork W Br St Joseph R - Card Rd	WW	1
	300312	Trib to E Fork W Br St Joseph R - Austin Rd	WW	2
Pine	370177	Yonker Drn (Trib to Coldwater) - off W Bridge St	WW	5
	370180	Lake of the Hills (Trib to) - W Rosebush Rd	WW	1
Escanaba	520259	Sawmill Cr - Escanaba R Rd	CW	2
	520381	Warner Cr - M35	CW	3
	520463	Little W Br Escanaba R - Little West Rd	CW	5
Ottawa-Stony	580451	Bay Cr - Bay Cr Rd	WW	4
	580584	Little Lake Cr - Suder Rd	WW	1
	580642	Flat Cr - Dean Rd	WW	2
	580645	Cousino Drn - Vienna Rd	WW	2
	580646	Muddy Cr - Cousino Rd	WW	3
Shiawassee	780095	Webb Drn - S Vernon Rd	WW	3
Pigeon-Wiscoggin	790228	Wiscoggin Drn - W Cass City Rd	WW	1
	790239	Quanicassee R - Old State Rd - West	WW	3
	790241	Northwest Drn (Trib to) - N Vassar Rd	WW	1
	790242	Northwest Drn (Trib to) - N Kirk Rd	WW	1
	790243	Quanicassee R - Old State Rd - East	WW	2
	790244	Allen Drn - N Ringle Rd	WW	1
	790245	Trib to Quanicassee R - Akron/VanBuren	WW	1
	320319	Columbia Drn - Lange Rd	WW	2
	320371	State Drn - Sebewaing Rd	WW	1

Table 16. Summary of sites, by watershed, with calculated TDS above the threshold of 500 mg/L.

Watershed	Site ID	Site description	Count of TDS results above 500 mg/L
Ottawa-Stony	580413	Otter Cr - Goutz Rd	1
	580451	Bay Cr - Bay Cr Rd	1
	580584	Little Lake Cr - Suder Rd	2
	580642	Flat Cr - Dean Rd	3
Pigeon-Wiscoggin	320319	Columbia Drn - Lange Rd	1
Pine	370172	Wagner Drn - N Vandecar Rd	4
	370180	Lake of the Hills (Trib to) - W Rosebush Rd	1
Shiawassee	250119	Shiawassee R - Meier Rd	3
	470643	Bogue Cr - Marr Rd	1
	470663	S Br Shiawassee R - Lovejoy Rd	3
	470677	Sprague Cr - Byron Rd	1
	470678	N Ore Cr (Trib to) - E Clyde Rd	1
	470680	N Ore Cr - Cullen Rd	1
	780095	Webb Drn - S Vernon Rd	1
	780136	S Br Shiawassee R - S Byron Rd	5
	780270	Shiawassee R - Exchange Rd	2
	780273	Kanouse Lake Drn - E Beard Rd	1
St. Joseph	120256	Lehr Lake Inlet - Mendon Rd	5
	120259	Sauk R- Butters Ave	2
	300312	Trib to E Fork W Br St Joseph R - Austin Rd	4
	300320	St Joseph R - Pedestrian Bridge N of Fayette Rd	3

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LimnoTech, Inc. (Subcontractor: Ottawa-Stony Project)
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Whitewater Associates (Subcontractor: Escanaba Project)
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Appendix 1. Site location information including watershed name, 12-digit HUC, site ID (WQX/Storet) and description, county, coordinates, and weather station . All weather stations are from the Michigan State University weather network (<https://mawn.geo.msu.edu/>).

Watershed	12-Digit HUC	Site ID	Site Description	County	Latitude	Longitude	Weather Station
Escanaba	040301100108	520381	Warner Cr - M35	Marquette	46.43701	-87.59519	escanaba
	040301100110	520502	E Br Escanaba R - Iron St	Marquette	46.28313	-87.43614	escanaba
	040301100111	520562	Middle Br Escanaba R - M35	Marquette	46.28541	-87.45417	escanaba
	040301100206	520561	W Br Escanaba R - County Road 557	Marquette	46.14641	-87.46277	escanaba
	040301100301	520563	Escanaba R - Power Line Ln	Marquette	46.26741	-87.44407	escanaba
	040301100302	520259	Sawmill Cr - Escanaba R Rd	Marquette	46.13367	-87.39717	escanaba
	040301100303	520463	Little W Br Escanaba R - Little West Rd	Marquette	46.11540	-87.40060	escanaba
	040301100304	520266	Swimming Hole Cr - Escanaba River Rd	Marquette	46.08836	-87.34435	escanaba
	040301100304	520560	Un-Named Cr - Homestead Rd	Marquette	46.04043	-87.27878	escanaba
	040301100305	210241	Squaw Cr - Saint Nicholas 31st Rd	Delta	45.98534	-87.22649	escanaba
	040301100305	210328	Escanaba R - Robing Rd	Delta	45.97315	-87.24292	escanaba
	040301100306	210322	Hunters Br - Boney Falls H Rd	Delta	45.95340	-87.23449	escanaba
	040301100308	210100	Escanaba R - County 420 21st Rd	Delta	45.84069	-87.08929	escanaba
	040301100308	210329	Reno Cr - County 420 21st Rd	Delta	45.84054	-87.09408	escanaba
St. Joseph	040500010107	120266	Coldwater R - E Fenn Rd	Branch	41.89827	-85.04710	coldwater
	040500010108	120259	Sauk R- Butters Ave	Branch	41.94110	-85.02054	coldwater
	040500010109	120261	S Br Hog Cr - Clarendon Rd	Branch	41.99478	-84.87329	coldwater
	040500010111	120260	Coldwater R - Union City Rd	Branch	42.06544	-85.12836	coldwater
	040500010201	300317	Beebe Cr - State Rd	Hillsdale	41.94057	-84.55053	coldwater
	040500010202	300144	Beebe Cr - E Moore Rd	Hillsdale	41.95389	-84.63889	coldwater
	040500010203	300320	St Joseph R - Pedestrian Bridge N of Fayette Rd	Hillsdale	41.92916	-84.63926	coldwater
	040500010205	120238	St Joseph R - S County Line Rd	Branch	42.07248	-84.82881	coldwater
	040500010205	300315	Sand Cr - W Litchfield Rd	Hillsdale	42.04381	-84.80345	coldwater
	040500010207	130419	Tekonsha Cr - Old US 27 S	Calhoun	42.08569	-84.98738	coldwater
	040500010208	130420	St Joseph R - T Drn S	Calhoun	42.10184	-84.97127	coldwater
	040500010209	130305	St Joseph R - 9 Mile Rd	Calhoun	42.08090	-85.11912	coldwater
	040500010403	120256	Lehr Lake Inlet - Mendon Rd	Branch	42.06144	-85.25598	coldwater
	040500010403	120257	Spencer Cr - off Mendon Rd (M60)	Branch	42.06040	-85.23055	coldwater

Watershed	12-Digit HUC	Site ID	Site Description	County	Latitude	Longitude	Weather Station
St. Joseph	040500010505	390647	Portage R - YZ Ave	Kalamazoo	42.07813	-85.49403	mendon
	040500010506	750292	Portage R - S Fisher Lake Rd	St. Joseph	41.97676	-85.60143	mendon
Pere Marquette-White	040601010303	430572	Middle Br Pere Marquette R - S James Rd	Lake	43.85627	-85.84103	ludington
	040601010304	430569	S Br Pere Marquette R - W 76th St	Lake	43.85001	-85.84339	ludington
	040601010401	620318	Beaver Cr - Comstock Ave	Newaygo	43.68181	-85.99933	hart
	040601010402	620220	Big S Br Pere Marquette R - Croswell Ave	Newaygo	43.67692	-85.90082	hart
	040601010404	640183	Freeman Cr - Maple Island Ave	Newaygo	43.74109	-86.03923	hart
	040601010405	620248	Pere Marquette R - Dickinson Ave	Newaygo	43.78446	-86.01875	hart
	040601010406	530029	Big S Br Pere Marquette R - E Wilson	Mason	43.91843	-86.17846	ludington
	040601010503	430009	Baldwin R - M 37	Lake	43.88570	-85.85170	ludington
	040601010506	530226	Weldon Cr - M10	Mason	43.95333	-86.15387	ludington
	040601010507	530032	Black R - E 1st St	Mason	43.94736	-86.21119	ludington
	040601010508	530027	Pere Marquette R - S Scottville Rd	Mason	43.94470	-86.27923	ludington
	040601010508	530229	Swan Cr - W Chauvez Rd	Mason	43.90485	-86.30801	ludington
	040601010508	530231	Swan Cr (Trib to) - W Kinney Rd	Mason	43.89015	-86.29882	ludington
	040601010508	530294	Swan Cr - W Kinney Rd	Mason	43.89003	-86.28323	ludington
	040601010509	530233	Lichte Cr - S Morton Rd	Mason	43.90941	-86.35903	ludington
	040601010509	530273	Trib to Pere Marquette - downstream of W Chauvez Rd	Mason	43.90540	-86.33410	ludington
	040601010603	640186	S Branch Pentwater R - N 120th Ave	Oceana	43.72581	-86.25814	hart
	040601010604	640205	N Branch Pentwater R - N 96th Ave	Oceana	43.80309	-86.31806	hart
	040601010706	620343	Bowman/Dragoon Drn - off 32nd St	Newaygo	43.49626	-86.01609	fremont
	040601010706	620344	Brayton Drn - off 32nd St (above Bowman confluence)	Newaygo	43.49636	-86.01592	fremont
	040601010706	640318	Brayton Drn - E Wilke Rd	Oceana	43.51074	-86.05160	fremont
	040601010706	640349	Brayton Cr - Cleveland Rd	Oceana	43.52537	-86.06314	fremont
	040601010706	640353	Brayton Drn (Trib to) - E of 200th Ave	Oceana	43.51865	-86.05777	fremont
	040601010706	640354	Brayton Drn - E of 200th Ave	Oceana	43.51863	-86.05787	fremont
	040601010706	640355	Brayton Drn (Trib to) - Maple Island Rd	Oceana	43.50763	-86.03963	fremont
Boardman Charlevoix	040601050203	150198	N Br Boyne R - US 131	Charlevoix	45.18021	-84.91415	gaylord
	040601050204	150010	Jordan R - Rogers Rd	Charlevoix	45.13258	-85.12397	gaylord
	040601050204	150056	Lake Charlevoix - Bridge St	Charlevoix	45.15380	-85.12970	gaylord
	040601050204	150204	Deer Cr - Pearsall Rd	Charlevoix	45.13565	-85.08068	gaylord

Watershed	12-Digit HUC	Site ID	Site Description	County	Latitude	Longitude	Weather Station
Boardman Charlevoix	040601050204	150257	Birney Cr - Rogers Rd	Charlevoix	45.13369	-85.12952	gaylord
	040601050205	150100	Boyne R - S Lake St	Charlevoix	45.21435	-85.01461	gaylord
	040601050205	150187	S Br Boyne R - Boyne Mountain Rd	Charlevoix	45.15767	-84.92133	gaylord
	040601050206	150106	Monroe Cr - M 66	Charlevoix	45.17964	-85.16439	gaylord
Pigeon-Wiscoggin	040801030102	790239	Quanicassee R - Old State Rd - West	Tuscola	43.57667	-83.68740	munger
	040801030102	790243	Quanicassee R - Old State Rd - East	Tuscola	43.57543	-83.68296	munger
	040801030102	790245	Trib to Quanicassee R - Akron/VanBuren	Tuscola	43.56559	-83.68280	munger
	040801030103	790241	Northwest Drn (Trib to) - N Vassar Rd	Tuscola	43.53315	-83.58273	fairgrove
	040801030103	790242	Northwest Drn (Trib to) - N Kirk Rd	Tuscola	43.52575	-83.56321	fairgrove
	040801030104	790244	Allen Drn - N Ringle Rd	Tuscola	43.57194	-83.52423	fairgrove
	040801030106	790228	Wiscoggin Drn - W Cass City Rd	Tuscola	43.59576	-83.47055	fairgrove
	040801030108	790240	Wiscoggin Drn - W Bay City Forestville Rd	Tuscola	43.65394	-83.45736	fairgrove
	040801030109	320371	State Drn - Sebewaing Rd	Huron	43.72622	-83.43691	fairgrove
	040801030110	320319	Columbia Drn - Lange Rd	Huron	43.73623	-83.41622	fairgrove
Pine	040802020204	370176	Coldwater R - W Weidman Rd	Isabella	43.68329	-84.96641	mecosta
	040802020204	370177	Yonker Drn (Trib to Coldwater) - off W Bridge St	Isabella	43.68873	-84.96125	mecosta
	040802020204	370178	Coldwater R - W Bridge St (West)	Isabella	43.68866	-84.96401	mecosta
	040802020204	370179	Coldwater R - N Woodruff Rd (N Crossing)	Isabella	43.71003	-84.96836	mecosta
	040802020204	370180	Lake of the Hills (Trib to) - W Rosebush Rd	Isabella	43.69799	-84.95580	mecosta
	040802020204	370181	Yonker Drn (Trib to Coldwater) - Bridge St	Isabella	43.68873	-84.96239	mecosta
	040802020206	370172	Wagner Drn - N Vandecar Rd	Isabella	43.66556	-84.88866	mecosta
	040802020206	370173	Wagner Drn - W Weidman Rd	Isabella	43.68367	-84.90589	mecosta
	040802020308	290186	Pine R - W Lincoln Rd	Gratiot	43.37910	-84.83280	entrican
	040802020308	290228	Pine R Backwaters (West Bank) - Off River St	Gratiot	43.38563	-84.83217	entrican
	040802020308	290229	Pine R - Rails To Trails Bridge	Gratiot	43.38919	-84.83330	entrican
	040802020308	290230	County Drn 178 - Confluence With Pine	Gratiot	43.38077	-84.83307	entrican
	040802020308	290231	County Drn 178 - 5th St	Gratiot	43.38651	-84.84041	entrican
	040802020308	290233	Pine R - Lumberjack Rd - S of Riverdale	Gratiot	43.37221	-84.83573	entrican
Shiawassee	040802030102	470677	Sprague Cr - Byron Rd	Livingston	42.73204	-83.96867	flint
	040802030104	470643	Bogue Cr - Marr Rd	Livingston	42.66407	-83.91688	flint
	040802030105	470663	S Br Shiawassee R - Lovejoy Rd	Genesee	42.78101	-83.91093	flint
	040802030106	470678	N Ore Cr (Trib to) - E Clyde Rd	Livingston	42.67587	-83.78195	flint

Watershed	12-Digit HUC	Site ID	Site Description	County	Latitude	Longitude	Weather Station
Shiawassee	040802030106	470680	N Ore Cr - Cullen Rd	Livingston	42.67755	-83.77974	flint
	040802030107	631311	Shiawassee R - Legrande St	Oakland	42.78717	-83.63002	flint
	040802030108	250113	Shiawassee R - Bridge St	Genesee	42.81586	-83.78247	flint
	040802030108	250462	Shiawassee R - Hogan Rd	Genesee	42.81551	-83.80238	flint
	040802030110	780136	S Br Shiawassee R - S Byron Rd	Shiawassee	42.81778	-83.94237	flint
	040802030111	250119	Shiawassee R - Meier Rd	Genesee	42.81667	-83.92028	flint
	040802030202	780201	Rowley Cr - Bath Rd	Shiawassee	42.82286	-84.00066	flint
	040802030202	780271	Aginaw Lake Drn - Reed Rd (North)	Shiawassee	42.81609	-84.00600	flint
	040802030202	780272	Euler Lake Drn - Reed Rd (South)	Shiawassee	42.81143	-84.00418	flint
	040802030202	780273	Kanouse Lake Drn - E Beard Rd	Shiawassee	42.80840	-83.99309	flint
	040802030204	780095	Webb Drn - S Vernon Rd	Shiawassee	42.95834	-84.02778	flint
	040802030205	780270	Shiawassee R - Exchange Rd	Shiawassee	42.88340	-84.04630	flint
Ottawa-Stony	041000010202	580646	Muddy Cr - Cousino Rd	Monroe	41.83475	-83.43535	deerfield
	041000010203	580413	Otter Cr - Goutz Rd	Monroe	41.87417	-83.48953	deerfield
	041000010205	580451	Bay Cr - Bay Cr Rd	Monroe	41.78962	-83.47209	deerfield
	041000010205	580584	Little Lake Cr - Suder Rd	Monroe	41.77279	-83.49096	deerfield
	041000010205	580642	Flat Cr - Dean Rd	Monroe	41.76480	-83.50469	deerfield
	041000010205	580643	Bay Cr - Summit St	Monroe	41.78933	-83.49133	deerfield
	041000010205	580645	Cousino Drn - Vienna Rd	Monroe	41.78697	-83.48152	deerfield
St. Joseph	041000030201	300215	E Fork W Br St Joseph R - Card Rd	Hillsdale	41.85435	-84.67782	hudson
	041000030202	300264	E Fork W Br St Joseph R - Camden Rd	Hillsdale	41.75289	-84.66589	hudson
	041000030202	300312	Trib to E Fork W Br St Joseph R - Austin Rd	Hillsdale	41.73809	-84.69058	hudson
	041000030202	300313	E Fork W Br St Joseph R - Austin Rd	Hillsdale	41.73829	-84.68244	hudson
	041000030202	300318	W Fork W Br St Joseph R - Sampson Rd	Hillsdale	41.72353	-84.70900	hudson
	041000030202	300319	Carruthers Drn - W Montgomery Rd	Hillsdale	41.78202	-84.66517	hudson
	041000030202	300322	Trib to E Fork W Br St Joseph R - Camden Rd	Hillsdale	41.75294	-84.70422	hudson
	041000030203	300214	Prouty Drn - Brott Rd	Hillsdale	41.79775	-84.78209	hudson
	041000030203	300314	W Fork W Br St Joseph R - Long Lake Rd	Hillsdale	41.78482	-84.79523	hudson

Appendix 2. E. coli results by 10-digit Hydrologic Unit Code (HUC), including prior precipitation (in inches) and relative water level change (in cm). Relative water level change was calculated using the lowest levels recorded during the study as the zero baseline. Exceedances of the WQS are indicated in light red (TBC) and black (PBC).

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Watershed Name: Escanaba		Middle Branch Escanaba River						
8-Digit HUC: 04030110		10-Digit HUC: 0403011001						
Site ID/Storet: 520381		Site Description Warner Cr - M35						
7/2/2020	84	75	110	88		0.43	0.43	61
7/8/2020	170	330	180	216		0.00	0.64	61
7/17/2020	240	130	230	193		0.01	0.03	62
7/24/2020	75	86	220	112		0.00	0.01	64
7/29/2020	73	50	120	76	126	0.00	0.00	0
Site ID/Storet: 520502		Site Description E Br Escanaba R - Iron St						
7/2/2020	31	52	31	37		0.43	0.43	3
7/8/2020	41	20	74	39		0.00	0.64	0
7/17/2020	30	10	52	25		0.01	0.03	8
7/24/2020	63	41	75	58		0.00	0.01	15
7/29/2020	62	85	41	60	42	0.00	0.00	5
Site ID/Storet: 520562		Site Description Middle Br Escanaba R - M35						
7/2/2020	10	10	41	16		0.43	0.43	1
7/8/2020	41	10	10	16		0.00	0.64	0
7/17/2020	10	41	1	7		0.01	0.03	4
7/24/2020	41	41	10	26		0.00	0.01	4
7/29/2020	20	20	10	16	15	0.00	0.00	5
Watershed Name: Escanaba		West Branch Escanaba River						
8-Digit HUC: 04030110		10-Digit HUC: 0403011002						
Site ID/Storet: 520561		Site Description W Br Escanaba R - County Road 557						
7/2/2020	31	20	30	26		0.43	0.43	0
7/8/2020	31	20	63	34		0.00	0.64	0
7/17/2020	41	74	85	64		0.01	0.03	15
7/24/2020	41	97	41	55		0.00	0.01	25
7/29/2020	97	41	63	63	46	0.00	0.00	25

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Watershed Name: Escanaba		Escanaba River						
8-Digit HUC: 04030110		10-Digit HUC: 0403011003						
Site ID/Storet: 520563		Site Description Escanaba R - Power Line Ln						
7/2/2020	52	41	52	48		0.43	0.43	0
7/8/2020	86	108	52	78		0.00	0.64	0
7/17/2020	31	41	52	40		0.01	0.03	3
7/24/2020	20	10	41	20		0.00	0.01	8
7/29/2020	75	20	74	48	43	0.00	0.00	5
Site ID/Storet: 520259		Site Description Sawmill Cr - Escanaba R Rd						
7/1/2020	63	85	130	89		0.00	0.00	12
7/9/2020	85	31	75	58		0.07	0.07	0
7/15/2020	180	300	230	232		0.78	0.78	20
7/23/2020	52	98	97	79		0.01	0.30	37
7/30/2020	31	41	51	40	82	0.00	0.00	17
Site ID/Storet: 520463		Site Description Little W Br Escanaba R - Little West Rd						
7/2/2020	170	96	85	112		0.42	0.42	9
7/8/2020	110	170	170	147		0.00	0.64	0
7/17/2020	63	75	63	67		0.01	0.03	44
7/24/2020	63	31	63	50		0.00	0.01	61
7/29/2020	10	20	20	16	61	0.00	0.00	69
Site ID/Storet: 520266		Site Description Swimming Hole Cr - Escanaba River Rd						
7/1/2020	51	51	74	58		0.00	0.00	0
Site ID/Storet: 520560		Site Description Un-Named Cr - Homestead Rd						
7/1/2020	63	31	41	43		0.00	0.00	0
Site ID/Storet: 210241		Site Description Squaw Cr - Saint Nicholas 31st Rd						
7/1/2020	730	610	890	735		0.00	0.00	8
7/9/2020	690	750	820	751		0.07	0.07	0
7/15/2020	820	610	860	755		0.76	0.78	43
7/23/2020	120	170	210	162		0.01	0.30	27
7/30/2020	210	200	140	180	414	0.00	0.00	16

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	210328	Site Description		Escanaba R - Robing Rd				
7/1/2020	20	31	1	9		0.00	0.00	3
7/9/2020	52	1	30	12		0.07	0.07	0
7/15/2020	52	10	41	28		0.68	0.78	20
7/23/2020	20	1	1	3		0.01	0.30	25
7/30/2020	20	20	20	20	11	0.00	0.00	15
Site ID/Storet:	210322	Site Description		Hunters Br - Boney Falls H Rd				
7/1/2020	86	31	31	44		0.00	0.00	0
7/9/2020	30	63	110	59		0.07	0.07	0
7/15/2020	51	97	41	59		0.68	0.78	22
7/23/2020	41	10	10	16		0.01	0.30	18
7/30/2020	20	20	20	20	34	0.00	0.00	8
Site ID/Storet:	210100	Site Description		Escanaba R - County 420 21st Rd				
7/1/2020	63	63	150	84		0.00	0.00	3
7/9/2020	120	20	31	42		0.09	0.09	3
7/15/2020	75	52	31	49		0.68	0.78	25
7/23/2020	10	41	75	31		0.01	0.30	4
7/30/2020	41	20	63	37	46	0.00	0.00	0
Site ID/Storet:	210329	Site Description		Reno Cr - County 420 21st Rd				
7/1/2020	200	63	150	124		0.00	0.00	9
7/9/2020	200	190	130	170		0.10	0.10	9
7/15/2020	220	210	220	217		0.68	0.78	31
7/23/2020	120	110	96	108		0.01	0.30	11
7/30/2020	200	86	12	59	124	0.00	0.00	0
Watershed Name:	St. Joseph			Coldwater River				
8-Digit HUC:	04050001		10-Digit HUC:		0405000101			
Site ID/Storet:	120266	Site Description		Coldwater R - E Fenn Rd				
9/29/2020	190	180	220	196		0.12	0.40	0
10/6/2020	290	360	350	332		0.00	0.06	6
10/13/2020	420	340	380	379		0.55	0.55	3
10/19/2020	130	120	70	103		0.27	0.28	6
10/26/2020	130	100	110	113	196	0.00	0.00	7

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	120259	Site Description		Sauk R- Butters Ave				
9/29/2020	250	280	230	253		0.13	0.40	2
10/6/2020	90	70	60	72		0.00	0.07	1
10/13/2020	1,000	1,200	1,800	1,293		0.55	0.55	1
10/19/2020	210	240	270	239		0.27	0.28	0
10/26/2020	60	30	40	42	188	0.00	0.00	1
Site ID/Storet:	120261	Site Description		S Br Hog Cr - Clarendon Rd				
8/24/2020	710	820	710	745		0.00	0.00	0
8/31/2020	680	710	690	693		0.00	0.00	7
9/8/2020	27,000	19,000	25,000	23,407		1.92	1.92	13
9/15/2020	410	510	380	430		0.00	0.00	11
9/21/2020	1,200	940	1,600	1,218	1,446	0.00	0.00	5
Site ID/Storet:	120260	Site Description		Coldwater R - Union City Rd				
9/29/2020	160	80	200	137		0.14	0.40	3
10/6/2020	120	90	190	127		0.00	0.09	1
10/13/2020	230	330	310	287		0.55	0.55	1
10/19/2020	70	30	70	53		0.27	0.28	0
10/26/2020	70	70	80	73	114	0.00	0.00	8
Watershed Name:	St. Joseph			Headwaters St Joseph River				
8-Digit HUC:	04050001		10-Digit HUC:		0405000102			
Site ID/Storet:	300317	Site Description		Beebe Cr - State Rd				
8/24/2020	650	750	640	678		0.00	0.00	0
8/31/2020	730	460	440	529		0.00	0.00	4
9/8/2020	14,000	11,000	9,100	11,191		1.92	1.92	11
9/15/2020	790	700	740	742		0.00	0.00	6
9/21/2020	1,300	1,800	1,200	1,411	1,333	0.00	0.00	1
Site ID/Storet:	300144	Site Description		Beebe Cr - E Moore Rd				
8/24/2020	420	320	310	347		0.00	0.00	0
8/31/2020	300	420	310	339		0.00	0.00	8
9/8/2020	10,000	10,000	10,000	10,000		1.92	1.92	16
9/15/2020	290	340	320	316		0.00	0.00	11
9/21/2020	280	290	280	283	638	0.00	0.00	4

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	300320	Site Description		St Joseph R - Pedestrian Bridge N of Fayette Rd				
8/24/2020	500	710	660	616		0.00	0.00	0
8/31/2020	760	700	790	749		0.00	0.00	3
9/8/2020	14,000	21,000	17,000	17,097		1.92	1.92	32
9/15/2020	290	220	260	255		0.00	0.00	6
9/21/2020	250	140	180	185	821	0.00	0.00	4
Site ID/Storet:	120238	Site Description		St Joseph R - S County Line Rd				
8/24/2020	240	200	210	216		0.00	0.00	0
8/31/2020	220	160	200	192		0.00	0.00	9
9/8/2020	4,500	3,100	3,700	3,723		1.92	1.92	12
9/15/2020	110	220	170	160		0.00	0.00	12
9/21/2020	150	220	250	202	346	0.00	0.00	5
Site ID/Storet:	300315	Site Description		Sand Cr - W Litchfield Rd				
8/24/2020	560	650	610	606		0.00	0.00	0
8/31/2020	970	850	1,100	968		0.00	0.00	6
9/8/2020	8,800	9,600	10,000	9,453		1.92	1.92	11
9/15/2020	690	530	650	619		0.00	0.00	8
9/21/2020	1,100	1,400	1,300	1,260	1,340	0.00	0.00	4
Site ID/Storet:	130419	Site Description		Tekonsha Cr - Old US 27 S				
8/24/2020	690	1,000	800	820		0.00	0.00	0
8/31/2020	410	420	440	423		0.00	0.00	6
9/8/2020	17,000	13,000	10,000	13,026		1.92	1.92	13
9/15/2020	600	660	420	550		0.00	0.00	7
9/21/2020	640	670	650	653	1,102	0.00	0.00	4
Site ID/Storet:	130420	Site Description		St Joseph R - T Drn S				
8/24/2020	240	180	170	194		0.00	0.00	0
8/31/2020	190	220	80	150		0.00	0.00	11
9/8/2020	1,700	2,200	2,000	1,956		1.92	1.92	11
9/15/2020	160	120	120	132		0.00	0.00	13
9/21/2020	70	130	100	97	236	0.00	0.00	5

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	130305	Site Description		St Joseph R - 9 Mile Rd				
9/29/2020	390	370	370	377		0.17	0.40	0
10/6/2020	130	120	120	123		0.00	0.10	2
10/13/2020	200	160	240	197		0.55	0.55	1
10/19/2020	80	110	160	112		0.27	0.28	6
10/26/2020	110	70	130	100	159	0.00	0.00	24
Watershed Name:		St. Joseph		Swan Creek-St Joseph River				
8-Digit HUC:	04050001		10-Digit HUC:		0405000104			
Site ID/Storet:	120256	Site Description		Lehr Lake Inlet - Mendon Rd				
9/29/2020	190	190	170	183		0.18	0.40	
10/6/2020	90	220	130	137		0.00	0.14	
10/13/2020	240	260	250	250		0.55	0.55	
10/19/2020	270	360	230	282		0.27	0.28	
10/26/2020	120	80	140	110	181	0.00	0.00	
Site ID/Storet:	120257	Site Description		Spencer Cr - off Mendon Rd (M60)				
9/29/2020	530	560	470	519		0.18	0.40	
10/6/2020	500	510	320	434		0.00	0.12	
10/13/2020	590	440	510	510		0.55	0.55	
10/19/2020	270	230	230	243		0.27	0.28	
10/26/2020	110	120	140	123	321	0.00	0.00	
Watershed Name:		St. Joseph		Portage River				
8-Digit HUC:	04050001		10-Digit HUC:		0405000105			
Site ID/Storet:	390647	Site Description		Portage R - YZ Ave				
9/29/2020	270	370	240	288		0.09	0.19	0
10/6/2020	170	140	200	168		0.00	0.08	2
10/13/2020	410	390	510	434		0.33	0.33	5
10/19/2020	170	100	140	134		0.25	0.27	8
10/26/2020	140	110	70	103	196	0.00	0.00	15
Site ID/Storet:	750292	Site Description		Portage R - S Fisher Lake Rd				
9/29/2020	190	160	190	179		0.09	0.19	0
10/6/2020	100	80	80	86		0.00	0.08	2
10/13/2020	90	90	80	87		0.33	0.33	2
10/19/2020	60	100	80	78		0.25	0.27	3
10/26/2020	80	60	40	58	90	0.00	0.00	14

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Watershed Name:		Pere Marquette-White		Little South Branch Pere Marquette River				
8-Digit HUC:		04060101		10-Digit HUC:		0406010103		
Site ID/Storet:		430572		Site Description		Middle Br Pere Marquette R - S James Rd		
7/14/2020	115	86	115	105		0.00	0.00	2
7/21/2020	150	235	205	193		0.00	0.00	3
7/28/2020	214	162	153	175		0.00	0.17	0
8/4/2020	126	124	91	112		0.00	0.10	4
8/11/2020	137	147	151	145	142	0.51	0.51	1
Site ID/Storet:		430569		Site Description		S Br Pere Marquette R - W 76th St		
7/14/2020	111	194	119	136		0.00	0.00	3
7/21/2020	276	186	291	246		0.00	0.00	5
7/28/2020	161	125	126	136		0.00	0.17	0
8/4/2020	2,420	2,420	2,420	2,420		0.00	0.10	14
8/11/2020	156	115	138	135	272	0.51	0.51	5
Watershed Name:		Pere Marquette-White		Big South Branch Pere Marquette River				
8-Digit HUC:		04060101		10-Digit HUC:		0406010104		
Site ID/Storet:		620318		Site Description		Beaver Cr - Comstock Ave		
7/14/2020	133	122	142	132		0.00	0.00	13
7/21/2020	166	186	249	197		0.00	0.00	3
7/28/2020	613	308	461	443		0.00	0.68	0
8/4/2020	291	461	411	380		0.00	0.02	27
8/11/2020	345	319	344	336	272	0.27	0.27	25
Site ID/Storet:		620220		Site Description		Big S Br Pere Marquette R - Croswell Ave		
7/14/2020	166	135	187	162		0.00	0.00	0
7/21/2020	185	172	142	165		0.00	0.00	1
7/28/2020	81	98	96	92		0.00	0.68	1
8/4/2020	196	194	194	194		0.00	0.02	9
8/11/2020	821	870	977	887	211	0.27	0.27	13
Site ID/Storet:		640183		Site Description		Freeman Cr - Maple Island Ave		
7/14/2020	2,420	2,420	2,420	2,420		0.00	0.00	7
7/21/2020	690	731	821	745		0.00	0.00	2
7/28/2020	922	1,633	922	1,116		0.00	0.68	0
8/4/2020	1,159	870	922	976		0.00	0.02	9
8/11/2020	821	521	731	679	1,059	0.27	0.27	10

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	620248	Site Description		Pere Marquette R - Dickinson Ave				
7/14/2020	236	201	199	211		0.00	0.00	12
7/21/2020	201	166	179	182		0.00	0.00	8
7/28/2020	93	150	110	115		0.00	0.68	0
8/4/2020	517	548	579	547		0.00	0.02	26
8/11/2020	252	370	222	275	232	0.27	0.28	19
Site ID/Storet:	530029	Site Description		Big S Br Pere Marquette R - E Wilson				
7/16/2020	146	150	126	140		0.45	0.45	6
7/22/2020	135	108	110	117		0.00	0.00	3
7/29/2020	435	308	308	345		0.38	0.38	0
8/5/2020	178	249	201	207		0.00	0.00	13
8/12/2020	167	123	123	136	174	0.00	0.51	9
Watershed Name:		Pere Marquette-White		Pere Marquette River				
8-Digit HUC:		04060101		10-Digit HUC:		0406010105		
Site ID/Storet:	430009	Site Description		Baldwin R - M 37				
7/14/2020	138	173	135	148		0.00	0.00	2
7/21/2020	411	378	299	359		0.00	0.00	9
7/28/2020	142	129	166	145		0.00	0.17	0
8/4/2020	105	148	157	135		0.00	0.10	5
8/11/2020	240	215	211	222	187	0.51	0.51	2
Site ID/Storet:	530226	Site Description		Weldon Cr - M10				
7/16/2020	291	228	225	246		0.45	0.45	5
7/22/2020	411	291	308	332		0.04	0.04	3
7/29/2020	365	261	238	283		0.38	0.38	2
8/5/2020	345	411	435	395		0.00	0.00	0
8/12/2020	359	345	456	383	323	0.00	0.51	2
Site ID/Storet:	530032	Site Description		Black R - E 1st St				
7/16/2020	2,420	2,420	2,420	2,420		0.45	0.45	
7/22/2020	870	1,540	1,159	1,158		0.00	0.00	
7/29/2020	496	922	731	694		0.38	0.38	
8/5/2020	429	344	209	313		0.00	0.00	
8/12/2020	4,839	4,839	4,839	4,839	1,242	0.00	0.51	

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	530027	Site Description		Pere Marquette R - S Scottville Rd				
7/16/2020	261	206	276	246		0.45	0.45	4
7/22/2020	135	173	87	127		0.00	0.00	7
7/29/2020	866	866	921	884		0.38	0.38	0
8/5/2020	345	411	411	387		0.00	0.00	8
8/12/2020	1,733	1,842	1,961	1,843	456	0.00	0.51	7
Site ID/Storet:	530229	Site Description		Swan Cr - W Chauvez Rd				
7/16/2020	1,203	1,414	1,203	1,270		0.45	0.45	30
7/22/2020	1,553	1,553	1,300	1,464		0.00	0.00	1
7/29/2020	2,420	2,420	2,420	2,420		0.38	0.38	4
8/5/2020	821	1,034	1,159	995		0.00	0.00	0
8/12/2020	3,106	3,973	2,827	3,268	1,710	0.00	0.51	15
Site ID/Storet:	530231	Site Description		Swan Cr (Trib to) - W Kinney Rd				
7/16/2020	1,046	866	1,300	1,056		0.45	0.45	0
7/22/2020	980	1,300	2,420	1,455		0.00	0.00	2
7/29/2020	1,553	1,300	1,120	1,312		0.38	0.38	7
8/5/2020	770	980	1,120	946		0.00	0.00	13
8/12/2020	1,733	2,092	2,240	2,010	1,308	0.00	0.51	14
Site ID/Storet:	530294	Site Description		Swan Cr - W Kinney Rd				
7/16/2020	1,120	1,120	816	1,008		0.45	0.45	
7/22/2020	461	579	727	579		0.00	0.00	
7/29/2020	2,420	2,420	2,420	2,420		0.38	0.38	
8/5/2020	582	690	690	652		0.00	0.00	
8/12/2020	2,240	2,827	2,240	2,421	1,174	0.00	0.51	
Site ID/Storet:	530233	Site Description		Lichte Cr - S Morton Rd				
7/16/2020	1,046	1,120	980	1,047		0.45	0.45	2
7/22/2020	435	365	435	411		0.00	0.00	1
7/29/2020	461	461	548	488		0.38	0.38	2
8/5/2020	411	488	365	418		0.00	0.00	0
8/12/2020	472	615	690	585	552	0.00	0.51	1

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	530273	Site Description		Trib to Pere Marquette - downstream of W Chauvez Rd				
7/16/2020	1,986	2,420	1,414	1,894		0.45	0.45	
7/22/2020	977	977	922	958		0.00	0.00	
7/29/2020	2,240	1,633	2,240	2,016		0.38	0.38	
8/5/2020	1,373	1,159	1,373	1,298		0.00	0.00	
8/12/2020	1,226	1,454	1,373	1,348	1,450	0.00	0.51	
Watershed Name:		Pere Marquette-White		Pentwater River				
8-Digit HUC:		04060101		10-Digit HUC:		0406010106		
Site ID/Storet:	640186	Site Description		S Branch Pentwater R - N 120th Ave				
7/14/2020	727	488	365	506		0.00	0.00	11
7/21/2020	345	387	206	302		0.00	0.00	0
7/28/2020	579	517	387	488		0.00	0.68	9
8/4/2020	135	179	194	167		0.00	0.02	8
8/11/2020	1,298	1,842	1,373	1,486	450	0.27	0.29	25
Site ID/Storet:	640205	Site Description		N Branch Pentwater R - N 96th Ave				
7/14/2020	240	228	214	227		0.00	0.00	15
7/21/2020	238	291	261	263		0.00	0.00	3
7/28/2020	411	411	435	419		0.00	0.68	0
8/4/2020	365	291	326	326		0.00	0.02	0
8/11/2020	3,973	3,466	3,466	3,627	494	0.27	0.41	26
Watershed Name:		Pere Marquette-White		South Branch White River				
8-Digit HUC:		04060101		10-Digit HUC:		0406010107		
Site ID/Storet:	620343	Site Description		Bowman/Dragon Drn - off 32nd St				
7/13/2020	3,973	4,839	4,839	4,531		0.00	0.00	0
7/20/2020	2,723	2,310	2,187	2,396		0.22	0.22	0
7/27/2020	1,089	953	953	996		0.00	0.00	0
8/3/2020	2,069	1,954	2,747	2,231		0.25	0.63	2
8/10/2020	461	468	476	468	1,624	0.00	0.26	0
Site ID/Storet:	620344	Site Description		Brayton Drn - off 32nd St (above Bowman confluence)				
7/13/2020	870	870	821	854		0.00	0.00	
7/20/2020	2,098	1,720	1,515	1,762		0.09	0.22	
7/27/2020	782	1,379	1,045	1,041		0.00	0.00	
8/3/2020	9,678	6,932	7,945	8,108		0.25	0.63	
8/10/2020	767	782	621	720	1,556	0.00	0.26	

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	640318	Site Description		Brayton Drn - E Wilke Rd				
7/13/2020	2,599	3,106	2,092	2,566		0.00	0.00	4
7/20/2020	1,860	1,789	1,722	1,789		0.00	0.22	2
7/27/2020	1,379	1,741	2,190	1,739		0.00	0.00	0
8/3/2020	6,932	6,932	3,683	5,614		0.25	0.63	4
8/10/2020	839	689	471	648	1,962	0.00	0.26	0
Site ID/Storet:	640349	Site Description		Brayton Cr - Cleveland Rd				
7/13/2020	1,095	870	821	922		0.00	0.00	5
7/20/2020	1,354	1,515	1,236	1,364		0.00	0.22	2
7/27/2020	1,045	1,549	839	1,108		0.00	0.00	0
8/3/2020	1,302	1,230	1,164	1,231		0.24	0.63	5
8/10/2020	384	448	448	425	939	0.00	0.26	1
Site ID/Storet:	640353	Site Description		Brayton Drn (Trib to) - E of 200th Ave				
7/13/2020	922	1,373	870	1,033		0.00	0.00	5
7/20/2020	2,142	2,143	1,376	1,849		0.00	0.22	3
7/27/2020	1,549	1,462	1,164	1,381		0.00	0.00	0
8/3/2020	2,908	2,595	3,683	3,029		0.24	0.63	4
8/10/2020	1,462	1,379	944	1,239	1,582	0.00	0.26	1
Site ID/Storet:	640354	Site Description		Brayton Drn - E of 200th Ave				
7/13/2020	731	731	870	775		0.00	0.00	5
7/20/2020	1,789	1,296	1,723	1,587		0.00	0.22	3
7/27/2020	1,302	1,642	1,549	1,491		0.00	0.00	0
8/3/2020	1,302	1,302	1,302	1,302		0.25	0.63	6
8/10/2020	526	510	587	540	1,052	0.00	0.26	2
Site ID/Storet:	640355	Site Description		Brayton Drn (Trib to) - Maple Island Rd				
7/13/2020	496	521	523	513		0.00	0.00	1
7/20/2020	677	537	295	475		0.01	0.22	2
7/27/2020	442	489	343	420		0.00	0.00	0
8/3/2020	1,549	1,954	1,302	1,579		0.25	0.63	4
8/10/2020	1,549	558	417	712	649	0.00	0.26	1

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Watershed Name:		Boardman Charlevoix		Lake Charlevoix				
8-Digit HUC:		04060105		10-Digit HUC:		0406010502		
Site ID/Storet:		150198		Site Description		N Br Boyne R - US 131		
7/15/2020	20	57	47	38		0.00	0.00	62
7/23/2020	137	201	161	164		0.50	1.73	72
7/30/2020	56	46	60	54		0.00	0.00	67
8/6/2020	36	38	33	35		0.00	0.00	67
8/13/2020	75	77	58	70	61	0.00	0.00	66
Site ID/Storet:		150010		Site Description		Jordan R - Rogers Rd		
7/15/2020	42	71	62	57		0.00	0.00	0
7/23/2020	308	435	291	339		0.50	1.73	24
7/30/2020	52	38	36	42		0.00	0.00	2
8/6/2020	37	46	43	42		0.00	0.00	0
8/13/2020	36	36	45	39	66	0.00	0.00	2
Site ID/Storet:		150056		Site Description		Lake Charlevoix - Bridge St		
7/15/2020	84	91	172	110		0.00	0.00	1
7/23/2020	921	435	326	507		0.50	1.73	6
7/30/2020	58	345	488	214		0.00	0.00	6
8/6/2020	90	613	308	257		0.00	0.00	0
8/13/2020	172	517	727	402	262	0.00	0.00	2
Site ID/Storet:		150204		Site Description		Deer Cr - Pearsall Rd		
7/15/2020	120	117	96	110		0.00	0.00	0
7/23/2020	488	613	365	478		0.50	1.73	25
7/30/2020	63	50	43	51		0.00	0.00	7
8/6/2020	39	35	37	37		0.00	0.00	4
8/13/2020	91	72	79	80	96	0.00	0.00	3
Site ID/Storet:		150257		Site Description		Birney Cr - Rogers Rd		
7/15/2020	770	579	579	637		0.00	0.00	1
7/23/2020	687	770	687	713		0.50	1.73	12
7/30/2020	179	228	248	216		0.00	0.00	2
8/6/2020	178	161	192	176		0.00	0.00	0
8/13/2020	228	214	194	212	326	0.00	0.00	2

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	150100	Site Description		Boyne R - S Lake St				
7/15/2020	186	179	138	166		0.00	0.00	9
7/23/2020	191	308	261	248		0.50	1.73	8
7/30/2020	172	166	186	175		0.00	0.00	7
8/6/2020	185	210	172	188		0.00	0.00	0
8/13/2020	206	179	238	207	195	0.00	0.00	4
Site ID/Storet:	150187	Site Description		S Br Boyne R - Boyne Mountain Rd				
7/15/2020	55	61	58	58		0.00	0.00	1
7/23/2020	150	122	147	139		0.50	1.73	9
7/30/2020	50	74	50	57		0.00	0.00	2
8/6/2020	34	36	43	37		0.00	0.00	2
8/13/2020	26	16	15	18	50	0.00	0.00	1
Site ID/Storet:	150106	Site Description		Monroe Cr - M 66				
7/15/2020	161	199	194	184		0.00	0.00	2
7/23/2020	613	1,203	770	828		0.50	1.73	24
7/30/2020	225	214	238	226		0.00	0.00	2
8/6/2020	155	141	115	136		0.00	0.00	2
8/13/2020	70	102	64	77	205	0.00	0.00	0
Watershed Name:		Pigeon-Wiscoggin		Sebewaing River-Frontal Lake Huron				
8-Digit HUC:		04080103		10-Digit HUC:		0408010301		
Site ID/Storet:	790239	Site Description		Quanicassee R - Old State Rd - West				
6/15/2020	1	20	10	6		0.00	0.00	9
6/23/2020	20	10	30	18		0.00	0.00	0
6/29/2020	30	10	10	14		0.00	0.00	3
7/6/2020	1	40	20	9		0.00	0.00	3
7/13/2020	40	10	40	25	13	0.01	0.01	10
Site ID/Storet:	790243	Site Description		Quanicassee R - Old State Rd - East				
6/15/2020	80	130	60	85		0.00	0.00	9
6/23/2020	40	60	90	60		0.00	0.00	0
6/29/2020	40	80	110	71		0.00	0.00	5
7/6/2020	40	10	50	27		0.00	0.00	3
7/13/2020	60	110	120	93	62	0.01	0.01	11
Site ID/Storet:	790245	Site Description		Trib to Quanicassee R - Akron/VanBuren				
7/6/2020	60	120	40	66		0.00	0.00	

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	790241	Site Description		Northwest Drn (Trib to) - N Vassar Rd				
6/15/2020	180	210	240	209		0.00	0.00	24
6/23/2020	470	500	330	426		0.06	0.06	12
6/29/2020	160	140	60	110		0.00	0.00	4
7/6/2020	60	120	180	109		0.00	0.00	0
7/13/2020	360	590	290	395	211	0.00	0.00	19
Site ID/Storet:	790242	Site Description		Northwest Drn (Trib to) - N Kirk Rd				
6/15/2020	350	130	290	236		0.00	0.00	23
6/23/2020	250	410	440	356		0.06	0.06	12
6/29/2020	340	340	410	362		0.00	0.00	4
7/6/2020	1,500	1,900	2,300	1,872		0.00	0.00	0
7/13/2020	340	430	380	382	465	0.00	0.00	8
Site ID/Storet:	790244	Site Description		Allen Drn - N Ringle Rd				
6/15/2020	140	200	160	165		0.00	0.00	21
6/23/2020	810	720	590	701		0.06	0.06	12
6/29/2020	220	330	310	282		0.00	0.00	7
7/6/2020	590	570	1,500	796		0.00	0.00	0
7/13/2020	210	240	280	242	363	0.00	0.00	10
Site ID/Storet:	790228	Site Description		Wiscoggin Drn - W Cass City Rd				
6/15/2020	450	540	440	475		0.00	0.00	12
6/23/2020	800	970	910	891		0.06	0.06	9
6/29/2020	1,800	1,700	1,700	1,733		0.00	0.00	5
7/6/2020	2,100	2,400	2,900	2,445		0.00	0.00	0
7/13/2020	720	490	480	553	998	0.00	0.00	11
Site ID/Storet:	790240	Site Description		Wiscoggin Drn - W Bay City Forestville Rd				
6/15/2020	310	290	290	297		0.00	0.00	
6/23/2020	620	510	510	544		0.06	0.06	
6/29/2020	850	830	670	779		0.00	0.00	
7/6/2020	2,700	2,400	2,500	2,530		0.00	0.00	
7/13/2020	500	470	550	506	694	0.00	0.00	

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	320371	Site Description		State Drn - Sebewaing Rd				
6/15/2020	320	290	250	285		0.00	0.00	1
6/23/2020	90	80	90	87		0.06	0.06	0
6/29/2020	170	130	140	146		0.00	0.00	1
7/6/2020	140	230	160	173		0.00	0.00	2
7/13/2020	410	400	290	362	186	0.00	0.00	7
Site ID/Storet:	320319	Site Description		Columbia Drn - Lange Rd				
6/15/2020	100	130	130	119		0.00	0.00	21
6/23/2020	440	330	470	409		0.06	0.06	10
6/29/2020	480	470	460	470		0.00	0.00	6
7/6/2020	80	110	140	107		0.00	0.00	0
7/13/2020	220	330	110	200	218	0.00	0.00	17
Watershed Name:		Pine		Coldwater River-Chippewa River				
8-Digit HUC:		04080202		10-Digit HUC:		0408020202		
Site ID/Storet:	370176	Site Description		Coldwater R - W Weidman Rd				
8/25/2020	140	100	70	99		0.00	0.00	0
9/1/2020	20	30	70	35		0.00	0.00	9
9/9/2020	270	310	290	290		0.21	0.60	13
9/16/2020	60	40	90	60		0.00	0.00	6
9/22/2020	20	10	30	18	64	0.00	0.00	2
Site ID/Storet:	370177	Site Description		Yonker Drn (Trib to Coldwater) - off W Bridge St				
8/25/2020	770	670	720	719		0.00	0.00	
9/1/2020	520	440	680	538		0.00	0.00	
9/9/2020	24,000	20,000	17,000	20,132		0.21	0.60	
9/16/2020	320	210	270	263		0.00	0.00	
9/22/2020	370	370	200	301	908	0.00	0.00	
Site ID/Storet:	370178	Site Description		Coldwater R - W Bridge St (West)				
8/25/2020	10	1	10	5		0.00	0.00	0
9/1/2020	20	30	1	8		0.00	0.00	8
9/9/2020	90	120	100	103		0.21	0.60	14
9/16/2020	110	130	120	120		0.00	0.00	7
9/22/2020	10	10	20	13	23	0.00	0.00	4

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	370179	Site Description		Coldwater R - N Woodruff Rd (N Crossing)				
8/25/2020	420	450	580	479		0.00	0.00	0
9/1/2020	540	530	410	490		0.00	0.00	6
9/9/2020	600	410	320	429		0.21	0.60	11
9/16/2020	370	400	200	309		0.00	0.00	5
9/22/2020	190	230	180	199	362	0.00	0.00	3
Site ID/Storet:	370180	Site Description		Lake of the Hills (Trib to) - W Rosebush Rd				
8/25/2020	310	450	560	427		0.00	0.00	1
9/1/2020	310	270	380	317		0.00	0.00	2
9/9/2020	1,100	1,100	920	1,036		0.21	0.60	3
9/16/2020	330	430	270	337		0.00	0.00	1
9/22/2020	300	410	390	363	444	0.00	0.00	0
Site ID/Storet:	370181	Site Description		Yonker Drn (Trib to Coldwater) - Bridge St				
9/1/2020	160	120	110	128		0.00	0.00	
9/9/2020	2,900	2,700	2,000	2,502		0.21	0.60	
9/16/2020	140	110	170	138		0.00	0.00	
9/22/2020	130	100	70	97		0.00	0.00	
Site ID/Storet:	370172	Site Description		Wagner Drn - N Vandecar Rd				
8/25/2020	270	430	220	294		0.00	0.00	0
9/1/2020	370	350	300	339		0.00	0.00	1
9/9/2020	1,400	1,000	1,200	1,189		0.21	0.60	3
9/16/2020	340	240	310	294		0.00	0.00	1
9/22/2020	340	320	260	305	403	0.00	0.00	1
Site ID/Storet:	370173	Site Description		Wagner Drn - W Weidman Rd				
8/25/2020	540	590	600	576		0.00	0.00	
9/1/2020	400	330	300	341		0.00	0.00	
9/9/2020	3,500	2,600	3,200	3,077		0.21	0.60	
9/16/2020	100	120	190	132		0.00	0.00	
9/22/2020	30	50	10	25	287	0.00	0.00	
Watershed Name:	Pine		Honeyoey Creek-Pine Creek					
8-Digit HUC:	04080202		10-Digit HUC:	0408020203				
Site ID/Storet:	290186	Site Description		Pine R - W Lincoln Rd				
9/14/2020	300	250	270	273		0.00	0.10	0

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	290228	Site Description		Pine R Backwaters (West Bank) - Off River St				
9/14/2020	180	280	310	250		0.00	0.10	
Site ID/Storet:	290229	Site Description		Pine R - Rails To Trails Bridge				
9/14/2020	220	260	200	225		0.00	0.10	
Site ID/Storet:	290230	Site Description		County Drn 178 - Confluence With Pine				
9/14/2020	220	120	220	180		0.00	0.10	
Site ID/Storet:	290231	Site Description		County Drn 178 - 5th St				
9/14/2020	330	300	210	275		0.00	0.10	
Site ID/Storet:	290233	Site Description		Pine R - Lumberjack Rd - S of Riverdale				
9/14/2020	210	250	260	239		0.00	0.10	
Watershed Name:	Shiawassee		South Branch Shiawassee River-Shiawassee River					
8-Digit HUC:	04080203		10-Digit HUC:	0408020301				
Site ID/Storet:	470677	Site Description		Sprague Cr - Byron Rd				
7/20/2020	1,500	2,000	1,500	1,651		0.54	0.54	6
7/27/2020	4,000	3,200	2,300	3,088		0.00	0.00	1
8/3/2020	3,800	5,400	2,700	3,812		0.47	1.12	8
8/10/2020	1,600	1,800	1,000	1,423		0.00	0.00	1
8/17/2020	1,300	1,100	820	1,055	1,963	0.00	0.01	0
Site ID/Storet:	470643	Site Description		Bogue Cr - Marr Rd				
7/20/2020	1,600	810	760	995		0.54	0.54	7
7/27/2020	700	1,100	700	814		0.00	0.00	2
8/3/2020	1,900	1,100	1,700	1,526		0.49	1.12	11
8/10/2020	640	750	560	645		0.00	0.00	0
8/17/2020	2,300	1,400	2,500	2,004	1,098	0.00	0.01	8
Site ID/Storet:	470663	Site Description		S Br Shiawassee R - Lovejoy Rd				
7/21/2020	260	230	230	240		0.00	0.54	11
7/28/2020	290	370	170	263		0.07	0.07	0
8/4/2020	480	740	430	535		0.06	0.50	21
8/11/2020	250	240	220	236		0.00	0.00	0
8/18/2020	210	260	250	239	286	0.00	0.00	7

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	470678	Site Description		N Ore Cr (Trib to) - E Clyde Rd				
7/21/2020	1,800	1,300	2,100	1,700		0.00	0.02	5
7/28/2020	500	430	450	459		0.07	0.07	0
8/4/2020	730	600	660	661		0.12	0.17	8
8/11/2020	760	710	740	736		0.00	0.00	5
8/18/2020	800	760	700	752	778	0.00	0.00	13
Site ID/Storet:	470680	Site Description		N Ore Cr - Cullen Rd				
7/21/2020	620	620	650	630		0.00	0.54	14
7/28/2020	550	650	600	599		0.07	0.07	0
8/4/2020	660	660	610	643		0.11	0.18	18
8/11/2020	660	710	520	625		0.00	0.00	14
8/18/2020	610	760	680	681	635	0.00	0.00	19
Site ID/Storet:	631311	Site Description		Shiawassee R - Legrande St				
7/21/2020	140	160	170	156		0.00	0.54	12
7/28/2020	160	80	110	112		0.07	0.07	0
8/4/2020	190	170	240	198		0.10	0.18	8
8/11/2020	40	100	120	78		0.00	0.00	6
8/18/2020	80	180	160	132	129	0.00	0.00	8
Site ID/Storet:	250113	Site Description		Shiawassee R - Bridge St				
7/21/2020	1	10	40	7		0.00	0.54	6
7/28/2020	50	90	90	74		0.07	0.07	0
8/4/2020	1	20	10	6		0.10	0.22	7
8/11/2020	10	1	20	6		0.00	0.00	6
8/18/2020	50	80	70	65	16	0.00	0.00	4
Site ID/Storet:	250462	Site Description		Shiawassee R - Hogan Rd				
7/21/2020	220	170	160	182		0.00	0.54	5
7/28/2020	280	220	160	214		0.07	0.07	0
8/4/2020	300	260	280	280		0.10	0.29	5
8/11/2020	290	200	260	247		0.00	0.00	4
8/18/2020	180	150	130	152	210	0.00	0.00	2

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	780136	Site Description		S Br Shiawassee R - S Byron Rd				
7/21/2020	190	190	180	187		0.00	0.54	7
7/28/2020	230	220	180	209		0.07	0.07	0
8/4/2020	310	270	300	293		0.07	0.56	25
8/11/2020	200	220	90	158		0.00	0.00	2
8/18/2020	210	250	210	223	209	0.00	0.00	10
Site ID/Storet:	250119	Site Description		Shiawassee R - Meier Rd				
7/21/2020	200	210	170	193		0.00	0.54	12
7/28/2020	170	200	260	207		0.07	0.07	0
8/4/2020	440	540	480	485		0.06	0.53	34
8/11/2020	200	210	260	222		0.00	0.00	15
8/18/2020	200	340	300	273	259	0.00	0.00	20
Watershed Name:		Shiawassee		Webb Creek-Shiawassee River				
8-Digit HUC:		04080203		10-Digit HUC:		0408020302		
Site ID/Storet:	780201	Site Description		Rowley Cr - Bath Rd				
7/20/2020	2,000	2,600	2,200	2,253		0.54	0.54	6
7/27/2020	2,800	2,100	1,700	2,154		0.00	0.00	3
8/3/2020	2,600	2,700	2,400	2,564		0.10	1.12	16
8/10/2020	2,500	3,000	2,800	2,759		0.00	0.00	3
8/17/2020	1,400	2,000	1,400	1,577	2,222	0.00	0.01	0
Site ID/Storet:	780271	Site Description		Aginaw Lake Drn - Reed Rd (North)				
7/20/2020	1,300	840	1,300	1,124		0.54	0.54	5
7/27/2020	1,000	1,800	1,800	1,374		0.00	0.00	4
8/3/2020	980	1,100	1,200	1,090		0.13	1.12	13
8/10/2020	1,400	1,800	2,400	1,822		0.00	0.00	3
8/17/2020	840	980	650	812	1,210	0.00	0.01	0
Site ID/Storet:	780272	Site Description		Euler Lake Drn - Reed Rd (South)				
7/20/2020	2,300	4,000	3,600	3,211		0.54	0.54	1
7/27/2020	5,300	6,000	5,700	5,659		0.00	0.00	0
8/3/2020	5,000	4,500	2,500	3,832		0.23	1.12	5
8/10/2020	2,900	2,300	1,700	2,247		0.00	0.00	1
8/17/2020	2,300	2,400	1,900	2,189	3,213	0.00	0.01	1

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	780273	Site Description		Kanouse Lake Drn - E Beard Rd				
7/20/2020	1,100	1,700	1,000	1,232		0.54	0.54	
7/27/2020	1,500	2,000	2,000	1,817		0.00	0.00	
8/3/2020	4,700	4,500	3,600	4,238		0.28	1.12	
8/10/2020	1,700	2,400	1,500	1,829		0.00	0.00	
8/17/2020	1,500	3,300	2,000	2,147	2,062	0.00	0.01	
Site ID/Storet:	780095	Site Description		Webb Drn - S Vernon Rd				
7/20/2020	580	470	390	474		0.02	0.54	5
7/27/2020	190	280	370	270		0.00	0.00	2
8/3/2020	1,700	1,200	2,400	1,698		0.07	1.12	11
8/10/2020	1,700	1,500	1,800	1,662		0.00	0.00	4
8/17/2020	450	520	440	469	701	0.00	0.01	0
Site ID/Storet:	780270	Site Description		Shiawassee R - Exchange Rd				
7/20/2020	160	120	130	136		0.54	0.54	5
7/27/2020	80	70	90	80		0.00	0.00	0
8/3/2020	490	490	350	438		0.08	1.12	12
8/10/2020	160	150	160	157		0.00	0.00	3
8/17/2020	180	130	200	167	165	0.00	0.01	0
Watershed Name:	Ottawa-Stony			Otter Creek-Frontal Lake Erie				
8-Digit HUC:	04100001		10-Digit HUC:		0410000102			
Site ID/Storet:	580646	Site Description		Muddy Cr - Cousino Rd				
9/24/2020	230	200	360	255		0.00	0.00	27
9/30/2020	280	250	260	263		0.01	0.16	6
10/7/2020	260	120	180	178		0.00	0.00	0
10/14/2020	300	280	190	252		0.00	0.34	12
10/21/2020	220	120	110	143	212	0.66	0.77	6
Site ID/Storet:	580413	Site Description		Otter Cr - Goutz Rd				
9/24/2020	41	41	10	26		0.00	0.00	6
10/21/2020	9,200	24,000	8,200	12,188		0.66	0.76	0

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	580451	Site Description		Bay Cr - Bay Cr Rd				
9/24/2020	74	30	120	64		0.00	0.00	32
9/30/2020	300	170	250	234		0.01	0.16	9
10/7/2020	110	520	440	293		0.00	0.00	0
10/14/2020	250	200	120	182		0.00	0.34	24
10/21/2020	110	63	200	111	155	0.66	0.80	9
Site ID/Storet:	580584	Site Description		Little Lake Cr - Suder Rd				
10/14/2020	960	1,300	990	1,073		0.00	0.34	0
10/21/2020	1,000	1,400	2,100	1,433		0.66	0.83	37
Site ID/Storet:	580642	Site Description		Flat Cr - Dean Rd				
9/24/2020	12,000	6,900	24,196	12,606		0.00	0.00	6
9/30/2020	24,196	24,196	24,196	24,196		0.01	0.16	0
10/7/2020	87,000	98,000	61,000	80,419		0.00	0.01	0
10/14/2020	7,800	11,000	12,000	10,098		0.00	0.34	27
10/21/2020	1,700	2,300	1,800	1,916	13,655	0.66	0.84	40
Site ID/Storet:	580643	Site Description		Bay Cr - Summit St				
9/24/2020	560	370	390	432		0.00	0.00	3
9/30/2020	820	710	570	692		0.01	0.16	3
10/7/2020	31	85	85	61		0.00	0.00	0
10/14/2020	240	430	470	365		0.00	0.34	0
10/21/2020	2,600	3,400	3,700	3,198	463	0.66	0.79	3
Site ID/Storet:	580645	Site Description		Cousino Drn - Vienna Rd				
9/24/2020	550	290	200	317		0.00	0.00	37
9/30/2020	500	440	190	347		0.01	0.16	0
10/21/2020	910	3,900	680	1,341		0.66	0.80	15
Watershed Name:	St. Joseph		West Branch St Joseph River					
8-Digit HUC:	04100003		10-Digit HUC:	0410000302				
Site ID/Storet:	300215	Site Description		E Fork W Br St Joseph R - Card Rd				
6/16/2020	50	50	50	50		0.00	0.00	7
6/22/2020	150	80	100	106		0.00	0.00	4
6/30/2020	50	40	140	65		0.00	0.00	5
7/7/2020	270	490	440	388		0.00	0.00	1
7/14/2020	130	320	200	203	122	0.00	0.00	0

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	300264	Site Description		E Fork W Br St Joseph R - Camden Rd				
6/16/2020	210	90	110	128		0.00	0.00	
Site ID/Storet:	300312	Site Description		Trib to E Fork W Br St Joseph R - Austin Rd				
6/22/2020	1,500	990	930	1,114		0.00	0.00	1
6/30/2020	790	830	740	786		0.00	0.00	1
7/7/2020	750	830	840	806		0.00	0.00	0
7/14/2020	3,400	3,100	3,400	3,297		0.00	0.00	0
Site ID/Storet:	300313	Site Description		E Fork W Br St Joseph R - Austin Rd				
6/22/2020	590	470	540	531		0.00	0.00	9
6/30/2020	960	820	930	901		0.00	0.00	8
7/7/2020	620	790	900	761		0.00	0.00	2
7/14/2020	850	880	970	899		0.00	0.00	0
Site ID/Storet:	300318	Site Description		W Fork W Br St Joseph R - Sampson Rd				
6/16/2020	260	330	390	322		0.00	0.00	8
6/22/2020	500	480	650	538		0.00	0.00	5
6/30/2020	700	590	590	625		0.00	0.00	4
7/7/2020	600	520	500	538		0.00	0.00	0
7/14/2020	690	640	760	695	527	0.00	0.00	1
Site ID/Storet:	300319	Site Description		Carruthers Drn - W Montgomery Rd				
6/16/2020	600	540	470	534		0.00	0.00	1
6/22/2020	290	350	300	312		0.00	0.00	3
6/30/2020	300	340	310	316		0.00	0.00	3
7/7/2020	470	360	460	427		0.00	0.00	0
7/14/2020	190	170	220	192	337	0.00	0.00	1
Site ID/Storet:	300322	Site Description		Trib to E Fork W Br St Joseph R - Camden Rd				
6/16/2020	1,800	2,000	1,900	1,898		0.00	0.00	
Site ID/Storet:	300214	Site Description		Prouty Drn - Brott Rd				
6/16/2020	1,200	1,200	1,100	1,166		0.00	0.00	
6/22/2020	1,300	1,000	1,000	1,091		0.00	0.00	
6/30/2020	2,100	2,300	2,100	2,165		0.00	0.00	
7/7/2020	1,400	1,400	1,000	1,251		0.00	0.00	
7/14/2020	810	910	820	845	1,239	0.00	0.00	

Date	L	C	R	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Rain	48-Hour Prior Rain	Relative water level change
Site ID/Storet:	300314	Site Description		W Fork W Br St Joseph R - Long Lake Rd				
6/16/2020	1,900	2,100	1,800	1,929		0.00	0.00	8
6/22/2020	2,200	2,500	2,200	2,296		0.00	0.00	3
6/30/2020	6,900	6,400	7,700	6,980		0.00	0.00	3
7/7/2020	1,800	2,900	3,300	2,583		0.00	0.00	1
7/14/2020	1,100	1,800	1,600	1,469	2,593	0.00	0.00	0

Appendix 3. Weather information, water temperature, turbidity, conductivity, calculated total dissolved solids (TDS), pH, and dissolved oxygen (D.O.) results by watershed. Instantaneous readings below the minimum D.O. standards (coldwater [CW] or warmwater [WW], as applicable) are shaded red. TDS results of concern (above the 500 mg/L threshold) are highlighted in red. NOTE: Blanks indicate that the parameter is not available for that event. Daily average D.O. measurements are not available.

Date and Time	24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Watershed Escanaba									
Site ID	210100	Site Description		Escanaba R - County 420 21st Rd					
7/1/2020 11:48:00 AM	0	78.3	9.67	86		229	136	8.53	WW
7/9/2020 10:50:00 AM	0.09	70.9	8.35	81.7		297	184	8.46	WW
7/15/2020 10:40:00 AM	0.68	72.9	7.47	75.4		245	162	7.53	WW
7/23/2020 10:23:00 AM	0.01	69.6	6.7	72.3		269	184	6.7	WW
7/30/2020 10:50:00 AM	0	72.8	8.62	75.7		308	203	8.07	WW
Site ID	210241	Site Description		Squaw Cr - Saint Nicholas 31st Rd					
7/1/2020 10:23:00 AM	0	76.5	8.99	70.3		178	124	7.1	CW
7/9/2020 9:38:00 AM	0.07	73.6	8.75	69.4		363	257	7.45	CW
7/15/2020 9:30:00 AM	0.76	71.1	9.35	64.4		268	201	7.72	CW
7/23/2020 9:20:00 AM	0.01	63.6	9.05	61.3		268	209	7.26	CW
7/30/2020 10:00:00 AM	0	70.4	8.68	64.6		275	206	7.89	CW
Site ID	210322	Site Description		Hunters Br - Boney Falls H Rd					
7/1/2020 11:16:00 AM	0	77	9.61	75.6		357	236	7.75	CW
7/9/2020 10:12:00 AM	0.07	73.4	9.29	73.2		381	258	7.94	CW
7/15/2020 10:05:00 AM	0.68	71.8	9.44	66.2		342	251	7.7	CW
7/23/2020 10:00:00 AM	0.01	67.3	9.03	63.3		362	275	7.52	CW
7/30/2020 10:20:00 AM	0	71.9	8.85	66.9		391	285	8.21	CW
Site ID	210328	Site Description		Escanaba R - Robing Rd					
7/1/2020 10:50:00 AM	0	77	8.61	77.4		221	143	7.16	CW
7/9/2020 9:52:00 AM	0.07	73.9	9.15	78.4		280	179	8.42	CW
7/15/2020 9:55:00 AM	0.68	72	9.38	69.6		234	165	7.81	CW
7/23/2020 9:30:00 AM	0.01	64.4	8.58	65.3		205	152	8.01	CW
7/30/2020 10:12:00 AM	0	70.6	8.23	70		218	153	7.85	CW
Site ID	210329	Site Description		Reno Cr - County 420 21st Rd					
7/1/2020 12:19:00 PM	0	78.8	8.62	69.8		450	317	6.56	CW
7/9/2020 11:06:00 AM	0.1	70.5	7.55	78.4		410	262	7.98	CW
7/15/2020 10:56:00 AM	0.68	73.5	9.08	67.1		381	277	7.7	CW
7/23/2020 10:42:00 AM	0.01	69.9	8.75	63.5		431	327	7.31	CW
7/30/2020 11:10:00 AM	0	72.8	8.3	66.2		487	358	8.2	CW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	520259	Site Description		Sawmill Cr - Escanaba R Rd						
7/1/2020 8:55:00 AM		0	74.1	7.67	70.7		188	131	6.66	CW
7/9/2020 8:45:00 AM		0.07	72.8	7.54	71.4		382	264	7.18	CW
7/15/2020 8:37:00 AM		0.78	67.9	8.18	64.6		176	132	7.29	CW
7/23/2020 8:20:00 AM		0.01	60.2	6.88	62.2		103	79	6.59	CW
7/30/2020 8:42:00 AM		0	65.4	6.74	64.9		134	100	7	CW
Site ID	520266	Site Description		Swimming Hole Cr - Escanaba River Rd						
7/1/2020 9:25:00 AM		0	75.8	7.9	66.6		145	106	6.72	CW
Site ID	520381	Site Description		Warner Cr - M35						
7/2/2020 11:10:00 AM		0.43	84.3	6.82	68.5		660	471	7.12	CW
7/8/2020 11:55:00 AM		0	80.3	7.03	68		612	440	7.42	CW
7/17/2020 9:50:00 AM		0.01	74.8	7.1	63.5		626	475	7.12	CW
7/24/2020 10:10:00 AM		0	71.9	6.31	61.3		592	461	6.14	CW
7/29/2020 8:23:00 AM		0	66.5	6.32	59.5		343	274	6.86	CW
Site ID	520463	Site Description		Little W Br Escanaba R - Little West Rd						
7/2/2020 8:11:00 AM		0.42	71.3	6.81	72.1		286	196	6.8	CW
7/8/2020 10:10:00 AM		0	76	6.81	73.8		307	207	7.74	CW
7/17/2020 7:44:00 AM		0.01	66.5	6.61	66.7		258	188	7.29	CW
7/24/2020 8:00:00 AM		0	60.5	5.55	62.8		295	226	6.96	CW
7/29/2020 10:30:00 AM		0	74.4	4.87	68		173	124	6.89	CW
Site ID	520502	Site Description		E Br Escanaba R - Iron St						
7/2/2020 11:05:00 AM		0.43	84.3	8.1	72.9		509	346	8.1	CW
7/8/2020 10:50:00 AM		0	78.4	8.67	72.9		585	398	7.44	CW
7/17/2020 9:04:00 AM		0.01	71.9	8.64	68.7		552	393	7.71	CW
7/24/2020 9:25:00 AM		0	72.4	8.24	64.8		411	307	7.35	CW
7/29/2020 8:58:00 AM		0	69.1	7.96	66		285	210	7.01	CW
Site ID	520560	Site Description		Un-Named Cr - Homestead Rd						
7/1/2020 9:50:00 AM		0	76.6	7.92	69.6		347	245	6.96	CW
Site ID	520561	Site Description		W Br Escanaba R - County Road 557						
7/2/2020 8:55:00 AM		0.43	74.2	9.08	70.5		238	166	7.18	CW
7/8/2020 10:45:00 AM		0	78.6	9.4	71.8		264	182	7.63	CW
7/17/2020 8:15:00 AM		0.01	68.8	9.21	66		229	168	7.66	CW
7/24/2020 8:30:00 AM		0	66.4	8.5	63.3		219	167	6.97	CW
7/29/2020 10:00:00 AM		0	70.4	7.94	68		225	162	6.68	CW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	520562	Site Description		Middle Br Escanaba R - M35						
7/2/2020 10:35:00 AM		0.43	82.6	7.63	79.5		142	90	7.05	CW
7/8/2020 11:21:00 AM		0	80.3	8.12	77		164	107	7.06	CW
7/17/2020 9:20:00 AM		0.01	73	8.3	70.5		149	104	7.11	CW
7/24/2020 9:45:00 AM		0	71.8	7.98	66.7		142	104	6.27	CW
7/29/2020 8:45:00 AM		0	66.5	7.36	70.2		156	109	6.23	CW
Site ID	520563	Site Description		Escanaba R - Power Line Ln						
7/2/2020 9:36:00 AM		0.43	78.2	8.27	73.6		267	180	7.28	CW
7/8/2020 10:20:00 AM		0	77.1	8.42	75.2		289	192	7.57	CW
7/17/2020 8:45:00 AM		0.01	70.2	8.68	68.5		284	203	7.35	CW
7/24/2020 9:00:00 AM		0	70.4	8.25	64.8		390	291	6.61	CW
7/29/2020 9:30:00 AM		0	68.4	7.77	69.1		188	133	6.58	CW
Watershed	St. Joseph									
Site ID	120238	Site Description		St Joseph R - S County Line Rd						
8/24/2020 10:30:00 AM		0	76.5	7.99	70.2	1.26	696	488	8.11	WW
8/31/2020 10:18:00 AM		0	67.2	8.28	63.9	2.15	579	437	8.1	WW
9/8/2020 10:41:00 AM		1.92	60.9	7.9	64.6	10.01	499	373	8.05	WW
9/15/2020 11:04:00 AM		0	61.5	9.32	58.8	2.36	560	451	8.2	WW
9/21/2020 10:41:00 AM		0	60.9	10.04	53.8	1.88	557	480	8.25	WW
Site ID	120256	Site Description		Lehr Lake Inlet - Mendon Rd						
9/29/2020 9:52:00 AM		0.18	51.5	7.22	52	1.15	599	530	7.44	WW
10/6/2020 9:49:00 AM		0	54.2	7.83	49.8	1.32	581	531	7.46	WW
10/13/2020 9:29:00 AM		0.55	46.4	6.87	49.6	1.1	572	524	7.37	WW
10/19/2020 9:47:00 AM		0.27	39.8	7.22	47.3	1.4	554	526	7.4	WW
10/26/2020 9:57:00 AM		0	41.7	7.35	47.8	2.4	560	527	7.38	WW
Site ID	120257	Site Description		Spencer Cr - off Mendon Rd (M60)						
9/29/2020 10:07:00 AM		0.18	52.5	9.06	55.4	1.79	553	465	7.83	WW
10/6/2020 10:02:00 AM		0	54.9	9.6	50.7	1.96	492	443	7.8	WW
10/13/2020 9:43:00 AM		0.55	47.8	7.79	52.5	1.33	530	465	7.65	WW
10/19/2020 10:01:00 AM		0.27	40.1	8.9	47.1	1.23	496	472	7.7	WW
10/26/2020 10:07:00 AM		0	41.6	9.64	47.3	2.1	523	496	7.7	WW
Site ID	120259	Site Description		Sauk R- Butters Ave						
9/29/2020 11:17:00 AM		0.13	56.4	10.41	58.1	0.45	557	453	7.75	WW
10/6/2020 11:07:00 AM		0	58.5	11.84	53.9	0.47	577	498	7.83	WW
10/13/2020 11:05:00 AM		0.55	55.6	8.01	55.9	0.24	595	497	7.44	WW
10/19/2020 11:18:00 AM		0.27	41.6	7.37	51.3	0.55	577	517	7.37	WW
10/26/2020 11:13:00 AM		0	42.6	8.62	50.4	0.24	568	514	7.48	WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	120260	Site Description		Coldwater R - Union City Rd						
9/29/2020 10:46:00 AM		0.14	54.9	9.58	58.8	0.39	499	402	7.89	WW
10/6/2020 10:40:00 AM		0	57.1	10.61	52.5	0.54	470	412	7.95	WW
10/13/2020 10:18:00 AM		0.55	51.2	8.64	55.2	0.38	490	414	7.74	WW
10/19/2020 10:46:00 AM		0.27	40.9	9.72	48.7	0.27	456	425	7.78	WW
10/26/2020 10:39:00 AM		0	41.8	9.97	48.4	0.4	453	423	7.83	WW
Site ID	120261	Site Description		S Br Hog Cr - Clarendon Rd						
8/24/2020 9:48:00 AM		0	74.4	7.42	68.7	3.63	614	438	8.07	WW
8/31/2020 9:22:00 AM		0	63.2	8.01	63.1	3.52	523	398	8.06	WW
9/8/2020 9:51:00 AM		1.92	60.1	7.66	64	22.8	396	298	7.86	WW
9/15/2020 10:13:00 AM		0	58.7	8.95	59	2.93	472	380	8.14	WW
9/21/2020 9:40:00 AM		0	54	9.74	52.9	1.71	506	442	8.19	WW
Site ID	120266	Site Description		Coldwater R - E Fenn Rd						
9/29/2020 11:38:00 AM		0.12	58	8.38	55.4	0.52	515	434	7.66	WW
10/6/2020 11:25:00 AM		0	59.5	9.07	52.5	0.7	480	422	7.7	WW
10/13/2020 11:16:00 AM		0.55	56.6	5.69	53.4	0.56	506	439	7.47	WW
10/19/2020 11:35:00 AM		0.27	41.9	7.17	48	0.7	471	442	7.55	WW
10/26/2020 11:29:00 AM		0	42.8	8.46	48.4	0.44	448	418	7.68	WW
Site ID	130305	Site Description		St Joseph R - 9 Mile Rd						
9/29/2020 10:30:00 AM		0.17	53.9	9.14	56.8	0.48	556	456	7.98	WW
10/6/2020 10:20:00 AM		0	56.2	10.26	50.4	0.67	521	472	8.02	WW
10/13/2020 9:59:00 AM		0.55	49.4	8.46	54.1	0.57	543	466	7.83	WW
10/19/2020 10:26:00 AM		0.27	40.6	9.54	47.5	0.37	514	486	7.86	WW
10/26/2020 10:25:00 AM		0	41.7	9.66	47.5	0.74	475	450	7.86	WW
Site ID	130419	Site Description		Tekonsha Cr - Old US 27 S						
8/24/2020 10:51:00 AM		0	77.5	7	71.2	4.85	615	485	7.88	WW
8/31/2020 10:42:00 AM		0	68.8	8.05	64.2	3.65	592	445	7.98	WW
9/8/2020 11:17:00 AM		1.92	62.3	7.27	63.3	16.2	367	279	7.8	WW
9/15/2020 11:35:00 AM		0	63.4	9.13	60.1	3.56	555	440	8.05	WW
9/21/2020 11:04:00 AM		0	62.5	10.29	55.2	2.56	537	452	8.13	WW
Site ID	130420	Site Description		St Joseph R - T Drn S						
8/24/2020 11:03:00 AM		0	78.4	7.58	70.9	0.82	628	436	8.09	WW
8/31/2020 10:54:00 AM		0	70.1	7.69	66.6	1.5	570	416	8.08	WW
9/8/2020 11:25:00 AM		1.92	63	7.73	64.6	3.24	472	353	8.04	WW
9/15/2020 11:48:00 AM		0	64.4	8.94	61.5	3.6	545	423	8.21	WW
9/21/2020 11:45:00 AM		0	65.7	10.07	54.9	0.3	525	446	8.29	WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	300144	Site Description		Beebe Cr - E Moore Rd						
8/24/2020 9:11:00 AM		0	72.1	7.72	68.9	1.72	570	406	8.03	WW
8/31/2020 9:03:00 AM		0	62.5	7.66	64	3.85	485	365	7.92	WW
9/8/2020 9:21:00 AM		1.92	59.3	7.45	64.9	10.79	400	298	7.86	WW
9/15/2020 9:38:00 AM		0	56.3	8.74	58.6	5.8	468	377	8.02	WW
9/21/2020 9:10:00 AM		0	49.5	9.72	53.2	1.76	474	412	8.16	WW
Site ID	300315	Site Description		Sand Cr - W Litchfield Rd						
8/24/2020 10:15:00 AM		0	75.7	8.47	64.9	2.73	572	426	7.94	WW
8/31/2020 9:44:00 AM		0	65	8.59	60.3	3.8	522	412	7.95	WW
9/8/2020 10:24:00 AM		1.92	60.7	8.07	62.6	24.6	408	312	7.84	WW
9/15/2020 10:40:00 AM		0	59.9	9.31	56.5	4.15	488	406	7.99	WW
9/21/2020 10:13:00 AM		0	58.3	9.9	52	3.4	483	428	8.02	WW
Site ID	300317	Site Description		Beebe Cr - State Rd						
8/24/2020 8:26:00 AM		0	69.1	5.79	65.5	4.15	581	429	7.82	WW
8/31/2020 8:33:00 AM		0	60.7	6.73	60.1	4.44	495	391	7.82	WW
9/8/2020 8:43:00 AM		1.92	58.3	7.15	64.6	40.7	339	256	7.72	WW
9/15/2020 8:35:00 AM		0	51	8.24	55.8	10.85	498	418	7.96	WW
9/21/2020 8:14:00 AM		0	42.3	8.83	49.6	11.01	506	463	8.02	WW
Site ID	300320	Site Description		St Joseph R - Pedestrian Bridge N of Fayette Rd						
8/24/2020 8:46:00 AM		0	70.5	7.37	65.1	1.93	800	595	7.9	WW
8/31/2020 8:49:00 AM		0	62.7	7.34	62.4	1.47	667	513	7.83	WW
9/8/2020 9:04:00 AM		1.92	59.2	7.9	65.5	50	173	114	7.66	WW
9/15/2020 8:58:00 AM		0	53.7	7.96	60.4	2.62	573	452	7.92	WW
9/21/2020 8:43:00 AM		0	46.1	8.57	55	0.91	608	515	7.94	WW
Site ID	390647	Site Description		Portage R - YZ Ave						
9/29/2020 8:40:00 AM		0.09	47.4	7.94	59.5	2.7	423	337	7.78	WW
10/6/2020 8:32:00 AM		0	50.8	9.02	53.1	2.29	402	350	7.73	WW
10/13/2020 8:25:00 AM		0.33	43.8	8.16	55.9	2.29	412	347	7.63	WW
10/19/2020 8:36:00 AM		0.25	39.2	8.95	49.3	1.82	384	358	7.71	WW
10/26/2020 8:38:00 AM		0	41.1	8.94	48	0.99	383	360	7.65	WW
Site ID	750292	Site Description		Portage R - S Fisher Lake Rd						
9/29/2020 9:10:00 AM		0.09	47.4	7.87	59.5	1.7	418	334	7.86	WW
10/6/2020 9:00:00 AM		0	50.8	8.35	55.2	1.89	401	339	7.75	WW
10/13/2020 8:53:00 AM		0.33	43.8	7.89	55.9	1.29	404	338	7.74	WW
10/19/2020 9:02:00 AM		0.25	39.2	8.46	51.1	1	385	345	7.71	WW
10/26/2020 9:07:00 AM		0	41.1	8.66	50.4	1.04	385	348	7.72	WW

Date and Time	24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Watershed	Pere Marquette-White								
Site ID	430009	Site Description		Baldwin R - M 37					
7/14/2020 11:10:00 AM	0	75.6	9.4	60.1		244	194	8.14	CW
7/21/2020 11:25:00 AM	0	71.3	8.9	61.5		241	188	8.06	CW
7/28/2020 11:45:00 AM	0	74.6	9.1	62.2		258	199	8.14	CW
8/4/2020 11:20:00 AM	0	65.6	9.7	57.6		242	198	8.1	CW
8/11/2020 11:40:00 AM	0.51	72.7	9.1	62.1		257	199	8.14	CW
Site ID	430569	Site Description		S Br Pere Marquette R - W 76th St					
7/14/2020 10:50:00 AM	0	74.8	9.2	60.4		252	199	8.18	CW
7/21/2020 11:00:00 AM	0	70.1	8.9	61.7		255	198	8.09	CW
7/28/2020 11:15:00 AM	0	74.2	9	62.2		267	206	8.18	CW
8/4/2020 10:55:00 AM	0	65.5	9.2	58.6		236	191	7.98	CW
8/11/2020 11:15:00 AM	0.51	72.3	8.9	63		266	203	8.13	CW
Site ID	430572	Site Description		Middle Br Pere Marquette R - S James Rd					
7/14/2020 11:00:00 AM	0	74.9	9.8	55.8		249	209	8.18	CW
7/21/2020 11:10:00 AM	0	70.1	9.4	57		251	207	8.05	CW
7/28/2020 11:30:00 AM	0	74.5	9.2	57.2		261	215	8.04	CW
8/4/2020 11:05:00 AM	0	66.5	9.8	54.1		249	214	8.04	CW
8/11/2020 11:25:00 AM	0.51	72.9	9.4	57.7		262	214	8.15	CW
Site ID	530027	Site Description		Pere Marquette R - S Scottville Rd					
7/16/2020 10:55:00 AM	0.45	74.3	8.2	66.2		317	233	8.22	CW
7/22/2020 9:40:00 AM	0	72.5	7.7	67.6		311	225	8.02	CW
7/29/2020 9:45:00 AM	0.38	73.2	7.5	68.5		329	235	8.11	CW
8/5/2020 9:30:00 AM	0	65.2	8.8	59.5		279	223	8.27	CW
8/12/2020 9:15:00 AM	0	72.2	7.8	65.5		306	227	7.99	CW
Site ID	530029	Site Description		Big S Br Pere Marquette R - E Wilson					
7/16/2020 11:45:00 AM	0.45	75.7	9.1	67.1		306	223	8.37	CW
7/22/2020 10:30:00 AM	0	72.8	8	67.8		313	226	8.24	CW
7/29/2020 10:30:00 AM	0.38	74.2	7.7	69.1		322	229	8.18	CW
8/5/2020 10:10:00 AM	0	67	8.8	60.3		252	200	8.23	CW
8/12/2020 9:50:00 AM	0	74	8.1	65.7		285	211	8.07	CW
Site ID	530032	Site Description		Black R - E 1st St					
7/16/2020 11:20:00 AM	0.45	74.6	8.4	54.9		410	349	7.92	CW
7/22/2020 10:10:00 AM	0	73.1	8.3	54.3		411	352	7.93	CW
7/29/2020 10:00:00 AM	0.38	73.6	8	54.5		404	346	7.89	CW
8/5/2020 9:50:00 AM	0	66.8	8.6	51.1		387	347	8.23	CW
8/12/2020 9:30:00 AM	0	73	8.1	55		392	333	7.82	CW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	530226	Site Description		Weldon Cr - M10						
7/16/2020 12:10:00 PM		0.45	76.4	8.4	64		304	229	8.04	CW
7/22/2020 11:00:00 AM		0.04	71.2	8.2	63.5		302	229	8.16	CW
7/29/2020 11:00:00 AM		0.38	74.4	8.3	61.7		307	239	7.11	CW
8/5/2020 10:40:00 AM		0	67.3	9.1	54.1		281	242	6.87	CW
8/12/2020 10:15:00 AM		0	74.6	8.6	58.3		295	240	6.78	CW
Site ID	530229	Site Description		Swan Cr - W Chauvez Rd						
7/16/2020 10:00:00 AM		0.45	71.8	9.5	60.8		427	335	8.11	CW
7/22/2020 8:40:00 AM		0	72.2	9.2	59.9		438	348	8.18	CW
7/29/2020 8:40:00 AM		0.38	72.4	8.6	61.5		420	327	8.13	CW
8/5/2020 8:35:00 AM		0	57	9.9	54		395	341	8.25	CW
8/12/2020 8:30:00 AM		0	67.4	8.7	60.3		363	287	7.96	CW
Site ID	530231	Site Description		Swan Cr (Trib to) - W Kinney Rd						
7/16/2020 10:20:00 AM		0.45	72.4	9.7	58.6		430	348	8.15	CW
7/22/2020 8:55:00 AM		0	71.7	9.6	57.6		434	356	8.07	CW
7/29/2020 9:00:00 AM		0.38	72.2	9.3	58.1		431	351	8.05	CW
8/5/2020 8:55:00 AM		0	61.4	10.2	52.2		402	356	8.35	CW
8/12/2020 8:45:00 AM		0	70.6	9.1	58.8		366	295	7.96	CW
Site ID	530233	Site Description		Lichte Cr - S Morton Rd						
7/16/2020 9:30:00 AM		0.45	70.7	9.5	57.9		393	321	7.85	WW
7/22/2020 8:10:00 AM		0	71.9	9.5	57.6		396	324	7.89	WW
7/29/2020 8:10:00 AM		0.38	70.6	9.3	57.9		397	324	7.94	WW
8/5/2020 8:05:00 AM		0	54	10.3	52		383	339	7.91	WW
8/12/2020 8:00:00 AM		0	62.1	9.7	55.8		390	328	7.9	WW
Site ID	530273	Site Description		Trib to Pere Marquette - downstream of W Chauvez Rd						
7/16/2020 9:45:00 AM		0.45	70.9	8.8	62.1		436	337	8.22	WW
7/22/2020 8:20:00 AM		0	72.2	8.8	62.4		456	351	8.23	WW
7/29/2020 8:25:00 AM		0.38	71.5	8.4	63		450	344	8.19	WW
8/5/2020 8:20:00 AM		0	56.2	9.9	54.3		397	340	8.3	WW
8/12/2020 8:15:00 AM		0	64.8	9.2	59.4		415	332	7.99	WW
Site ID	530294	Site Description		Swan Cr - W Kinney Rd						
7/16/2020 10:35:00 AM		0.45	72.8	9.4	61.2		381	298	8.31	CW
7/22/2020 9:10:00 AM		0	71.5	9.1	61		399	313	8.24	CW
7/29/2020 9:15:00 AM		0.38	72.7	9	61.5		391	304	8.19	CW
8/5/2020 9:05:00 AM		0	63	10.1	54		356	307	8.45	CW
8/12/2020 9:00:00 AM		0	71.5	9	60.3		347	274	8	CW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	620220	Site Description		Big S Br Pere Marquette R - Croswell Ave						
7/14/2020 10:20:00 AM		0	74.9	8.6	64.6		261	196	7.99	CW
7/21/2020 10:20:00 AM		0	68.1	8.3	65.3		266	198	7.91	CW
7/28/2020 10:40:00 AM		0	74.6	8.5	67.3		277	201	8.06	CW
8/4/2020 10:20:00 AM		0	65.6	8.4	61.3		245	191	7.84	CW
8/11/2020 10:40:00 AM		0.27	71.6	7	67.6		245	177	7.75	CW
Site ID	620248	Site Description		Pere Marquette R - Dickinson Ave						
7/14/2020 9:20:00 AM		0	69.5	7.8	65.1		285	213	8.1	CW
7/21/2020 9:15:00 AM		0	63.4	7.7	66		299	220	8.03	CW
7/28/2020 9:45:00 AM		0	73	7.6	67.5		318	230	8.13	CW
8/4/2020 9:30:00 AM		0	62.2	8.1	62.1		260	201	8.02	CW
8/11/2020 9:30:00 AM		0.27	70	7.4	67.5		288	209	7.95	CW
Site ID	620318	Site Description		Beaver Cr - Comstock Ave						
7/14/2020 9:55:00 AM		0	72.7	5.8	68		245	176	7.86	WW
7/21/2020 10:00:00 AM		0	66.9	6.3	66.9		270	197	7.76	WW
7/28/2020 10:20:00 AM		0	74.4	6.3	68.7		277	198	7.91	WW
8/4/2020 10:00:00 AM		0	64.5	5.6	63		217	166	7.77	WW
8/11/2020 10:10:00 AM		0.27	71.4	5.1	69.4		238	168	7.56	WW
Site ID	620343	Site Description		Bowman/Dragon Drn - off 32nd St						
7/13/2020 8:25:00 AM		0	64.8	8.2	53.8		330	285	7.76	WW
7/20/2020 8:00:00 AM		0.22	69.1	8.8	54.7		433	369	7.57	WW
7/27/2020 8:10:00 AM		0	73.7	8.5	57		404	333	7.65	WW
8/3/2020 8:05:00 AM		0.25	60.3	7.9	56.5		422	351	7.63	WW
8/10/2020 8:05:00 AM		0	70	8.6	55.4		389	328	7.8	WW
Site ID	620344	Site Description		Brayton Drn - off 32nd St (above Bowman confluence)						
7/13/2020 8:35:00 AM		0	66.1	9.5	52.9		378	331	7.87	WW
7/20/2020 8:10:00 AM		0.09	69.3	9.5	53.6		387	335	7.72	WW
7/27/2020 8:20:00 AM		0	73.9	9.2	54.7		387	330	7.71	WW
8/3/2020 8:15:00 AM		0.25	60.4	8.9	54.3		364	312	7.77	WW
8/10/2020 8:10:00 AM		0	70.3	9.2	54.7		382	326	7.84	WW
Site ID	640183	Site Description		Freeman Cr - Maple Island Ave						
7/14/2020 9:35:00 AM		0	70.5	8	60.6		295	233	7.94	CW
7/21/2020 9:30:00 AM		0	64.4	8	60.8		305	240	7.67	CW
7/28/2020 10:00:00 AM		0	73.5	7.9	63.5		334	254	7.92	CW
8/4/2020 9:45:00 AM		0	63.3	7.9	60.4		229	181	7.9	CW
8/11/2020 9:50:00 AM		0.27	70.6	7.5	64.6		250	188	8.01	CW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	640186	Site Description		S Branch Pentwater R - N 120th Ave						
7/14/2020 8:40:00 AM		0	65	8.6	59.5		325	260	8.12	CW
7/21/2020 8:40:00 AM		0	60.3	8.6	59.9		342	272	7.98	CW
7/28/2020 9:05:00 AM		0	72.4	8.3	62.1		352	272	7.95	CW
8/4/2020 8:45:00 AM		0	55.7	9.1	57.6		330	271	8.03	CW
8/11/2020 8:50:00 AM		0.27	67.6	7.1	64.4		330	248	7.75	CW
Site ID	640205	Site Description		N Branch Pentwater R - N 96th Ave						
7/14/2020 8:15:00 AM		0	64.4	7.7	62.1		292	226	7.71	CW
7/21/2020 8:15:00 AM		0	58.7	8	59.9		319	254	7.88	CW
7/28/2020 8:35:00 AM		0	71.2	7.9	61		318	250	7.81	CW
8/4/2020 8:10:00 AM		0	54.7	8.5	56.5		326	271	8.13	CW
8/11/2020 8:15:00 AM		0.27	65.6	7.5	64.6		244	183	7.73	CW
Site ID	640318	Site Description		Brayton Drn - E Wilke Rd						
7/13/2020 9:25:00 AM		0	68.1	8	70.2		406	285	8.3	WW
7/20/2020 8:40:00 AM		0	71.2	7.8	72		419	288	8.21	WW
7/27/2020 8:50:00 AM		0	74.5	7.4	76.6		427	279	8.21	WW
8/3/2020 8:45:00 AM		0.25	60.6	7.9	69.4		374	265	8.14	WW
8/10/2020 8:40:00 AM		0	72.1	7.7	72.3		420	287	8.22	WW
Site ID	640349	Site Description		Brayton Cr - Cleveland Rd						
7/13/2020 10:30:00 AM		0	71.5	8.1	66.6		406	297	8.33	CW
7/20/2020 9:20:00 AM		0	72.1	7.9	68.9		415	296	8.27	CW
7/27/2020 9:50:00 AM		0	75.3	7.3	73.9		425	286	8.28	CW
8/3/2020 9:30:00 AM		0.24	62.1	8	67.1		383	278	8.17	CW
8/10/2020 9:30:00 AM		0	75.2	7.7	70.3		422	296	8.24	CW
Site ID	640353	Site Description		Brayton Drn (Trib to) - E of 200th Ave						
7/13/2020 10:10:00 AM		0	71.2	8.6	62.6		510	392	8.22	WW
7/20/2020 9:10:00 AM		0	71.6	8.2	65.8		522	385	8.18	WW
7/27/2020 9:30:00 AM		0	75.3	7.5	70.9		544	378	8.14	WW
8/3/2020 9:15:00 AM		0.24	61.4	8.3	63.7		482	365	8.16	WW
8/10/2020 9:10:00 AM		0	74.4	8	67.3		522	379	8.15	WW
Site ID	640354	Site Description		Brayton Drn - E of 200th Ave						
7/13/2020 10:00:00 AM		0	70.4	8.12	68.5		368	263	8.26	WW
7/20/2020 9:00:00 AM		0	71.5	8	70.7		408	285	8.2	WW
7/27/2020 9:15:00 AM		0	74.9	7.5	75.9		419	276	8.23	WW
8/3/2020 9:05:00 AM		0.25	61.2	8	68.7		361	257	8.15	WW
8/10/2020 9:00:00 AM		0	73.6	7.8	71.8		414	285	8.21	WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	640355	Site Description		Brayton Drn (Trib to) - Maple Island Rd						
7/13/2020 9:00:00 AM		0	67.5	9	58.1		458	372	8.1	WW
7/20/2020 8:25:00 AM		0.01	70.6	8.9	58.6		483	390	8.03	WW
7/27/2020 8:30:00 AM		0	74.1	9.2	61.2		501	392	8.05	WW
8/3/2020 8:30:00 AM		0.25	60.6	8.2	62.4		383	295	8.09	WW
8/10/2020 8:30:00 AM		0	71.4	9.3	59.7		488	389	8.05	WW
Watershed	Boardman Charlevoix									
Site ID	150010	Site Description		Jordan R - Rogers Rd						
7/15/2020 9:10:00 AM		0	69.2	9.3	58.1		303	247	8.2	CW
7/23/2020 9:00:00 AM		0.5	64.5	8.1	61.5		259	202	7.91	CW
7/30/2020 9:20:00 AM		0	67.4	8.9	58.6		301	244	8.11	CW
8/6/2020 9:15:00 AM		0	65.4	9.5	54.7		290	247	8.21	CW
8/13/2020 9:15:00 AM		0	71.5	4.1	58.3		265	215	8.18	CW
Site ID	150056	Site Description		Lake Charlevoix - Bridge St						
7/15/2020 9:45:00 AM		0	73.6	7.4	63.9		332	251	8.07	WW
7/23/2020 9:35:00 AM		0.5	66.2	5	64.9		260	194	7.72	WW
7/30/2020 10:00:00 AM		0	67.3	5.9	65.1		328	244	8.05	WW
8/6/2020 9:50:00 AM		0	67.2	7.5	59.5		312	250	7.98	WW
8/13/2020 9:45:00 AM		0	73.4	6.6	63.7		331	251	8.04	WW
Site ID	150100	Site Description		Boyne R - S Lake St						
7/15/2020 8:30:00 AM		0	70.8	7	65.1		369	275	8.15	CW
7/23/2020 8:20:00 AM		0.5	62.7	7.5	64.2		306	231	8.05	CW
7/30/2020 8:25:00 AM		0	63.7	6.5	65.8		372	274	8.01	CW
8/6/2020 8:25:00 AM		0	61	7.6	59.5		353	282	8.09	CW
8/13/2020 8:30:00 AM		0	64.7	7	64.4		370	278	8.16	CW
Site ID	150106	Site Description		Monroe Cr - M 66						
7/15/2020 10:00:00 AM		0	74.1	9.2	62.8		373	286	8.22	CW
7/23/2020 9:50:00 AM		0.5	67	8.4	64.6		293	220	7.87	CW
7/30/2020 10:15:00 AM		0	67.1	9.1	61.7		356	276	8.29	CW
8/6/2020 10:10:00 AM		0	68	9.9	56.5		341	283	8.22	CW
8/13/2020 10:05:00 AM		0	75.2	9.4	61.5		379	295	8.36	CW
Site ID	150187	Site Description		S Br Boyne R - Boyne Mountain Rd						
7/15/2020 7:50:00 AM		0	68.6	10	56.1		322	269	7.99	CW
7/23/2020 7:40:00 AM		0.5	63.3	9.2	58.3		317	257	7.76	CW
7/30/2020 7:50:00 AM		0	60.7	9.8	55.8		320	269	8.05	CW
8/6/2020 7:50:00 AM		0	58.6	10.3	52.3		308	272	8.01	CW
8/13/2020 8:00:00 AM		0	64.3	10	55.2		319	270	8.2	CW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	150198	Site Description		N Br Boyne R - US 131						
7/15/2020 8:05:00 AM		0	70.2	9.8	57.2		327	270	8.26	CW
7/23/2020 7:55:00 AM		0.5	61.6	9.4	58.1		314	255	8.11	CW
7/30/2020 8:05:00 AM		0	61.7	9.6	56.5		323	268	8.24	CW
8/6/2020 8:10:00 AM		0	58.4	10.1	53.2		311	271	8.29	CW
8/13/2020 8:10:00 AM		0	63.7	9.8	56.3		325	271	8.31	CW
Site ID	150204	Site Description		Deer Cr - Pearsall Rd						
7/15/2020 8:55:00 AM		0	70.1	9.3	61.7		335	261	8.22	CW
7/23/2020 8:45:00 AM		0.5	63.4	8.2	64		269	203	7.94	CW
7/30/2020 9:05:00 AM		0	65.6	8.8	62.6		316	243	8.14	CW
8/6/2020 9:00:00 AM		0	64.6	9.7	56.7		303	252	8.15	CW
8/13/2020 9:00:00 AM		0	66.2	9.3	61		328	257	8.26	CW
Site ID	150257	Site Description		Birney Cr - Rogers Rd						
7/15/2020 9:30:00 AM		0	71.6	9.8	57.4		364	299	8.32	CW
7/23/2020 9:10:00 AM		0.5	66.8	9	59.4		361	289	8	CW
7/30/2020 9:35:00 AM		0	65.8	9.8	56.3		348	291	8.21	CW
8/6/2020 9:30:00 AM		0	65.9	10.3	53.1		347	303	8.25	CW
8/13/2020 9:30:00 AM		0	69.7	10	56.1		361	302	8.34	CW
Watershed		Pigeon-Wiscoggin								
Site ID	320319	Site Description		Columbia Drn - Lange Rd						
6/15/2020 9:16:00 AM		0	60.7	10.45	62.4	1.47	617	473		WW
6/23/2020 9:15:00 AM		0.06	70.2	4.67	75.9	3.29	630	413		WW
6/29/2020 9:23:00 AM		0	76.2		76.1					WW
7/6/2020 9:11:00 AM		0	79.8	4.01	73.9	0	461	310	7.75	WW
7/13/2020 9:34:00 AM		0	69.2	8.95	73	2.02	803	544		WW
Site ID	320371	Site Description		State Drn - Sebewaing Rd						
6/15/2020 9:32:00 AM		0	61.5	9.23	63.3	13.3	621	473		WW
6/23/2020 9:31:00 AM		0.06	71.8	5.75	76.3	10.14	666	435		WW
6/29/2020 9:44:00 AM		0	77.9		76.1					WW
7/6/2020 9:27:00 AM		0	80.6	4.82	77.9	1.5	612	394	7.5	WW
7/13/2020 9:45:00 AM		0	72.5	6.67	73.6	10.5	675	455		WW
Site ID	790228	Site Description		Wiscoggin Drn - W Cass City Rd						
6/15/2020 10:05:00 AM		0	63.6	12.96	59.7	3.01	528	419		WW
6/23/2020 10:09:00 AM		0.06	72	9.14	74.5	6.27	572	382		WW
6/29/2020 10:25:00 AM		0	79		73.4					WW
7/6/2020 10:08:00 AM		0	84.5	4.09	71.4	18.33	430	297	7.72	WW
7/13/2020 10:16:00 AM		0	72.8	10.63	71.1	5.31	647	449		WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	790239	Site Description		Quanicassee R - Old State Rd - West						
6/15/2020 11:20:00 AM		0	67.8	5.6	66	3.73	504	371		WW
6/23/2020 11:36:00 AM		0	74.7	2.86	75.4	1.04	556	368		WW
6/29/2020 11:42:00 AM		0	83.4		76.1					WW
7/6/2020 11:38:00 AM		0	88.8	0.61	79.3	0	473	300	7.06	WW
7/13/2020 11:32:00 AM		0.01	73.9	2.2	77.5	2.88	496	321		WW
Site ID	790240	Site Description		Wiscoggin Drn - W Bay City Forestville Rd						
6/15/2020 9:50:00 AM		0	63.4	10.96	59.9	1.89	579	460		WW
6/23/2020 9:50:00 AM		0.06	71.4	8.3	74.3	4.64	671	449		WW
6/29/2020 10:03:00 AM		0	78.8		74.3					WW
7/6/2020 9:48:00 AM		0	82.6	5.1	72.3	3.17	479	327	7.68	WW
7/13/2020 10:01:00 AM		0	72.2	7.91	72.3	8.5	603	412		WW
Site ID	790241	Site Description		Northwest Drn (Trib to) - N Vassar Rd						
6/15/2020 10:49:00 AM		0	66.3	13.34	61.2	3.11	572	447		WW
6/23/2020 11:01:00 AM		0.06	73.7	8.45	74.5	7.54	630	420		WW
6/29/2020 11:08:00 AM		0	81.1		76.1					WW
7/6/2020 10:54:00 AM		0	87.5	3.46	76.3	10.61	390	256	8.02	WW
7/13/2020 10:59:00 AM		0	71.3	9.76	70.5	10.18	678	472		WW
Site ID	790242	Site Description		Northwest Drn (Trib to) - N Kirk Rd						
6/15/2020 10:37:00 AM		0	65.6	12.22	59.9	3.72	552	438		WW
6/23/2020 10:46:00 AM		0.06	72.2	7.89	73.4	13.3	639	431		WW
6/29/2020 10:58:00 AM		0	81.5		73.4					WW
7/6/2020 10:44:00 AM		0	86.4	4.68	70	20.87	548	385	7.59	WW
7/13/2020 10:46:00 AM		0	71.6	5.05	71.6	8.3	610	420		WW
Site ID	790243	Site Description		Quanicassee R - Old State Rd - East						
6/15/2020 11:08:00 AM		0	67.9	10.27	66.7	5.33	648	472		WW
6/23/2020 11:24:00 AM		0	74.2	7.8	74.7	4.5	685	455		WW
6/29/2020 11:32:00 AM		0	83		77					WW
7/6/2020 11:28:00 AM		0	89	1.76	78.8	0	474	302	7.16	WW
7/13/2020 11:22:00 AM		0.01	74.1	1.51	78.3	0.77	505	324		WW
Site ID	790244	Site Description		Allen Drn - N Ringle Rd						
6/15/2020 10:25:00 AM		0	65.7	11.13	59.7	1.79	558	444		WW
6/23/2020 10:28:00 AM		0.06	72.7	6.42	74.7	1.52	629	419		WW
6/29/2020 10:42:00 AM		0	80.5		72.5					WW
7/6/2020 10:24:00 AM		0	85.1	3.1	74.1	0	626	420	7.33	WW
7/13/2020 10:32:00 AM		0	71.5	7.04	71.6	2.65	684	471		WW
Site ID	790245	Site Description		Trib to Quanicassee R - Akron/VanBuren						
7/6/2020 11:17:00 AM		0	87.9	3.86	77	0	551	357	7.34	WW

Date and Time	24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Watershed	Pine								
Site ID	290186	Site Description		Pine R - W Lincoln Rd					
9/14/2020 10:22:00 AM	0	55.3	8.92	59.2	4	451	362	8.15	WW
Site ID	290228	Site Description		Pine R Backwaters (West Bank) - Off River St					
9/14/2020 9:20:00 AM	0	54.3	7.83	59.3	4.28	476	381	7.97	WW
Site ID	290229	Site Description		Pine R - Rails To Trails Bridge					
9/14/2020 9:45:00 AM	0	54.8	8.85	59	4.86	451	362	8.16	WW
Site ID	290230	Site Description		County Drn 178 - Confluence With Pine					
9/14/2020 10:12:00 AM	0	55.2	8.57	60.2	7.33	448	354	8.03	WW
Site ID	290231	Site Description		County Drn 178 - 5th St					
9/14/2020 10:56:00 AM	0	56.8	7.81	61.5	1.06	443	344	7.95	WW
Site ID	290233	Site Description		Pine R - Lumberjack Rd - S of Riverdale					
9/14/2020 10:33:00 AM	0	55.8	8.96	59.2	4.25	452	362	8.15	WW
Site ID	370172	Site Description		Wagner Drn - N Vandecar Rd					
8/25/2020 9:48:00 AM	0	74.9	8.72	57.4	2.42	617	503	7.77	WW
9/1/2020 10:05:00 AM	0	69.3	8.77	56.9	3.4	608	503	7.78	WW
9/9/2020 10:10:00 AM	0.21	50.1	8.23	54.5	7.01	561	479	7.68	WW
9/16/2020 10:22:00 AM	0	64.5	10.07	55.2	3.5	619	523	7.87	WW
9/22/2020 10:10:00 AM	0	60.6	9.3	51.8	2.75	634	562	7.8	WW
Site ID	370173	Site Description		Wagner Drn - W Weidman Rd					
8/25/2020 9:37:00 AM	0	74.1	6.51	56.5	1.61	512	425	7.47	WW
9/1/2020 9:51:00 AM	0	68.9	6.23	56.1	1.91	515	430	7.49	WW
9/9/2020 10:01:00 AM	0.21	49.8	6.09	54.9	1.34	462	392	7.44	WW
9/16/2020 10:15:00 AM	0	63.8	6.54	55.8	1.14	488	410	7.56	WW
9/22/2020 10:01:00 AM	0	59.2	6.48	54.3	1.25	519	443	7.53	WW
Site ID	370176	Site Description		Coldwater R - W Weidman Rd					
8/25/2020 9:24:00 AM	0	74	6.08	74.3	1.65	436	292	7.94	WW
9/1/2020 9:34:00 AM	0	68.5	7.62	68.3	1.29	399	286	8.06	WW
9/9/2020 9:40:00 AM	0.21	49.6	8.39	59.7	2.49	315	251	8	WW
9/16/2020 10:05:00 AM	0	63.3	8.83	62.2	1.06	389	300	8.23	WW
9/22/2020 9:45:00 AM	0	57.4	9.71	58.6	0.89	367	296	8.41	WW
Site ID	370177	Site Description		Yonker Drn (Trib to Coldwater) - off W Bridge St					
8/25/2020 8:56:00 AM	0	70.6	3.88	55	2.22	439	371	7.49	WW
9/1/2020 8:45:00 AM	0	64	3.88	54.1	3.5	453	390	7.52	WW
9/9/2020 8:52:00 AM	0.21	48.7	3.27	51.4	3.81	388	345	7.45	WW
9/16/2020 9:10:00 AM	0	59.1	4.15	52.9	2.2	443	387	7.55	WW
9/22/2020 9:04:00 AM	0	52.8	4.58	49.3	2.28	416	383	7.54	WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	370178	Site Description		Coldwater R - W Bridge St (West)						
	8/25/2020 9:06:00 AM	0	72.1	8.49	76.8	1.78	426	278	8.29	WW
	9/1/2020 9:01:00 AM	0	66.2	8.87	69.4	1.91	387	274	8.25	WW
	9/9/2020 9:15:00 AM	0.21	49.1	9.17	60.1	2.77	309	245	8.01	WW
	9/16/2020 9:35:00 AM	0	61.3	9.84	62.8	1.62	380	291	8.39	WW
	9/22/2020 9:27:00 AM	0	54.9	11.13	59.4	1.07	354	283	8.62	WW
Site ID	370179	Site Description		Coldwater R - N Woodruff Rd (N Crossing)						
	8/25/2020 8:19:00 AM	0	66.8	7.93	66.7	4.4	406	296	8	WW
	9/1/2020 8:13:00 AM	0	62.8	7.95	63.3	6.22	385	292	7.97	WW
	9/9/2020 8:07:00 AM	0.21	48.2	8.68	57	7.3	323	267	7.94	WW
	9/16/2020 8:36:00 AM	0	57	8.79	57.6	4.2	370	303	8.05	WW
	9/22/2020 8:25:00 AM	0	52	9.31	53.5	3.37	352	304	8.06	WW
Site ID	370180	Site Description		Lake of the Hills (Trib to) - W Rosebush Rd						
	8/25/2020 8:43:00 AM	0	69.1	5.01	61.9	7.49	582	450	7.51	WW
	9/1/2020 8:31:00 AM	0	62.5	4.93	60.1	4.34	543	430	7.5	WW
	9/9/2020 8:27:00 AM	0.21	48.2	6.16	54.1	3.94	432	370	7.54	WW
	9/16/2020 8:46:00 AM	0	57.6	6.13	55	3.4	587	498	7.6	WW
	9/22/2020 8:42:00 AM	0	52.2	6.38	50.2	3.41	556	505	7.57	WW
Site ID	370181	Site Description		Yonker Drn (Trib to Coldwater) - Bridge St						
	9/1/2020 9:18:00 AM	0	68.1	6.63	66	1.87	417	306		WW
	9/9/2020 9:02:00 AM	0.21	48.9	6.59	58.5	4.09	343	278	7.74	WW
	9/16/2020 9:25:00 AM	0	60.4	7.83	60.6	1.92	405	318	8	WW
	9/22/2020 9:08:00 AM	0	52.9	9.48	57.5	2.1	380	312	8.2	WW
Watershed	Shiawassee									
Site ID	250113	Site Description		Shiawassee R - Bridge St						
	7/21/2020 9:18:00 AM	0	67	10.53	79.7	0.71	574	362	8.2	WW
	7/28/2020 10:55:00 AM	0.07	77.5	9.82	81.5	0.15	573	373	8.12	WW
	8/4/2020 9:47:00 AM	0.1	58.9	7.93	76.1	0.8	580	380	7.87	WW
	8/11/2020 9:20:00 AM	0	71.4	8.43	80.6	0	631	395	7.95	WW
	8/18/2020 9:34:00 AM	0	65.3	6.56	78.3	0.53	622	398	7.69	WW
Site ID	250119	Site Description		Shiawassee R - Meier Rd						
	7/21/2020 8:09:00 AM	0	64.8	5.4	74.8	1.79	786	523	7.68	WW
	7/28/2020 8:42:00 AM	0.07	69.7	5.5	75.2	1.9	820	533	7.73	WW
	8/4/2020 8:24:00 AM	0.06	60	6.11	73	3.1	600	407	7.71	WW
	8/11/2020 8:25:00 AM	0	70.8	5.24	77.4	1.82	795	515	7.74	WW
	8/18/2020 8:17:00 AM	0	60.1	5.93	72.1	2.01	685	470	7.78	WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	250462	Site Description		Shiawassee R - Hogan Rd						
7/21/2020 9:02:00 AM		0	66.3	3.56	75.9	2.62	574	377	7.41	WW
7/28/2020 10:28:00 AM		0.07	75.8	5.05	76.6	2.34	579	378	7.51	WW
8/4/2020 9:27:00 AM		0.1	59.3	4.18	72.3	4.2	574	392	7.47	WW
8/11/2020 9:06:00 AM		0	70.8	3.26	78.4	1.8	630	403	7.41	WW
8/18/2020 9:15:00 AM		0	63.7	3.31	72.1	2.17	589	404	7.41	WW
Site ID	470643	Site Description		Bogue Cr - Marr Rd						
7/20/2020 8:13:00 AM		0.54	71.4	7.19	68.5	6.83	674	481	7.96	WW
7/27/2020 7:45:00 AM		0	75.9	6.81	73	4.32	732	497	7.78	WW
8/3/2020 8:08:00 AM		0.49	66.1	7.34	65.7	9.2	600	443	7.76	WW
8/10/2020 8:06:00 AM		0	75.5	7.17	68.9	2.82	879	625	7.81	WW
8/17/2020 8:09:00 AM		0	64.8	7.45	65.8	9.36	622	458	7.8	WW
Site ID	470663	Site Description		S Br Shiawassee R - Lovejoy Rd						
7/21/2020 8:25:00 AM		0	65.1	6.35	73.6	4.62	810	546	7.83	WW
7/28/2020 9:30:00 AM		0.07	72.6	6.44	73.6	2.42	870	566	7.92	WW
8/4/2020 8:42:00 AM		0.06	59.7	6.68	69.4	6.5	692	488	7.83	WW
8/11/2020 8:36:00 AM		0	70.8	5.98	76.1	1.9	867	570	7.94	WW
8/18/2020 8:37:00 AM		0	61.5	6.38	68.9	3.73	655	467	7.84	WW
Site ID	470677	Site Description		Sprague Cr - Byron Rd						
7/20/2020 8:44:00 AM		0.54	72.6	7.93	66.7	6.87	608	444	8.13	WW
7/27/2020 8:17:00 AM		0	76.2	7.31	70.5	6.26	657	458	7.95	WW
8/3/2020 8:30:00 AM		0.47	66.8	7.86	64	9.76	574	432	7.83	WW
8/10/2020 8:31:00 AM		0	76.4	7.37	67.5	11.1	780	564	7.92	WW
8/17/2020 8:33:00 AM		0	65.8	8.02	62.4	8.18	594	456	7.94	WW
Site ID	470678	Site Description		N Ore Cr (Trib to) - E Clyde Rd						
7/21/2020 10:46:00 AM		0	70.9	8.75	66.4	6.52	555	407	7.97	WW
7/28/2020 12:22:00 PM		0.07	79.2	8.6	68	51.2	761	494	7.92	WW
8/4/2020 11:09:00 AM		0.12	61.5	8.62	63.5	7.69	539	408	7.97	WW
8/11/2020 10:35:00 AM		0	72.9	7.82	67.8	9.03	592	430	7.91	WW
8/18/2020 11:00:00 AM		0	69.7	8.28	66	9.1	525	386	8	WW
Site ID	470680	Site Description		N Ore Cr - Cullen Rd						
7/21/2020 10:27:00 AM		0	70.1	6.5	70	7.44	690	484	7.75	WW
7/28/2020 12:05:00 PM		0.07	80.9	7.47	72	6.98	656	426	7.84	WW
8/4/2020 10:57:00 AM		0.11	60.8	6.99	67.5	6.65	683	493	7.84	WW
8/11/2020 10:25:00 AM		0	71.8	6.34	71.2	4.55	731	506	7.84	WW
8/18/2020 10:40:00 AM		0	68	7.33	65.7	4.53	647	477	7.83	WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	631311	Site Description		Shiawassee R - Legrande St						
7/21/2020 9:45:00 AM		0	68.7	6.61	76.6	1.2	579	377	7.6	WW
7/28/2020 11:33:00 AM		0.07	78.7	6.71	79.5	0.85	602	391	7.59	WW
8/4/2020 10:15:00 AM		0.1	59.3	6.32	72.9	1.26	571	388	7.6	WW
8/11/2020 9:52:00 AM		0	71	6.54	77.5	0.54	625	404	7.66	WW
8/18/2020 10:02:00 AM		0	66.5	6.17	73.8	0.97	605	407	7.57	WW
Site ID	780095	Site Description		Webb Drn - S Vernon Rd						
7/20/2020 10:48:00 AM		0.02	75.2	4.5	71.9	6.82	648	445	7.83	WW
7/27/2020 10:34:00 AM		0	78.6	4.13	76.6	3.86	721	470	7.63	WW
8/3/2020 10:43:00 AM		0.07	71.3	5.28	68.2	9.08	638	457	7.61	WW
8/10/2020 10:40:00 AM		0	80.7	4.58	74.1	7.46	843	565	7.66	WW
8/17/2020 10:52:00 AM		0	70.2	5.17	68.7	6.06	652	465	7.74	WW
Site ID	780136	Site Description		S Br Shiawassee R - S Byron Rd						
7/21/2020 7:58:00 AM		0	64.5	5.6	74.5	3.7	774	516	7.76	WW
7/28/2020 7:51:00 AM		0.07	67.6	5.44	74.5	2.58	829	539	7.8	WW
8/4/2020 8:03:00 AM		0.07	60.1	6.47	70	5.01	771	540	7.84	WW
8/11/2020 8:05:00 AM		0	70.6	5.38	75.9	1.02	817	538	7.84	WW
8/18/2020 8:02:00 AM		0	58.8	6.29	70.3	1.54	761	532	7.88	WW
Site ID	780201	Site Description		Rowley Cr - Bath Rd						
7/20/2020 10:05:00 AM		0.54	74.5	7.84	68.5	6.22	533	382	8.13	WW
7/27/2020 9:43:00 AM		0	77.4	7.32	72.3	9.16	608	415	7.92	WW
8/3/2020 10:00:00 AM		0.1	69.8	7.62	68.4	7.71	494	353	7.77	WW
8/10/2020 9:59:00 AM		0	78.9	7.81	69.3	5.7	703	497	7.94	WW
8/17/2020 10:06:00 AM		0	71.2	8.84	63.9	6.9	585	441	7.97	WW
Site ID	780270	Site Description		Shiawassee R - Exchange Rd						
7/20/2020 10:27:00 AM		0.54	75.7	6.76	74.7	1.56	734	488	8.08	WW
7/27/2020 10:09:00 AM		0	78	6.39	78.4	1.12	761	487	7.89	WW
8/3/2020 10:21:00 AM		0.08	70.1	7.04	70.5	1.86	679	473	7.86	WW
8/10/2020 10:20:00 AM		0	79.5	6.87	75	1.11	917	609	7.93	WW
8/17/2020 10:25:00 AM		0	71.1	7.24	72.1	0.65	769	527	7.95	WW
Site ID	780271	Site Description		Aginaw Lake Drn - Reed Rd (North)						
7/20/2020 9:43:00 AM		0.54	74.9	6.98	69.4	2.07	507	358	8	WW
7/27/2020 9:22:00 AM		0	77	6.59	73	2.92	566	384	7.83	WW
8/3/2020 9:39:00 AM		0.13	68.8	6.9	70.5	4.3	471	329	7.86	WW
8/10/2020 9:32:00 AM		0	77.5	6.79	70.9	4.84	660	458	7.84	WW
8/17/2020 9:40:00 AM		0	70.3	7.45	64	4.8	567	428	7.83	WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	780272	Site Description		Euler Lake Drn - Reed Rd (South)						
7/20/2020 9:28:00 AM		0.54	73.9	6.79	64.4	8.32	528	396	7.95	WW
7/27/2020 9:00:00 AM		0	76.7	5.3	66.2	25.7	605	444	7.59	WW
8/3/2020 9:16:00 AM		0.23	67.9	7.07	65.8	6.33	480	354	7.66	WW
8/10/2020 9:14:00 AM		0	77.2	6.31	65.7	10.89	674	497	7.68	WW
8/17/2020 9:21:00 AM		0	67.8	6.53	59.5	13.76	544	433	7.69	WW
Site ID	780273	Site Description		Kanouse Lake Drn - E Beard Rd						
7/20/2020 9:12:00 AM		0.54	73.5	7.33	66.4	13.7	527	386	8.03	WW
7/27/2020 8:46:00 AM		0	76.4	6.57	69.1	20.13	667	434	7.8	WW
8/3/2020 9:04:00 AM		0.28	67.7	7.5	64.8	25.2	480	358	7.76	WW
8/10/2020 8:57:00 AM		0	76.6	6.98	66.4	14.9	753	550	7.83	WW
8/17/2020 9:02:00 AM		0	66.9	6.82	59.4	13.4	576	460	7.73	WW
Watershed	Ottawa-Stony									
Site ID	580413	Site Description		Otter Cr - Goutz Rd						
9/24/2020 10:10:00 AM		0	62.6	6.65	59		667	536	7.57	WW
10/21/2020 10:15:00 AM		0.66	55.6	7.07	55.7		423	356	7.83	WW
Site ID	580451	Site Description		Bay Cr - Bay Cr Rd						
9/24/2020 8:20:00 AM		0	51.7	1.28	59.4		571	457	7.37	WW
9/30/2020 8:20:00 AM		0.01	49.1	1.43	58.1		510	415	7.56	WW
10/7/2020 8:15:00 AM		0	56.8	4.13	54.3		460	395	7.54	WW
10/14/2020 8:15:00 AM		0	38.1	2.46	54.2		645	554	7.63	WW
10/21/2020 8:40:00 AM		0.66	56	6.18	52.9		470	411	7.71	WW
Site ID	580584	Site Description		Little Lake Cr - Suder Rd						
10/14/2020 7:50:00 AM		0	35.9	3.84	52.4		786	692	7.66	WW
10/21/2020 7:50:00 AM		0.66	57.9	8.05	55.2		616	521	7.72	WW
Site ID	580642	Site Description		Flat Cr - Dean Rd						
9/24/2020 7:30:00 AM		0	52.9	6.76	55.8		445	373	7.5	WW
9/30/2020 7:30:00 AM		0.01	48.1	0.87	55		623	529	7.3	WW
10/7/2020 7:40:00 AM		0	56.5	0.55	56.3		540	450	7.58	WW
10/14/2020 7:30:00 AM		0	35	8.9	47.6		557	527	7.86	WW
10/21/2020 7:30:00 AM		0.66	58.5	8.54	53.6		603	521	7.72	WW
Site ID	580643	Site Description		Bay Cr - Summit St						
9/24/2020 8:50:00 AM		0	56.7	8.03	61.9		364	282	7.68	WW
9/30/2020 8:45:00 AM		0.01	49.7	8.82	56.2		337	281	7.81	WW
10/7/2020 9:00:00 AM		0	58	8.56	57.1		339	280	7.81	WW
10/14/2020 8:45:00 AM		0	40.4	7.28	52.9		340	298	7.92	WW
10/21/2020 9:00:00 AM		0.66	56.1	6.18	57.4		323	266	7.75	WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	580645	Site Description		Cousino Drn - Vienna Rd						
9/24/2020 8:00:00 AM		0	51.3	3.32	62.7		458	352	7.62	WW
9/30/2020 8:00:00 AM		0.01	49.1	5.67	55.4		375	317	7.68	WW
10/21/2020 8:30:00 AM		0.66	56.1	3.17	55.6		575	484	7.57	WW
Site ID	580646	Site Description		Muddy Cr - Cousino Rd						
9/24/2020 9:40:00 AM		0	59.9	3.71	60.7		479	377	7.36	WW
9/30/2020 9:35:00 AM		0.01	50	2.65	57.6		506	415	7.58	WW
10/7/2020 9:30:00 AM		0	60.6	7.39	64		560	422	7.61	WW
10/14/2020 9:15:00 AM		0	42.6	4.39	55.2		481	407	7.67	WW
10/21/2020 9:45:00 AM		0.66	56.1	9.2	53.6		485	420	7.6	WW
Watershed	St. Joseph									
Site ID	300214	Site Description		Prouty Drn - Brott Rd						
6/16/2020 9:11:00 AM		0	66.6	8.71	60.4	5.6	521	410		WW
6/22/2020 9:07:00 AM		0	70.1	7.95	65.5	5.22	566	418		WW
7/7/2020 8:46:00 AM		0	77.8	7.23	69.4	3.74	574	405	7.92	WW
7/14/2020 8:40:00 AM		0	68.1	7.6	64.6	4.08	580	434		WW
Site ID	300215	Site Description		E Fork W Br St Joseph R - Card Rd						
6/16/2020 10:32:00 AM		0	71.8	7.26	66.2	5.66	466	342		WW
6/22/2020 11:04:00 AM		0	75.4	6.41	76.6	1.4	418	272		WW
6/30/2020 10:45:00 AM		0	80.3	6.32	78.1	0	441	283	7.87	WW
7/7/2020 10:23:00 AM		0	83.5	4.93	80.2	4.29	438	275	7.65	WW
7/14/2020 10:27:00 AM		0	74	5.34	75.2	4.71	411	272		WW
Site ID	300264	Site Description		E Fork W Br St Joseph R - Camden Rd						
6/16/2020 11:18:00 AM		0	74.2	7.34	70.7	0.87	392	273		WW
Site ID	300312	Site Description		Trib to E Fork W Br St Joseph R - Austin Rd						
6/22/2020 10:00:00 AM		0	73	5.16	61.3	5.08	749	587		WW
6/30/2020 9:46:00 AM		0	74.7	5.2	63.7	3.11	821	621	7.18	WW
7/7/2020 9:40:00 AM		0	80.7	4.06	62.1	10.02	784	606	7.05	WW
7/14/2020 9:42:00 AM		0	72.3	4.93	58.1	5.18	771	626		WW
Site ID	300313	Site Description		E Fork W Br St Joseph R - Austin Rd						
6/22/2020 10:12:00 AM		0	73.2	7.6	69.4	10.14	502	354		WW
6/30/2020 9:58:00 AM		0	76.2	7.31	72.7	8.6	533	363	8.01	WW
7/7/2020 9:46:00 AM		0	81.2	7.32	72.9	10.32	544	370	8	WW
7/14/2020 9:46:00 AM		0	72.5	7.74	67.5	6.55	520	376		WW

Date and Time		24-Hour Precip (in)	Air Temp (F)	D.O. (mg/L)	Water Temp (F)	Turbidity (NTU)	Cond (us/cm)	TDS (mg/L)	pH	CW or WW
Site ID	300314	Site Description		W Fork W Br St Joseph R - Long Lake Rd						
6/16/2020 9:20:00 AM		0	68.1	8.51	63.1	5.69	437	333		WW
6/22/2020 9:25:00 AM		0	71.2	7.85	65.1	6.37	536	398		WW
6/30/2020 9:15:00 AM		0	73	6.53	69.4	25.6	571	402	7.71	WW
7/7/2020 8:59:00 AM		0	78.5	7.04	67.6	6.63	599	432	7.7	WW
7/14/2020 9:02:00 AM		0	71.1	7.7	63	5.92	564	431		WW
Site ID	300318	Site Description		W Fork W Br St Joseph R - Sampson Rd						
6/16/2020 9:46:00 AM		0	69.4	8.26	63.5	12.26	475	360		WW
6/22/2020 9:46:00 AM		0	72.1	7.54	68.4	13.23	530	379		WW
6/30/2020 9:36:00 AM		0	73.4	7.04	72	7.7	560	384	7.97	WW
7/7/2020 9:24:00 AM		0	80.2	6.8	72.9	12.95	579	393	7.95	WW
7/14/2020 9:25:00 AM		0	72.1	7.34	67.8	5.87	553	397		WW
Site ID	300319	Site Description		Carruthers Drn - W Montgomery Rd						
6/16/2020 10:53:00 AM		0	73.4	14.46	68.2	8.33	545	390		WW
6/22/2020 10:33:00 AM		0	74.1	11.97	71.6	7.15	579	399		WW
6/30/2020 10:14:00 AM		0	77.8	10.1	72	33.9	647	444	8	WW
7/7/2020 10:03:00 AM		0	82.4	8.34	69.4	11.41	567	401	7.76	WW
7/14/2020 10:10:00 AM		0	73.6	8.35	63.1	5.48	585	443		WW

Appendix 4. Microbial Source Tracking (MST) results for selected sites and events. Human (B. theta and HF183), bovine (CowM2), and porcine marker results are in gene copies per 100 mL. Non-detectable results are represented as zero; however amounts less than the detection level may be present (between 177-354 gene copies / 100 ml).

Date	DGM (E. coli/100mL)	24-Hour Prior Rain (in)	DNA Conc. (ng/ul)	B theta (Human)	HF183 (Human)	CowM2 (Cow/Bovine)	Pig/ Porcine
Watershed Boardman Charlevoix							
Site ID	150257	Description	Birney Cr - Rogers Rd				
7/15/2020	637	0	11.1	0	0	0	0
7/23/2020	713	0.5	31.9	0	0	0	0
Watershed Escanaba							
Site ID	210241	Description	Squaw Cr - Saint Nicholas 31st Rd				
7/9/2020	751	0.07	53	0	716	1,210	0
7/15/2020	755	0.76	154.5	0	1,730	1,590	0
Watershed Ottawa-Stony							
Site ID	580642	Description	Flat Cr - Dean Rd				
10/7/2020	80419	0	366.2	315,000	3,730,000	0	4,640
10/14/2020	10098	0	86.4	0	38,500	0	4,800
10/21/2020	1916	0.66	31	0	10,200	472	0
Site ID	580643	Description	Bay Cr - Summit St				
9/24/2020	432	0	30.4	0	224,000	0	0
9/30/2020	692	0.01	12	0	0	0	0
10/14/2020	365	0	21.5	0	15,000	0	0
10/21/2020	3198	0.66	30.1	2,120	113,000	0	0
Site ID	580645	Description	Cousino Drn - Vienna Rd				
9/24/2020	317	0	26.5	0	9,990	0	4,720
9/30/2020	347	0.01	253	417	33,100	0	0
10/21/2020	1341	0.66	43.2	0	905	0	0

Date	DGM (E. coli/100mL)	24-Hour Prior Rain (in)	DNA Conc. (ng/ul)	B theta (Human)	HF183 (Human)	CowM2 (Cow/Bovine)	Pig/ Porcine
Watershed Pere Marquette-White							
Site ID	620343	Description	Bowman/Dragon Drn - off 32nd St				
7/13/2020	4531	0	85.6	2,300	0	2,520	43,700
7/20/2020	2396	0.22	20.8	0	0	0	2,830
7/27/2020	996	0	15.1	0	0	0	0
8/3/2020	2231	0.25	33.9	0	417	0	0
8/10/2020	468	0	20.3	0	0	0	0
Site ID	620344	Description	Brayton Drn - off 32nd St (above Bowman confluence)				
7/13/2020	854	0	19.8	0	2,960	0	0
7/20/2020	1762	0.09	13.2	641	1,810	0	0
7/27/2020	1041	0	15.4	6,610	2,490	0	0
8/3/2020	8108	0.25	16.1	0	0	0	0
8/10/2020	720	0	25	0	0	401	0
Site ID	640318	Description	Brayton Drn - E Wilke Rd				
7/13/2020	2566	0	18.8	0	0	0	0
7/20/2020	1789	0	17.7	0	0	0	0
7/27/2020	1739	0	19	0	0	0	0
8/3/2020	5614	0.25	10.3	0	0	0	0
8/10/2020	648	0	15.3	0	0	1,100	0
Site ID	640349	Description	Brayton Cr - Cleveland Rd				
7/13/2020	922	0	14.5	0	0	0	0
7/20/2020	1364	0	17.4	0	0	0	0
7/27/2020	1108	0	23.3	0	0	0	0
8/3/2020	1231	0.24	28.4	0	0	0	0
8/10/2020	425	0	20.4	0	0	0	0

Date	DGM (E. coli/100mL)	24-Hour Prior Rain (in)	DNA Conc. (ng/ul)	B theta (Human)	HF183 (Human)	CowM2 (Cow/Bovine)	Pig/ Porcine
Site ID	640353	Description	Brayton Drn (Trib to) - E of 200th Ave				
7/13/2020	1033	0	14.3	0	0	0	0
7/20/2020	1849	0	21.4	0	7,980	0	0
7/27/2020	1381	0	19.9	0	0	0	0
8/3/2020	3029	0.24	28.4	0	0	0	0
8/10/2020	1239	0	22	0	0	0	0
Site ID	640354	Description	Brayton Drn - E of 200th Ave				
7/13/2020	775	0	13.5	0	0	0	0
7/20/2020	1587	0	19.8	0	0	0	0
7/27/2020	1491	0	15.2	0	0	0	0
8/3/2020	1302	0.25	16.6	0	0	0	0
8/10/2020	540	0	14	0	0	0	0
Site ID	640355	Description	Brayton Drn (Trib to) - Maple Island Rd				
7/13/2020	513	0	20.2	0	370	1,130	0
7/20/2020	475	0.01	23.7	0	0	1,050	1,840
7/27/2020	420	0	10.9	0	0	0	0
8/3/2020	1579	0.25	36.2	3,510	0	527	0
8/10/2020	712	0	19.4	0	0	4,140	0
Watershed	Shiawassee						
Site ID	780271	Description	Aginaw Lake Drn - Reed Rd (North)				
7/20/2020	1124	0.54	18.5	0	1,680	0	0
7/27/2020	1374	0	19.5	0	1,380	0	0
8/3/2020	1090	0.13	18	0	1,380	0	0
8/10/2020	1822	0	13.8	0	1,850	0	0
8/17/2020	812	0	17.1	0	378	0	0

Date	DGM (E. coli/100mL)	24-Hour Prior Rain (in)	DNA Conc. (ng/ul)	B theta (Human)	HF183 (Human)	CowM2 (Cow/Bovine)	Pig/ Porcine
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Site ID	780272	Description	Euler Lake Drn - Reed Rd (South)				
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7/20/2020	3211	0.54	31	0	606	0	0
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7/27/2020	5659	0	23.8	0	0	0	0
-----------	------	---	------	---	---	---	---

8/3/2020	3832	0.23	28.4	0	0	0	10,900
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8/10/2020	2247	0	29.1	0	0	0	0
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8/17/2020	2189	0	26.3	0	0	0	0
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Site ID	780273	Description	Kanouse Lake Drn - E Beard Rd				
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7/20/2020	1232	0.54	43.1	0	1,250	0	0
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7/27/2020	1817	0	40.6	0	810	0	0
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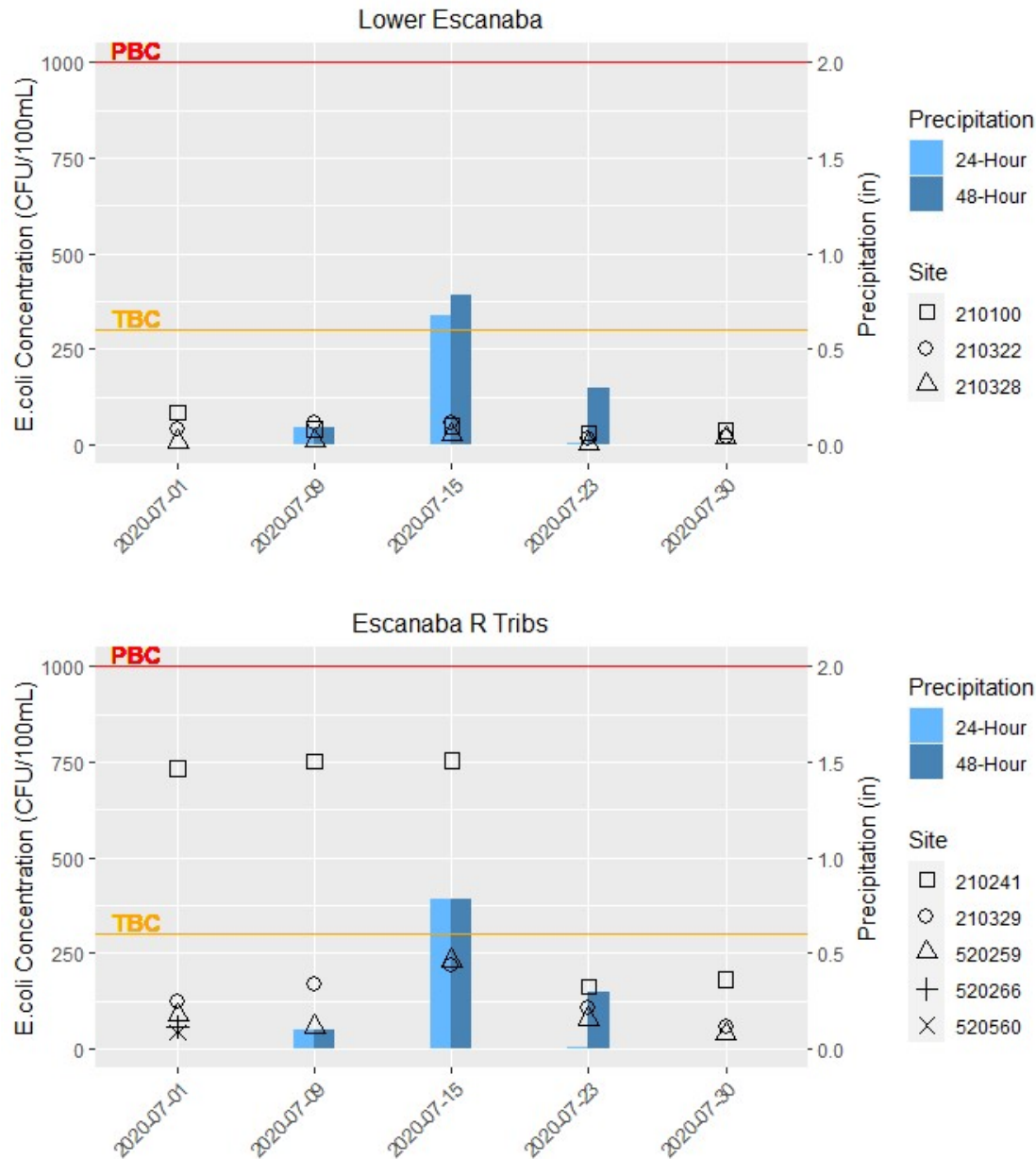
8/3/2020	4238	0.28	55.2	0	913	0	0
----------	------	------	------	---	-----	---	---

8/10/2020	1829	0	50.9	0	0	0	0
-----------	------	---	------	---	---	---	---

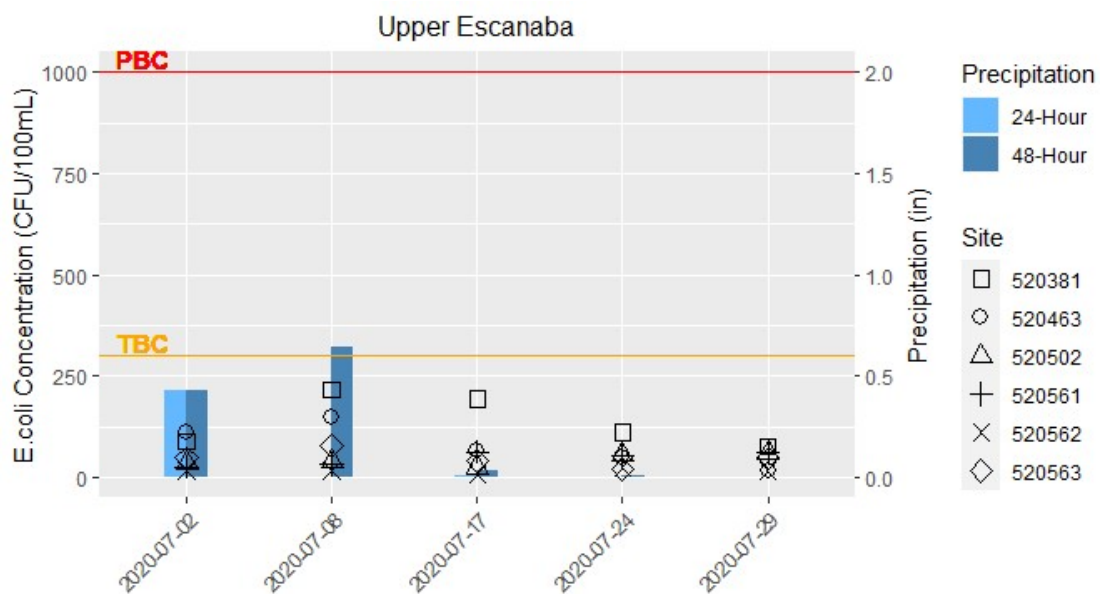
8/17/2020	2147	0	36.6	0	472	0	0
-----------	------	---	------	---	-----	---	---

Appendix 5. *E. coli* concentrations for each site graphed with prior precipitation (organized by watershed). Prior precipitation is represented by light (24-hour) and dark (48-hour) blue bars on the secondary axis. These graphs are a visual representation of the information in Appendix 2.

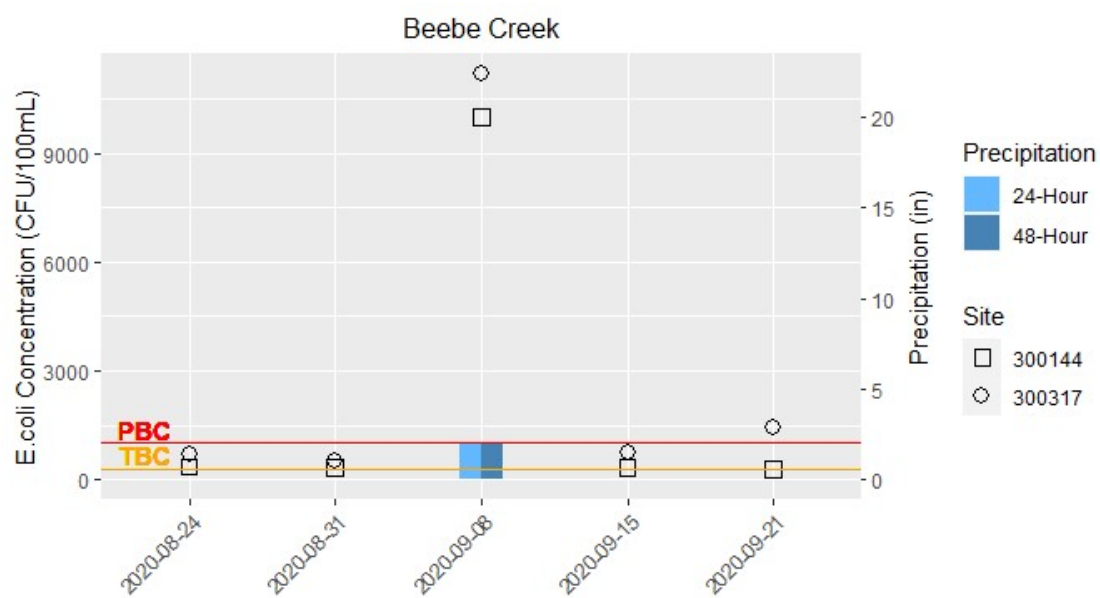
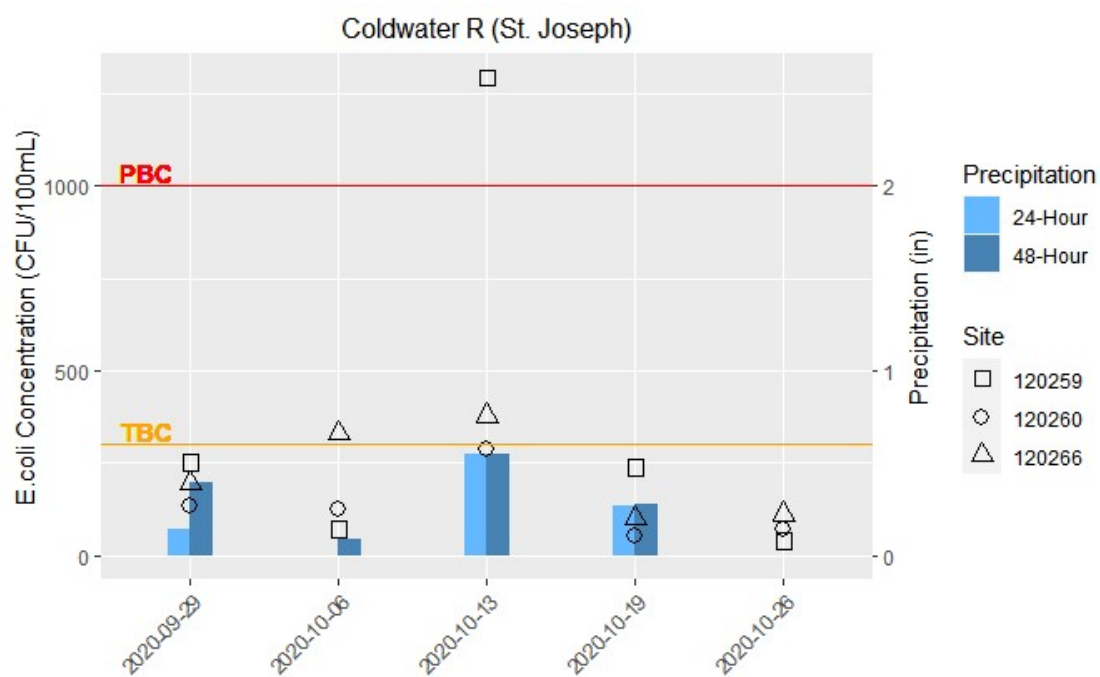
Escanaba Watershed (HUC 04030110)



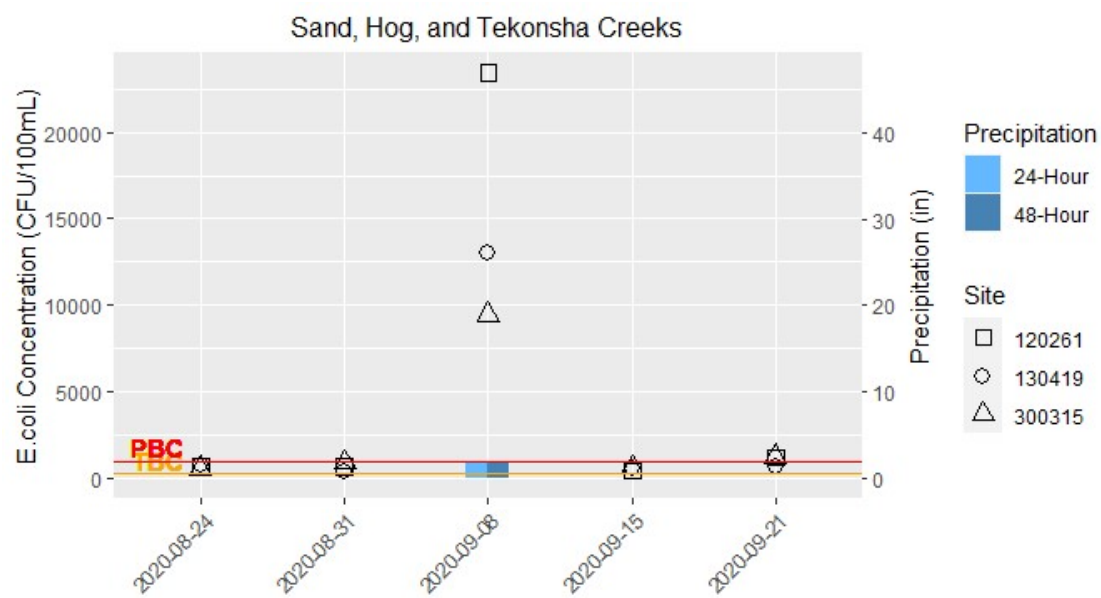
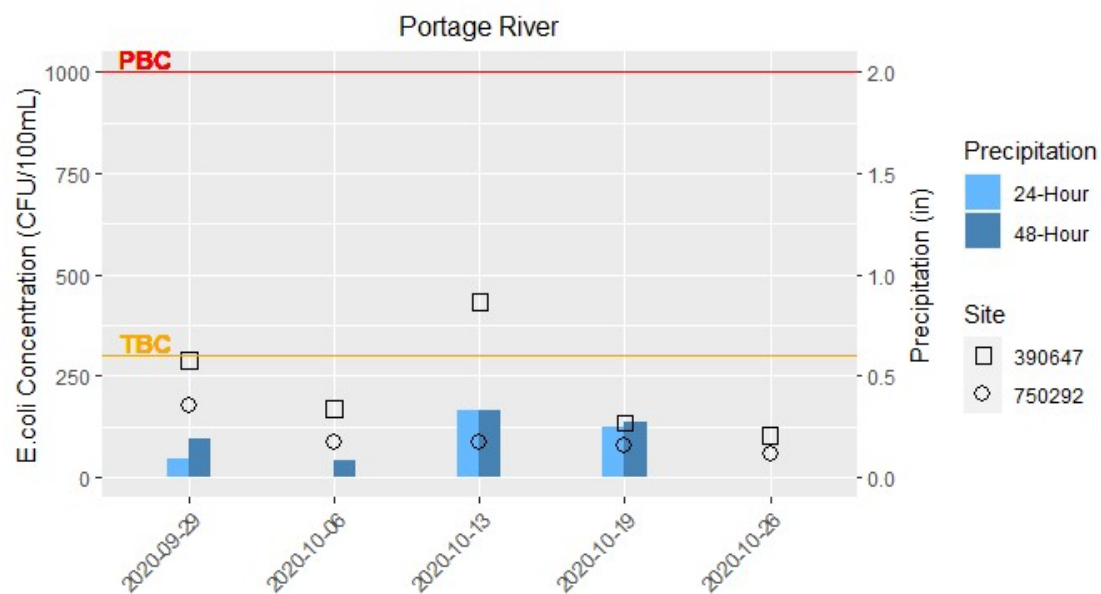
Appendix 5. (continued)



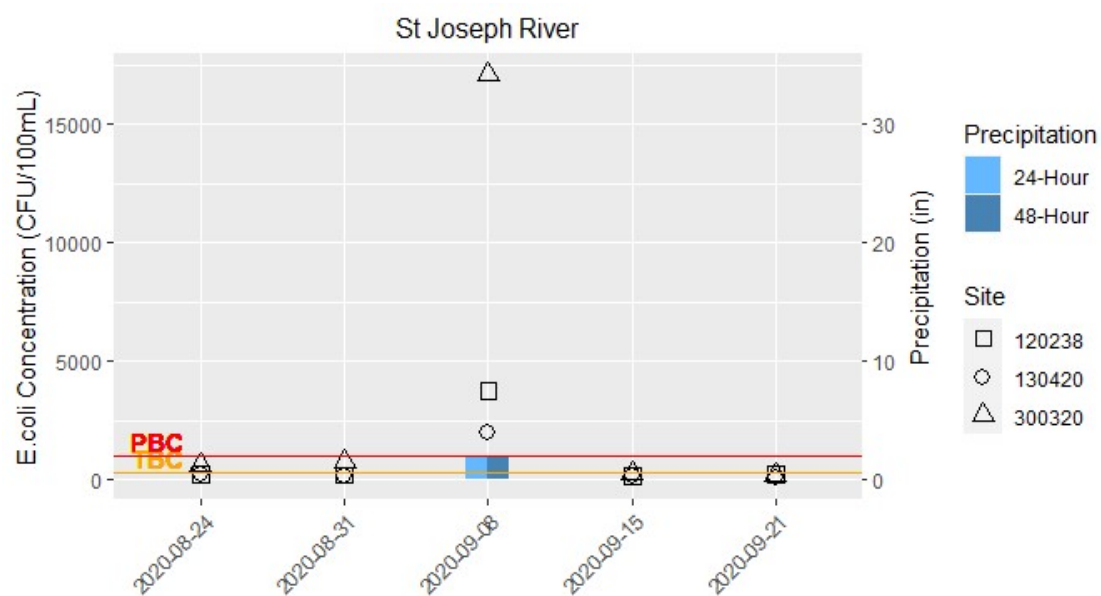
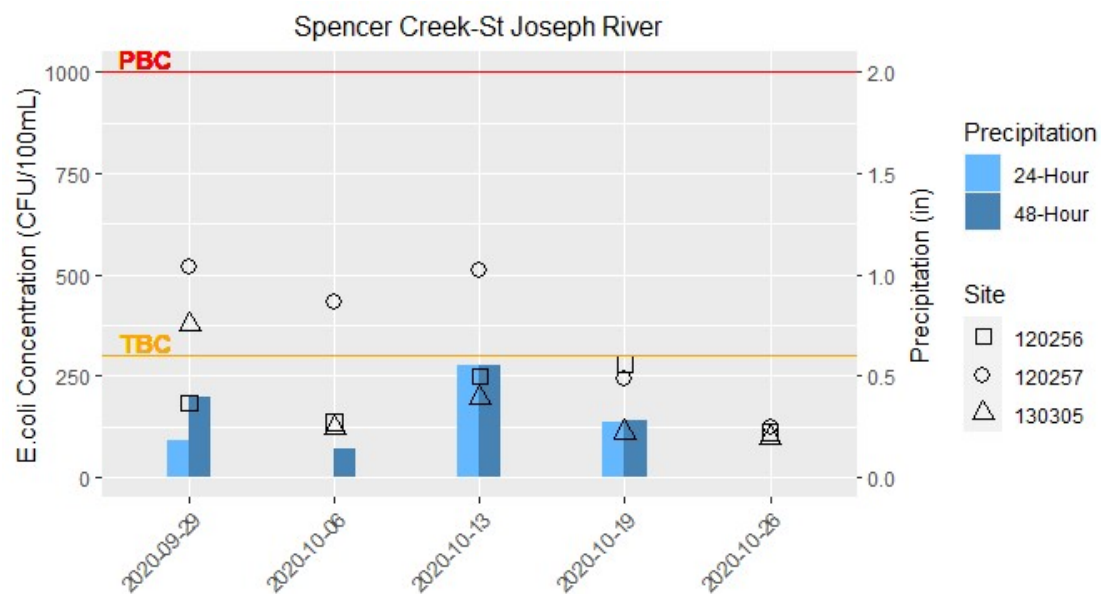
St. Joseph River (West - HUC 04050001)



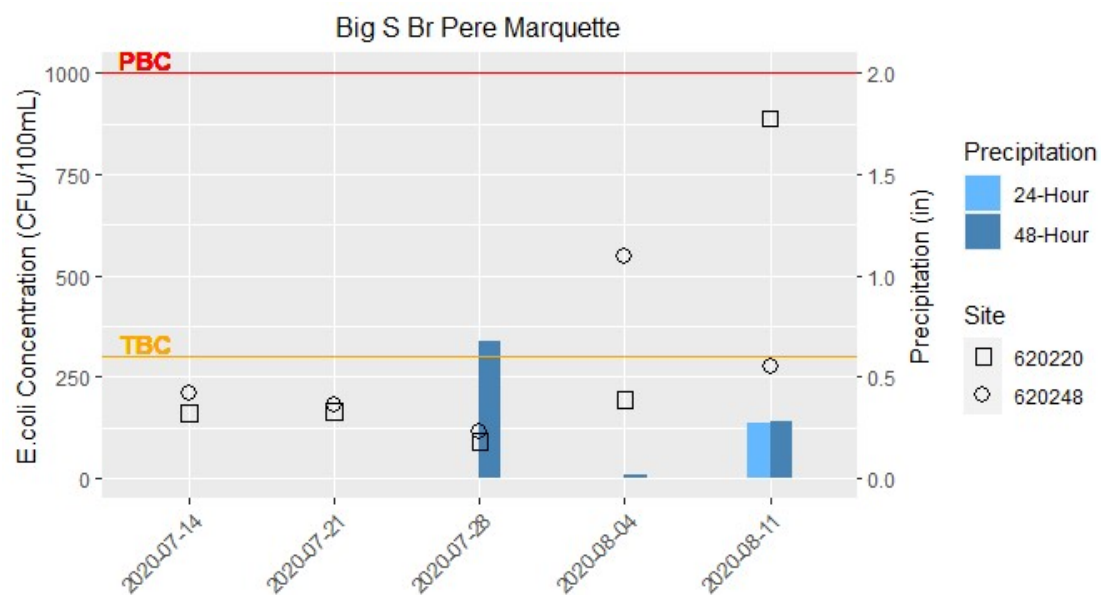
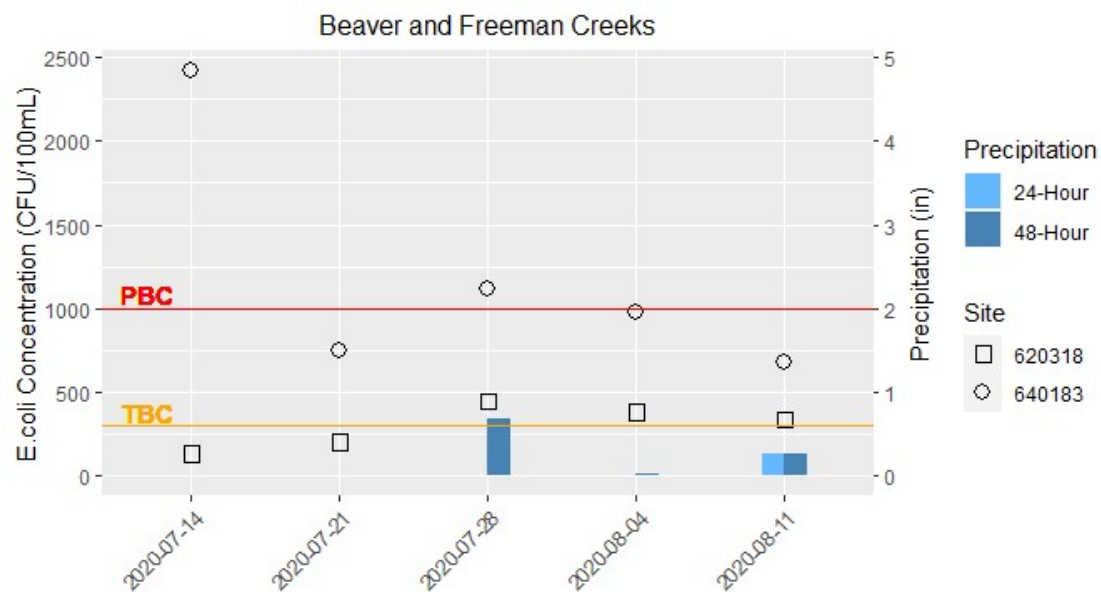
Appendix 5. (continued)



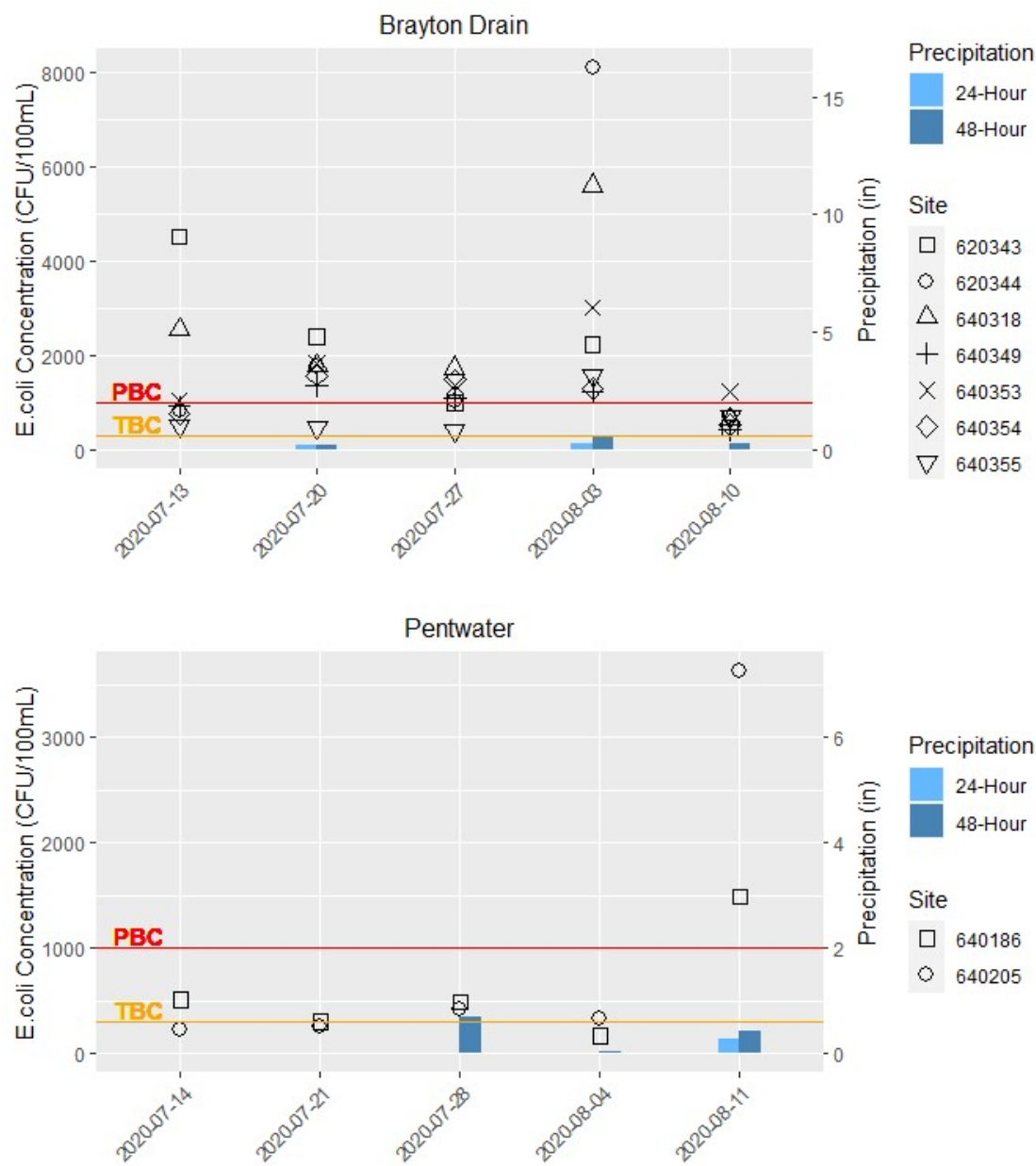
Appendix 5. (continued)



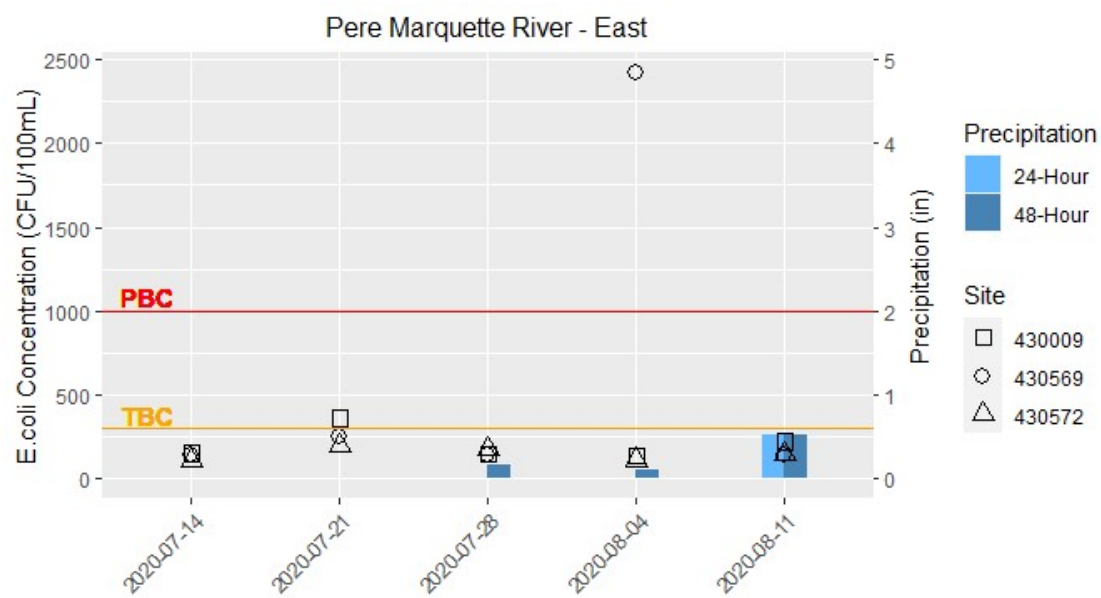
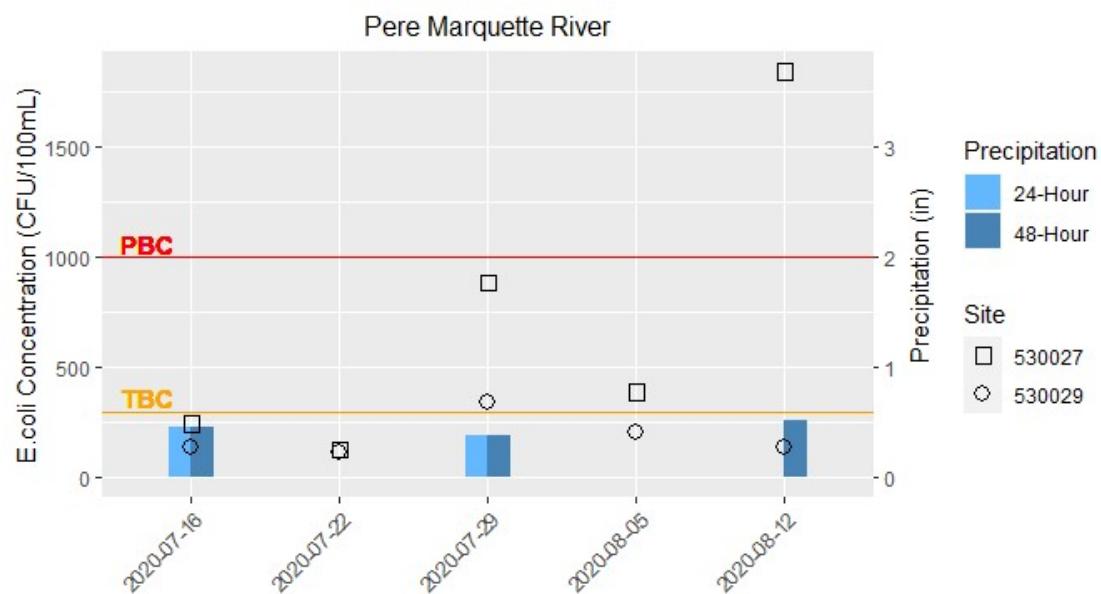
Pere Marquette (HUC 04060101)



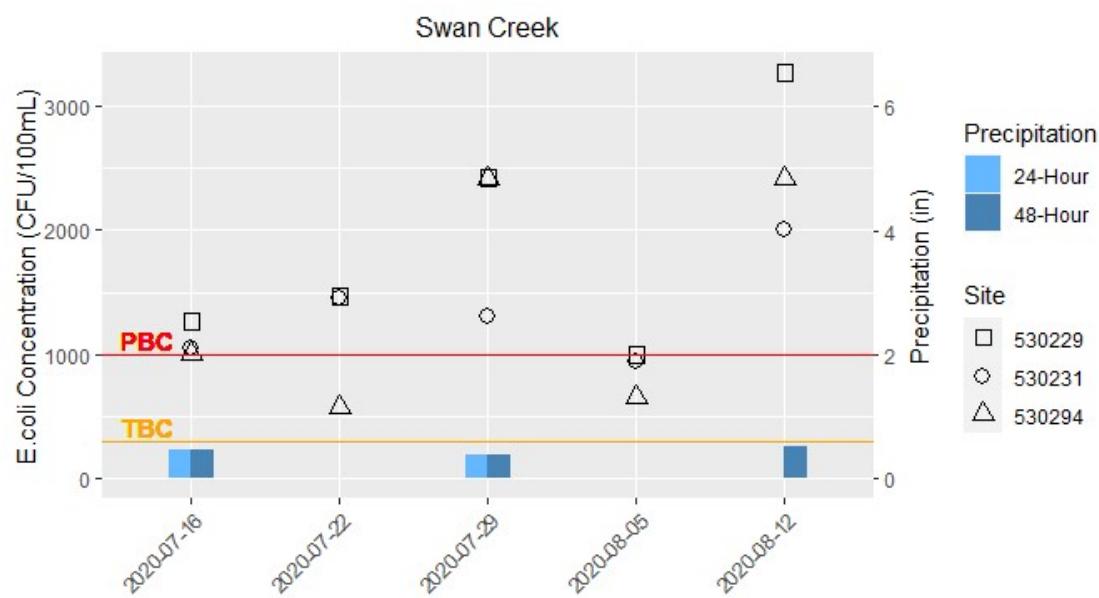
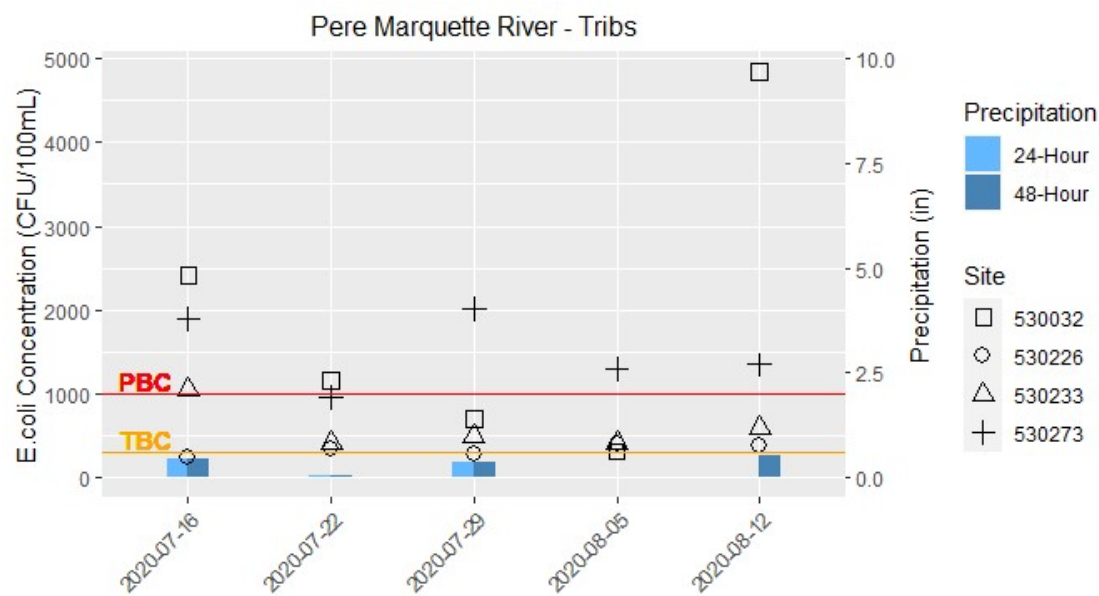
Appendix 5. (continued)



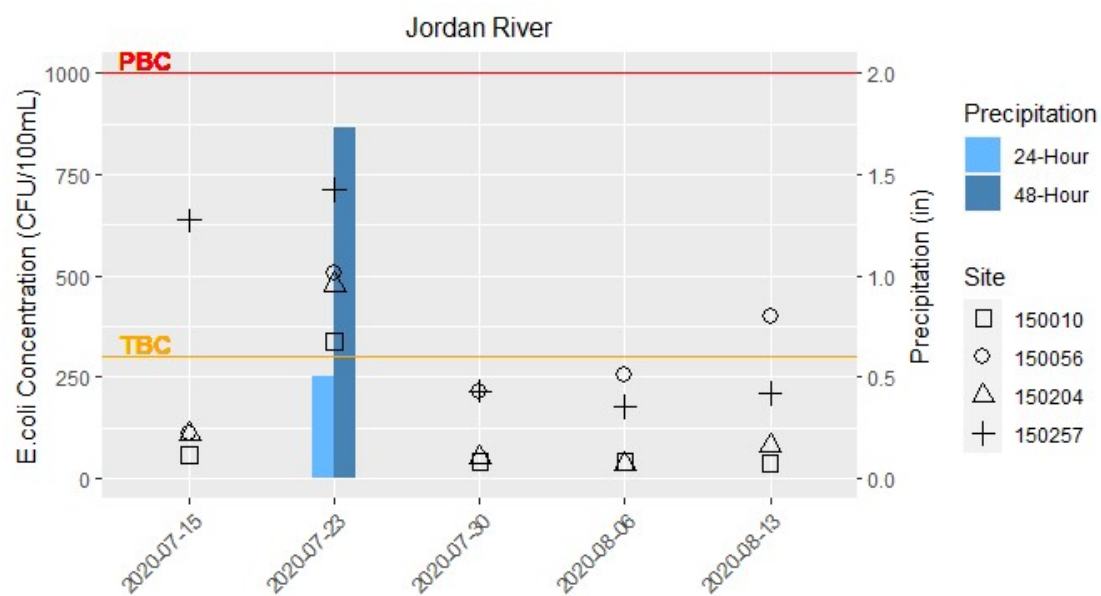
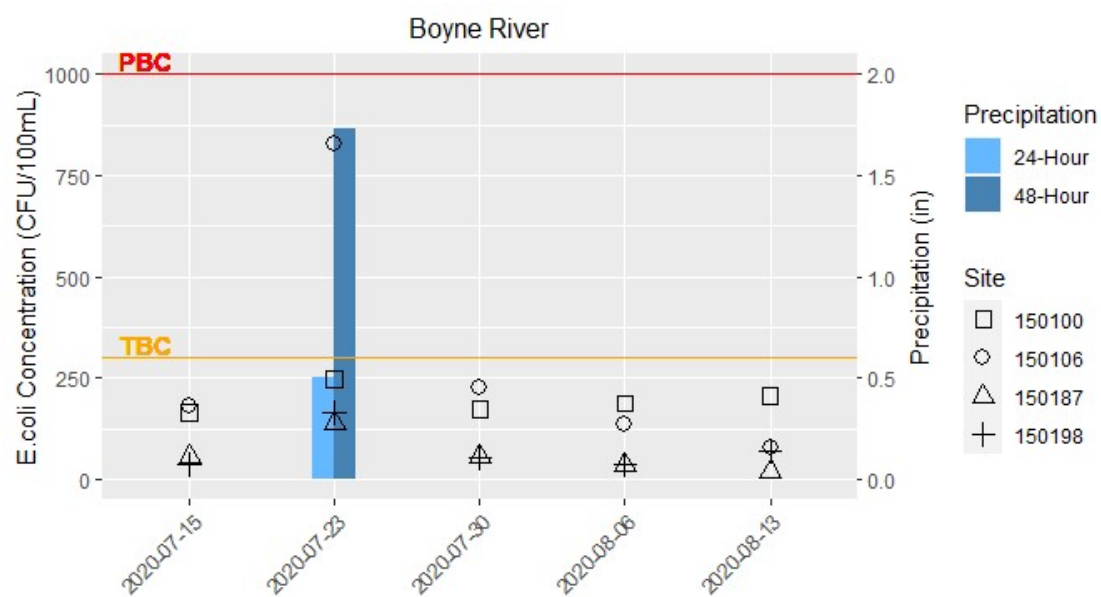
Appendix 5. (continued)



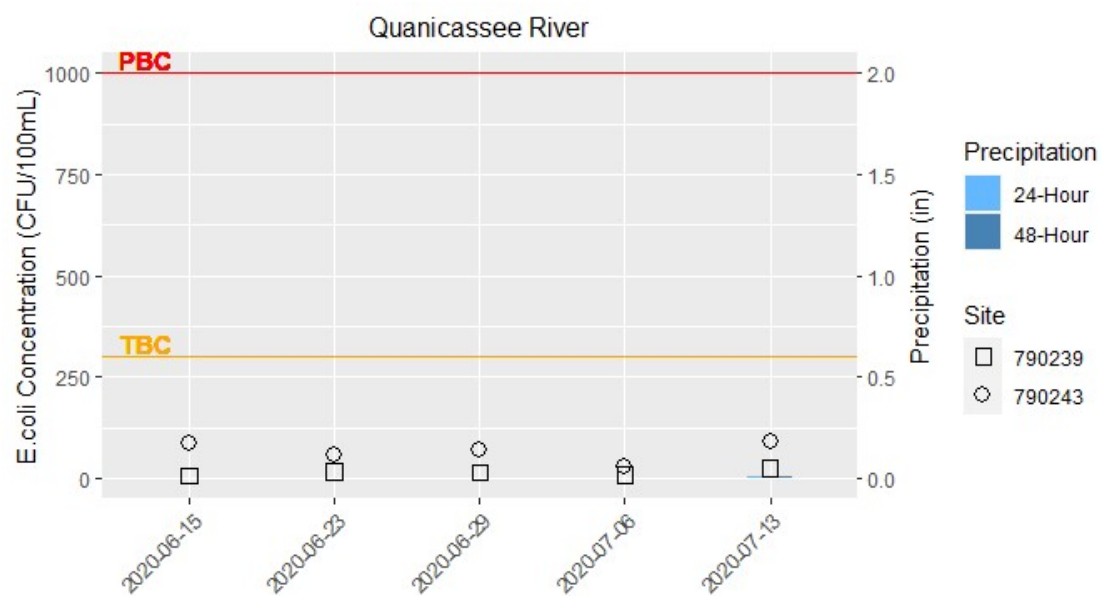
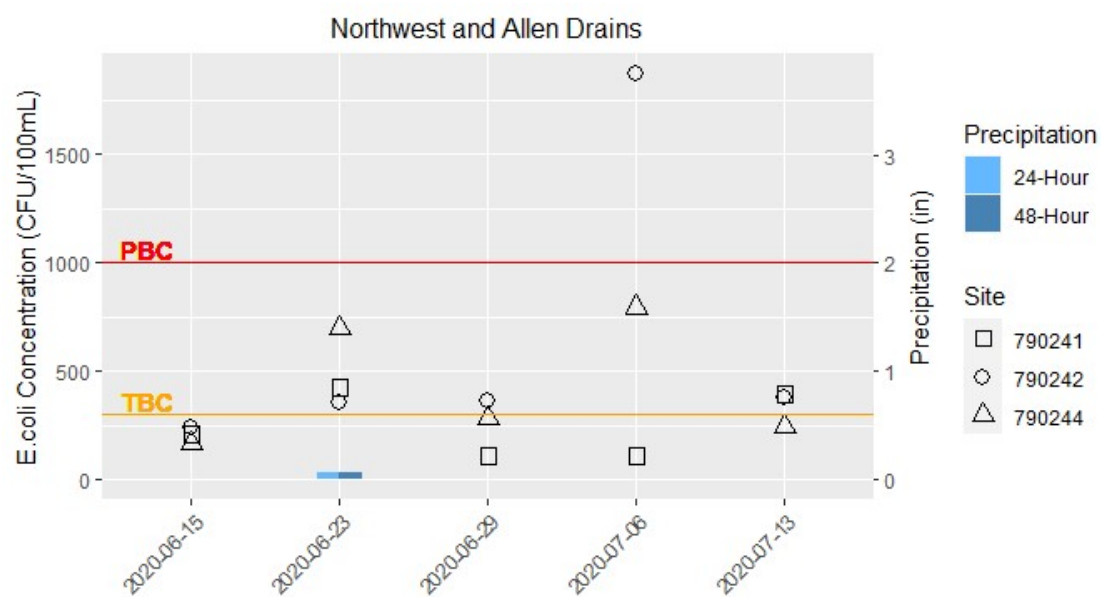
Appendix 5. (continued)



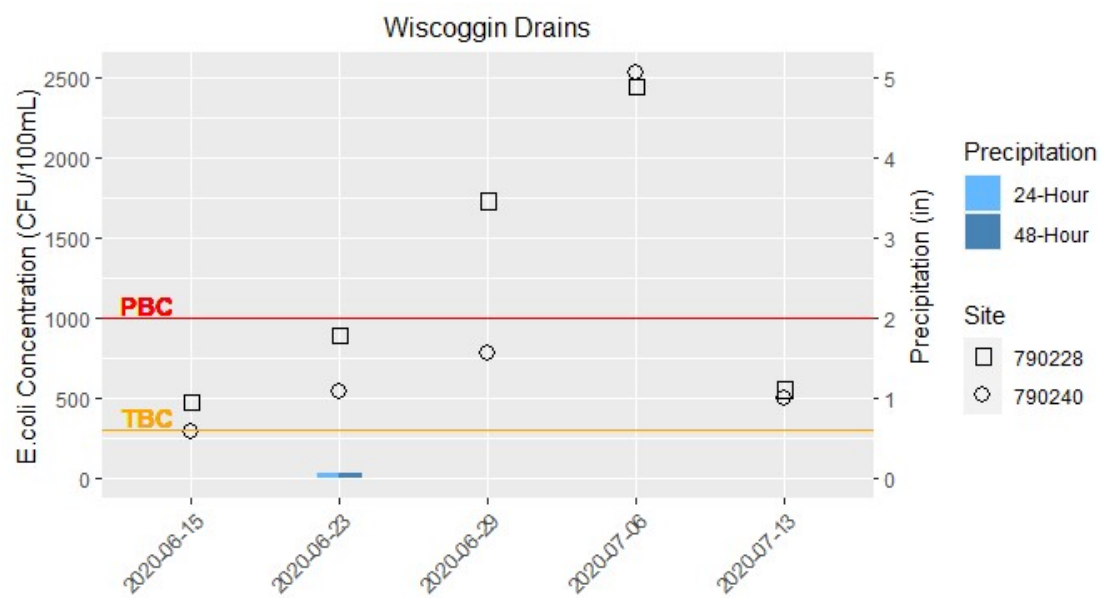
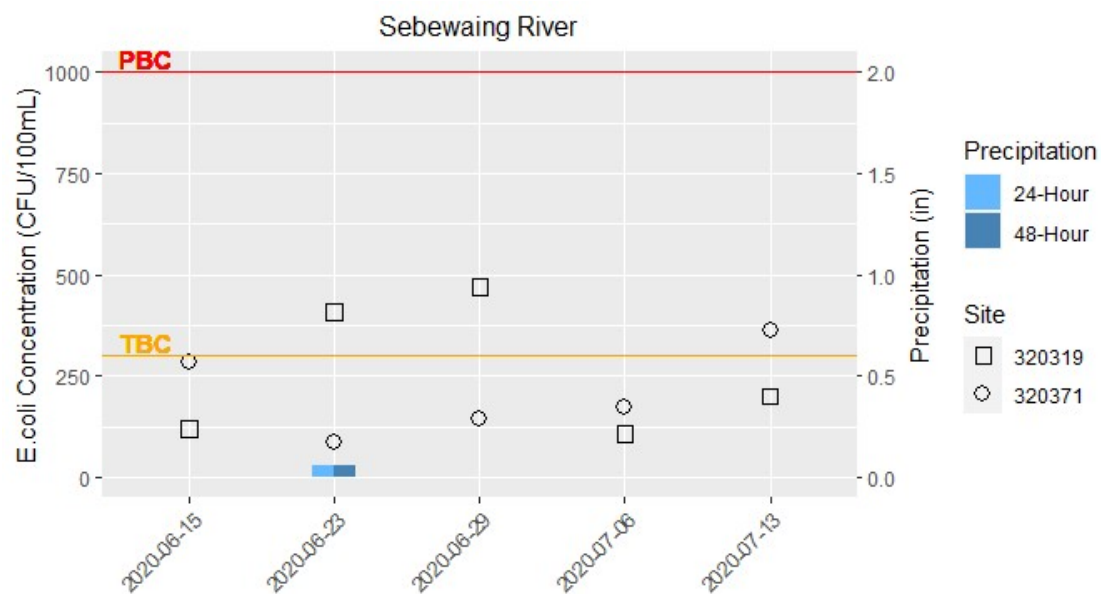
Boardman-Charlevoix (HUC 04060105)



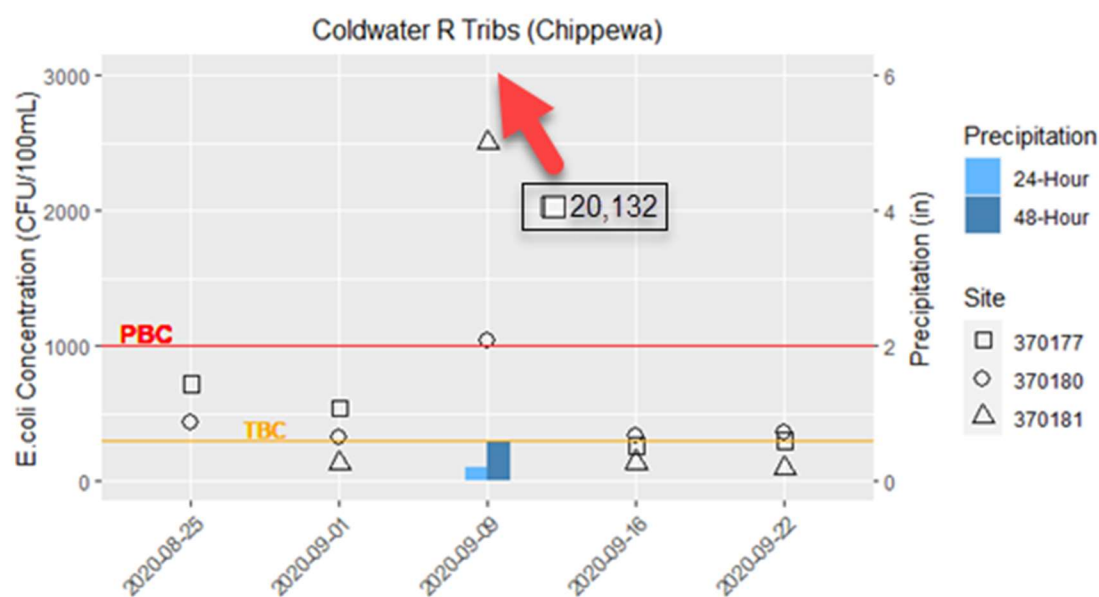
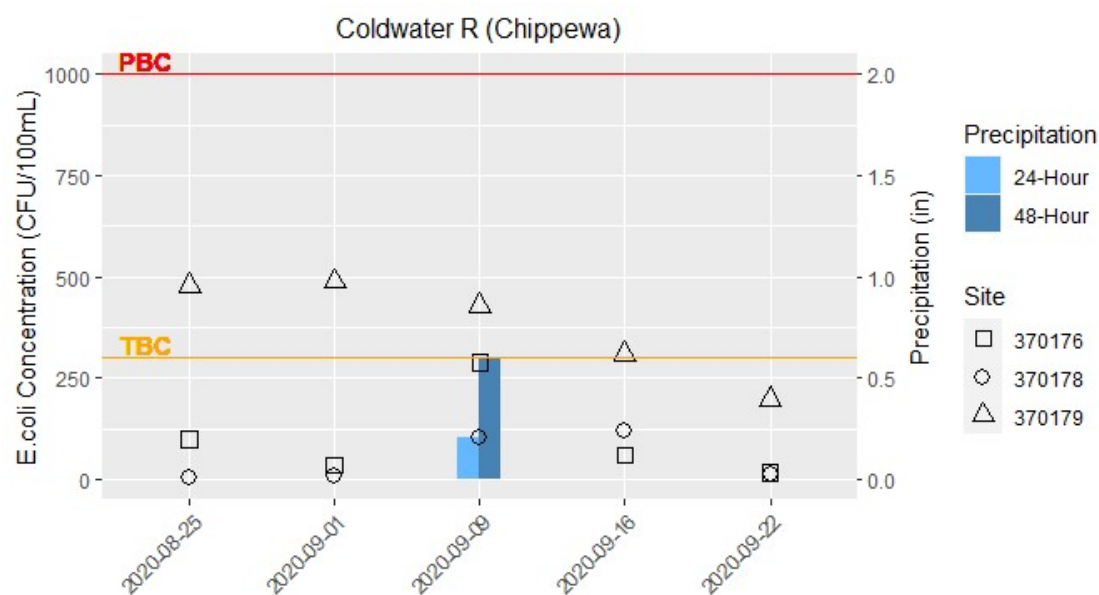
Pigeon-Wiscoggin (HUC 04080103)



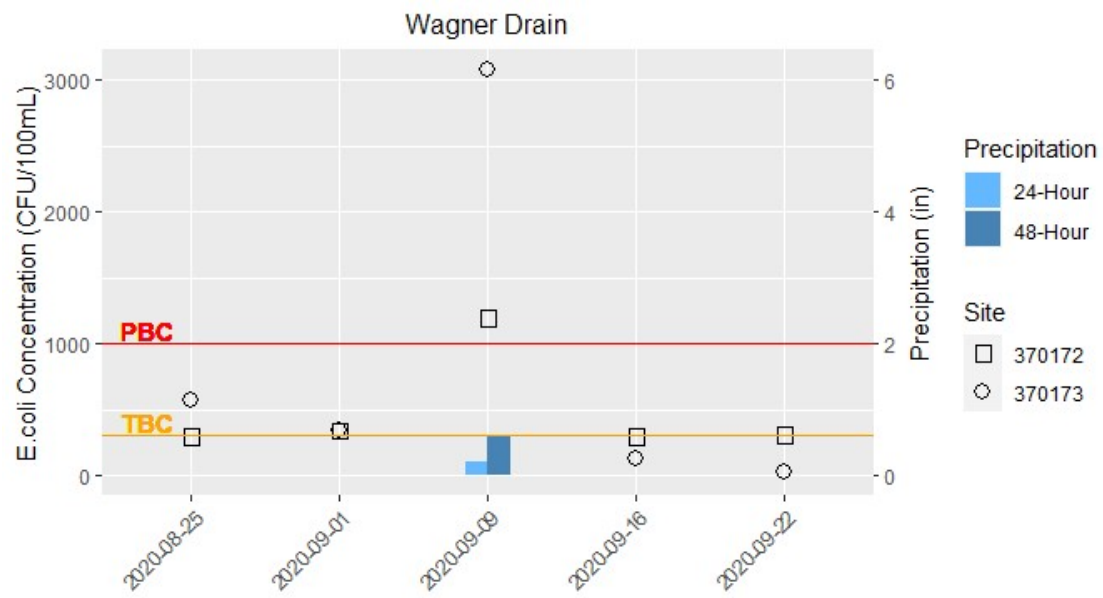
Appendix 5. (continued)



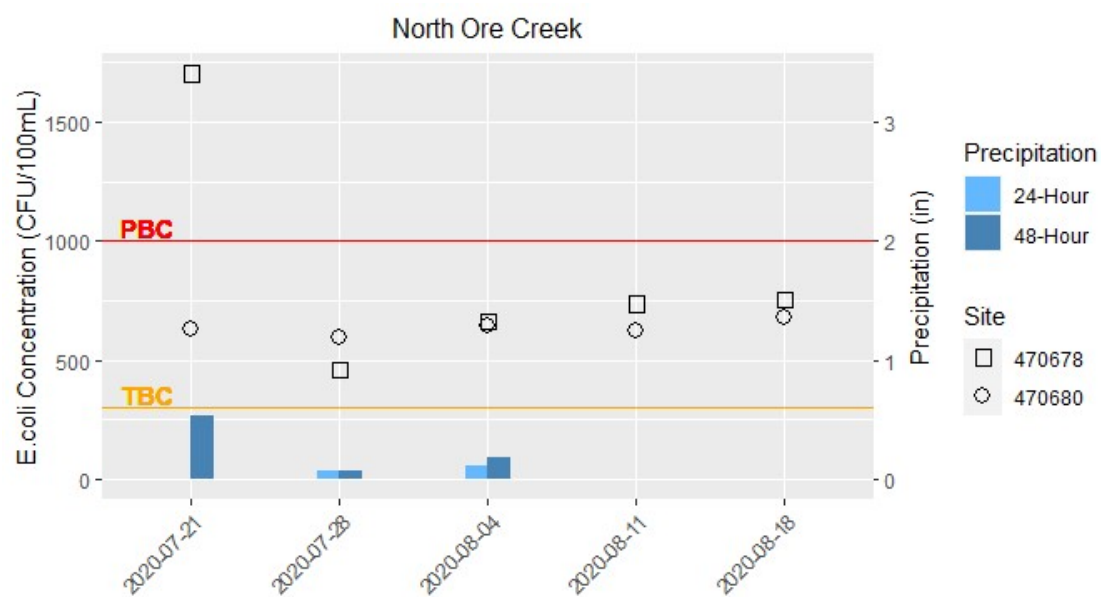
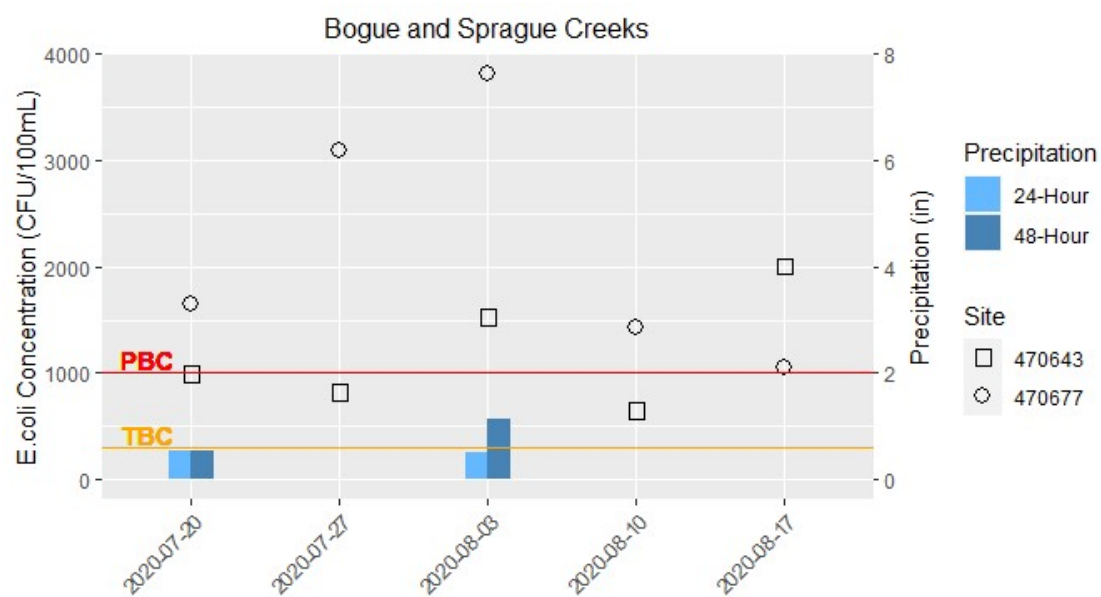
Pine (HUC 04080202)



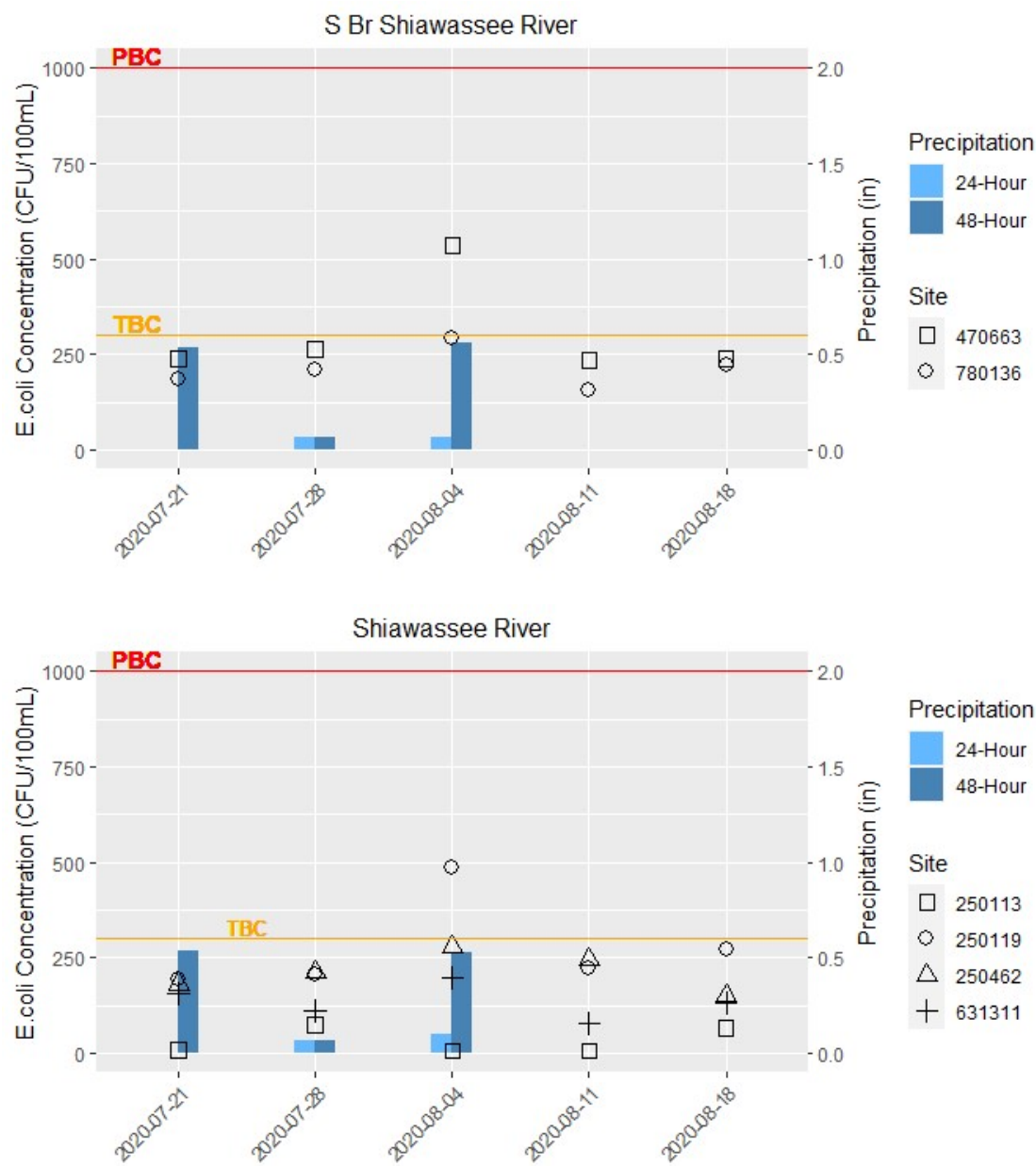
Appendix 5. (continued)



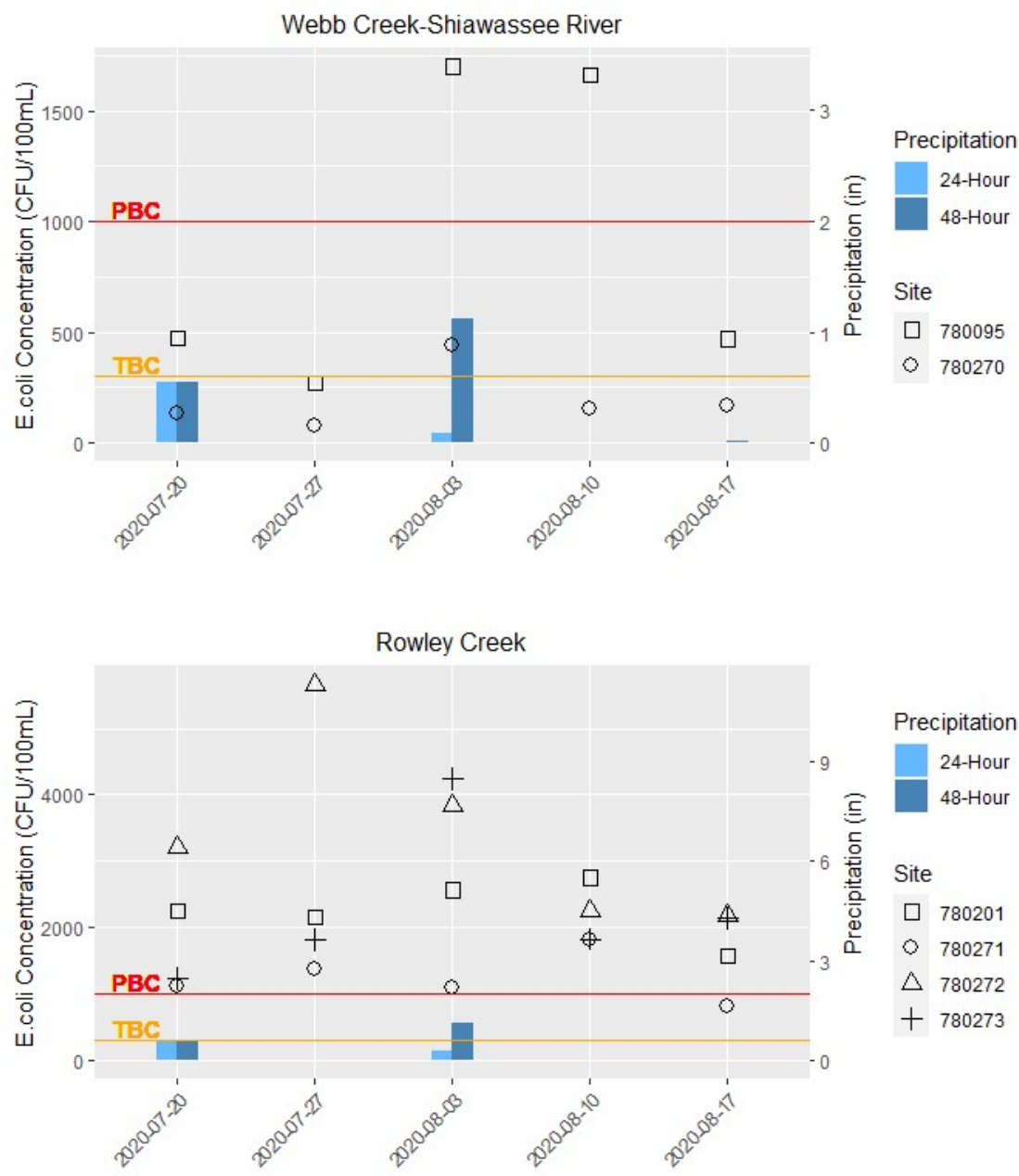
Shiawassee (HUC 04080203)



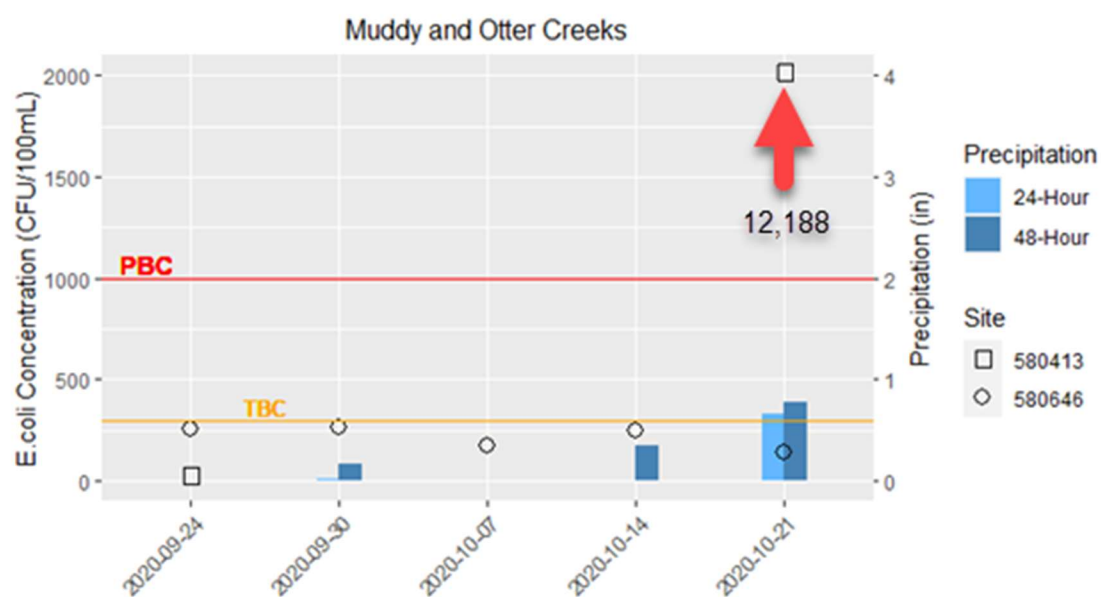
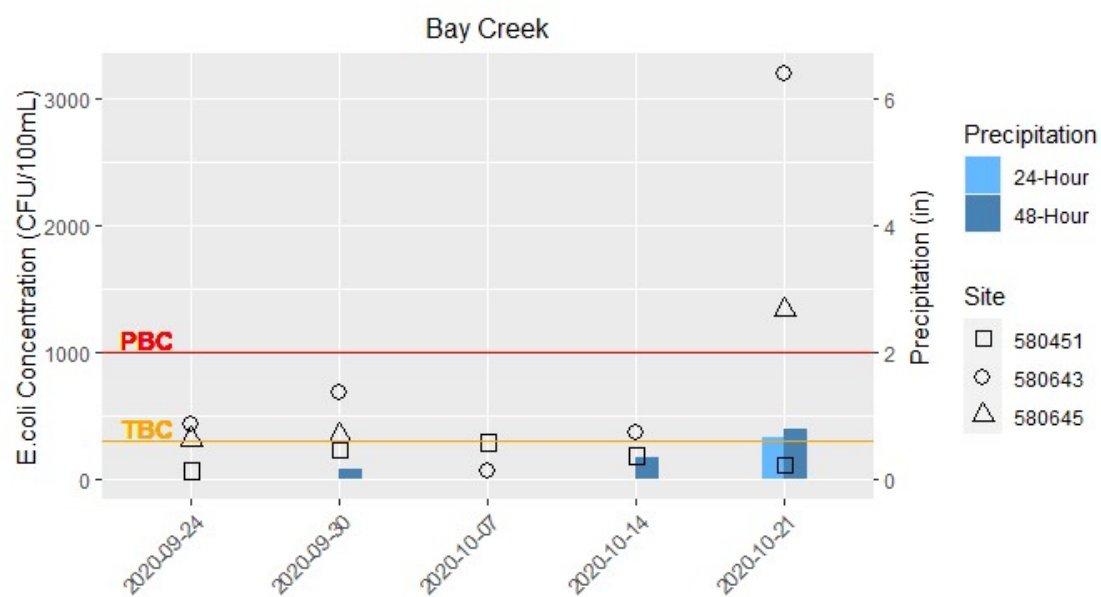
Appendix 5. (continued)



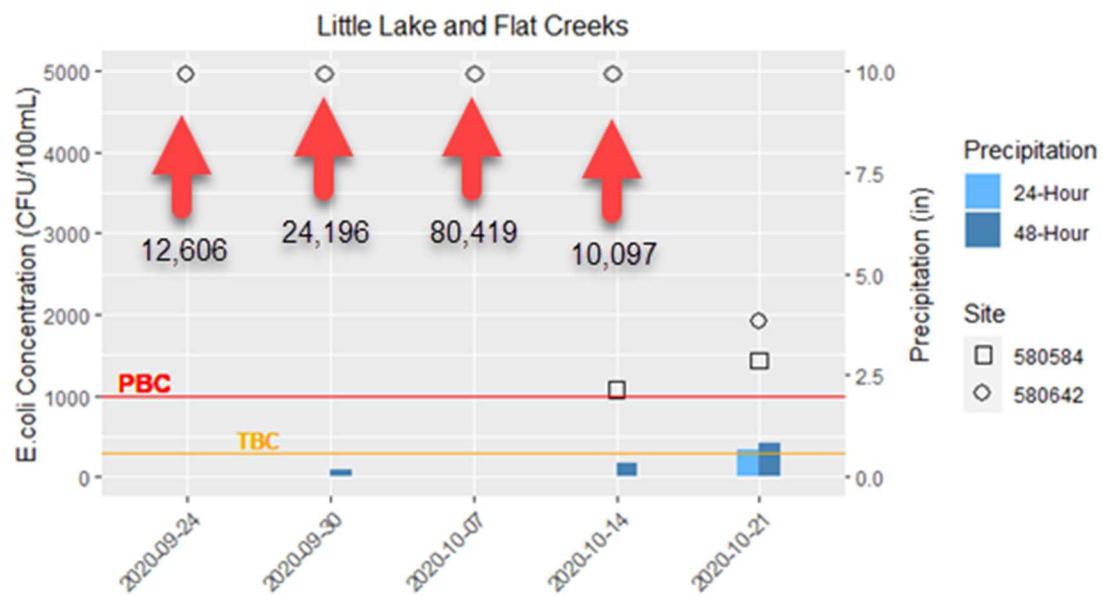
Appendix 5. (continued)



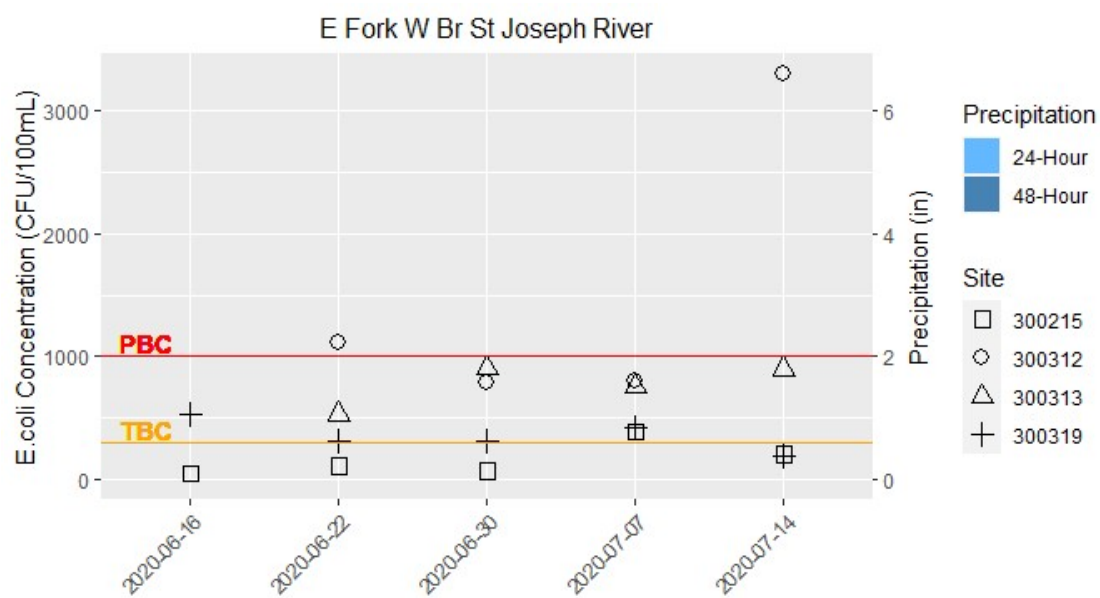
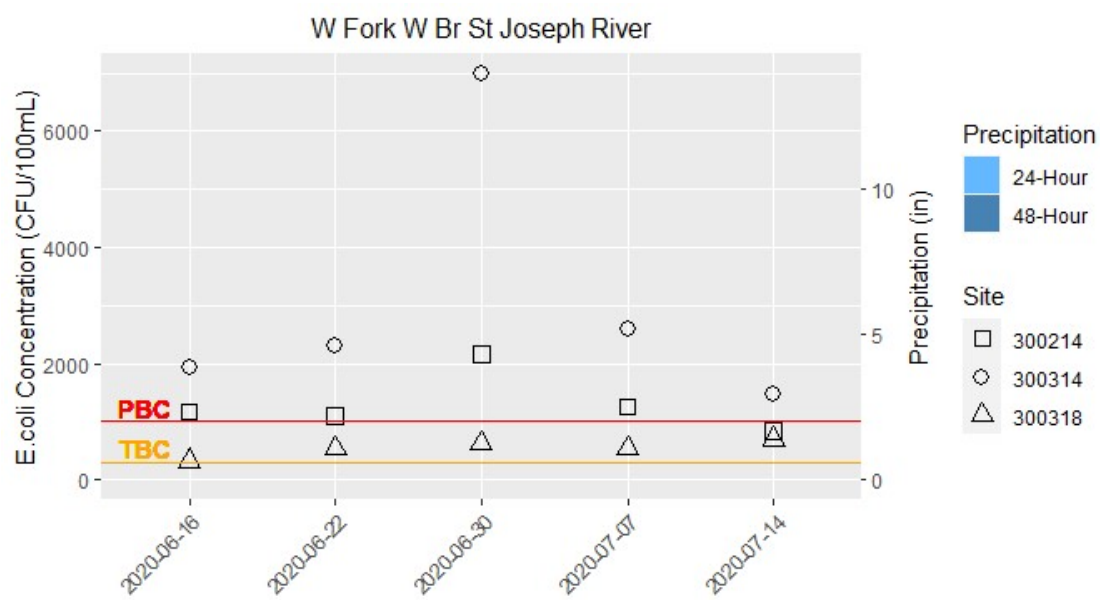
Ottawa-Stony (HUC 04100001)



Appendix 5. (continued)



St. Joseph (East - HUC 04100003)

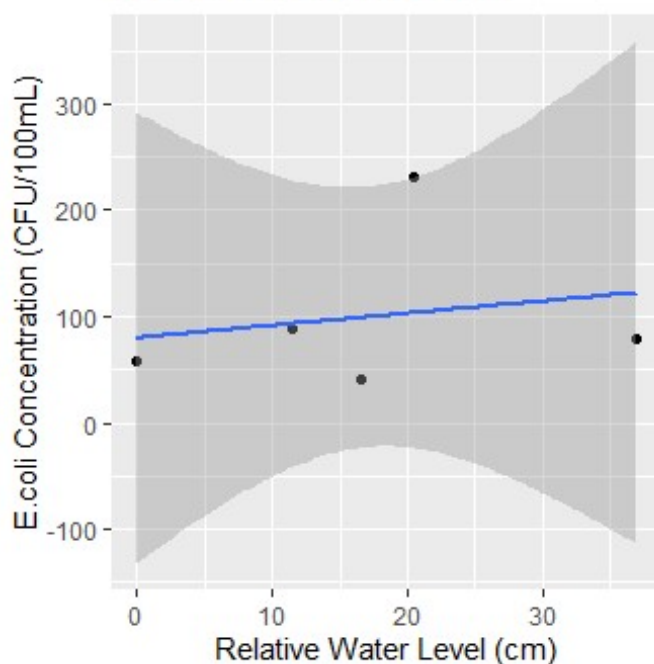


Appendix 6. Relationships between *E. coli* and water levels for selected sites in the 2020 study. Water levels are relative to the lowest recorded water level during the study. The blue lines show statistical trends (in any) while the gray shaded area shows the confidence interval (the narrower the gray band, the more confidence in the relationship). Only sites with water level changes more than 3 cm are shown. These graphs are a visual representation of the information in Appendix 2.

Escanaba (HUC 04030110)

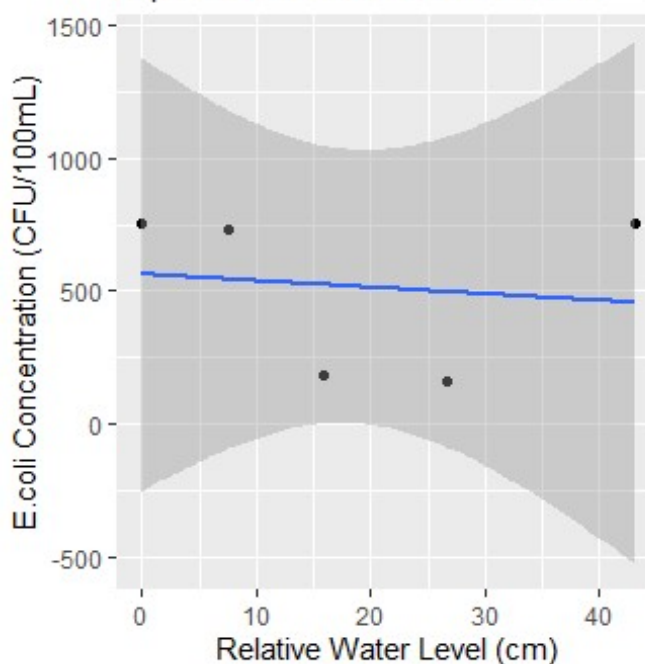
Site ID: 520259

Sawmill Cr - Escanaba R Rd



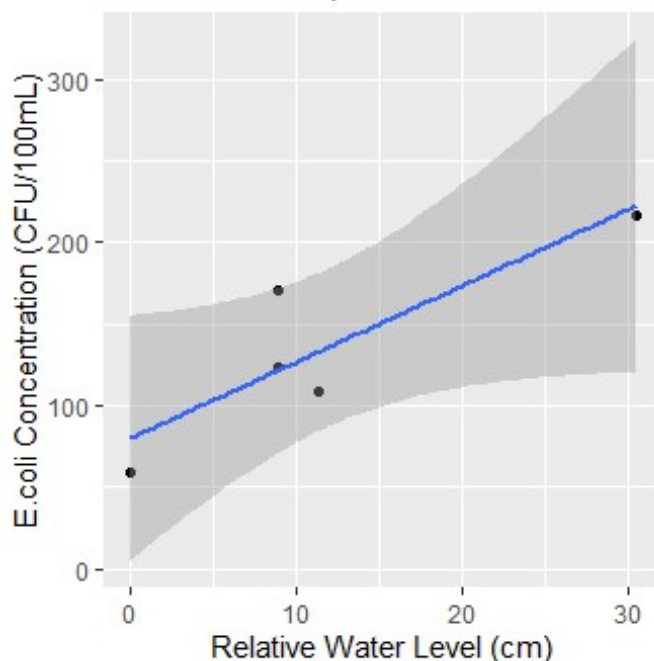
Site ID: 210241

Squaw Cr - Saint Nicholas 31st Rd



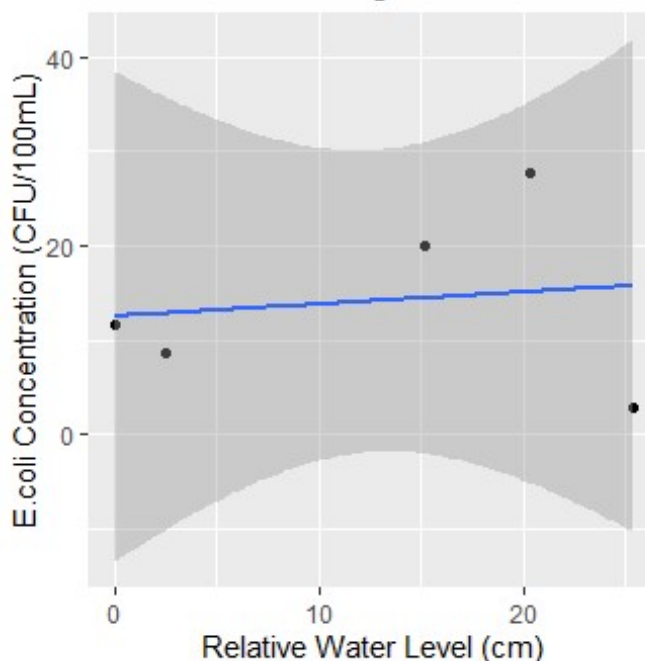
Site ID: 210329

Reno Cr - County 420 21st Rd



Site ID: 210328

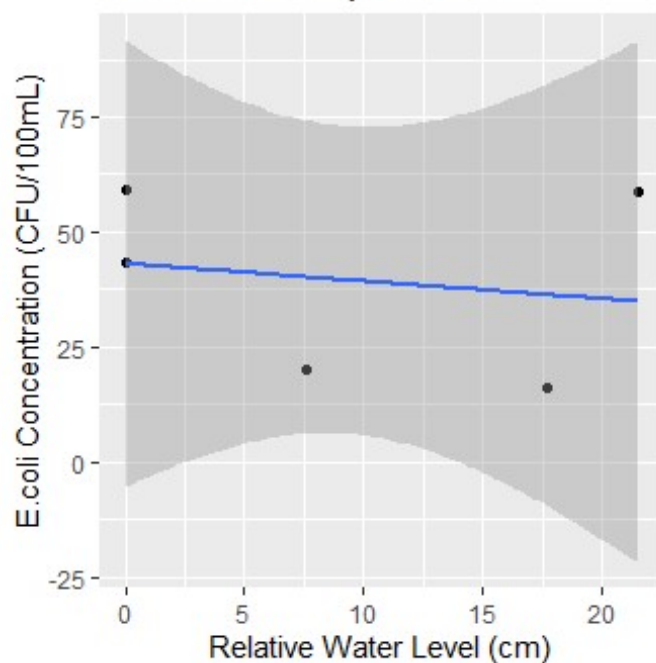
Escanaba R - Robing Rd



Appendix 6. (continued)

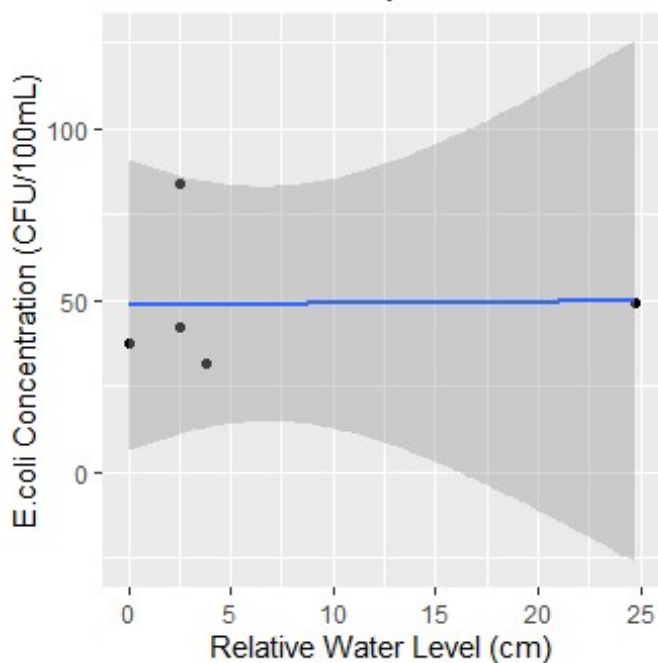
Site ID: 210322

Hunters Br - Boney Falls H Rd



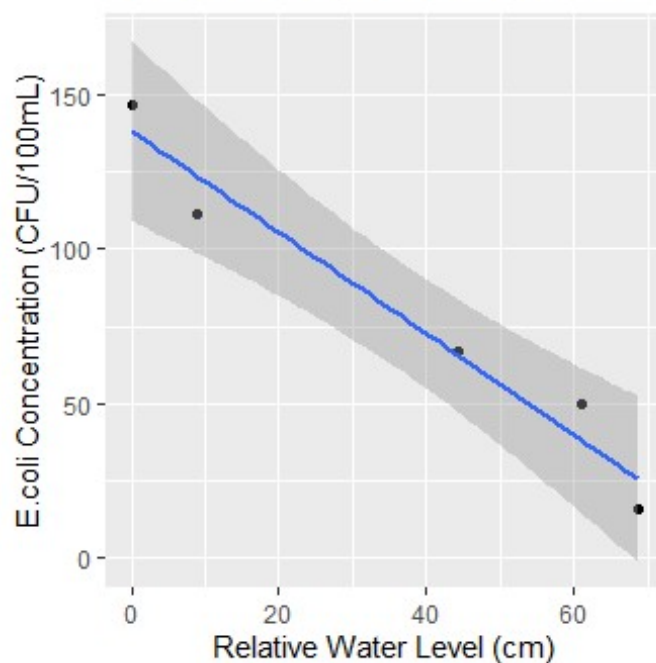
Site ID: 210100

Escanaba R - County 420 21st Rd



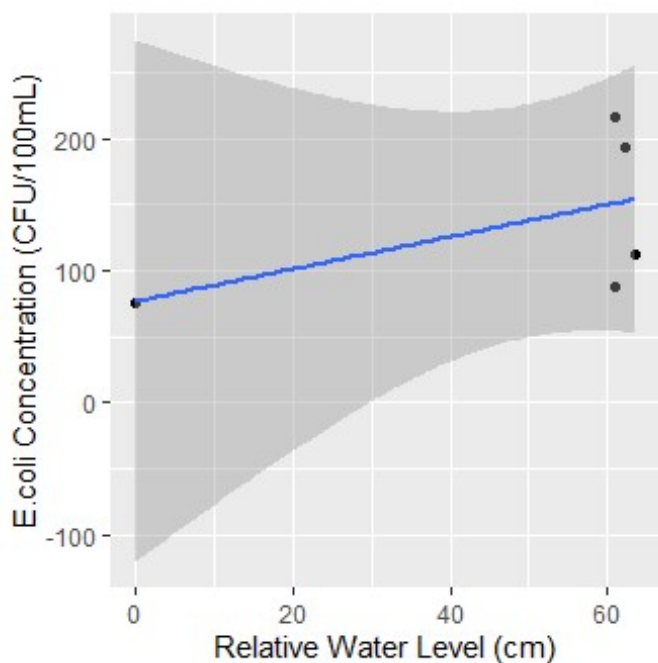
Site ID: 520463

Little W Br Escanaba R - Little West Rd



Site ID: 520381

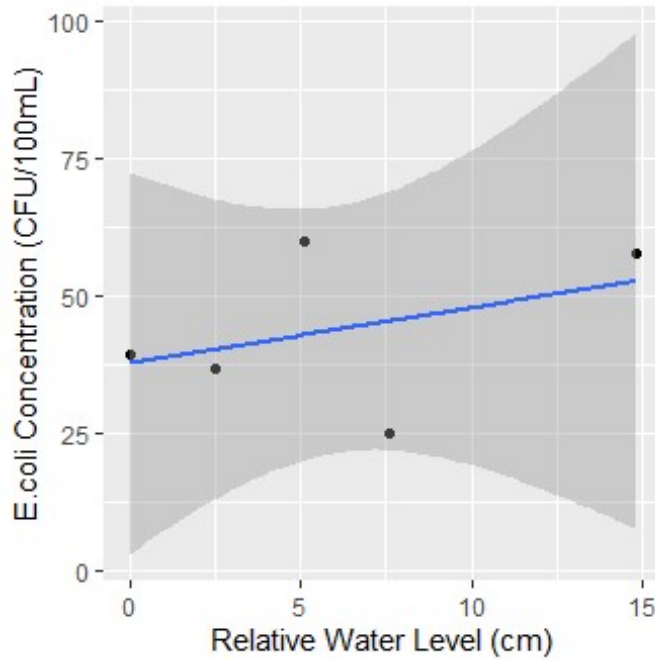
Warner Cr - M35



Appendix 6. (continued)

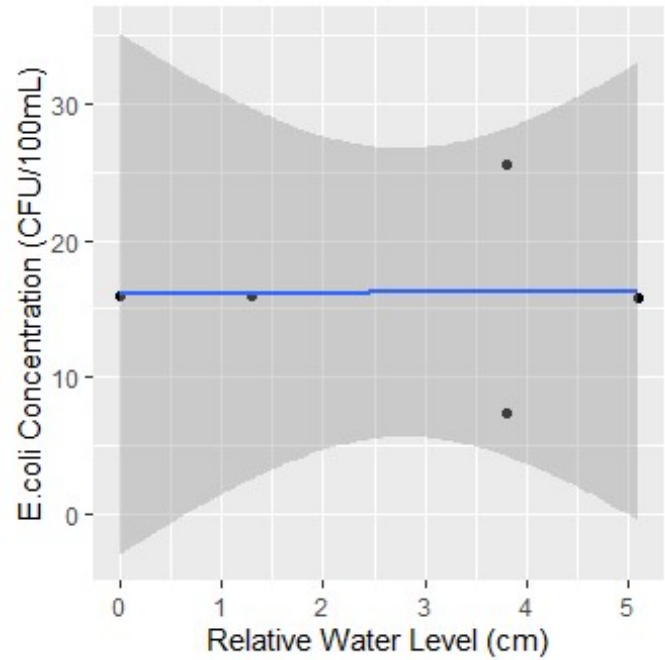
Site ID: 520502

E Br Escanaba R - Iron St



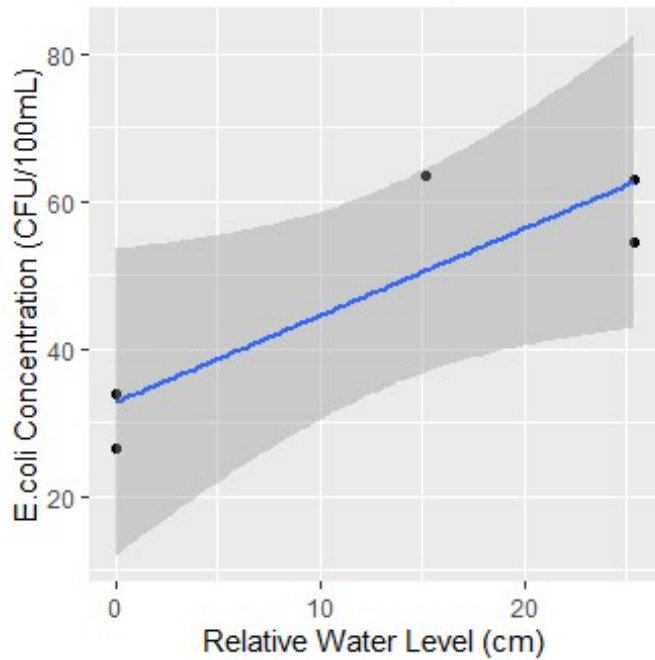
Site ID: 520562

Middle Br Escanaba R - M35



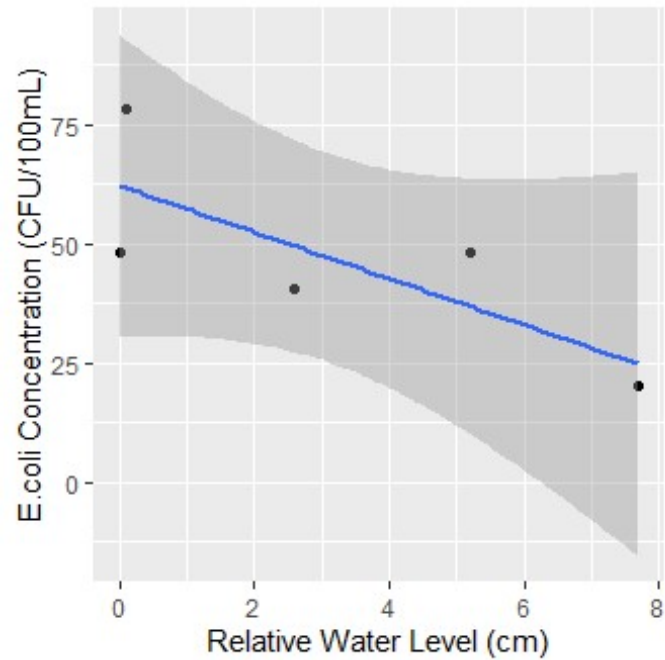
Site ID: 520561

W Br Escanaba R - County Road 557



Site ID: 520563

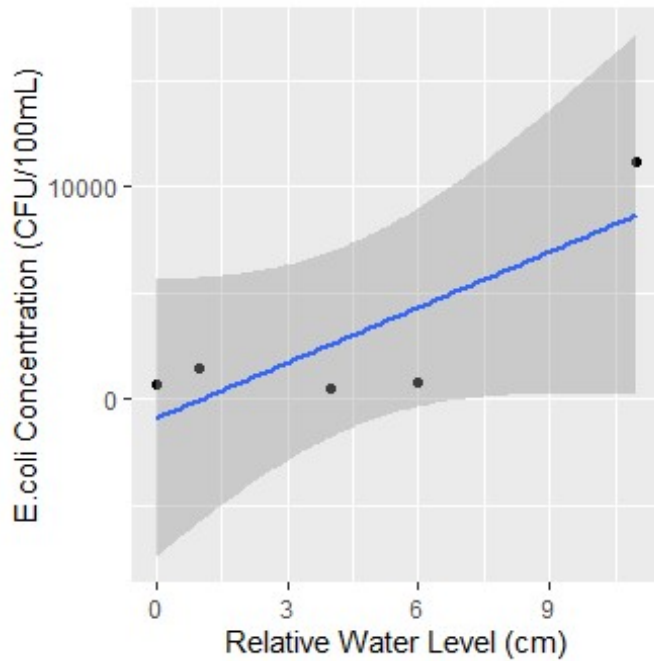
Escanaba R - Power Line Ln



St. Joseph (West - HUC 04050001)

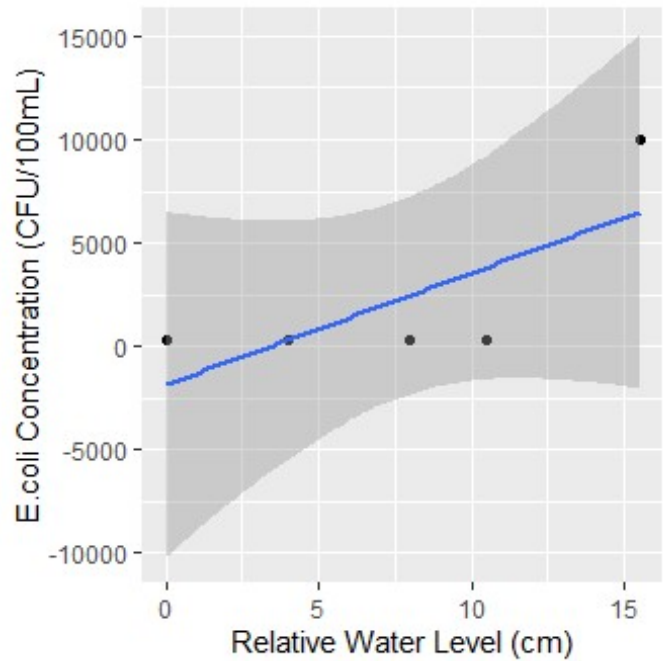
Site ID: 300317

Beebe Cr - State Rd



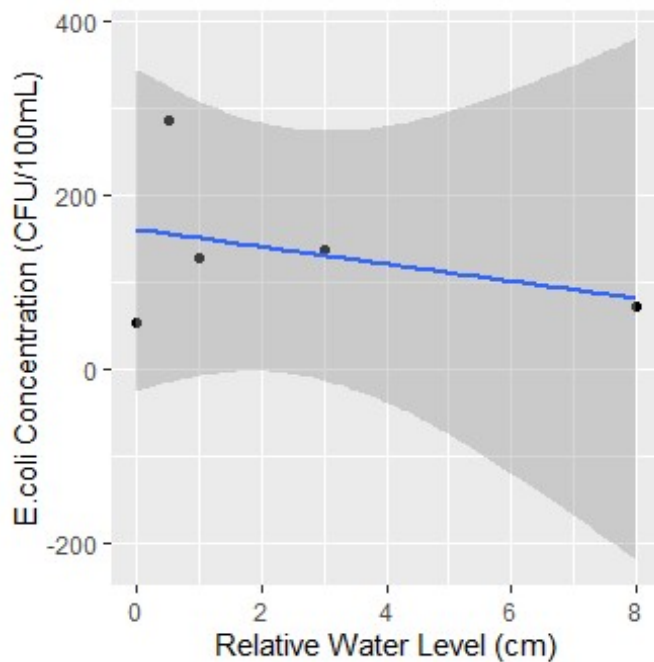
Site ID: 300144

Beebe Cr - E Moore Rd



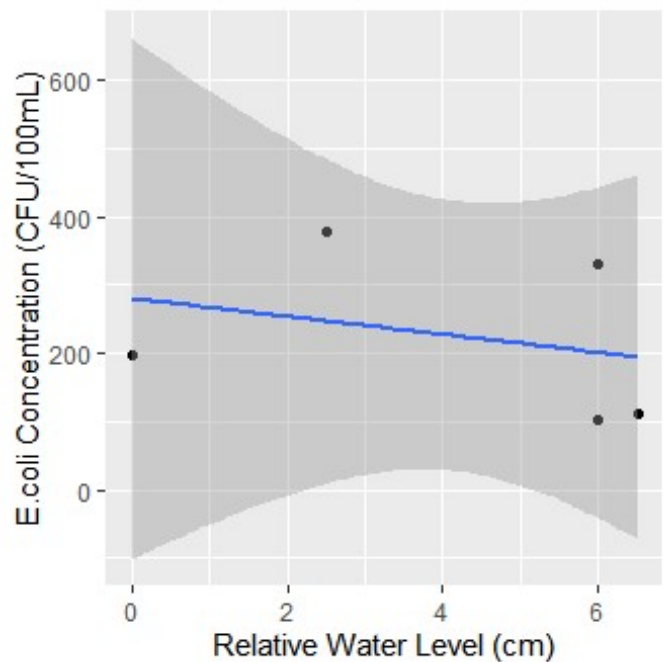
Site ID: 120260

Coldwater R - Union City Rd



Site ID: 120266

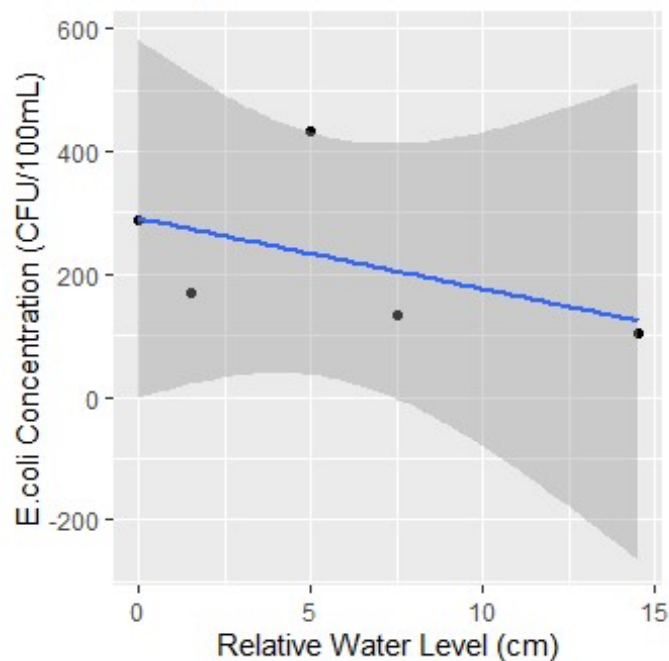
Coldwater R - E Fenn Rd



Appendix 6. (continued)

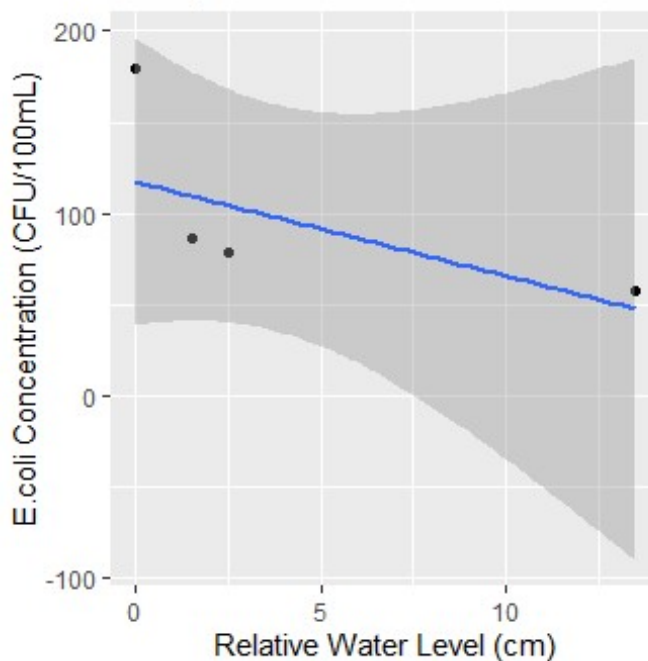
Site ID: 390647

Portage R - YZ Ave



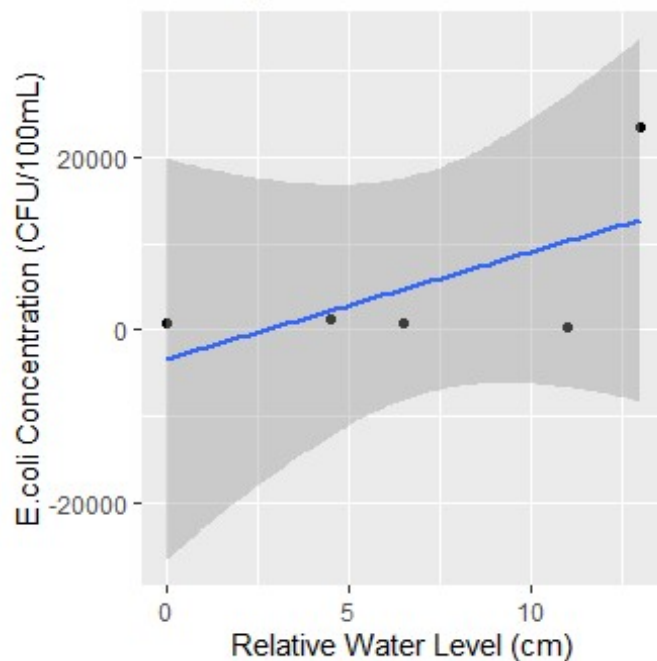
Site ID: 750292

Portage R - S Fisher Lake Rd



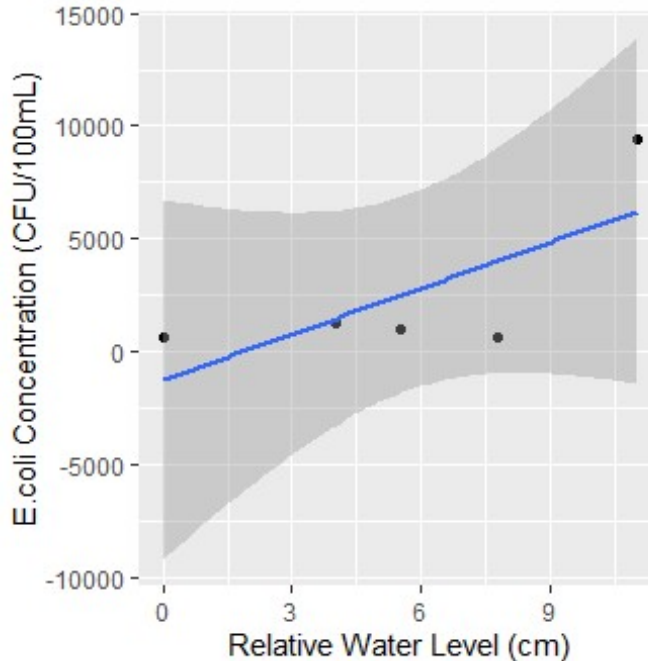
Site ID: 120261

S Br Hog Cr - Clarendon Rd



Site ID: 300315

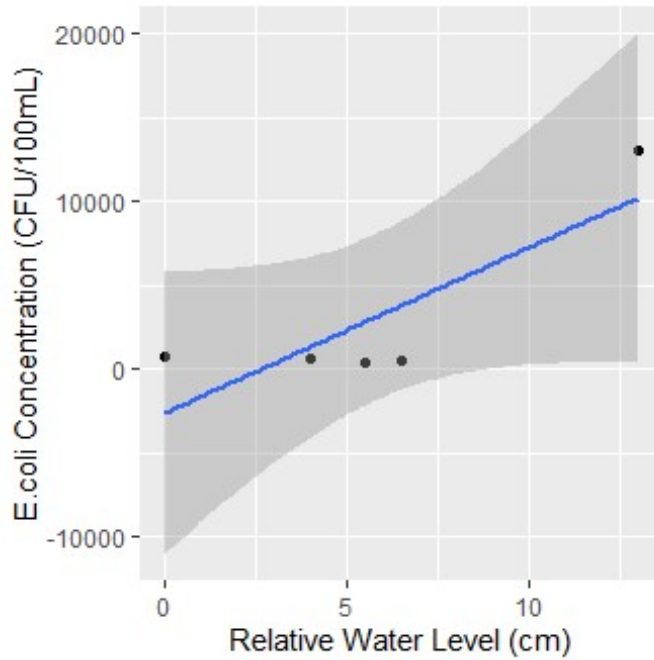
Sand Cr - W Litchfield Rd



Appendix 6. (continued)

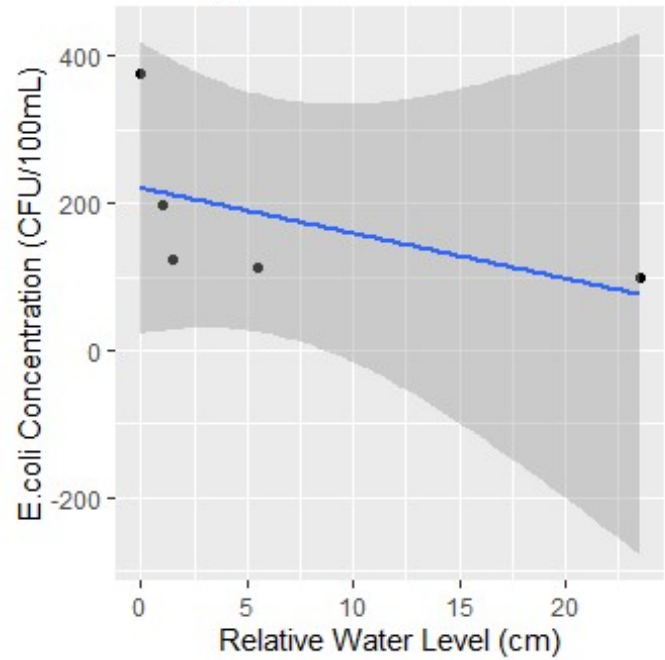
Site ID: 130419

Tekonsha Cr - Old US 27 S



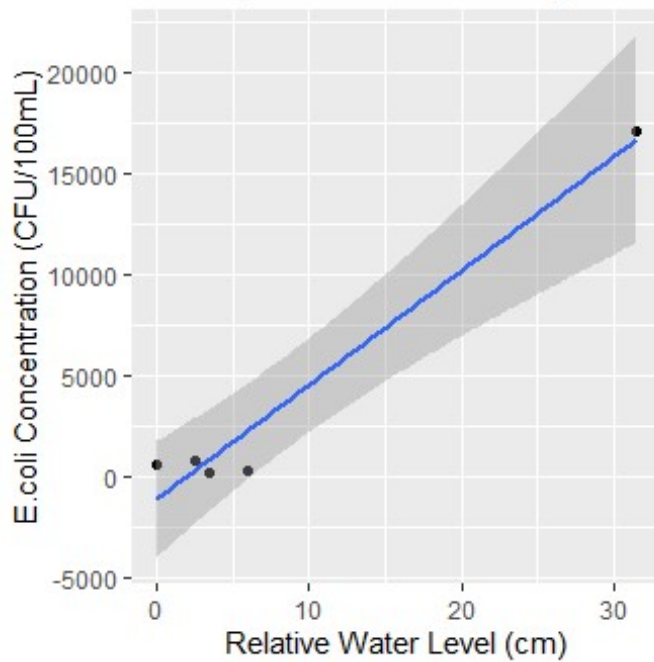
Site ID: 130305

St Joseph R - 9 Mile Rd



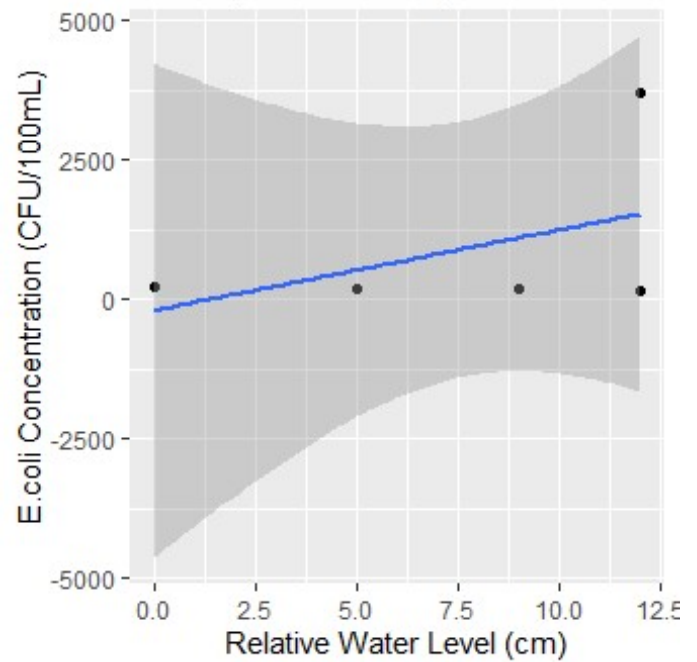
Site ID: 300320

St Joseph R - Pedestrian Bridge N of F



Site ID: 120238

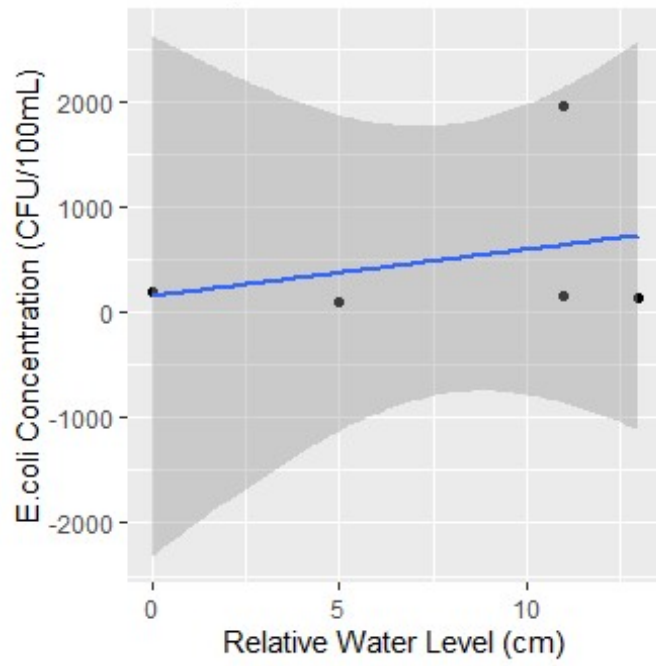
St Joseph R - S County Line Rd



Appendix 6. (continued)

Site ID: 130420

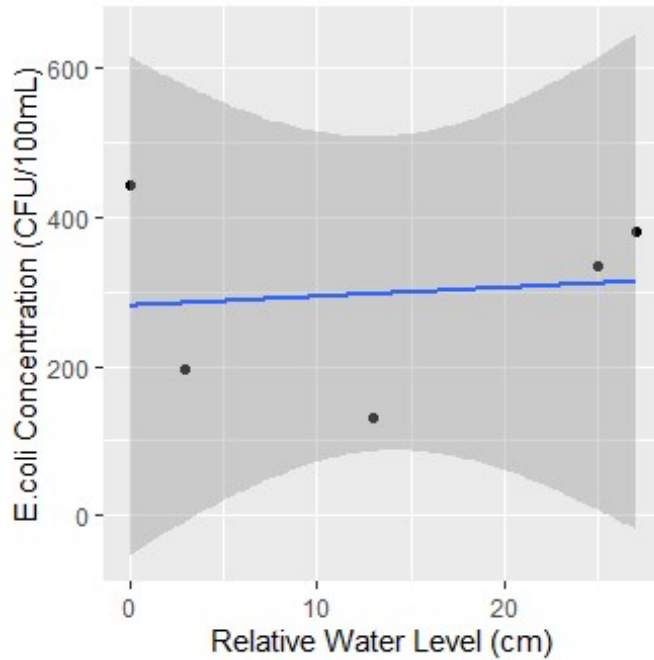
St Joseph R - T Dm S



Pere Marquette (HUC 04060101)

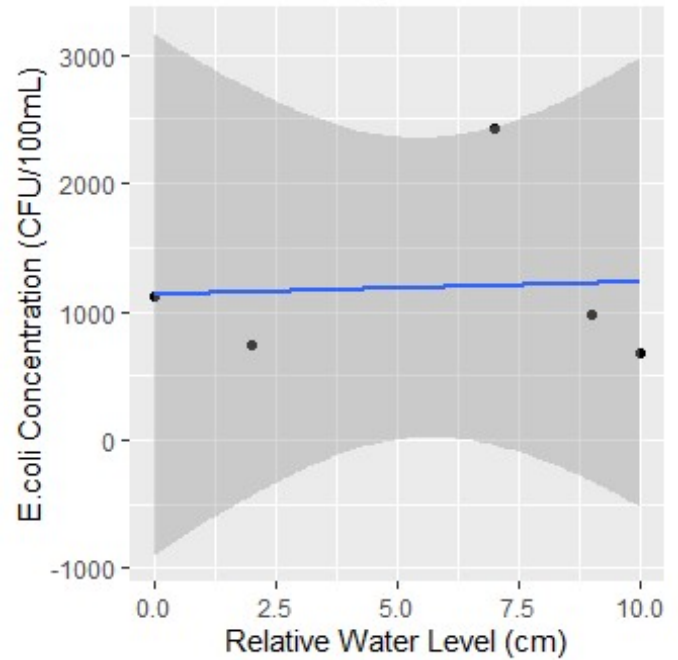
Site ID: 620318

Beaver Cr - Comstock Ave



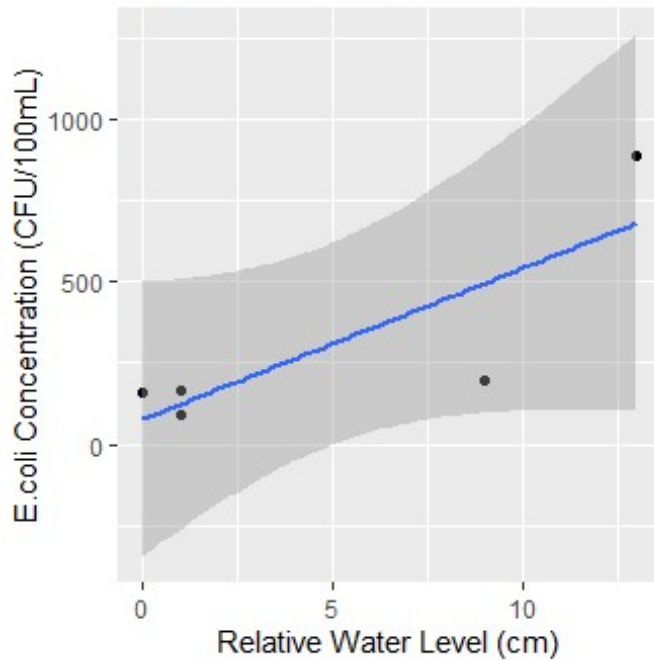
Site ID: 640183

Freeman Cr - Maple Island Ave



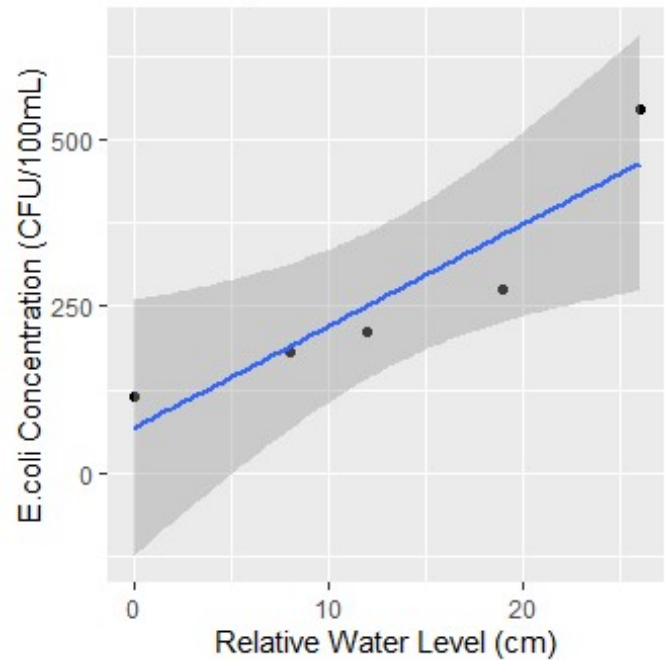
Site ID: 620220

Big S Br Pere Marquette R - Croswell Ave



Site ID: 620248

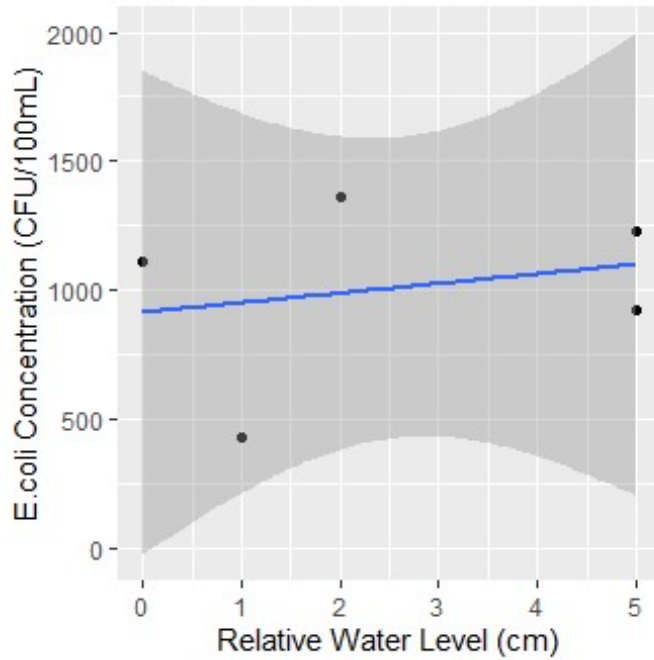
Pere Marquette R - Dickinson Ave



Appendix 6. (continued)

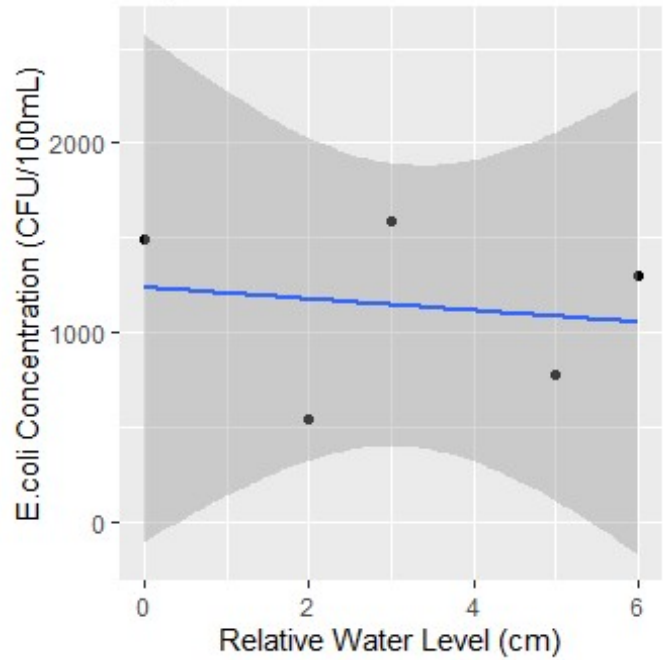
Site ID: 640349

Brayton Cr - Cleveland Rd



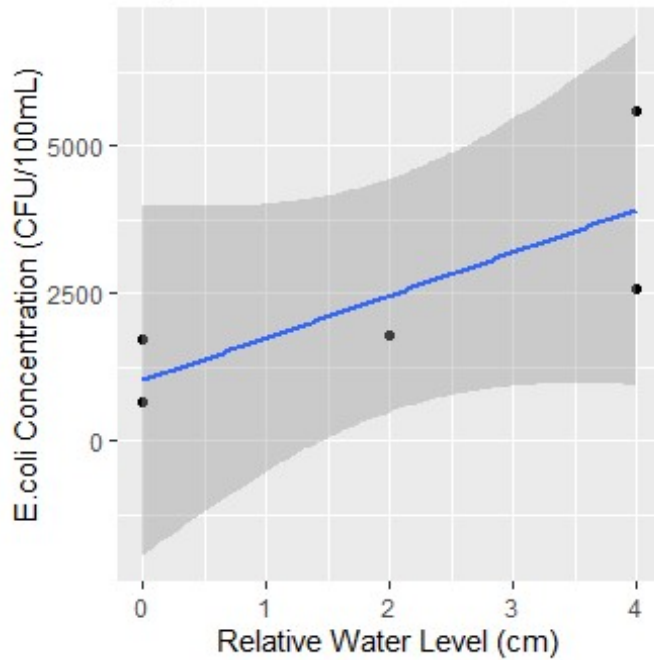
Site ID: 640354

Brayton Drn - E of 200th Ave



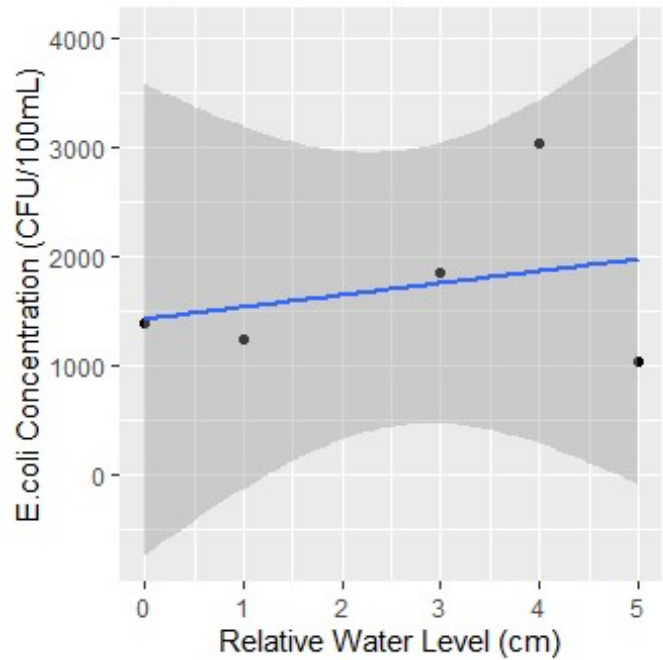
Site ID: 640318

Brayton Drn - E Wilke Rd



Site ID: 640353

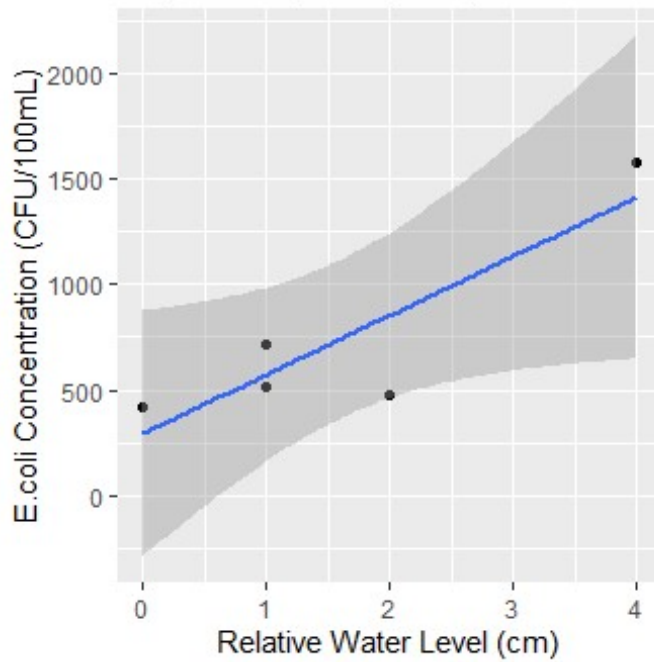
Brayton Drn (Trib to) - E of 200th Ave



Appendix 6. (continued)

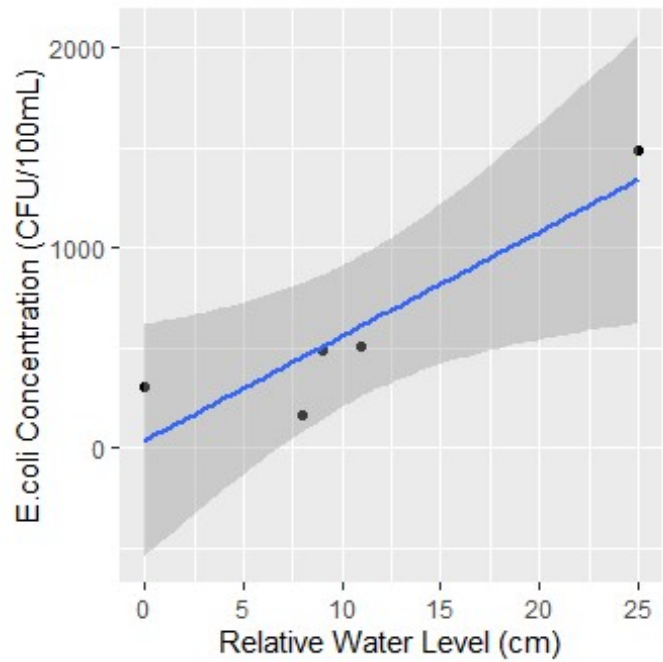
Site ID: 640355

Brayton Drn (Trib to) - Maple Island Rd



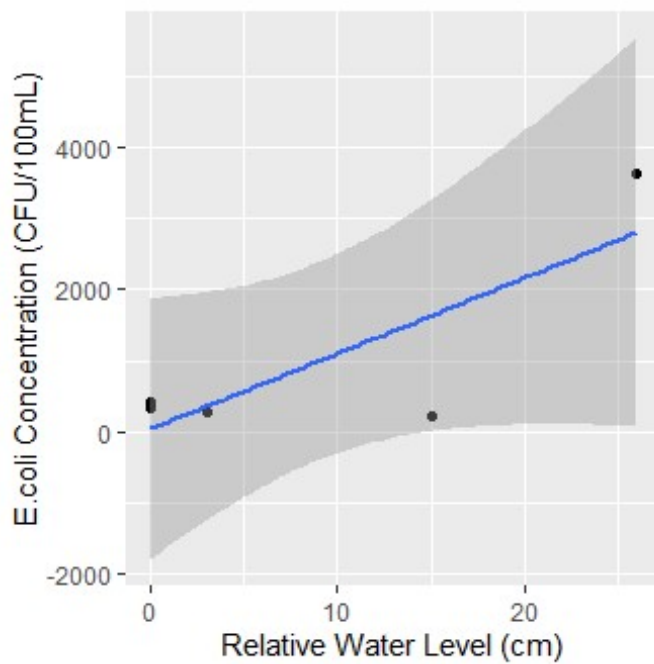
Site ID: 640186

S Branch Pentwater R - N 120th Ave



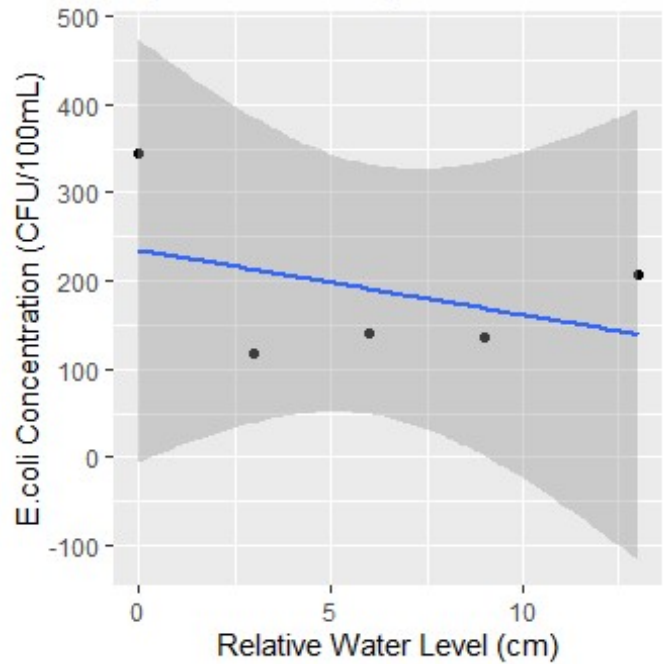
Site ID: 640205

N Branch Pentwater R - N 96th Ave



Site ID: 530029

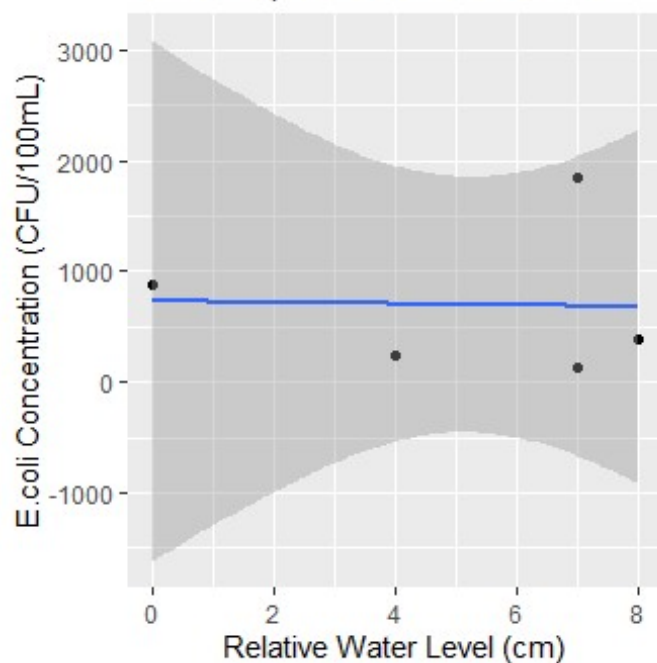
Big S Br Pere Marquette R - E Wilson



Appendix 6. (continued)

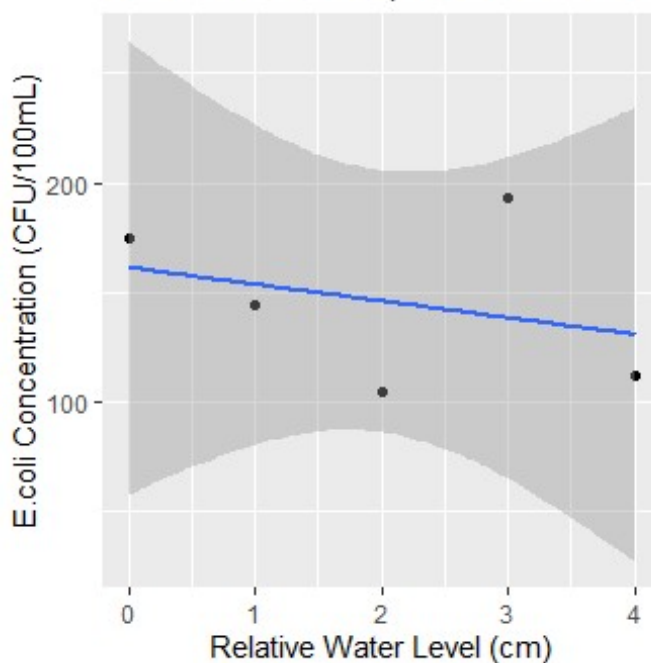
Site ID: 530027

Pere Marquette R - S Scottville Rd



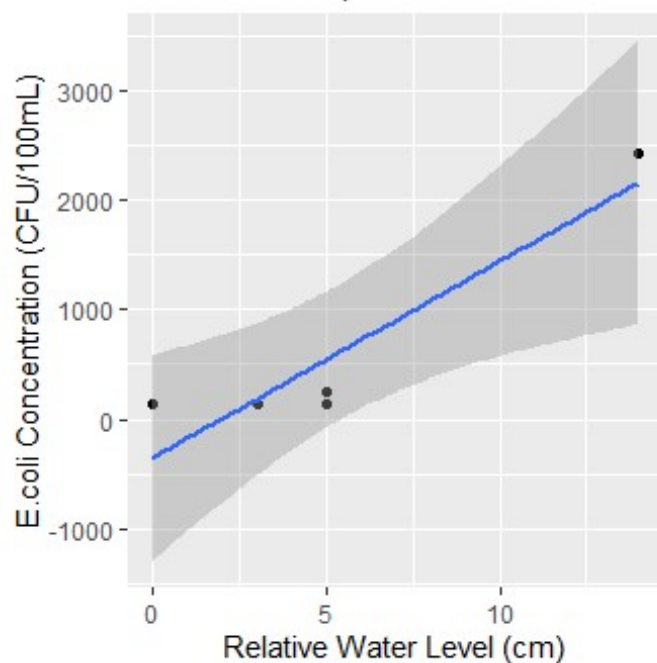
Site ID: 430572

Middle Br Pere Marquette R - S James R



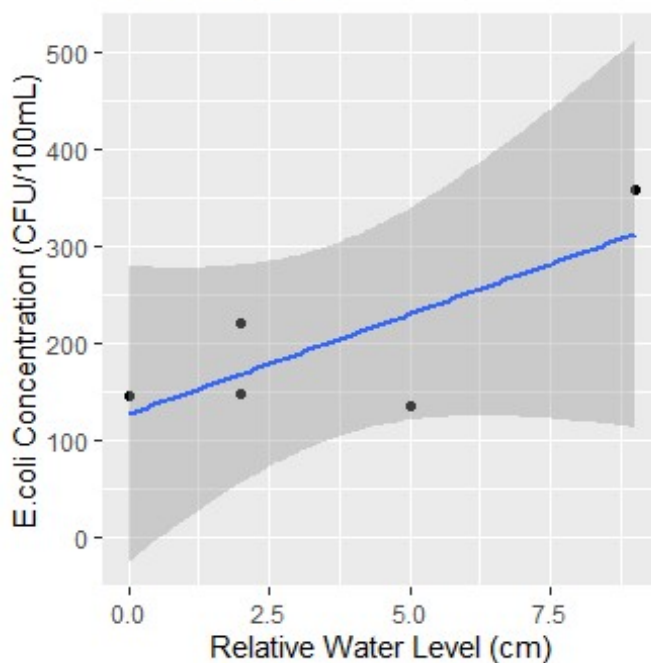
Site ID: 430569

S Br Pere Marquette R - W 76th St



Site ID: 430009

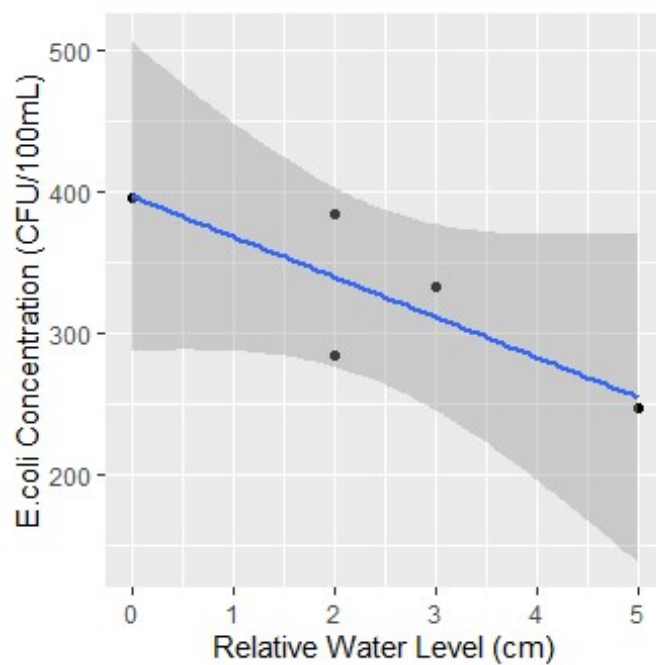
Baldwin R - M 37



Appendix 6. (continued)

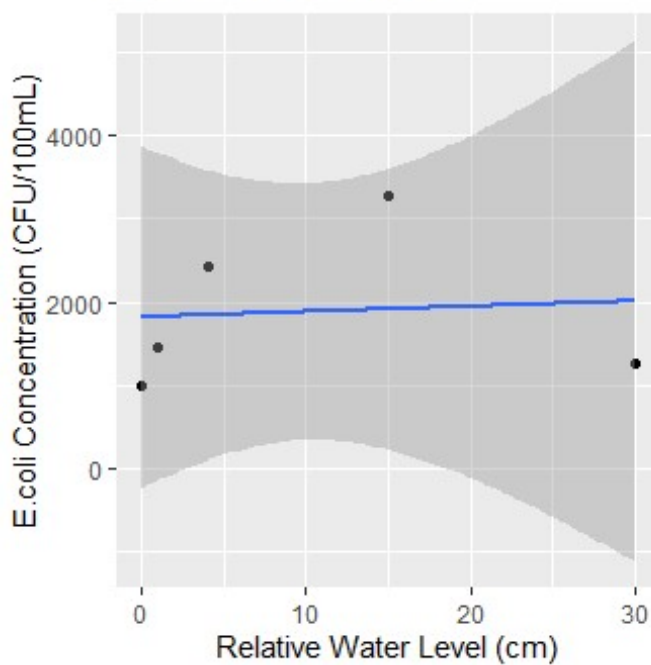
Site ID: 530226

Weldon Cr - M10



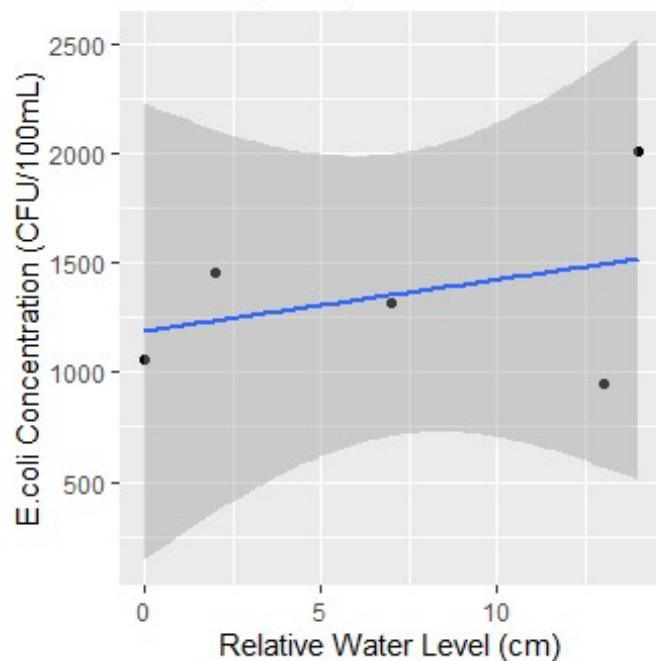
Site ID: 530229

Swan Cr - W Chauvez Rd



Site ID: 530231

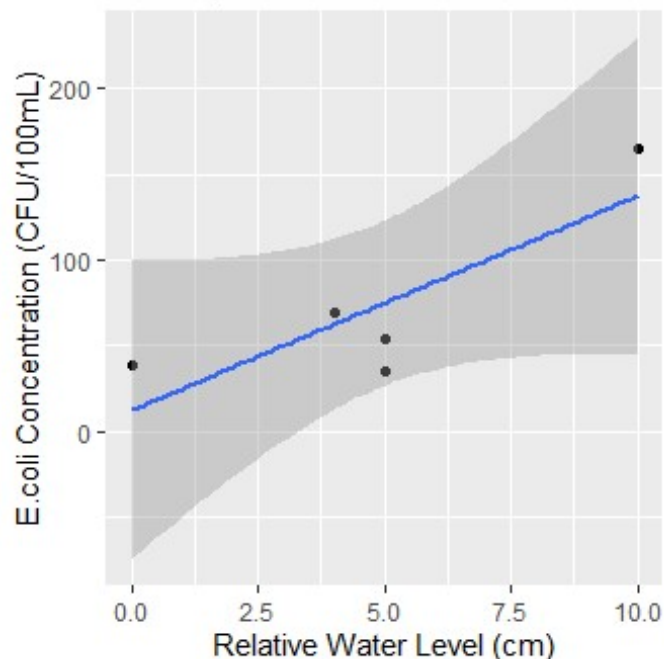
Swan Cr (Trib to) - W Kinney Rd



Boardman-Charlevoix (HUC 04060105)

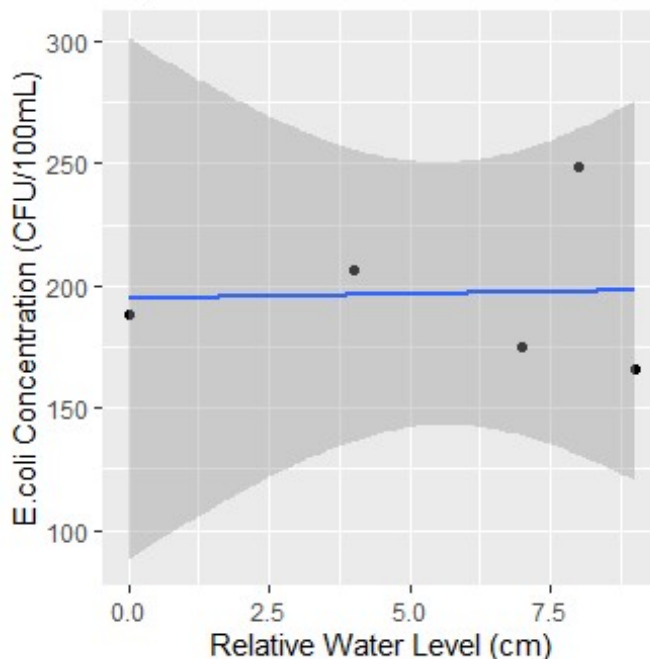
Site ID: 150198

N Br Boyne R - US 131



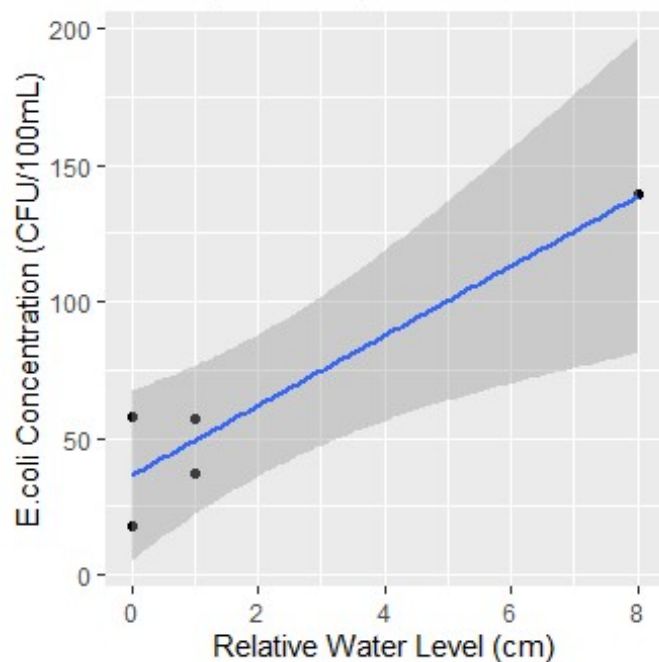
Site ID: 150100

Boyne R - S Lake St



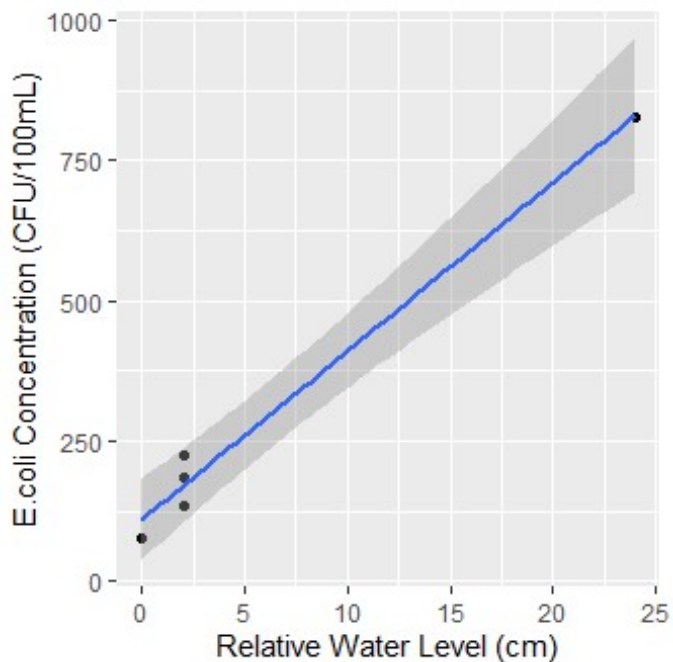
Site ID: 150187

S Br Boyne R - Boyne Mountain Rd



Site ID: 150106

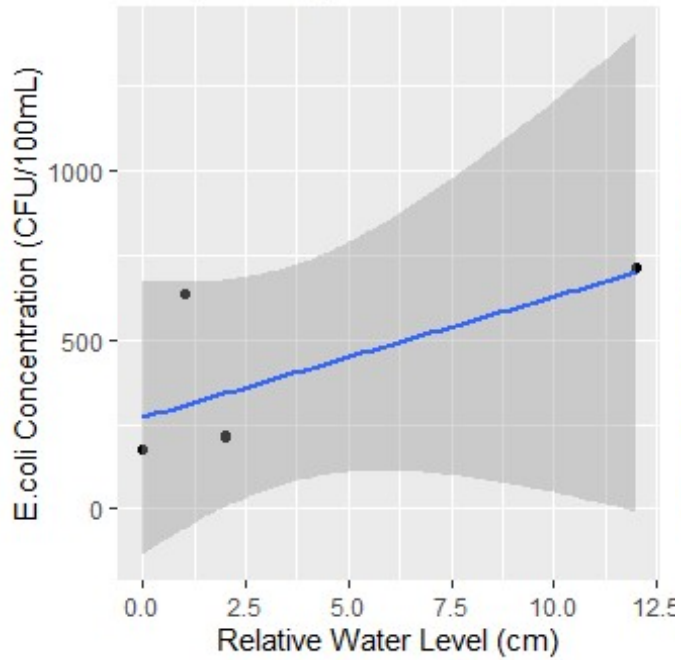
Monroe Cr - M 66



Appendix 6. (continued)

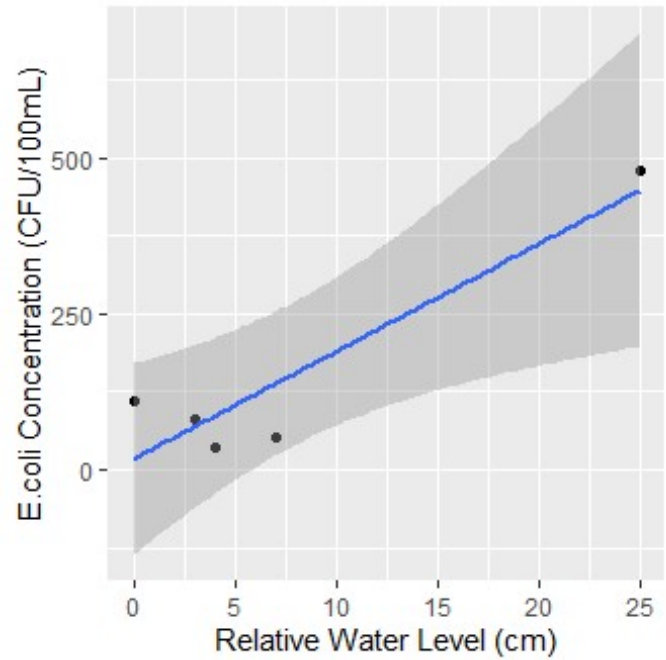
Site ID: 150257

Birney Cr - Rogers Rd



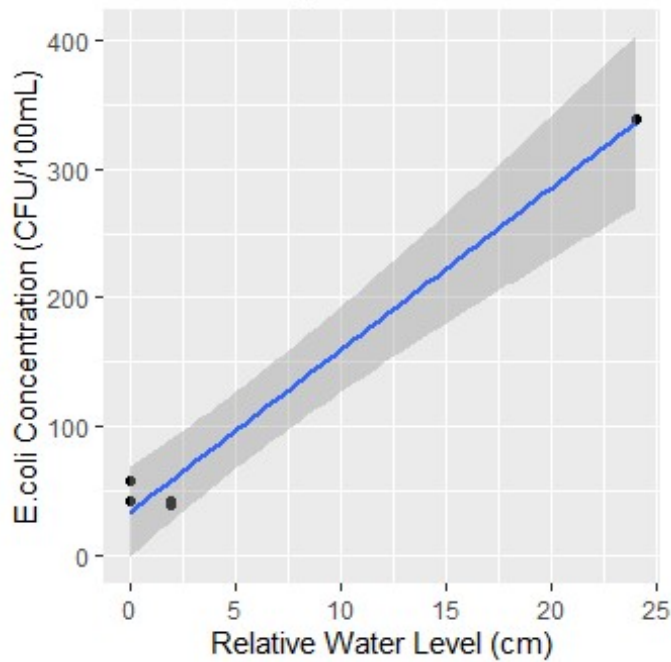
Site ID: 150204

Deer Cr - Pearsall Rd



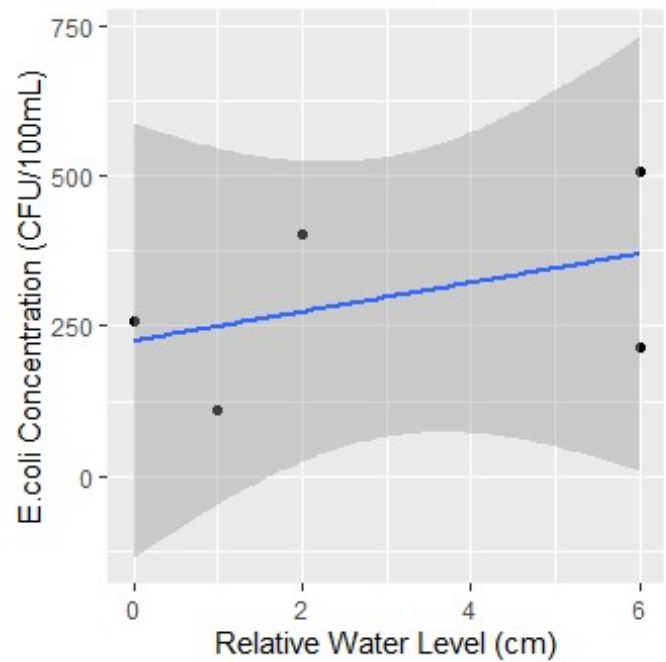
Site ID: 150010

Jordan R - Rogers Rd



Site ID: 150056

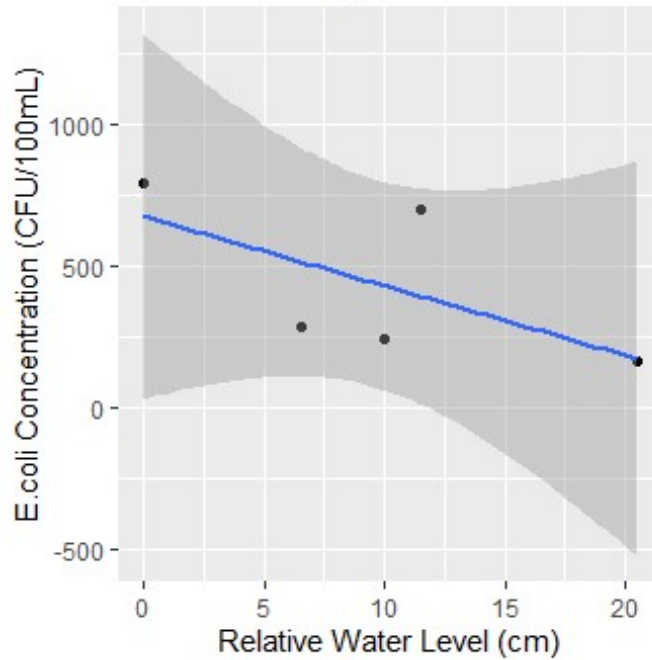
Lake Charlevoix - Bridge St



Pigeon-Wiscoggin (HUC 04080103)

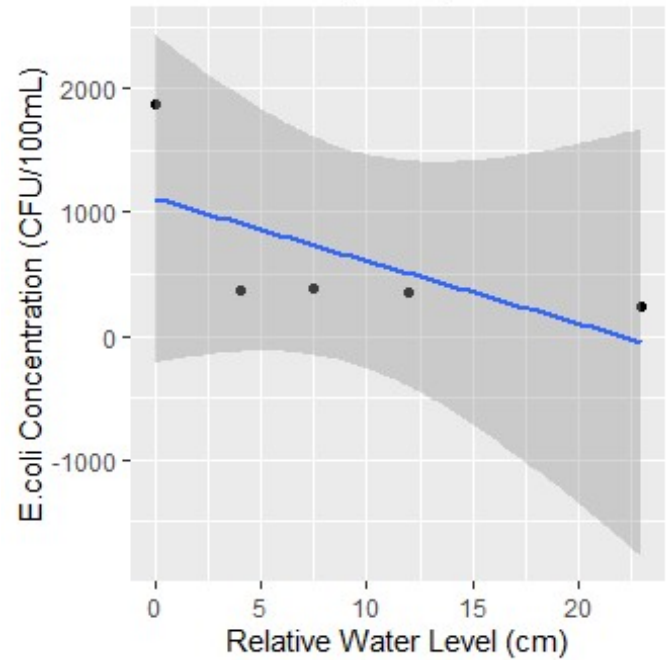
Site ID: 790244

Allen Drn - N Ringle Rd



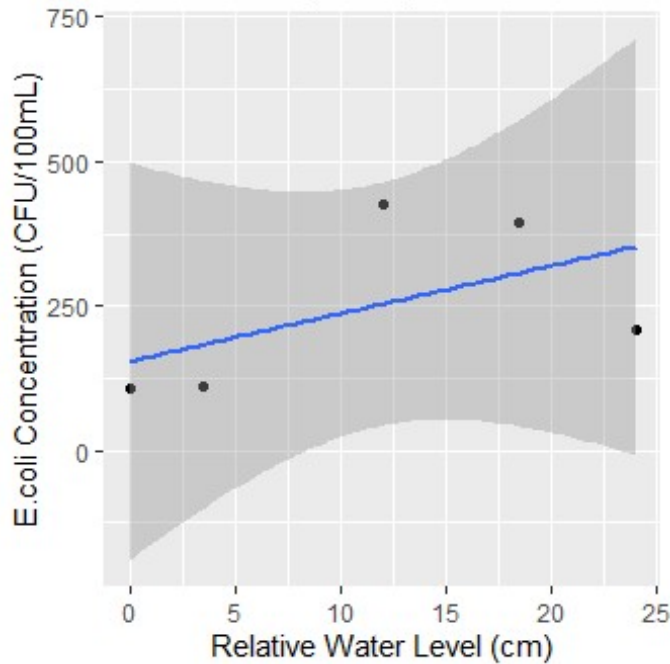
Site ID: 790242

Northwest Drn (Trib to) - N Kirk Rd



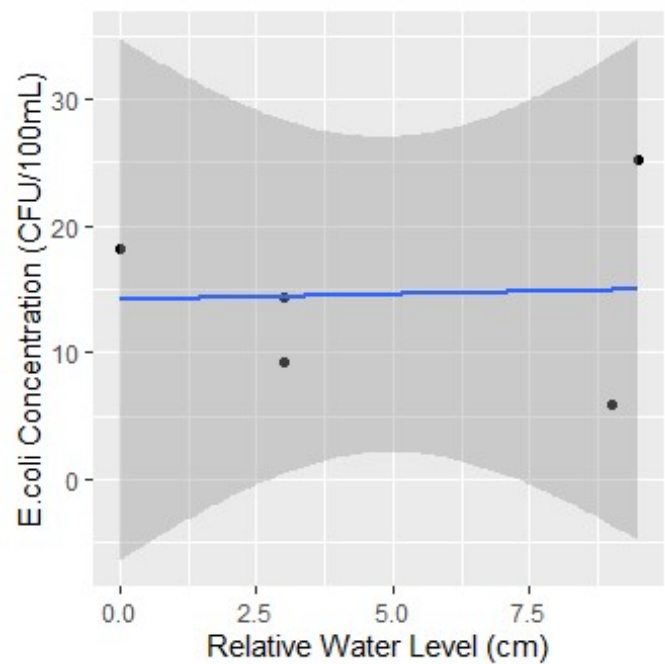
Site ID: 790241

Northwest Drn (Trib to) - N Vassar Rd



Site ID: 790239

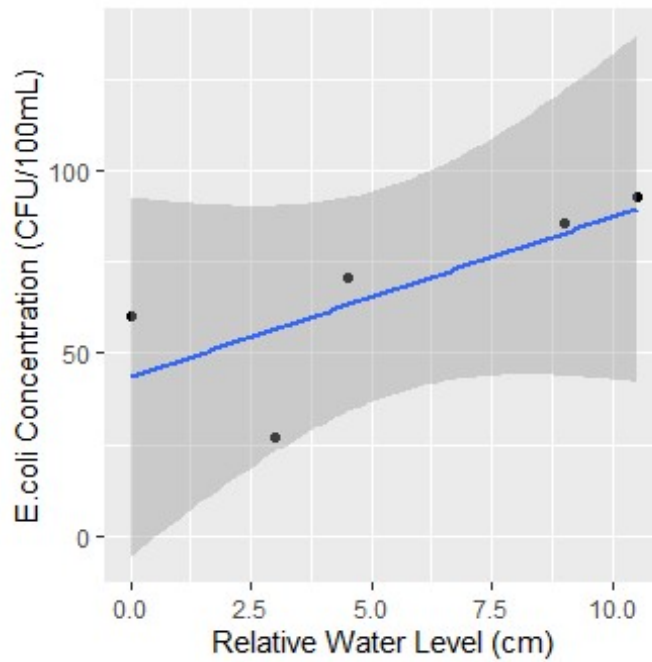
Quanicassee R - Old State Rd - West



Appendix 6. (continued)

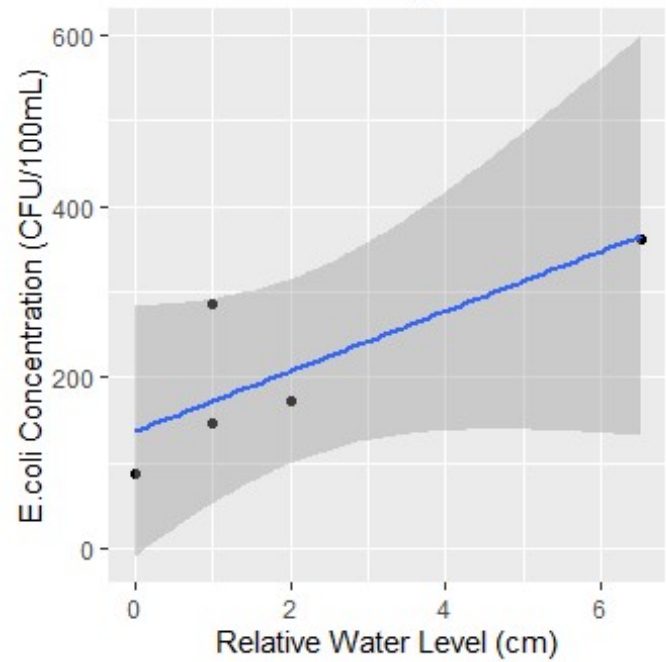
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Quanicassee R - Old State Rd - East



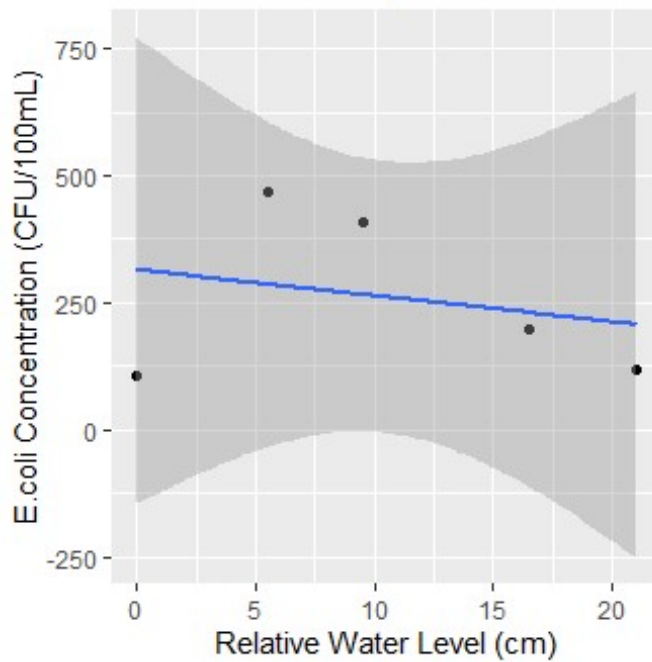
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State Drn - Sebewaing Rd



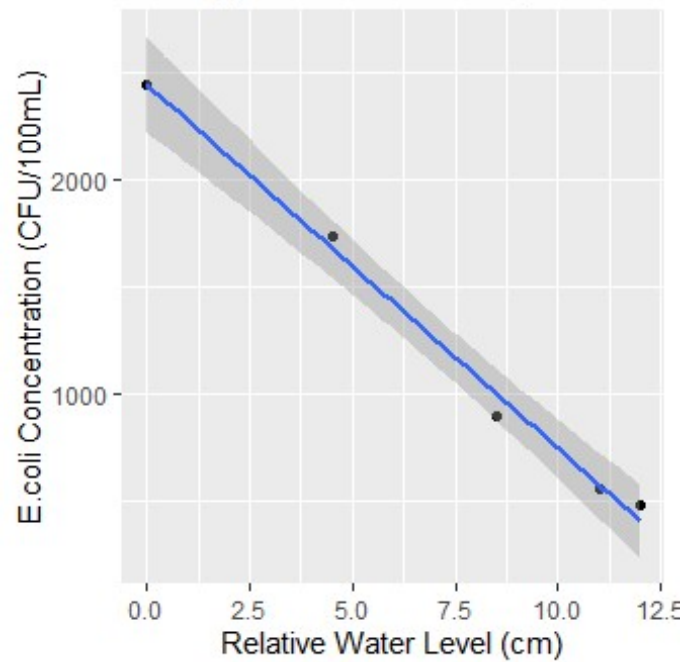
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Columbia Drn - Lange Rd



Site ID: 790228

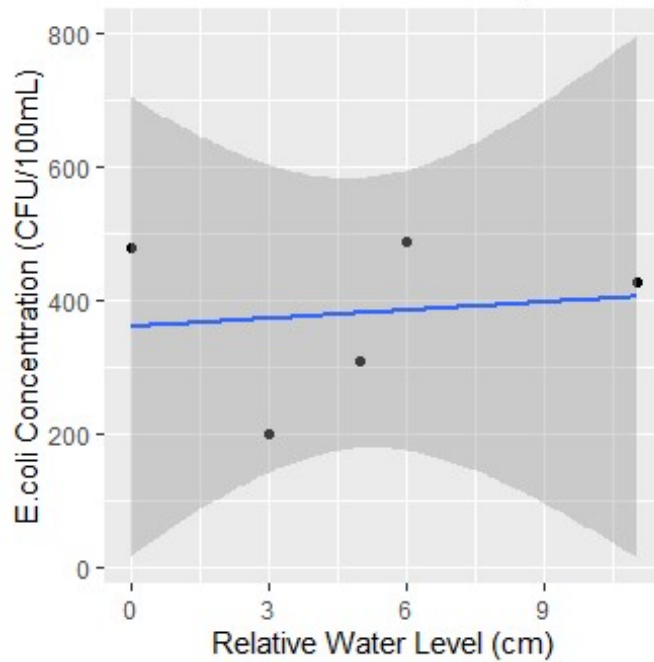
Wiscoggin Drn - W Cass City Rd



Pine (HUC 04080202)

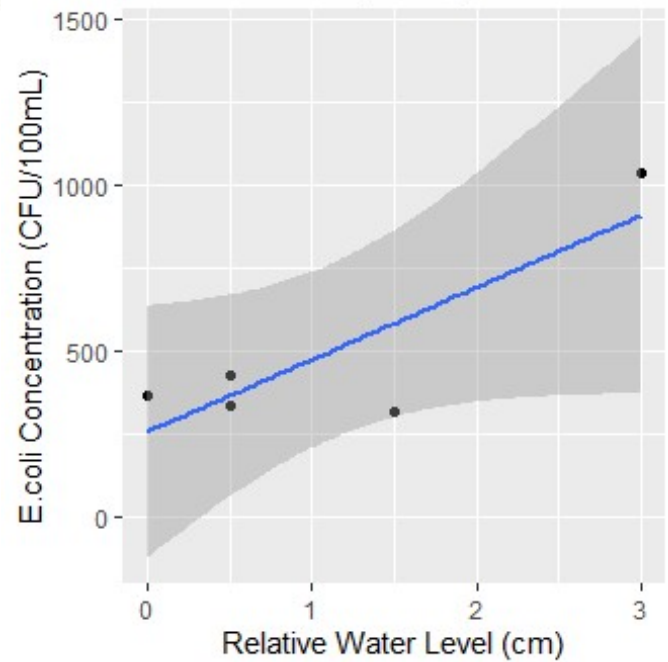
Site ID: 370179

Coldwater R - N Woodruff Rd (N Crossing)



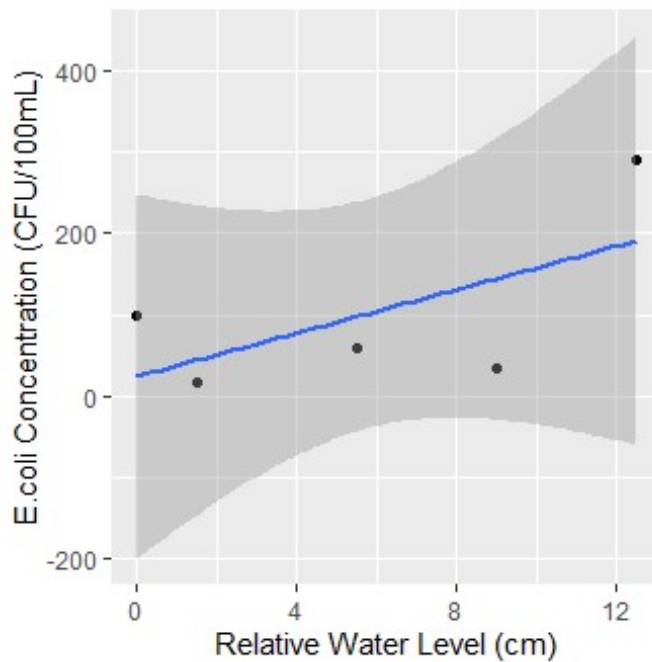
Site ID: 370180

Lake of the Hills (Trib to) - W Rosebush I



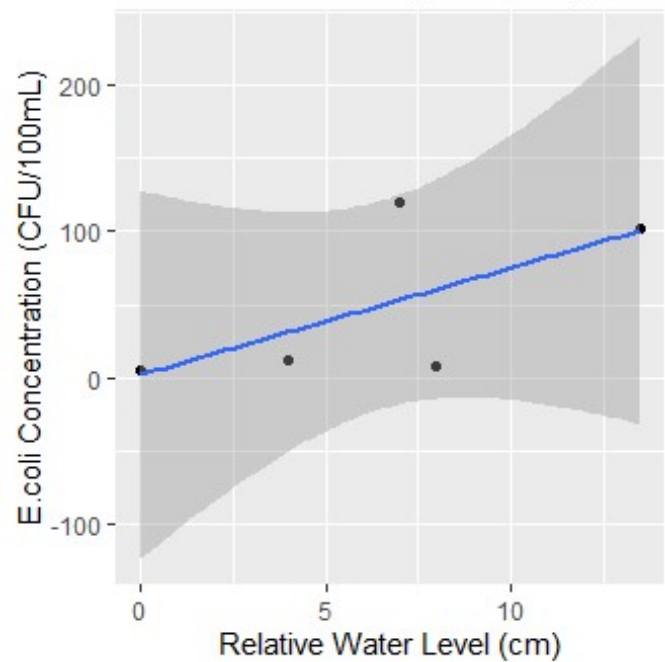
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Coldwater R - W Weidman Rd

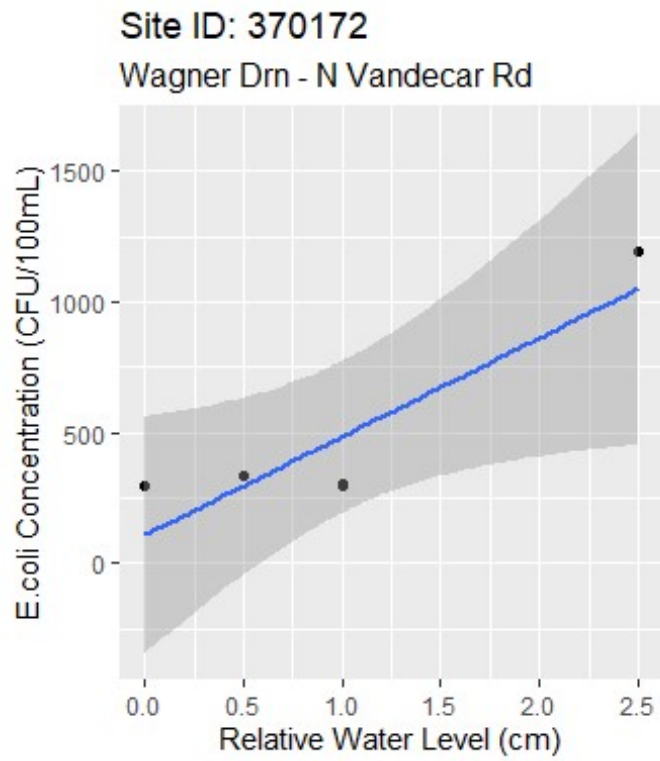


Site ID: 370178

Coldwater R - W Bridge St (West)



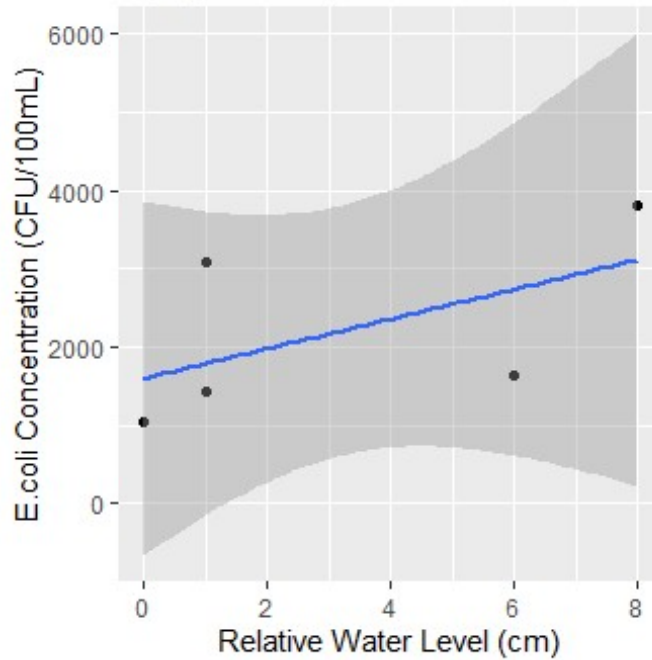
Appendix 6. (continued)



Shiawassee (HUC 04080203)

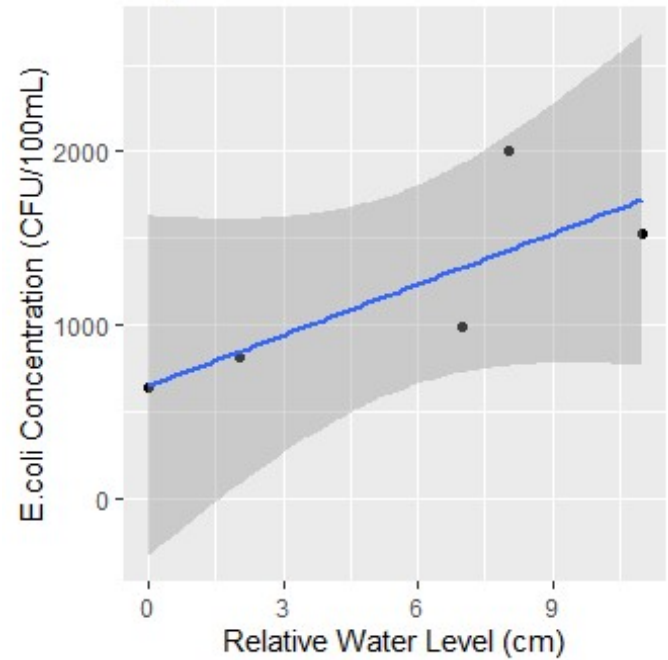
Site ID: 470677

Sprague Cr - Byron Rd



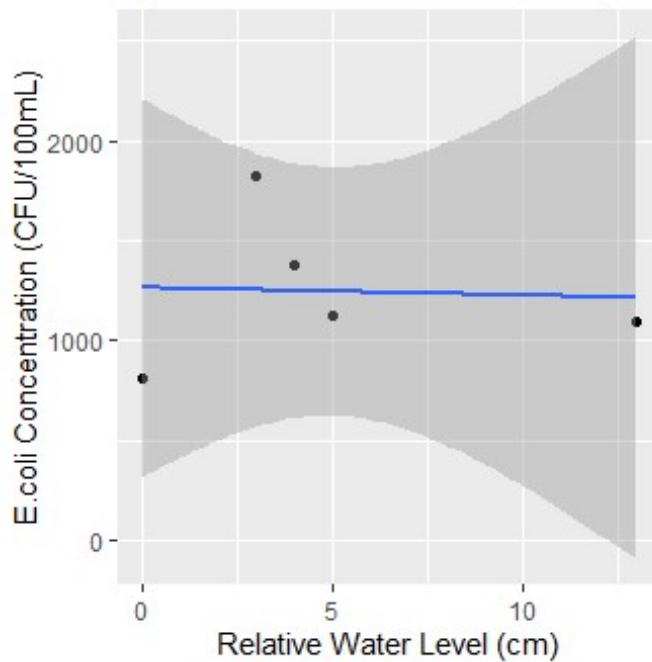
Site ID: 470643

Bogue Cr - Marr Rd



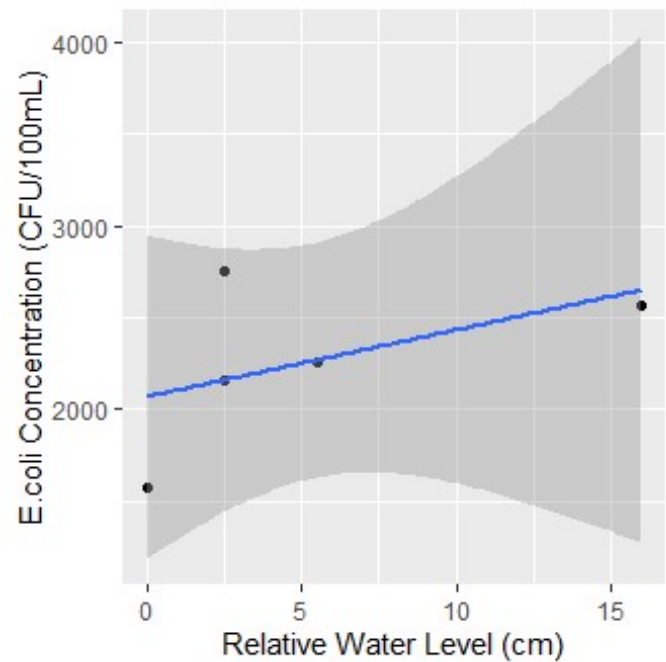
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Aginaw Lake Drn - Reed Rd (North)



Site ID: 780201

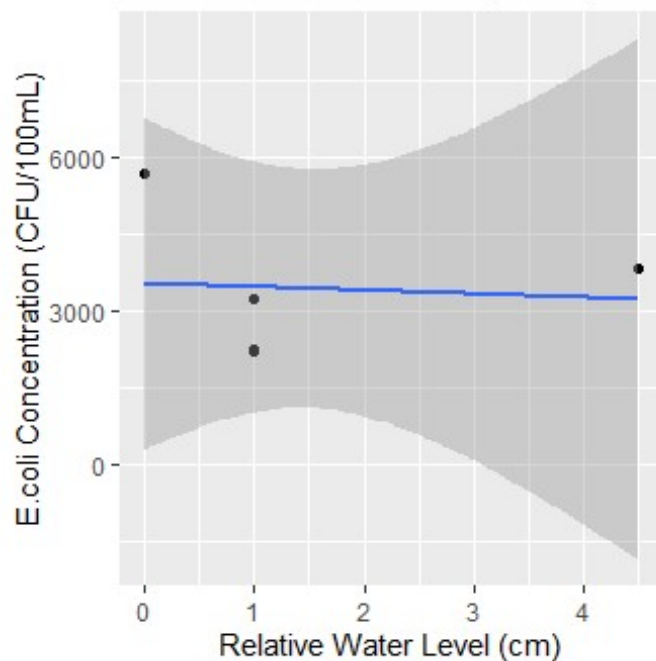
Rowley Cr - Bath Rd



Appendix 6. (continued)

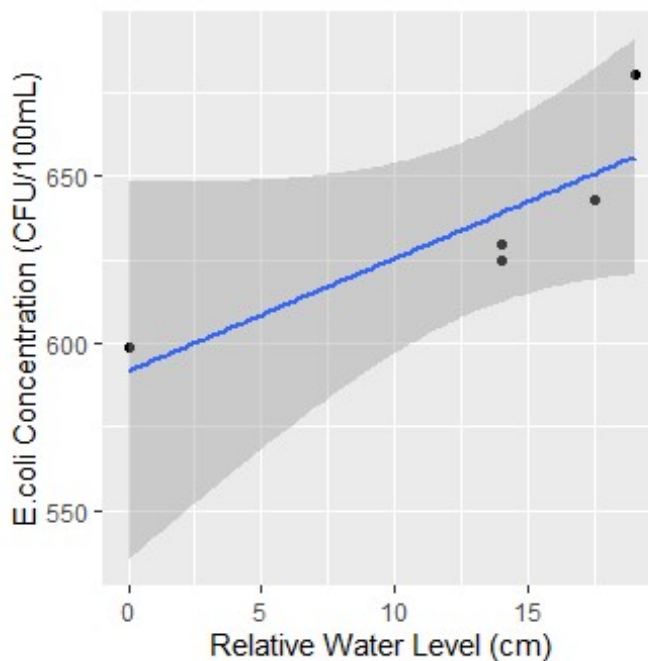
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Euler Lake Drn - Reed Rd (South)



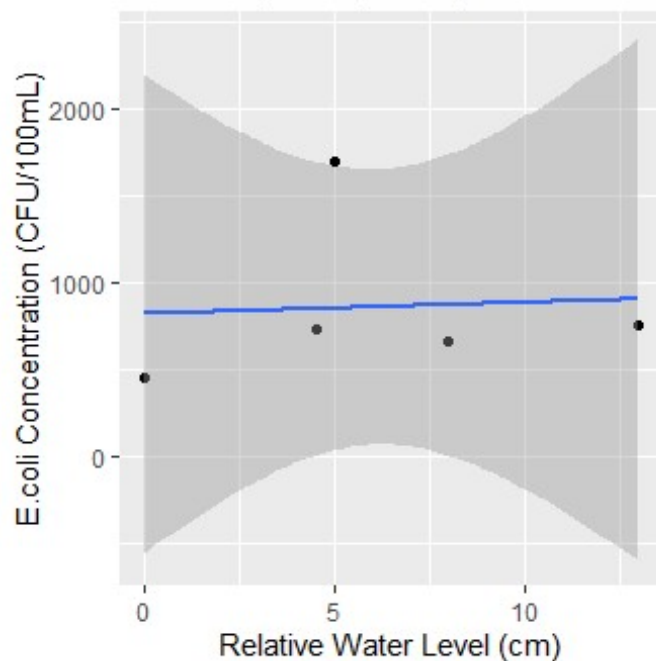
Site ID: 470680

N Ore Cr - Cullen Rd



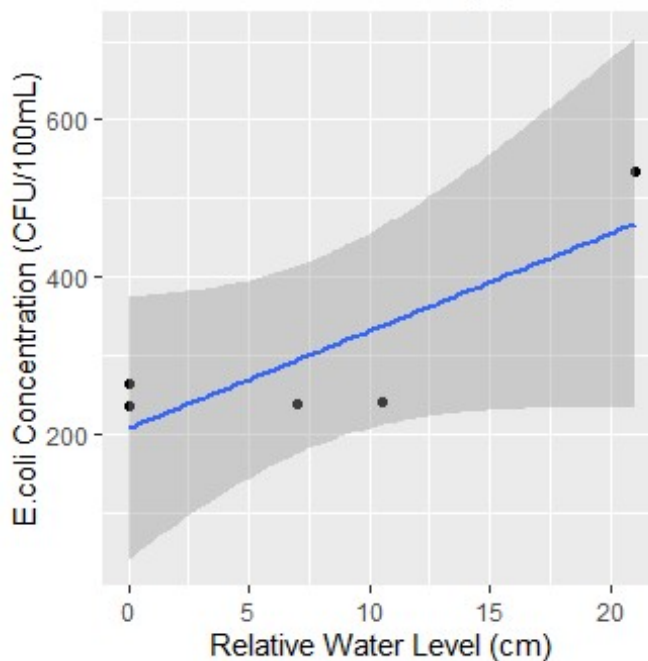
Site ID: 470678

N Ore Cr (Trib to) - E Clyde Rd



Site ID: 470663

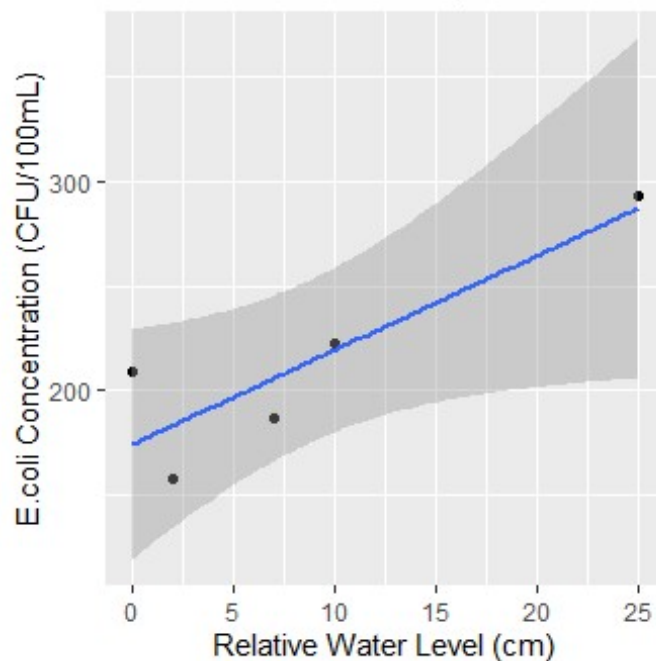
S Br Shiawassee R - Lovejoy Rd



Appendix 6. (continued)

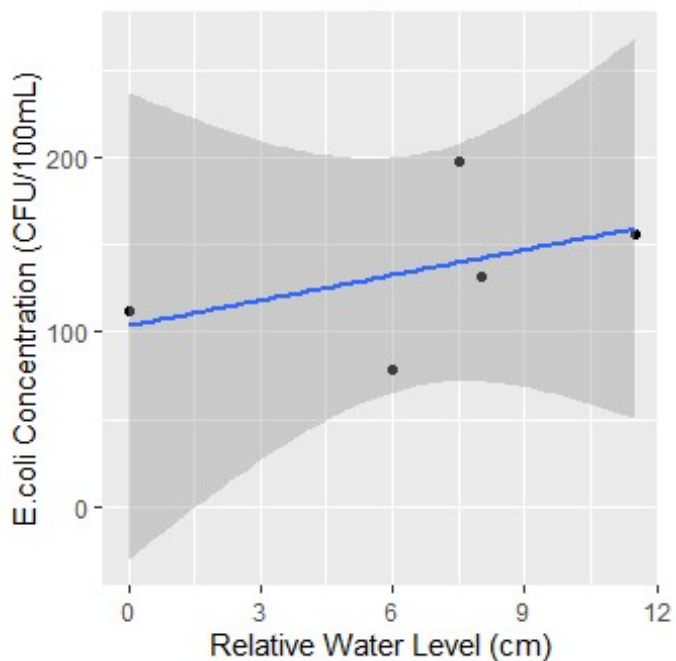
Site ID: 780136

S Br Shiawassee R - S Byron Rd



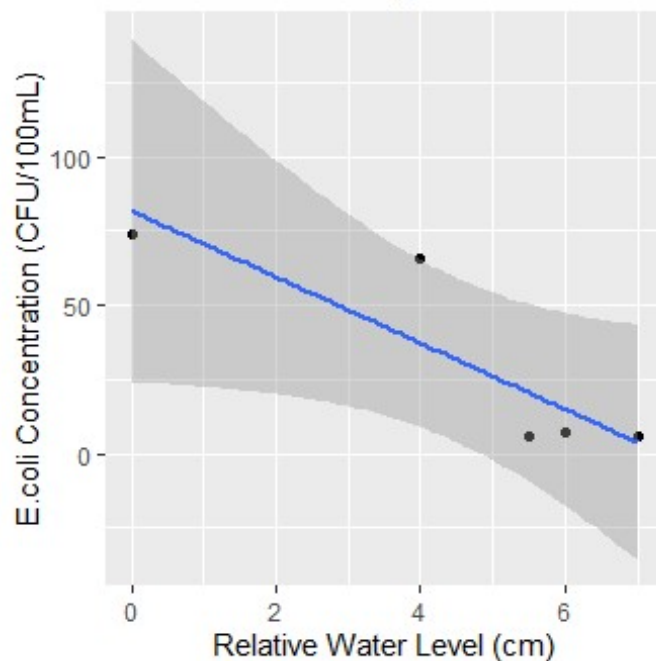
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Shiawassee R - Legrande St



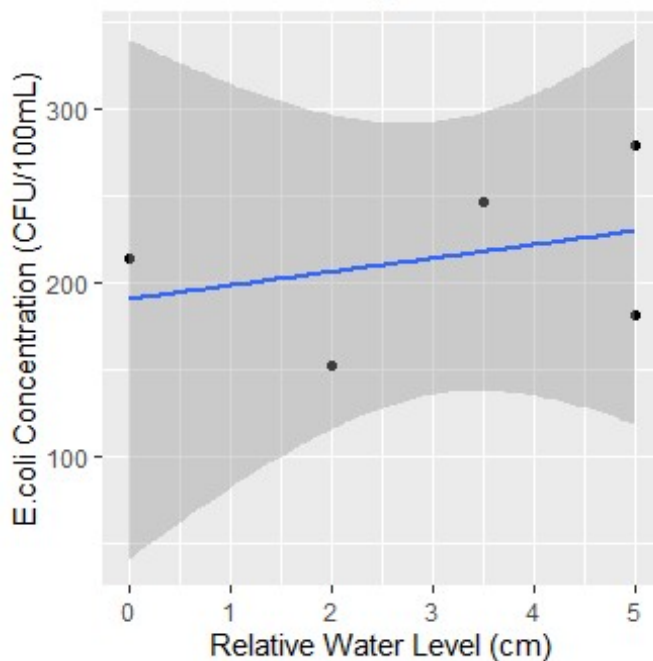
Site ID: 250113

Shiawassee R - Bridge St



Site ID: 250462

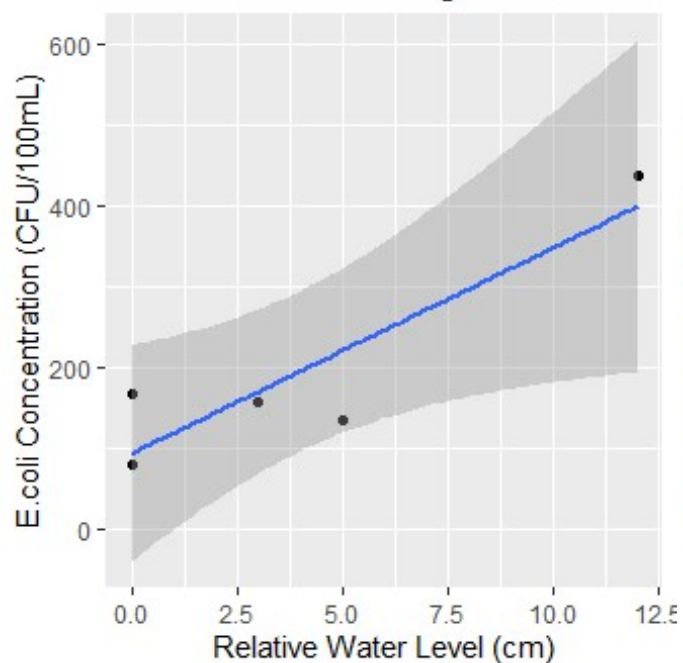
Shiawassee R - Hogan Rd



Appendix 6. (continued)

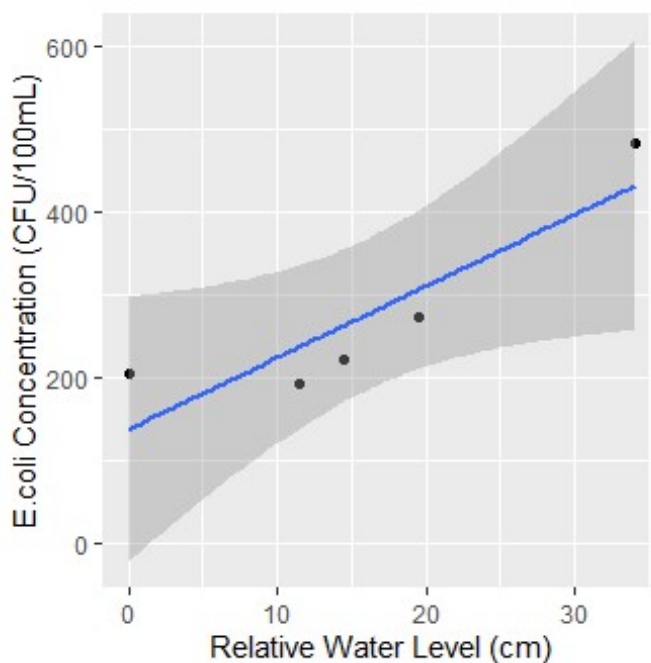
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Shiawassee R - Exchange Rd



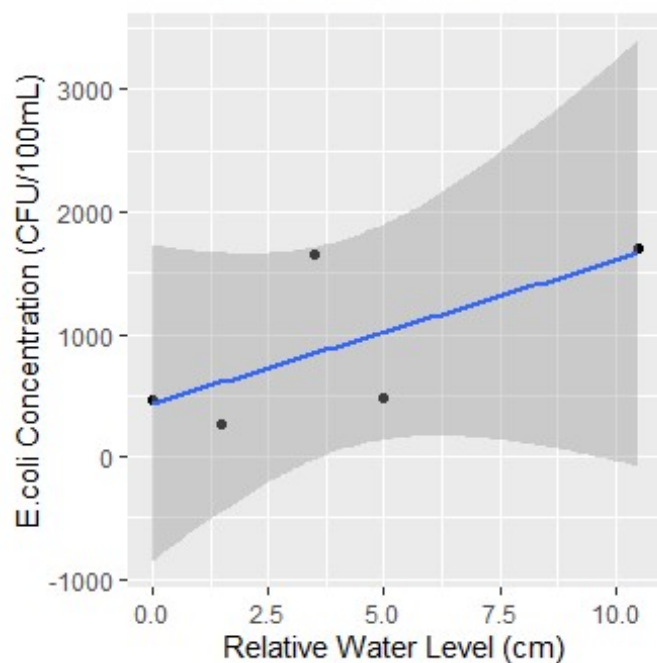
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Shiawassee R - Meier Rd

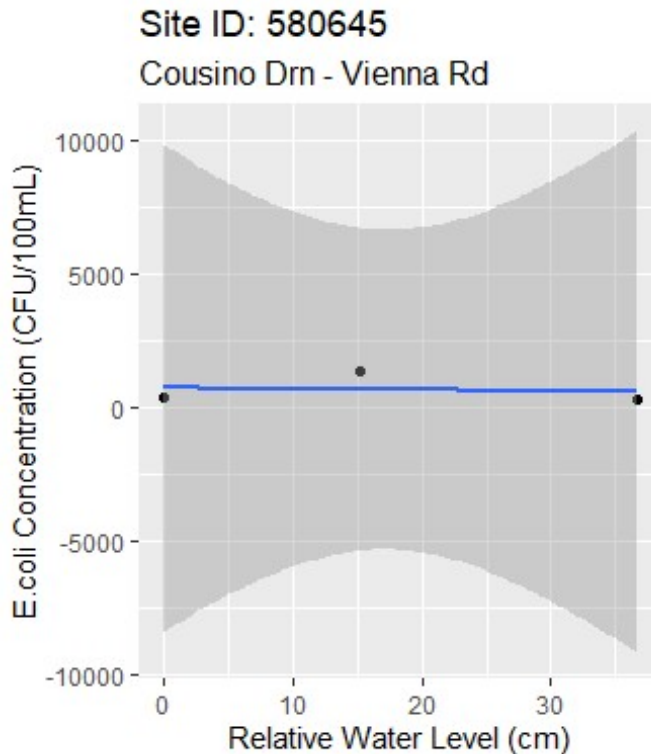
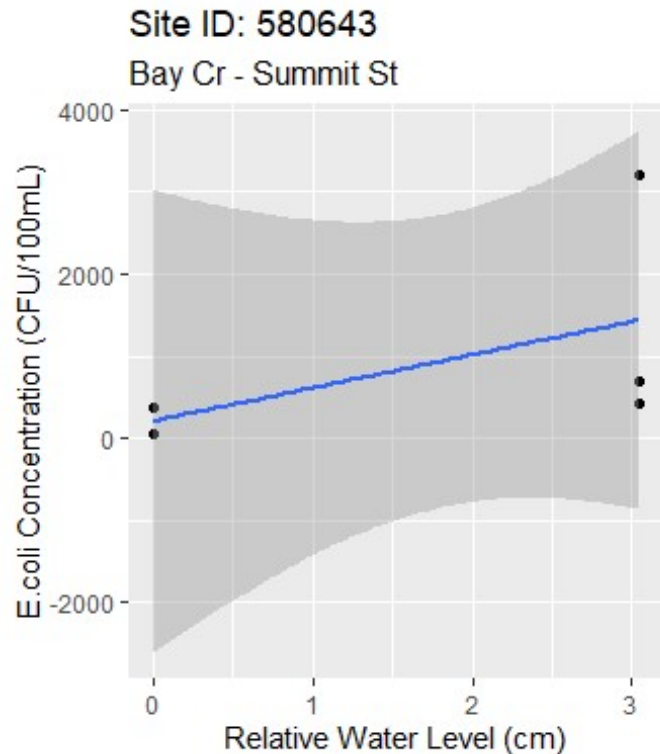
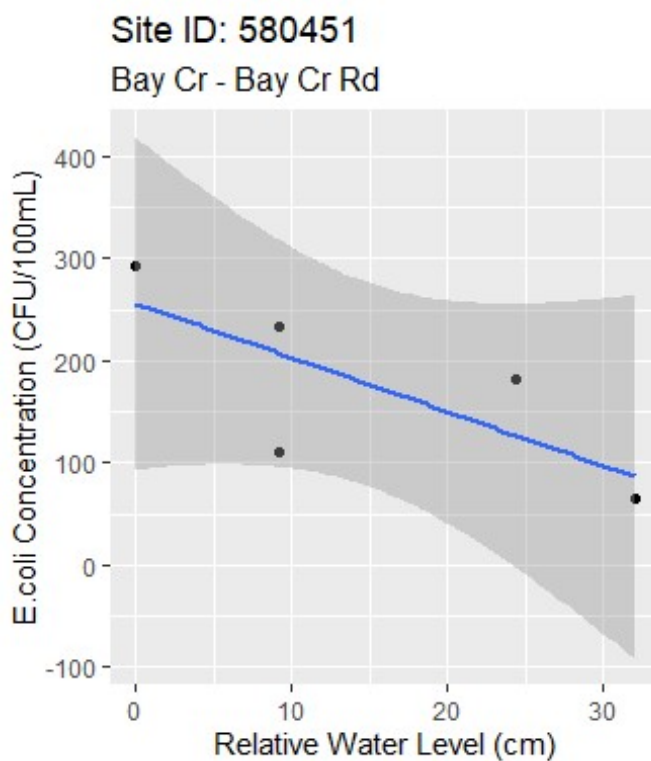
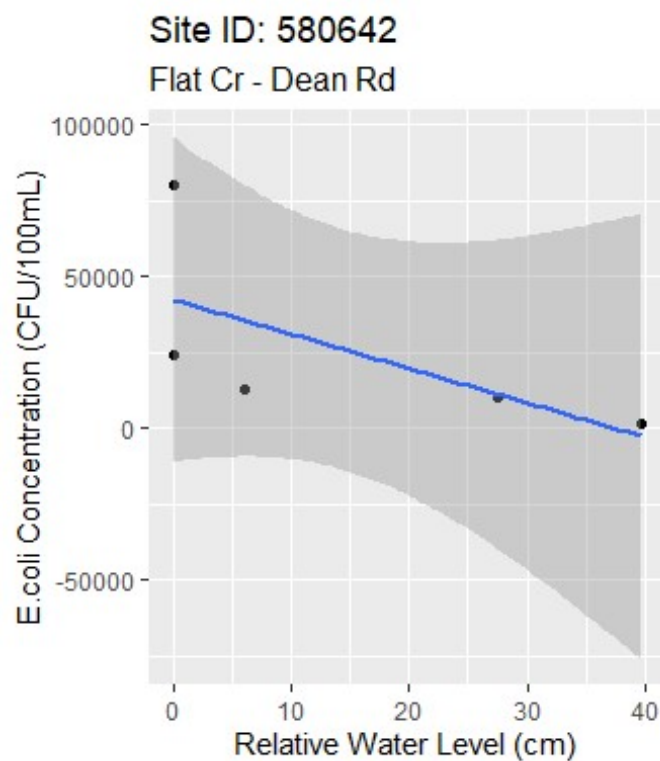


Site ID: 780095

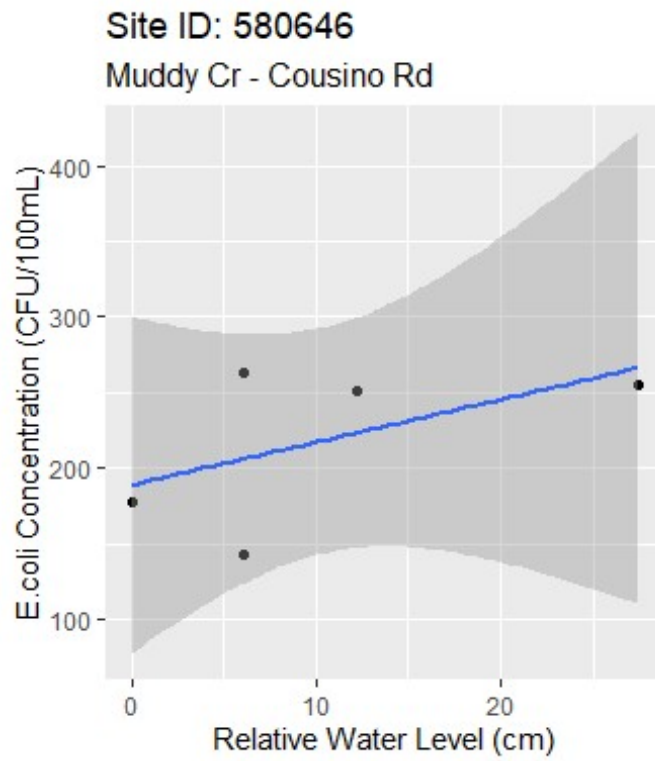
Webb Drn - S Vernon Rd



Ottawa-Stony (HUC 04100001)



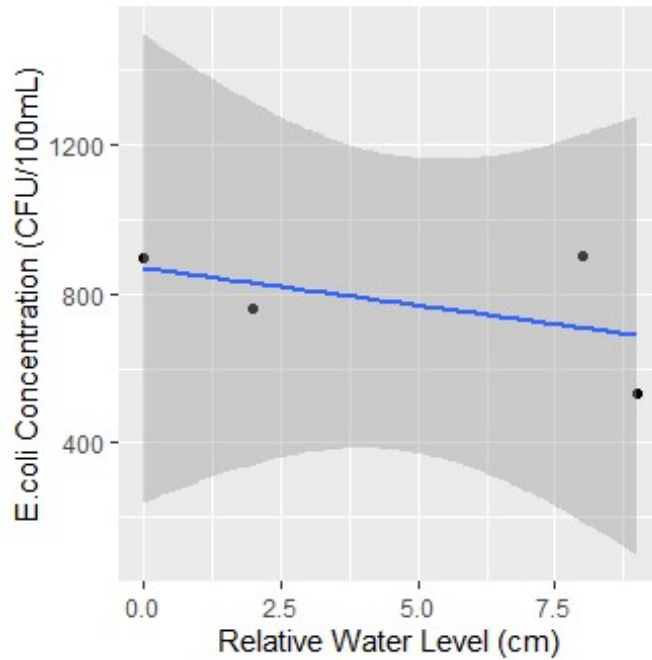
Appendix 6. (continued)



St. Joseph (East - (HUC 040100003))

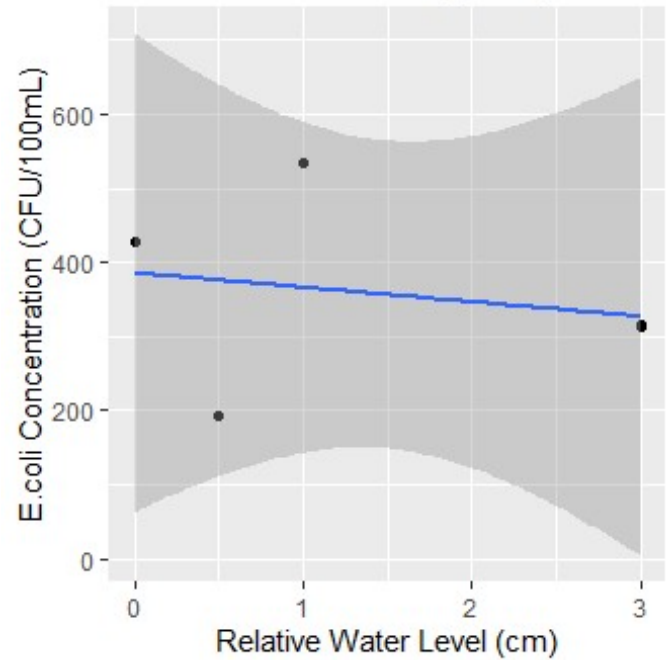
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E Fork W Br St Joseph R - Austin Rd



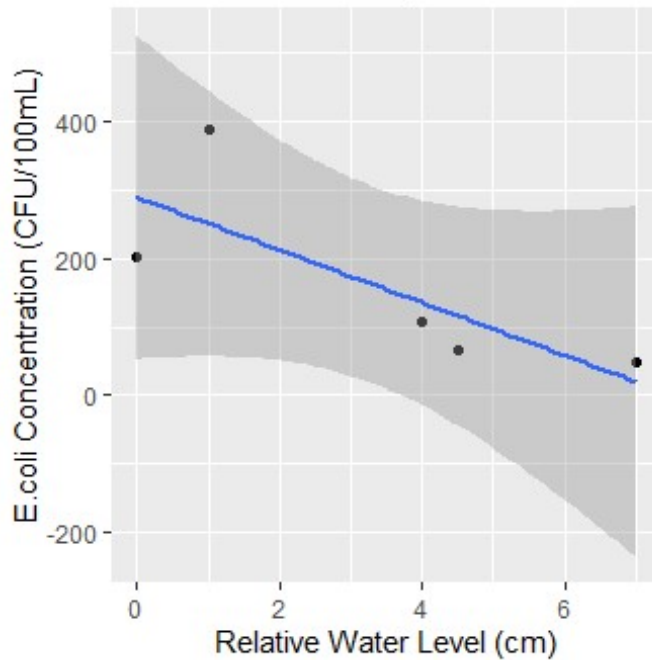
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Carruthers Drn - W Montgomery Rd



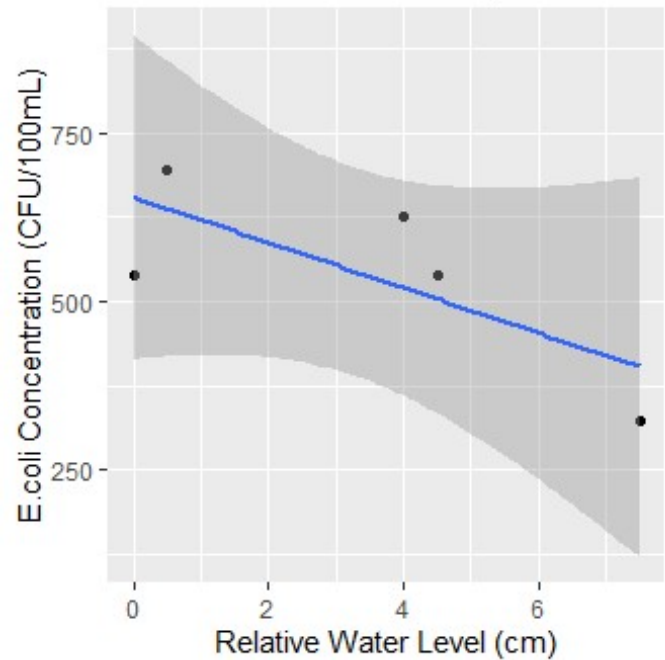
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E Fork W Br St Joseph R - Card Rd



Site ID: 300322

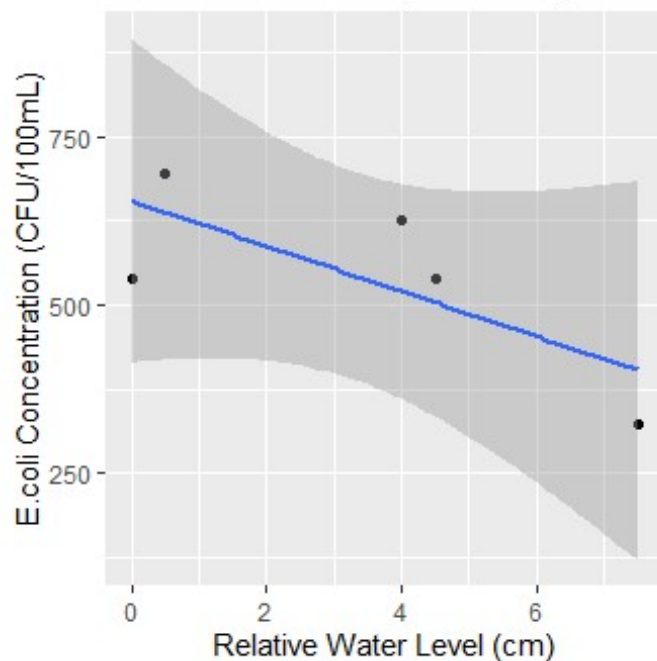
Trib to E Fork W Br St Joseph R - Camdk



Appendix 6. (continued)

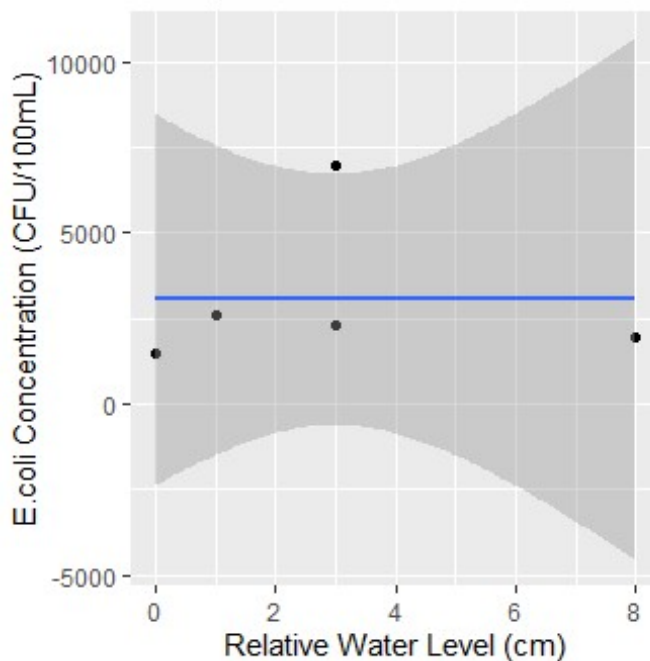
Site ID: 300318

W Fork W Br St Joseph R - Sampson Rd



Site ID: 300214

Prouty Drn - Brott Rd



Site ID: 300312

Trib to E Fork W Br St Joseph R - Austi

