

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
MAY 2016

STAFF REPORT

BACTERIAL MONITORING RESULTS FOR
MICHIGAN RIVERS AND STREAMS
2015

1 Introduction

Samples were collected from 28 sites on rivers and streams throughout the Lower Peninsula of Michigan, and 2 sites on Planter Creek in the Upper Peninsula (Figure 1). Samples from these sites were analyzed for *E. coli* on a weekly basis, for 5-8 weeks, and results are shown in Appendix 1. General water chemistry samples were collected from the site on Schnable Brook on 4 occasions, in addition to the 5 weekly *E. coli* sample events (Table 2). Site locations are described in Table 1 and shown in detail in Figures 2-8.

1.1 Monitoring Objectives

1. **Assess the current status and condition of individual waters of the state and determine whether the Total Body Contact (TBC) Designated Use is being met.**
Michigan is committed to assessing the waters of the state to determine the attainment status of the designated uses.
2. **Obtain data for preliminary pollution source assessment.**

1.2 *E. coli* Water Quality Standard (WQS)

Michigan's designated use rule (Rule 100 [R 323.1100] of the Part 4 Rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended) states that all water bodies shall be protected for TBC recreation from May 1 through October 31 and Partial Body Contact (PBC) recreation year-round. 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, and 1,000 *E. coli* per 100 mL as a daily maximum year-round to protect the PBC use.

1.3 Interpretation of *E. coli* 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 (such as in a lake or impoundment), dying off 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. 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 1 are color-coded to indicate TBC and PBC exceedances.

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

Wet weather exceedances indicate that the source is flushed during precipitation events, such as urban or rural storm water, runoff from agricultural fields or pastures, or illicit sanitary connections to storm drains or field tiles, accumulated waste (animal or human) in storm drains, or pet or wildlife waste on lawns or parks.

2 Sampling Methods

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, right, and center. The center sample is collected in the spatial center of the stream, the right sample is collected midway between the center and the right bank, and the left sample is collected midway between the center location and the left bank. 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, using a sampling pole. We avoided the surface microlayer of water and bottom sediment layer, both of which may be enriched in bacteria and not representative of the water column. Samples were not collected if the flow of the stream had become stagnant throughout the width of the channel. Appropriate personal protective equipment, including latex gloves, was worn during the sampling process. Gloves were replaced after sample collection at each location.

For *E. coli*, a field blank was collected every 20 samples by filling a sample bottle with factory sealed bottled drinking water. Duplicates were collected at a rate of 10 percent (one duplicate every 10 samples). Duplicates were taken by collecting a larger volume of sample and pouring alternately into the sample bottle and the duplicate bottle. A minimum of 1 duplicate and 1 blank were collected per sampling trip for each parameter measured. Samples were submitted to the Michigan Department of Environmental Quality (MDEQ), Environmental Laboratory. Chain of custody was maintained at all times and hold times were met.

For general chemistry water analysis at Schnable Brook, a duplicate and a blank were collected on each sampling event and samples were submitted to the MDEQ, Environmental Laboratory.

Blanks for general chemistry samples are deionized water preserved in the same manner as samples.

Precipitation data for the 24 hours and 48 hours prior to each sampling event are recorded in Appendix 1, and were obtained from nearby weather stations (Michigan State University Extension, 2015; Weather Underground, 2015).

3 Quality Control

3.1 Goals

The quality assurance and quality control for sampling are as follows:

- *E. coli* - The results of duplicate analyses should be used to calculate a relative percent difference (RPD) between the samples. The target for the RPD was ≤ 25 percent, and data falling outside of this RPD was flagged; however, *E. coli* is a highly variable parameter and data should not be discarded based solely on a high RPD. If both the sample and the duplicate fall within 0-299 *E. coli* per 100 mL (attainment with the TBC WQS), or conversely, both samples are more than 300 *E. coli* per 100 mL (nonattainment with the TBC WQS), then the data are considered acceptable. When the RPD is > 25 percent, and the samples indicate a split between attainment and nonattainment, then the sampling event represented by duplicate set would be deemed questionable.
- *General Chemistry* – The results of duplicate analyses should be used to calculate an RPD between the samples. The target for the RPD should be ≤ 25 percent, and data falling outside of this RPD should be flagged.

3.2 Quality Control Results

All but 1 *E. coli* sample met the quality control targets. The July 16, 2015, sample at Site 300324 (Lime Lake inlet) produced results of 980 *E. coli* per 100 mL, while the duplicate produced results of 10 *E. coli* per 100 mL. The cause of this error is unknown, but it is suspected that the duplicate may have been a mislabeled blank. The sample result of 980 is in line with the other samples collected that day (900 and 1010 *E. coli* per 100 mL) at that site, so the result was included in the daily geometric mean calculation. All blanks for *E. coli* contained less than 10 *E. coli* per 100 mL (reporting level).

For general chemistry water analysis at Schnable Brook, the target of 25 percent RPD was met for all samples and duplicates. On June 29, 2015, bottled drinking water was inadvertently used as the blank and the results of the blank analysis reflected that issue. The duplicates met RPD targets on that date, and this was corrected by using deionized water on the remainder of sampling dates. On August 14, total suspended solids were detected in the blank at low levels (5 milligrams per liter [mg/L]) close to the detection level (Table 2). This is a minor contamination issue and does not affect the validity of the results.

4 Conclusions

E. coli - Most of the sampled water bodies, with the notable exceptions of Fawn River at Kime Road and Planters Creek at Bingo Road, exceeded either (or both) the daily maximum or 30-day geometric mean TBC WQS, at least once (Appendix 1).

The vast majority of sites exceeded the TBC WQS during both wet and dry weather; however, there were exceptions. Sites that exceeded the daily TBC WQS only following rainfall were Beebe Creek and the mainstem Shiawassee at Lytle Road and Juddville Road. This is not surprising for a large river such as the Shiawassee, but it is remarkable to find this occurring in a small drain, such as Beebe Creek.

The South Branch Shiawassee River at Byron Road exceeded only the 30-day geometric mean TBC WQS, and not the daily maximum TBC WQS, indicating fairly good water quality when compared with other sites in this study. On August 3, 2015, when all other Shiawassee River watershed sites exceeded the PBC WQS, *E. coli* at the South Branch Shiawassee River site was slightly elevated, but did not exceed the daily maximum TBC WQS. It is possible that the main pulse of contaminated storm water, which was seen at the other Shiawassee River sites, was not captured in the sampling at the South Branch Shiawassee River at Byron Road due to timing of the sampling in relation to the storm event. More sampling would be needed to determine if this site also has a wet weather *E. coli* problem.

Among the Shiawassee River sites, and among all sites sampled in this study, Kanouse Lake Drain at East Bath Road is the only one to exceed the PBC WQS on every sampling event (wet or dry weather). This indicates a serious and persistent contamination issue due to illicit connections, failing septs, or livestock with direct access to the water. Bay Creek, in the Ottawa-Stony River watershed, exceeded the PBC WQS on 4 of 5 dates and on the remaining date, it was close to exceeding.

General Chemistry - The range of total phosphorus and ammonia found in reference streams in the Southern Michigan Northern Indiana Till Plain (SMNITP) ecoregion, in a 1992-1993 MDEQ study, was 0.012-0.28 mg P/L and 0.004-0.2 mg ammonia N/L (Lundgren, 1994). In that same study, the mean concentration of total phosphorus for the ecoregion was 0.058 mg/L, and the mean of total ammonia for the ecoregion was 0.042 mg/L. The total phosphorus in Schnable Brook (Site ID 030504) was within the expected range. Total ammonia, however, was nearly double the maximum of the reference range on August 17, 2015 (Table 2). Phosphorus was also elevated on that date compared to other sampling dates, despite the lack of rainfall within the prior 2 days.

As part of Michigan's Water Chemistry Monitoring Program (WCMP), 250 randomly located sites on inland tributaries were monitored for general water chemistry parameters. Median values of total ammonia collected in the years 2005-2009 as part of the WCMP were between .007-0.14 mg/L (Roush, 2013). The Schnable Brook August 17 sample (0.41 mg/L) was well above that range. The value of total ammonia cannot be compared to the unionized portion of ammonia, which is the most toxic to aquatic life and is the basis of Michigan WQS.

Total nitrogen is the sum of Kjeldahl nitrogen, nitrate, and nitrite. Median total nitrogen from the WCMP monitoring (2005-2009) was 0.22-3.2 mg/L. The highest Schnable Brook total nitrogen sample (3.01 mg/L) was collected on September 9, 2015, and was barely within the upper range of WCMP results.

All other chemistry parameters were within the expected reference ranges for the SMNITP ecoregion (Lundgren, 1994).

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5 References

Lundgren, R. (1994). Reference Site Monitoring Report for 1992 and 1993. (Sites in Crawford, Benzie, Hillsdale, Kalamazoo, Livingston, Iosco, Grand Traverse, Kalkaska, Kent, Jackson and Barry Counties). m. D. o. E. Quality.

Michigan State University Extension (2015). "Michigan Enviro-Weather." Retrieved October 6, 2015, 2015, from <http://www.enviro-weather.msu.edu/>.

Roush, K. D. (2013). Michigan's Water Chemistry Monitoring Program: A Report of Statewide Spatial Patterns 2005-2009 and Fixed Station Status and Trends 1998-2008. REVISED FEBRUARY 22, 2013.

Weather Underground (2015). <<http://www.wunderground.com>> KMIIRONW3 Ironwood MI US. Retrieved November 17, 2015, 2015.

Table 1. Site location information.

Watershed	Site ID	Site Description	Latitude	Longitude
Black-Presque Isle	270137	Planter Creek @ Bingo/Wertanen Rd. (PC-2)	46.49897	-89.92780
Black-Presque Isle	270223	Planter Creek @ Thomaston Rd. (PC-4)	46.50740	-89.93480
St. Joseph	750293	Bear Creek at Flach Rd	42.06448	-85.48096
St. Joseph	300274	Beebe Creek @ Hoxie Rd.	41.95631	-84.50132
St. Joseph	750334	Fawn River at Kime Rd	41.77596	-85.35946
St. Joseph	750335	Felker Drain at Moorepark Road	42.01307	-85.57827
St. Joseph	130303	Nottawa Creek at u/s 4 Mile Rd	42.09516	-85.21612
St. Joseph	130357	Pine Creek at u/s South R Drive	42.11063	-85.25264
St. Joseph	120229	South Branch Hog Creek at Marshall Rd.	42.03560	-85.00109
St. Joseph	120208	Tallahassee Creek at Fisher Rd.	41.88380	-84.88568
St. Joseph	120239	Trib to Cold Creek at Marshall St	41.97696	-85.00365
Black-Macatawa	700564	Pigeon River at 120th St	42.93288	-86.08197
Black-Macatawa	030557	South Branch Black River at Russcher	42.72980	-86.05486
Black-Macatawa	700664	South Branch Macatawa River at 46th	42.76976	-86.00021
Kalamazoo	030504	Schnable Brook at M89 Street	42.49890	-85.76010
Shiawassee	780201	Kanouse Lake Drain @ E. Bath Rd.	42.82286	-84.00066
Shiawassee	470508	Ore Creek @ Hogan Rd.	42.75042	-83.80476
Shiawassee	470115	S. Branch Shiawassee River @ Byron Rd.	42.72800	-83.96846
Shiawassee	780017	Shiawassee River @ Juddville Rd.	43.05670	-84.18109
Shiawassee	780066	Shiawassee River @ Lytle Rd.	42.97683	-84.07227
Shiawassee	250461	Shiawassee River @ Torrey Rd.	42.81491	-83.72554
Shiawassee	780067	Thompson Lake Inlet @ Lakeshore Pointe Rd.	42.98820	-84.09283
Shiawassee	470503	Yellow River Drain @ Lovejoy Rd.	42.78152	-83.88734
Ottawa-Stony	580451	Bay Creek @ Bay Creek Rd.	41.78962	-83.47209
Ottawa-Stony	580546	Halfway Creek @ Consear Rd.	41.77079	-83.65768
Ottawa-Stony	580595	Halfway Creek @ Dixie Hwy.	41.73353	-83.52984
Ottawa-Stony	580403	Otter Creek @ Dixie Hwy.	41.86678	-83.45271
Ottawa-Stony	580557	Plum Creek @ Kentucky Ave.	41.90248	-83.39303
Tiffin	300234	Lime Lake Inlet @ Lime Lake Rd.	41.78940	-84.37651
Tiffin	300291	Lime Lake Outlet @ US127	41.77892	-84.36154

Table 2. General water chemistry results from Schnable Brook (Site 030504).

Analyte	Units	Detection Level	Sampling Date			
			6/29/2015	7/30/2015	8/17/2015	9/9/2015
Ammonia	mg/L	0.01	0.04	0.01	0.41	0.03
Chemical Oxygen Demand	mg/L	5	24	15	23	16
Kjeldahl Nitrogen	mg/L	0.1	0.75	0.4	1.2	0.71
Nitrate/Nitrite	mg/L	0.01	1.1	1	1.2	2.3
Total Nitrogen (calculated)	mg/L		1.85	1.4	2.4	3.01
Ortho Phosphate	mg/L	0.01	0.014	0.014	0.13	0.071
Total Organic Carbon	mg/L	0.5	7.9	5.6	7.3	7.4
Total Phosphorus	mg/L	0.01	0.065	0.032	0.18	0.11
Total Suspended Solids	mg/L	4	48	4	11	22
Hardness - Calculated	mg/L	4.6	230	260	280	290
Calcium	mg/L	1	59	67	72	73
Magnesium	mg/L	0.5	20	23	26	26

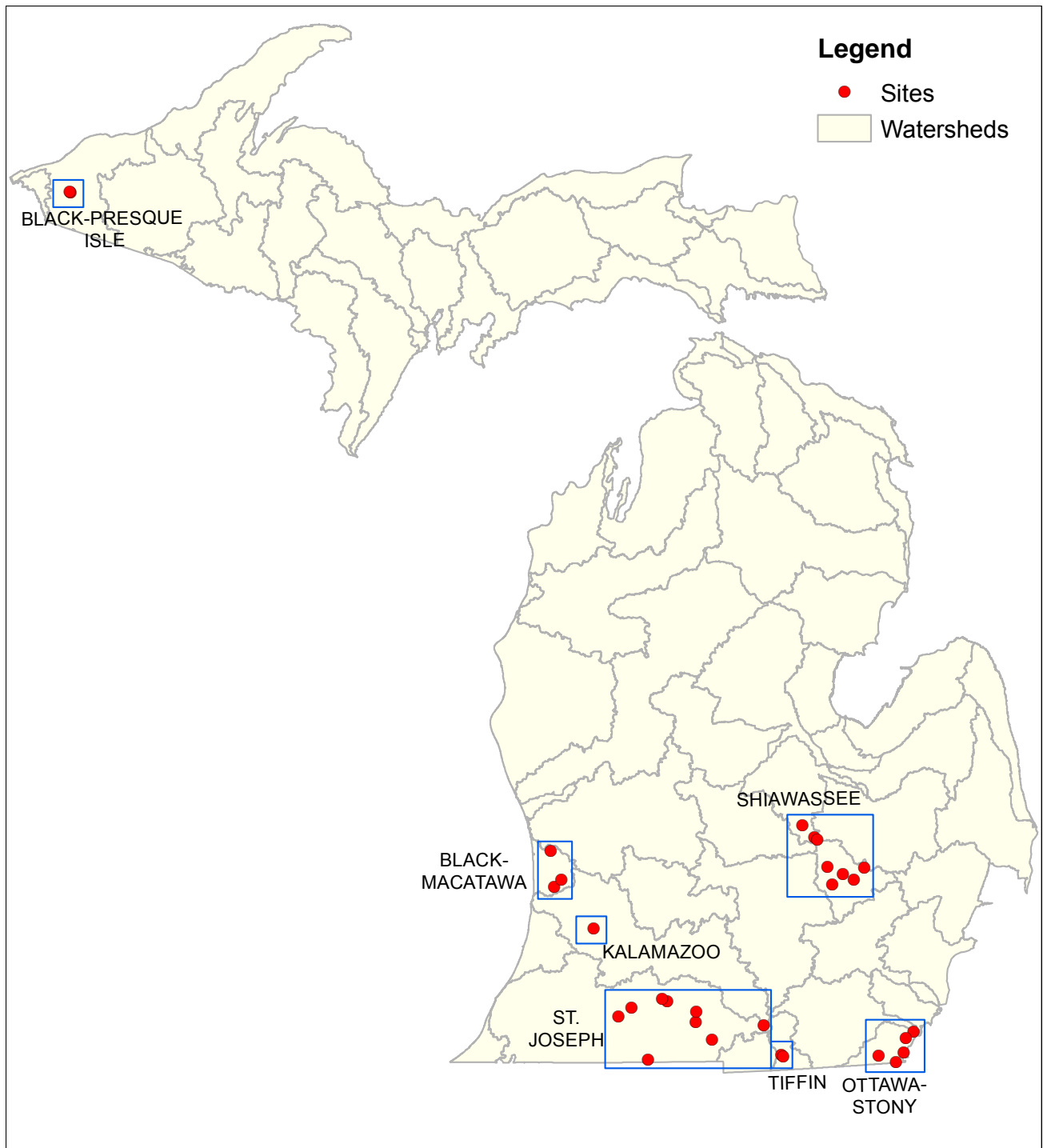


Figure 1. Locations of sites sampled in 2015 for *E. coli*. Detailed maps can be found in Figures 2-8.

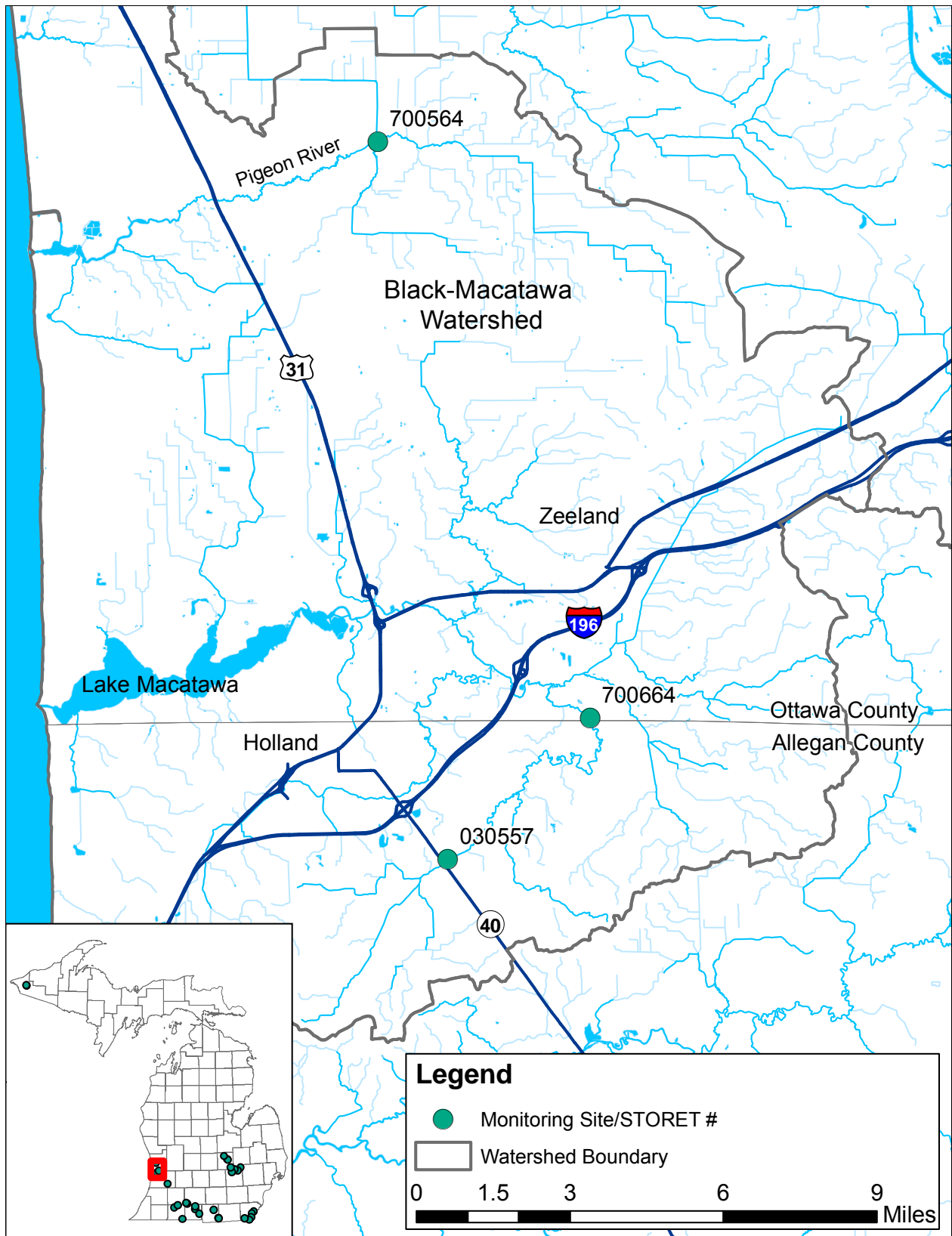


Figure 2. Black-Macatawa site locations.

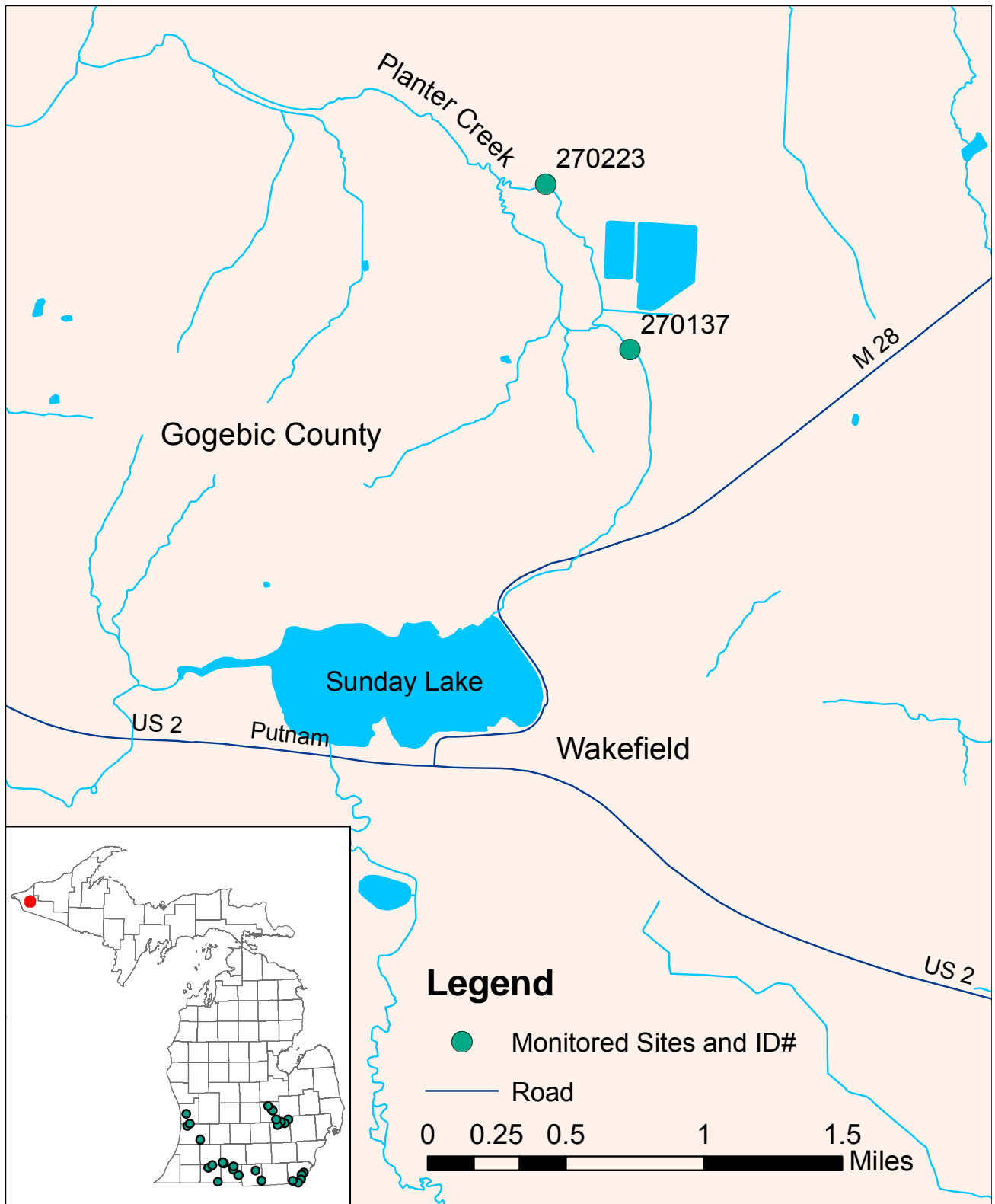


Figure 3. Black-Presque Isle site locations.

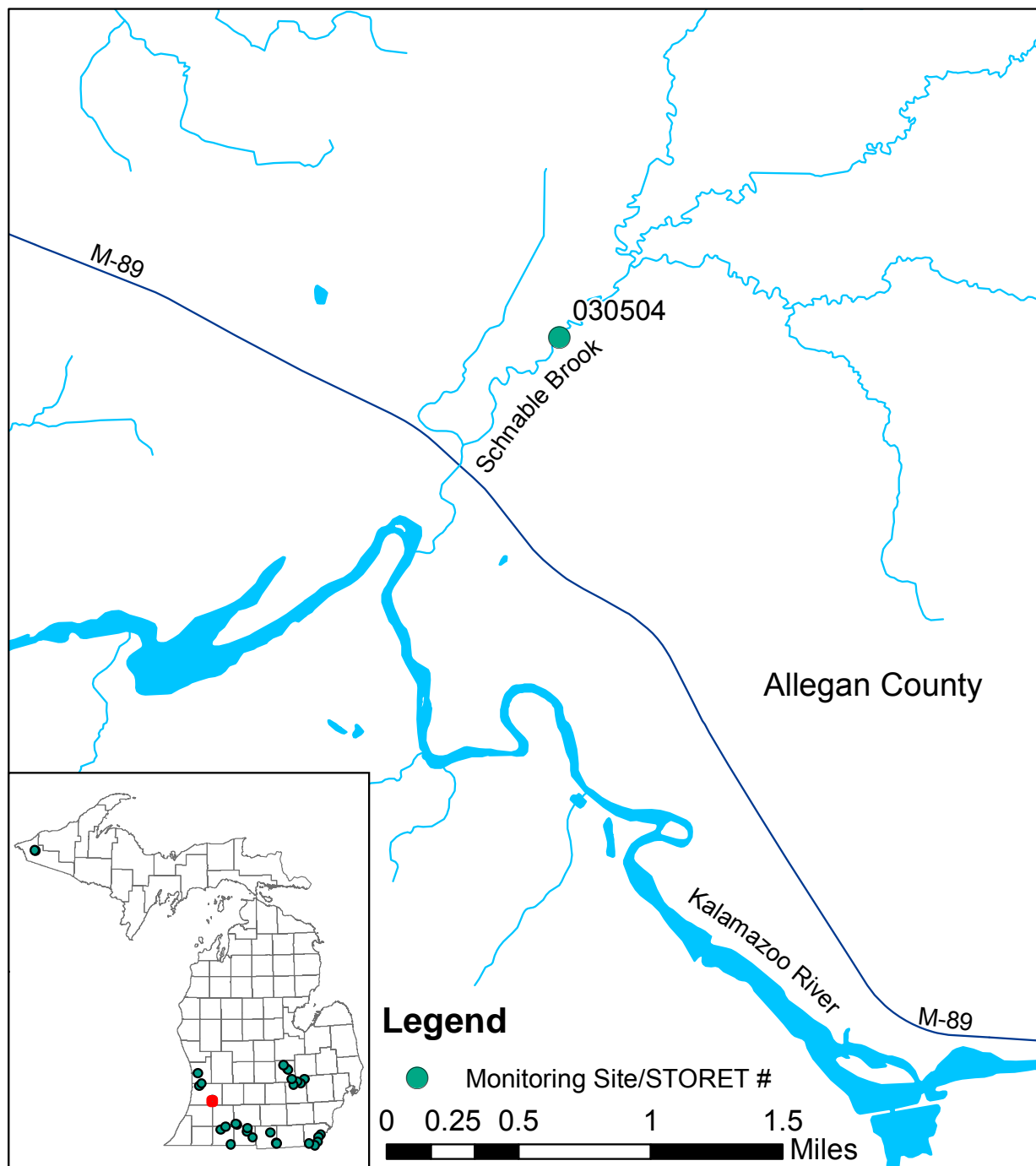


Figure 4. Kalamazoo site locations.

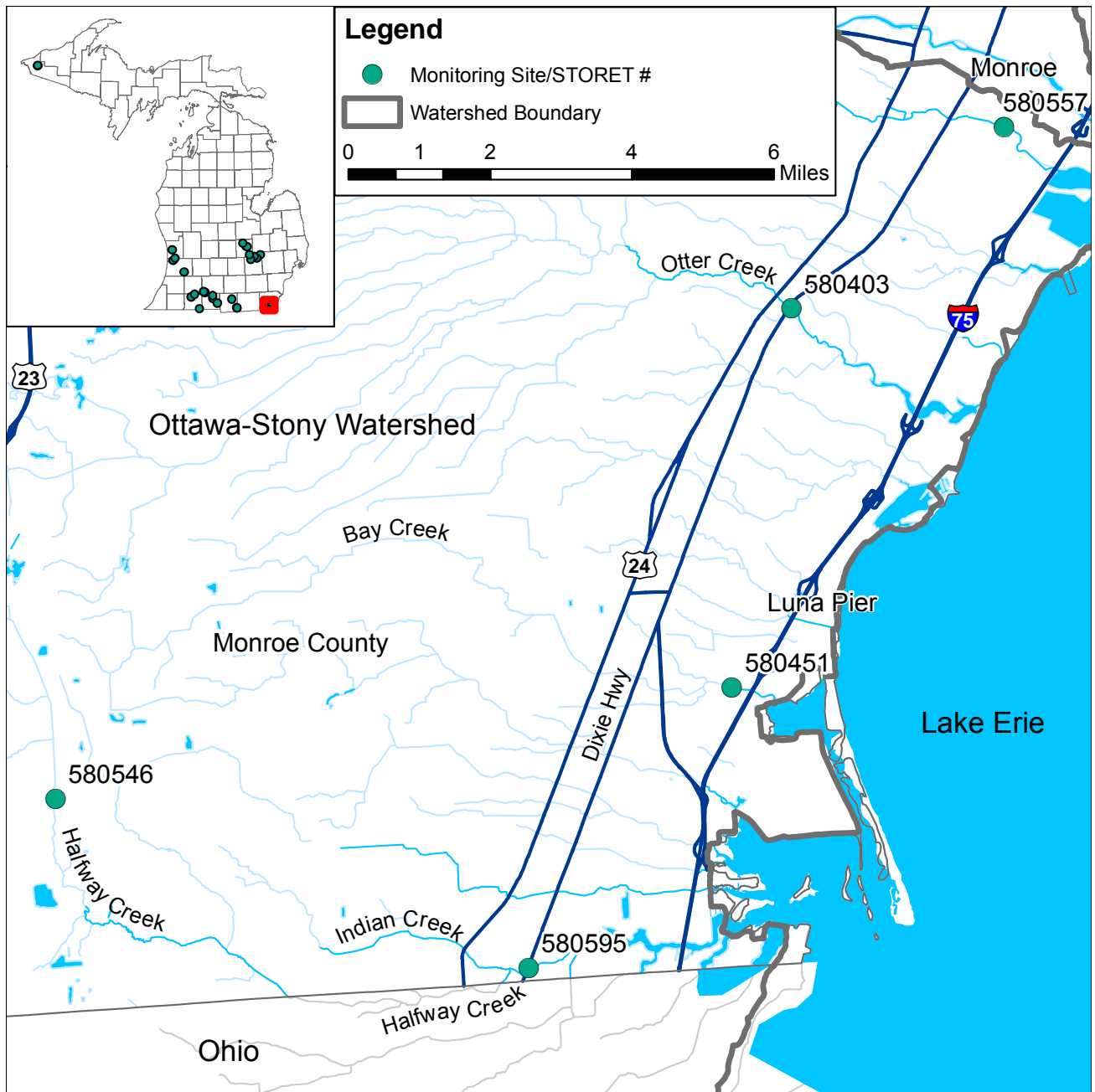


Figure 5. Ottawa-Stony site locations.

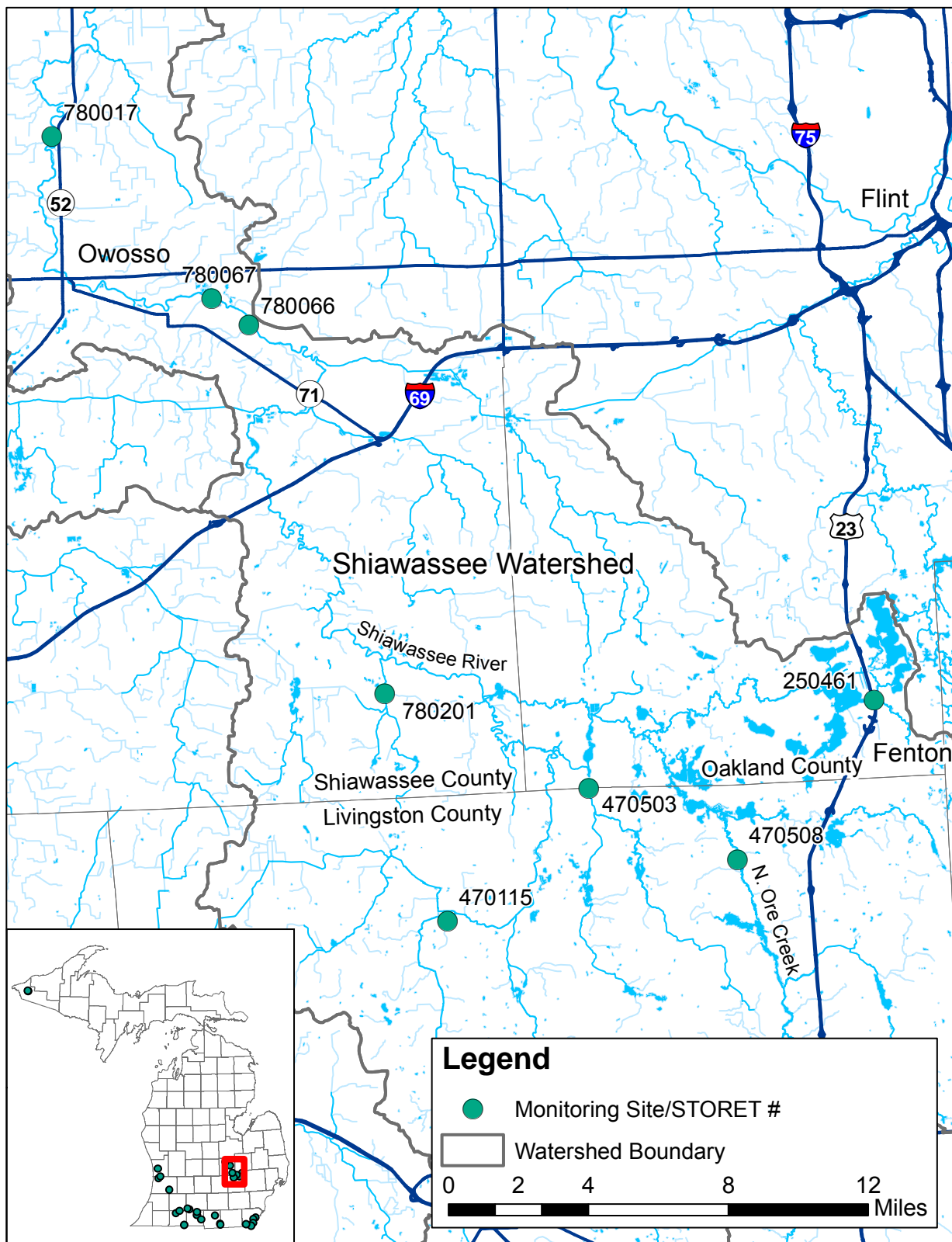


Figure 6. Shiawassee site locations.

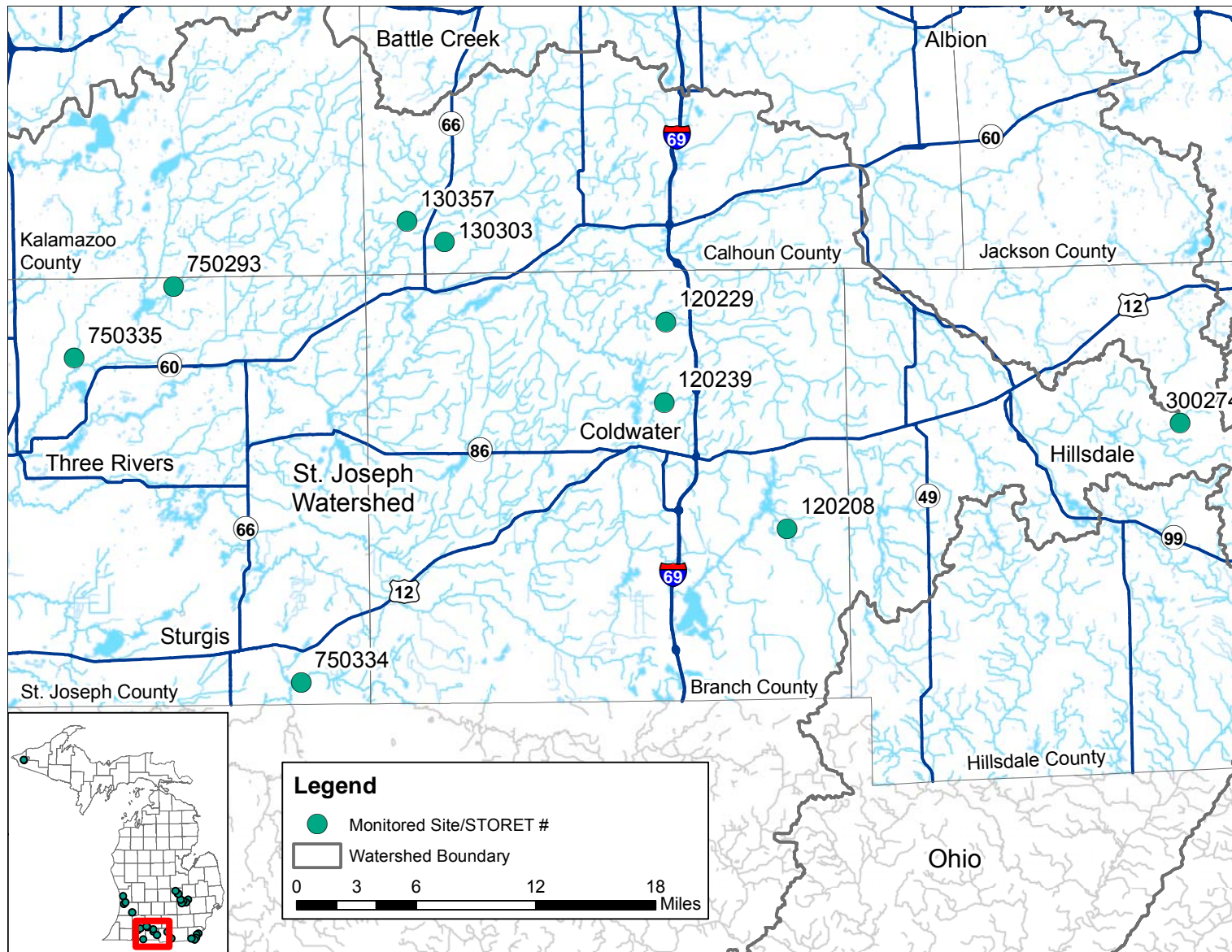


Figure 7. St. Joseph site locations.

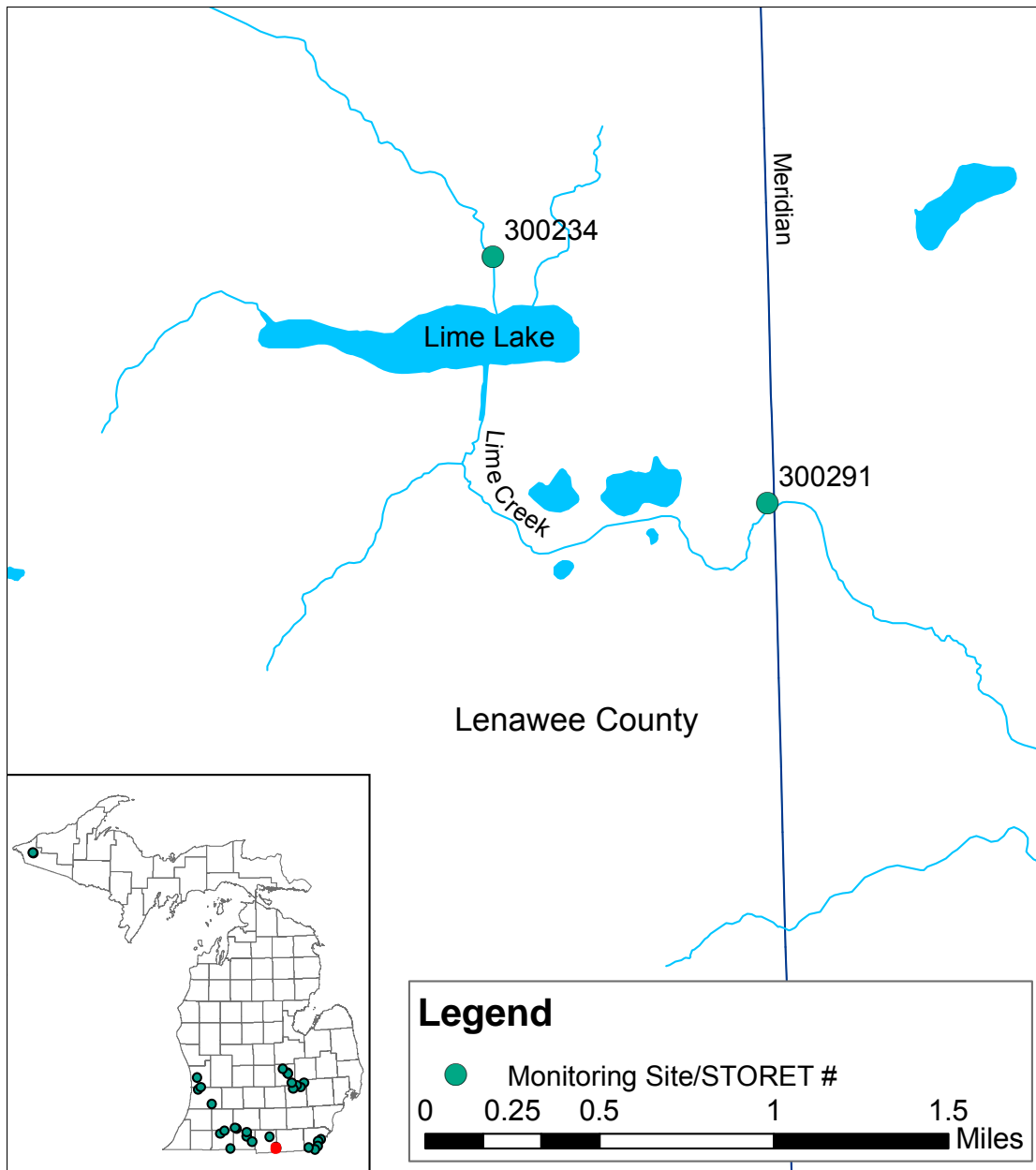


Figure 8. Tiffin site locations.

Appendix 1. Monitoring Results by Watershed.

8 Digit Hydrologic Unit Code:

04020101

Watershed Name:

Black-Presque Isle

Site ID/STORET:	270137	Weather Station:	Ironwood		
Planter Creek @ Bingo/Wertanen Rd. (PC-2)	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation	
7/8/2015	15		0.00	1.23	
7/14/2015	8		0.91	0.91	
7/21/2015	23		0.00	0.00	
7/29/2015	35		0.00	0.00	
8/4/2015	163	28	0.10	0.12	
8/13/2015	38	33	0.00	0.01	
8/17/2015	52	48	0.00	0.00	
8/24/2015	176	73	0.41	0.41	

Site ID/STORET:	270223	Weather Station:	Ironwood		
Planter Creek @ Thomaston Rd. (PC-4)	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation	
7/8/2015	18		0.00	1.23	
7/14/2015	69		0.91	0.91	
7/21/2015	391		0.00	0.00	
7/29/2015	268		0.00	0.00	
8/4/2015	163	116	0.10	0.12	
8/13/2015	91	161	0.00	0.01	
8/17/2015	672	254	0.00	0.00	
8/24/2015	180	217	0.41	0.41	

Appendix 1. Monitoring Results by Watershed.

8 Digit Hydrologic Unit Code:

04050001

Watershed Name:

St. Joseph

Site ID/STORET:	750293	Weather Station:	Mendon		
Bear Creek at Flach Rd	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation	
8/31/2015	214		0.00	0.25	
9/10/2015	272		0.00	0.01	
9/14/2015	413		0.00	0.00	
9/21/2015	306		0.00	0.01	
9/28/2015	232	280	0.00	0.00	

Site ID/STORET:	300274	Weather Station:	Hudson		
Beebe Creek @ Hoxie Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation	
7/9/2015	29,262		0.97	1.05	
7/16/2015	220		0.00	0.00	
7/23/2015	116		0.00	0.00	
7/30/2015	308		0.52	0.52	
8/6/2015	104	474	0.00	0.00	

Site ID/STORET:	750334	Weather Station:	Mendon		
Fawn River at Kime Rd	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation	
8/31/2015	145		0.00	0.25	
9/10/2015	111		0.00	0.01	
9/14/2015	81		0.00	0.00	
9/21/2015	106		0.00	0.01	
9/28/2015	266	130	0.00	0.00	
10/29/2015	135		0.36	0.76	

Appendix 1. Monitoring Results by Watershed.

Site ID/STORET:	750335	Weather Station:	Mendon	
Felker Drain at Moorepark Road	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
8/31/2015	356		0.00	0.25
9/10/2015	894		0.00	0.01
9/14/2015	1,045		0.00	0.00
9/21/2015	675		0.00	0.01
9/28/2015	1,370	790	0.00	0.00
Site ID/STORET:	130303	Weather Station:	Ceresco	
Nottawa Creek at u/s 4 Mile Rd	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
8/31/2015	133		0.00	0.40
9/10/2015	586		0.00	0.08
9/14/2015	250		0.00	0.00
9/21/2015	462		0.00	0.08
9/28/2015	795	373	0.00	0.00
Site ID/STORET:	130357	Weather Station:	Ceresco	
Pine Creek at u/s South R Drive	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
8/31/2015	572		0.00	0.40
9/10/2015	934		0.00	0.08
9/14/2015	531		0.00	0.00
9/21/2015	466		0.00	0.08
9/28/2015	463	698	0.00	0.00

Appendix 1. Monitoring Results by Watershed.

Site ID/STORET:	120229	Weather Station:	Coldwater	
South Branch Hog Creek at Marshall Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
8/31/2015	421		0.00	0.09
9/10/2015	743		0.00	0.03
9/14/2015	270		0.00	0.00
9/21/2015	2,056		0.00	0.00
9/28/2015	652	647	0.00	0.00
Site ID/STORET:	120208	Weather Station:	Coldwater	
Tallahassee Creek at Fisher Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
8/31/2015	583		0.00	0.09
9/10/2015	623		0.00	0.03
9/14/2015	870		0.00	0.00
9/21/2015	1,032		0.00	0.01
9/28/2015	496	695	0.00	0.00
Site ID/STORET:	120239	Weather Station:	Coldwater	
Trib to Cold Creek at Marshall St	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
8/31/2015	638		0.00	0.09
9/10/2015	266		0.00	0.03
9/14/2015	329		0.00	0.00
9/21/2015	567		0.00	0.01
9/28/2015	183	357	0.00	0.00

Appendix 1. Monitoring Results by Watershed.

8 Digit Hydrologic Unit Code:

04050002

Watershed Name:

Black-Macatawa

Site ID/STORET:	700564	Weather Station:	West Olive	
Pigeon River at 120th St	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
6/15/2015	20,448		0.07	0.44
6/22/2015	919		0.00	0.00
6/29/2015	803		0.00	0.00
7/6/2015	1,023		0.00	0.00
7/13/2015	13,821	2923	0.41	0.41

Site ID/STORET:	030557	Weather Station:	Fennville	
South Branch Black River at Russcher	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
6/15/2015	3,550		0.11	1.30
6/22/2015	1,120		0.00	0.00
6/29/2015	533		0.00	0.00
7/6/2015	667		0.00	0.00
7/13/2015	43,256	2276	1.37	1.37

Site ID/STORET:	700664	Weather Station:	Hudsonville	
South Branch Macatawa River at 46th	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
6/15/2015	795		0.12	0.86
6/22/2015	911		0.00	0.00
6/29/2015	917		0.00	0.00
7/6/2015	1,334		0.00	0.00
7/13/2015	12,198	1610	0.17	0.17

Appendix 1. Monitoring Results by Watershed.

8 Digit Hydrologic Unit Code: 04050003

Watershed Name: Kalamazoo

Site ID/STORET:	030504	Weather Station:	Kalamazoo	
Schnable Brook at M89 Street	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/30/2015	473		0.02	0.02
8/3/2015	2,025		0.95	0.95
8/11/2015	1,132		0.76	0.77
8/17/2015	367		0.00	0.00
8/25/2015	880	811	0.00	0.73

Appendix 1. Monitoring Results by Watershed.

8 Digit Hydrologic Unit Code:

04080203

Watershed Name:

Shiawassee

Site ID/STORET:	780201	Weather Station:	Flint		
Kanouse Lake Drain @ E. Bath Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation	
7/20/2015	1,721		0.00	0.01	
7/27/2015	2,803		0.00	0.06	
8/3/2015	4,430		1.20	1.20	
8/10/2015	3,712		0.11	0.11	
8/17/2015	3,414	3114	0.00	0.00	

Site ID/STORET:	470508	Weather Station:	Commerce Twp		
Ore Creek @ Hogan Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation	
7/20/2015	185		0.00	0.00	
7/27/2015	279		0.00	0.00	
8/3/2015	1,608		1.19	1.19	
8/10/2015	492		0.00	0.02	
8/17/2015	422	442	0.00	0.00	

Site ID/STORET:	470115	Weather Station:	Commerce Twp		
S. Branch Shiawassee River @ Byron Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation	
7/20/2015	176		0.00	0.00	
7/27/2015	114		0.00	0.00	
8/3/2015	239		1.19	1.19	
8/10/2015	140		0.00	0.02	
8/17/2015	195	167	0.00	0.00	

Appendix 1. Monitoring Results by Watershed.

Site ID/STORET:	780017	Weather Station:	Ithaca	
Shiawassee River @ Juddville Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/20/2015	159		0.00	0.04
7/27/2015	121		0.00	0.00
8/3/2015	1,522		0.81	0.81
8/10/2015	279		0.19	0.19
8/17/2015	112	249	0.00	0.00
Site ID/STORET:	780066	Weather Station:	Flint	
Shiawassee River @ Lytle Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/20/2015	213		0.00	0.01
7/27/2015	206		0.00	0.06
8/3/2015	1,651		1.20	1.20
8/10/2015	279		0.11	0.11
8/17/2015	223	339	0.00	0.00
Site ID/STORET:	250461	Weather Station:	Flint	
Shiawassee River @ Torrey Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/20/2015	336		0.00	0.01
7/27/2015	281		0.00	0.01
8/3/2015	2,931		1.20	1.20
8/10/2015	581		0.11	0.12
8/17/2015	299	545	0.00	0.00

Appendix 1. Monitoring Results by Watershed.

Site ID/STORET:	780067	Weather Station:	Flint	
Thompson Lake Inlet @ Lakeshore Pointe Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/20/2015	1,993		0.00	0.01
7/27/2015	965		0.00	0.01
8/3/2015	2,632		1.20	1.20
8/10/2015	760		0.11	0.12
8/17/2015	1,411	1403	0.00	0.00
Site ID/STORET:	470503	Weather Station:	Commerce Twp	
Yellow River Drain @ Lovejoy Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/20/2015	710		0.00	0.00
7/27/2015	644		0.00	0.00
8/3/2015	6,911		1.19	1.19
8/10/2015	618		0.00	0.02
8/17/2015	643	1047	0.00	0.00

Appendix 1. Monitoring Results by Watershed.

8 Digit Hydrologic Unit Code: 04100001
Watershed Name: Ottawa-Stony

Site ID/STORET:	580451	Weather Station:	Petersburg	
Bay Creek @ Bay Creek Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/9/2015	16,241		0.76	1.03
7/16/2015	1,011		0.00	0.21
7/23/2015	1,189		0.00	0.00
7/30/2015	1,230		0.49	0.49
8/6/2015	842	1825	0.00	0.00

Site ID/STORET:	580546	Weather Station:	Petersburg	
Halfway Creek @ Consear Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/9/2015	8,243		0.81	1.08
7/16/2015	230		0.00	0.20
7/23/2015	511		0.00	0.00
7/30/2015	1,945		0.49	0.49
8/6/2015	560	1010	0.00	0.00

Site ID/STORET:	580595	Weather Station:	Petersburg	
Halfway Creek @ Dixie Hwy.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/9/2015	12,658		0.76	1.03
7/16/2015	705		0.00	0.20
7/23/2015	1,232		0.00	0.00
7/30/2015	908		0.49	0.49
8/6/2015	549	1406	0.00	0.00

Appendix 1. Monitoring Results by Watershed.

Site ID/STORET:	580403	Weather Station:	Petersburg	
Otter Creek @ Dixie Hwy.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/9/2015	19,218		0.76	1.03
7/16/2015	769		0.00	0.21
7/23/2015	540		0.00	0.00
7/30/2015	687		0.49	0.49
8/6/2015	343	1135	0.00	0.00

Site ID/STORET:	580557	Weather Station:	Petersburg	
Plum Creek @ Kentucky Ave.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/9/2015	12,493		0.57	0.84
7/16/2015	820		0.00	0.21
7/23/2015	745		0.00	0.00
7/30/2015	2,006		0.49	0.49
8/6/2015	853	1672	0.00	0.00

Appendix 1. Monitoring Results by Watershed.

8 Digit Hydrologic Unit Code:

04100006

Watershed Name:

Tiffin

Site ID/STORET:	300234	Weather Station:	Hudson	
Lime Lake Inlet @ Lime Lake Rd.	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/9/2015	17,235		0.96	1.04
7/16/2015	962		0.00	0.00
7/23/2015	1,888		0.00	0.00
7/30/2015	6,747		0.52	0.52
8/6/2015	630	2659	0.00	0.00
8/13/2015	1,104	1535	0.00	0.00
8/20/2015	1,072	1568	0.31	0.31
8/27/2015	223	1023	0.00	0.00

Site ID/STORET:	300291	Weather Station:	Hudson	
Lime Lake Outlet @ US127	Daily Geometric Mean	30-Day Geometric Mean	24-Hour Prior Precipitation (inches)	48-Hour Prior Precipitation
7/9/2015	15,940		0.97	1.05
7/16/2015	516		0.00	0.00
7/23/2015	224		0.00	0.00
7/30/2015	1,293		0.52	0.52
8/6/2015	705	1110	0.00	0.00
8/13/2015	914	626	0.00	0.00
8/20/2015	1,012	717	0.31	0.31
8/27/2015	450	824	0.00	0.00