Michigan Department of Environmental Quality

Water Division

November 2003

Total Maximum Daily Load for *Escherichia coli* for the Cedar River Gladwin County

INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations [CFR], Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting water quality standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide a basis for determining the pollutant reductions necessary from both point and nonpoint sources (NPS) to restore and maintain the quality of the water resources. The purpose of this TMDL is to identify the allowable levels of *Escherichia coli* (*E. coli*) that will result in the attainment of the applicable WQS in the Cedar River located in Gladwin County, Michigan.

PROBLEM STATEMENT

This TMDL listing addresses approximately nine miles of the Cedar River in the vicinity of Gladwin. The TMDL reach is on the Section 303(d) list as:

CEDAR RIVER WBID#: **210429A**
County: GLADWIN HUC: 4080201 Size: 9 M
Location: Vicinity of Gladwin; M-61 d/s to Howard Oil Field Road
Problem: **CSO, pathogens (Rule 100).**
TMDL YEAR(s): 2004 RF3RchID: 4080201 37

The Cedar River (Figure 1a and 1b) was placed on the Section 303(d) list due to impairment of recreational uses as indicated by the presence of elevated levels of *E. coli* (Creal and Wuycheck, 2002). Sampling conducted by the Michigan Department of Environmental Quality (MDEQ) in 2002, on the Cedar River in the vicinity of Gladwin indicated exceedances of the WQS at three of six stations (Table 1). Thirty-day geometric mean *E. coli* concentrations in this segment of the river ranged from 25 *E. coli* per 100 milliliters (ml) in September at M-61, to 1,158 *E. coli* per 100 ml in July at the North Park Canoe Launch (Figure 2). Two stations, the North Park Canoe launch and the upstream Gladwin City Park station (CR-4A), exceeded the thirty-day standard during the months of June, July, and August. Monthly geometric mean concentrations greater than 1,000 *E. coli* per 100 ml were observed at the North Park Canoe Launch (CR-2A) for three consecutive weeks in July (Table 1). Daily geometric mean concentrations at these two stations exceeded 3,000 *E. coli* per 100 ml on various sampling events during June and July. Only one exceedance of the thirty-day geometric mean was noted at the downstream Gladwin City Park station (CR-5A). The remaining three stations, M-61, River/Campbell Road, and Howard Road met WQS for the entire sampling season (Table 1).

Two tributaries, the North Park Canoe Launch unnamed tributary (CR-1A) and Farm Drain (CR-6A), were also sampled as part of the 2002 TMDL monitoring. Early season sampling in the Farm Drain indicated slight exceedances of the thirty-day geometric mean; however, dry

conditions prevented consistent sample collection from July to the end of the sampling season (Table 2, Figure 3). The tributary at the North Park Canoe Launch exceeded the thirty-day geometric mean twice throughout the sampling period. One isolated exceedance in July indicated a daily geometric mean concentration of greater than 4,000 *E. coli* per 100 ml (Table 2).

The 2002 Section 303(d) listing for the Cedar River was nine miles in the vicinity of Gladwin from M-61 downstream to Howard Oil Field Road. Based on a review of the listing and the 2002 monitoring data, the listed Cedar River TMDL reach will be modified from Webber Road approximately ten miles downstream to Howard Oil Field Road.

NUMERIC TARGET

The impaired designated use addressed by this TMDL is total body contact recreation. Rule 100 of the Michigan WQS requires that this water body be protected for total body contact recreation from May 1 to October 31. The target levels for this designated use are the ambient *E. coli* standards established in Rule 62 of the WQS as follows:

> R 323.1062 Microorganisms.
>
> Rule 62. (1) All waters of the state protected for total body contact recreation shall not contain more than 130 *Escherichia coli* (*E. coli*) per 100 ml, as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during five or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of three or more samples taken at representative locations within a defined sampling area. At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 ml. Compliance shall be based on the geometric mean of three or more samples taken during the same sampling event at representative locations within a defined sampling area.

In addition, sanitary wastewater discharges have an additional target:

> Rule 62. (3) Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 ml, based on the geometric mean of all of five or more samples taken over a 30-day period, nor more than 400 fecal coliform bacteria per 100 ml, based on the geometric mean of all of three or more samples taken during any period of discharge not to exceed seven days. Other indicators of adequate disinfection may be utilized where approved by the department.

Sanitary wastewater discharges are considered in compliance with the WQS of 130 *E. coli* per 100 ml if their National Pollutant Discharge Elimination System (NPDES) permit limit of 200 fecal coliforms per 100 ml as a monthly average is met. This is assumed because *E. coli* are a subset of fecal coliform (American Public Health Association, 1995). Fecal coliform is substantially higher than *E. coli* (Whitman, 2001) when the wastewater of concern is sewage. It can reasonably be assumed that there are less than 130 *E. coli* per 100 ml in the effluent when the point source discharge is meeting its limit of 200 fecal coliform per 100 ml.

The WQS of 130 *E. coli* per 100 ml as a 30-day geometric mean and 300 *E. coli* per 100 ml as a daily maximum are the target levels for the TMDL reach from May 1 to October 31. The 2002 monitoring data indicated exceedances of WQS at several of the stations sampled.

SOURCE ASSESSMENT

The official listing for the Cedar River was nine miles in the vicinity of Gladwin from M-61 downstream to Howard Oil Field Road. Based on the 2002 data collected, the reach has been

modified as the Cedar River, from Webber Road approximately ten miles downstream to Howard Oil Field Road (Figure 1a and 1b). The Cedar River has moderate flows in this reach (Table 3). The Cedar River watershed covered by this TMDL is located in Gladwin and Clare Counties. Municipalities in the TMDL watershed include Sage Township, Grout Township, Hamilton Township, Buckeye Township, Arthur Township, the city of Gladwin, Gladwin Township, and Sherman Township. Table 4 shows the distribution of land for each municipality.

The primary pathogen sources for this water body are typical of mixed semi-urban and agricultural land uses. Unregulated storm water runoff, illicit connections, and agricultural inputs in the upper watershed are all possible sources of *E. coli* to the Cedar River. Elevated *E. coli* concentrations, particularly at the North Park Canoe Launch, were primarily found during June and July when little to no precipitation was recorded. This time period also coincides with peak recreational use of the river by canoeists. Probable sources in this area include cross connections in the storm sewer system with outlets to the river at the park, illicit discharges from homes in the immediate vicinity of the park, and a lack of appropriate facilities for people recreating in the river. Failing septic systems and/or illicit connections are also a possible source since homes in the vicinity of the park are not served by the city's collection system. Agricultural land uses, particularly unrestricted livestock access in the upper portion of the watershed, may be another contributor of *E. coli* to the Cedar River. The extent of such contributions cannot be made at this time.

Other exceedances found appear to be localized in nature. For example, sampling at the M-61 (CR-3A) crossing indicated WQS were met for the entire sampling season, whereas the next station downstream (Gladwin City Park [CR-4A]) indicated several exceedances of the standard. The remaining station in the park, Station CR-5A, exceeded the thirty-day geometric mean only one time during the sampling season.

There are four permitted point source discharges in the Cedar River TMDL reach - three general storm water permits and one individual permit (Table 5). The Gladwin Wastewater Treatment Plant (WWTP) (MI0023001) is permitted to discharge treated human waste. The remaining three discharges covered under the general storm water permit are not expected to contain treated or untreated human sewage at levels that contribute to WQS exceedances for *E. coli*.

The city of Gladwin has one Combined Sewer Overflow (CSO). Since the early 1990s, the MDEQ has been working with the city of Gladwin to eliminate overflows to the Cedar River. In 1993, a Director's Final Order of Abatement (Order) (DFO-SW93-002) was issued in response to overflows of untreated sewage. The Order had a construction completion date of June 2002. Failure to meet the Order dates resulted in an Administrative Consent Order (ACO) between the city of Gladwin and the MDEQ in August of 2002 (ACO-SW02-026). Revised project dates require sewer system improvements to be completed on or before June 30, 2005. The city has not had a reported discharge from their CSO since 1998 (City of Gladwin, 1998).

LINKAGE ANALYSIS

Determining the link between the *E. coli* concentrations in the Cedar River and the potential sources is necessary to develop the TMDL. This link provides the basis for estimating the total assimilative capacity of the river and any needed load reductions. For this TMDL, the major loadings of pathogens likely enter the Cedar River by both wet and dry weather sources such as unregulated storm water runoff, illicit connections, and agricultural runoff.

The guiding water quality management principle used to develop the TMDL was that compliance with the numeric pathogen target in the Cedar River depends on the control of *E. coli* from storm water runoff, illicit connections, and to a lesser extent agricultural inputs. If the *E. coli* inputs can be controlled to meet the numeric standards, then total body contact recreation in the Cedar River will be protected.

TMDL DEVELOPMENT

The TMDL represents the maximum loading that can be assimilated by the water body while still achieving WQS. As indicated in the Numeric Target section, the target for this pathogen TMDL is the WQS of 130 *E. coli* per 100 ml. Concurrent with the selection of a numeric concentration endpoint, TMDL development also defines the environmental conditions that will be used when defining allowable levels. Many TMDLs are designed around the concept of a "critical condition." The "critical condition" is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other conditions.

For most pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For *E. coli*, however, mass is not an appropriate measure, and the USEPA allows pathogen TMDLs to be expressed in terms of organism counts (or resulting concentration) (USEPA, 2001). Therefore, this pathogen TMDL is concentration-based consistent with R 323.1062, and the TMDL is equal to the target concentration of 130 *E. coli* per 100 ml as a 30-day geometric mean in all portions of the TMDL reach for each month of the recreational season (May through October). Expressing the TMDL as a concentration equal to the WQS ensures that the WQS will be met under all flow conditions; therefore, defining a critical condition is unnecessary for this TMDL.

ALLOCATIONS

TMDLs are comprised of the sum of individual waste load allocations (WLAs) for point sources, load allocations (LAs) for NPS, and natural background levels. The TMDL must include a margin of safety (MOS), either implicitly within the WLA and/or LA, or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving water body. This definition is denoted conceptually by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

WLAs

There are a total of four permitted point source discharges to the listed reach of the Cedar River. Three of the four permits authorize discharges for general storm water and are not considered a significant source of *E. coli* due to Best Management Practices required in the permit. The remaining permit, the Gladwin WWTP, is authorized to discharge treated human waste via outfall 001 and has a limit for fecal coliform. When the WWTP is meeting its fecal coliform permit limit, it is assumed the WQS for *E. coli* will be met in the discharge. The permit also authorizes a CSO discharge via outfall 003. The WLA for the above permits, including the three storm water permits and CSO discharge will be equal to 130 *E. coli* per 100 ml during the recreation season between May 1 and October 31.

LAs

The LA incorporates the pathogen sources for this water body which include semi-urban runoff, illicit connections, and agricultural runoff in the upper watershed. This TMDL is concentration-based. Therefore, the LA is equal to 130 *E. coli* per 100 ml. The determination of individual LAs will be based on the assumption of equal bacteria concentration per unit area for all lands in the watershed. Therefore, the relative responsibility for achieving the necessary reductions of bacteria and maintaining acceptable conditions will be determined by the amount of land under the jurisdiction of the various units of local government in the watershed. This gives a clear indication of the relative amount of effort that will be required by each entity to restore and maintain the total body contact designated uses in the Cedar River.

The government entity with the largest percent land area in the Cedar River TMDL watershed is Sage Township (43%). The remaining percentage of the watershed is made up of Grout Township (27%), Hamilton Township (15%), Buckeye Township (5%), Arthur Township (4%), the city of Gladwin (4%), Gladwin Township (1%), and Sherman Township (1%).

MOS

This section addresses the incorporation of an MOS in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality, including the pollutant decay rate if applicable. The MOS can be either implicit (i.e., incorporated into the TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS because no rate of decay is used. The MDEQ has determined that the use of the WQS of 130 *E. coli* per 100 ml is a more conservative approach because pathogen organisms have a limited capability of surviving outside of their hosts and a rate of decay would normally be used. Applying a rate of decay could result in a discharge limit that would be greater than the WQS, thus no rate of decay is applied in order to provide for greater protection of water quality. Applying the WQS to be met under all flow conditions also adds to the assurance of the MOS.

SEASONALITY

Seasonality in the TMDL is addressed by expressing the TMDL in terms of a total body contact recreation season that is defined as May 1 through October 31 by R 323.1100 of the WQS. There is no total body contact during the remainder of the year primarily due to cold weather. WQS will be met regardless of flow conditions in the applicable season because this is a concentration-based TMDL.

MONITORING

Pathogens were monitored at a total of eight stations from May through September 2002. Six of those stations were located on the Cedar River, and two were on selected tributaries. Future monitoring will take place during the rotating, five-year basin monitoring. When these results indicate that the water body may be meeting WQS, sampling will be conducted at the appropriate frequency (as defined in the numeric target section) to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml and 300 *E. coli* per 100 ml as a daily maximum are being met.

REASONABLE ASSURANCE ACTIVITIES

The Gladwin WWTP is permitted to discharge treated human waste and is responsible for meeting their NPDES permit limits for fecal coliform. Compliance is based on MDEQ facility inspections and a review of Discharge Monitoring Report data. The WWTP is presently within their permit limits for fecal coliform as confirmed by MDEQ staff. Since 1991, the city of Gladwin has been separating their combined sewer system with approximately 80% of the project complete. A CSO discharge has not been reported since 1998. In addition, the city conducted a smoke test on the entire sanitary system in 1998. The purpose of the project was to eliminate downspout connections, which alleviates excess inflow to the sewer system. During the smoke test, cross connections between the sanitary sewer and storm were also discovered and eliminated. The ACO entered between the city of Gladwin and the MDEQ requires final sewer system improvements to be made no later than June 30, 2005.

The Cedar River watershed is part of one of three large watersheds in Michigan taking part in the Conservation Reserve Enhancement Program (CREP). The CREP is an extension of the Conservation Reserve Program (CRP), which offers farmers annual rental payments for taking agricultural lands out of production. The CREP extends the scope of the CRP program and

allows the enrollment of land associated with specific conservation practices that improve water quality and wildlife habitat. Beneficial activities associated with this program include the instillation of filter strips, riparian buffer strips, controlled livestock access, and wetland restoration. Once installed, these practices will aid in the reduction of *E. coli* reaching the river by limiting cattle access and by filtering overland runoff. Program estimates in late 2002 indicate 478 acres of CREP land in Grout and Sage Townships - the townships with the most land in the Cedar River watershed. The duration of the CREP designation is 10 to 15 years.

The Gladwin Conservation District was awarded a Section 319 grant with similar goals as the CREP. The focus of the grant is to correct several thousand feet of eroding stream bank and improve eight road/stream crossings. The goal of this work is to prevent runoff and sediment from entering the Cedar River. In addition to the 319 project activities, the Gladwin County Conservation District, the local health department, and Trout Unlimited have committed to one year of *E. coli* monitoring using local volunteers for sample collection. This work will be done in conjunction with other watershed activities (i.e., walking tributaries to identify unrestricted livestock access points and other possible sources of *E. coli*). Laboratory analysis will be provided by the health department. The city of Gladwin has also committed to providing appropriate restroom facilities at the canoe launch, an area previously without restroom facilities, and to investigate the possibility of illicit connections in the North Park Canoe launch area.

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City of Gladwin, 1998. Combined Sewer Overflow Final Plan.

Creal, W. and J. Wuycheck. 2002. Federal CWA Section 303(d) List – Michigan's Submittal for Year 2002. MDEQ, Surface Water Quality Division, Report #MI/DEQ/SWQ-02/013.

USEPA. 2001. Protocol for Developing Pathogen TMDLs. USEPA, 841-R-00-002.

Whitman, R. Personal Communication. United States Geological Survey, October 2001.

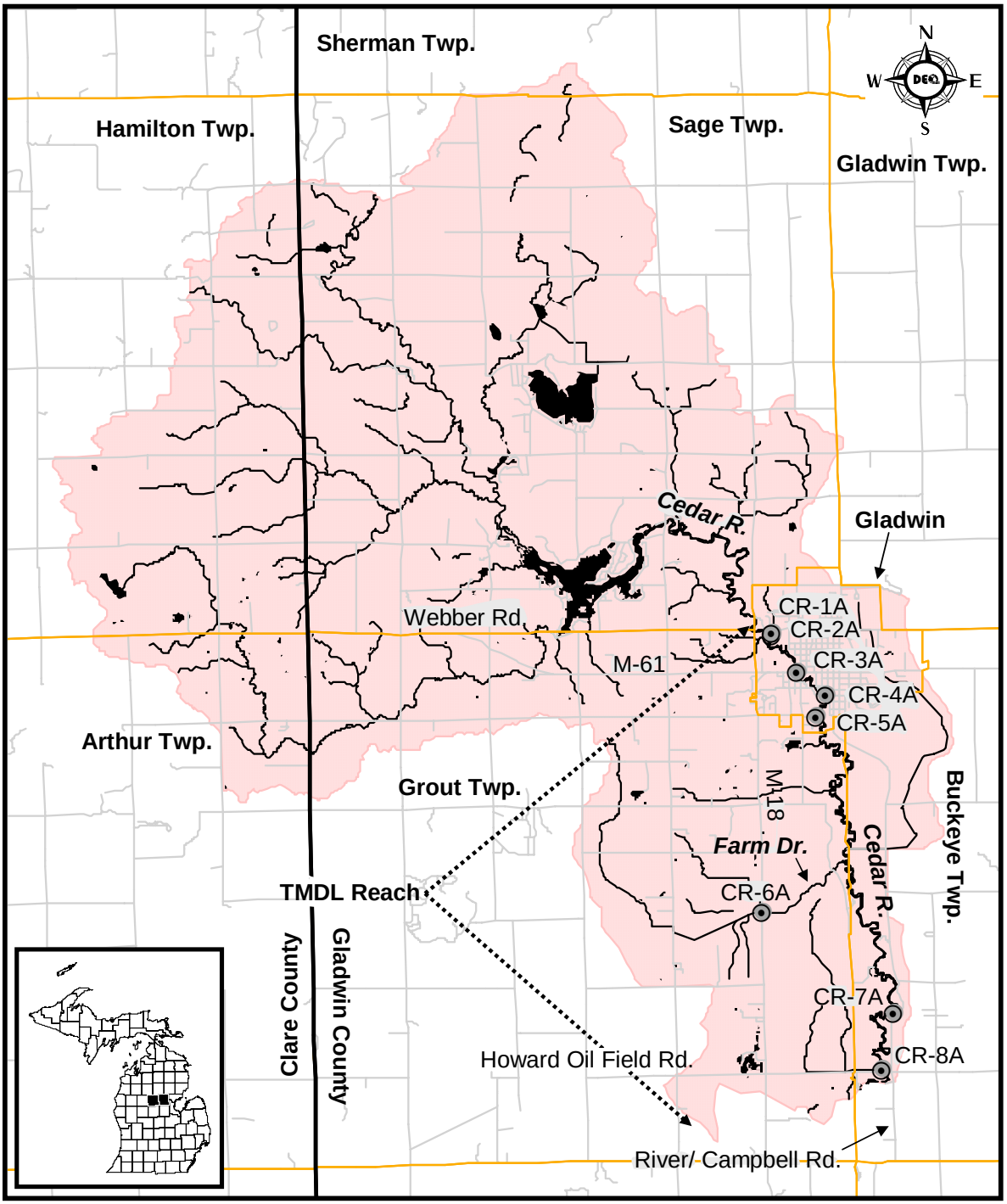

Figure 1a. The Cedar River *E. coli* sampling locations, vicinity of Gladwin, Michigan 2002.

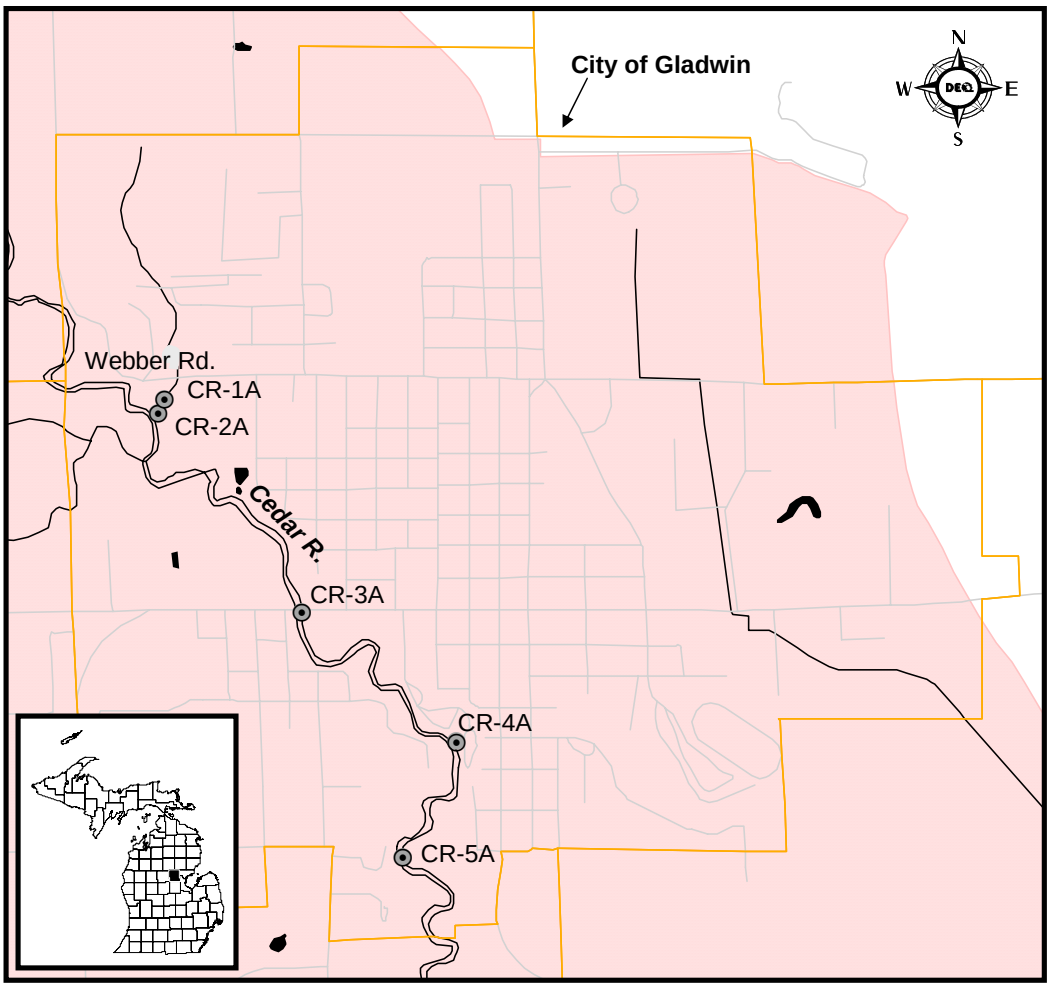

Figure 1b. The Cedar River *E. coli* sampling locations, city of Gladwin, Michigan 2002.

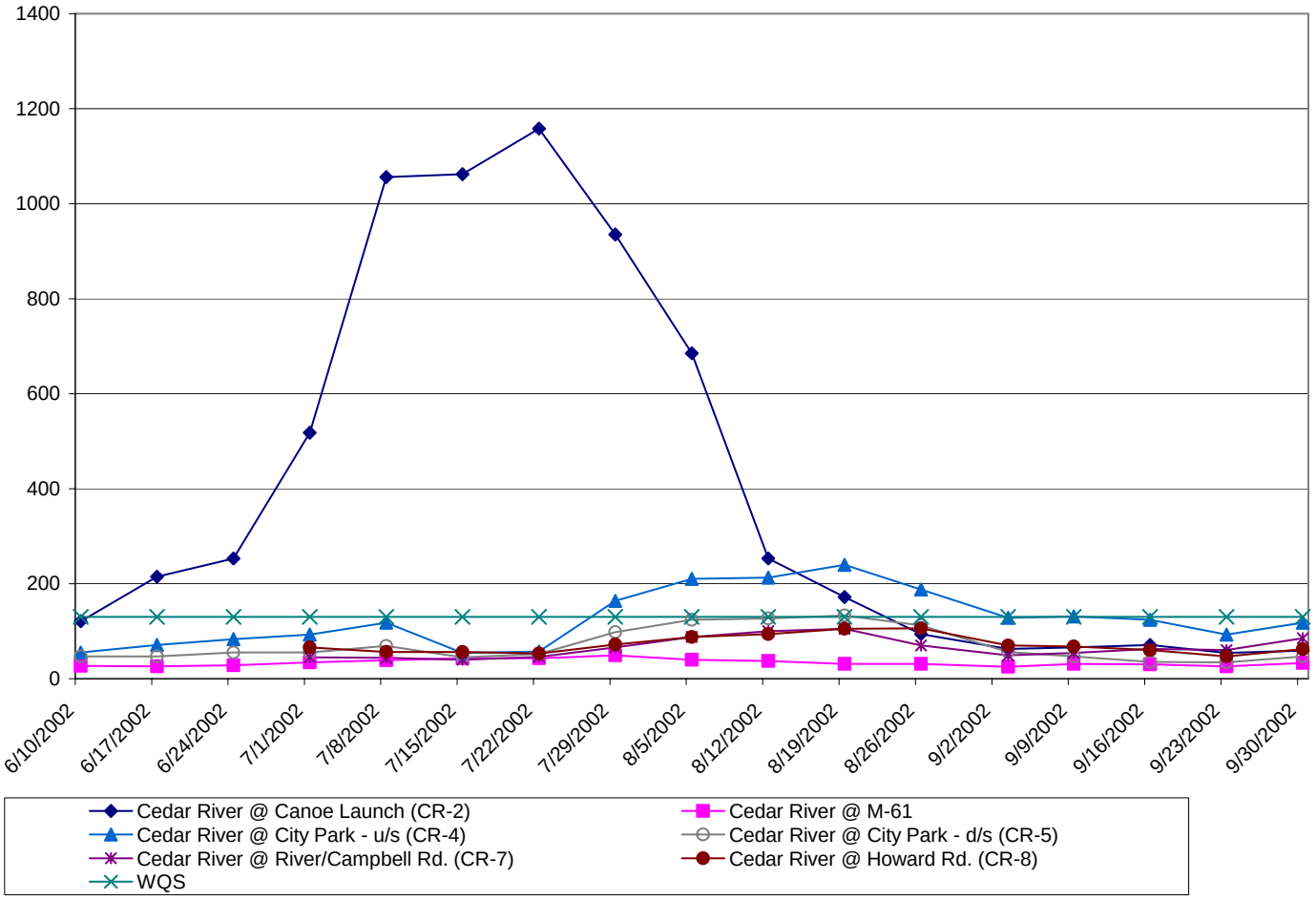

Figure 2. Thirty-day Geometric mean for *E. coli* in the Cedar River in the vicinity of Gladwin, Michigan 2002.

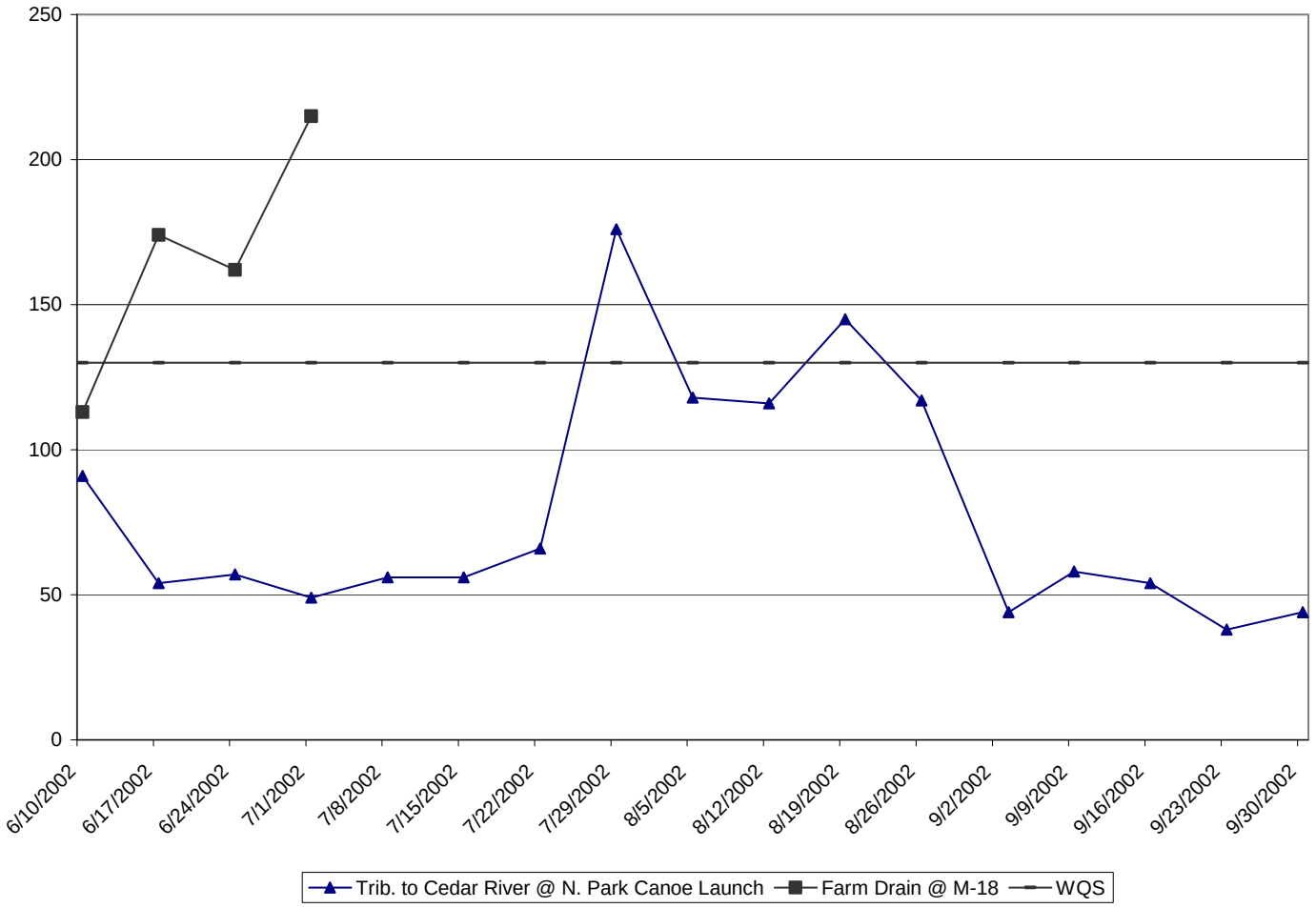

Figure 3. Thirty-day Geometric mean *E. coli* concentrations on selected tributaries of the Cedar River, Gladwin County, Michigan.

Table 1. MDEQ 2002 *E. coli* monitoring data for the Cedar River in the vicinity of Gladwin (*E. coli*/100 ml). Shaded areas indicate exceedances of the WQS. Data are presented upstream to downstream.

	Cedar River @ N. Park Canoe Launch CR-2A			Cedar River @ M-61 CR-3A			Cedar River @ Gladwin City Park CR-4A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
5/13/2002	40	25	---	20	32	---	20	20	---	overcast, 50°
	20			40			20			
	20			40			20			
5/20/2002	360	272	---	20	20	---	20	20	---	overcast, 45°
	280			20			20			
	200			20			20			
5/28/2002	20	20	---	20	20	---	20	20	---	sunny, 80°
	20			20			20			
	20			20			20			
6/3/2002	280	148	---	20	20	---	20	20	---	rain, 50°
	580			20			20			
	20			20			20			
6/10/2002	1640	1263	121	80	54	27	160	3132	55	hazy, 75°
	1180			100			6400			
	1040			20			30000			
6/17/2002	400	451	215	20	25	26	100	74	71	sunny, 70°
	520			20			40			
	440			40			100			
6/24/2002	1400	617	253	60	29	28	20	43	83	humid, 80°
	1400			20			20			
	120			20			200			
7/1/2002	200	717	518	80	54	34	20	34	93	hazy, 80°
	4600			20			20			
	400			100			100			

Table 1. continued (*E. coli*/100 ml).

	Cedar River @ N. Park Canoe Launch CR-2A			Cedar River @ M-61 CR-3A			Cedar River @ Gladwin City Park CR-4A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
7/8/2002	6800	5227	1056	20	43	39	180	66	118	sunny, 80°
	7000			20			80			
	3000			200			20			
7/15/2002	1280	1294	1062	80	86	43	80	66	54	sunny, 85°
	1160			100			60			
	1460			80			60			
7/22/2002	4200	695	1158	20	25	43	160	96	57	humid, 90°
	4000			40			40			
	20			20			140			
7/29/2002	20	212	935	120	58	49	9200	8348	164	thunderstorms, 90°
	640			20			6200			
	740			80			10200			
8/5/2002	240	151	685	20	20	40	80	115	210	sunny, 80°
	80			20			120			
	180			20			160			
8/12/2002	120	36	253	20	29	37	60	71	213	hazy, 75°
	20			20			100			
	20			60			60			
8/19/2002	280	184	172	20	36	31	120	120	240	thunderstorms, 70°
	160			20			80			
	140			120			180			
8/26/2002	20	34	94	40	25	31	60	29	188	sunny, 65°
	20			20			20			
	100			20			20			

Table 1. continued (*E. coli*/100 ml).

	Cedar River @ N. Park Canoe Launch CR-2A			Cedar River @ M-61 CR-3A			Cedar River @ Gladwin City Park CR-4A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
9/3/2002	20	29	63	20	20	25	1800	1187	128	cloudy, 75°
	20			20			1600			
	60			20			580			
9/9/2002	200	183	66	80	50	31	140	131	131	sunny, 80°
	140			80			100			
	220			20			160			
9/16/2002	40	54	71	20	25	30	40	54	124	sunny, 75°
	100			20			100			
	40			40			40			
9/23/2002	60	46	54	20	20	26	20	29	93	sunny, 60°
	40			20			60			
	40			20			20			
9/30/2002	11	56	59	160	73	33	60	94	118	partly, 70°
	100			40			140			
	160			60			100			

Table 1. continued (*E. coli*/100 ml).

	Cedar River @ Gladwin City Park CR-5A			Cedar River @ River/Campbell Rd. CR-7A			Cedar River @ Howard Rd. CR-8A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
5/13/2002	20	29	---	40	58	---	20	52	---	overcast, 50°
	20			80			60			
	60			60			120			
5/20/2002	20	20	---	40	32	---	20	40	---	overcast, 45°
	20			20			80			
	20			40			40			
5/28/2002	20	32	---	#	---	---	#	---	---	sunny, 80°
	80			#			#			
	20			#			#			
6/3/2002	40	25	---	80	40	---	120	92	---	rain, 50°
	20			40			80			
	20			20			80			
6/10/2002	380	512	47	80	80	---	160	73	---	hazy, 75°
	680			80			60			
	520			80			40			
6/17/2002	20	29	47	100	68	---	20	55	---	sunny, 70°
	60			40			140			
	20			80			60			
6/24/2002	60	42	55	40	43	---	60	60	---	humid, 80°
	60			20			20			
	20			100			180			
7/1/2002	20	32	55	20	20	45	40	58	66	hazy, 80°
	20			20			40			
	80			20			120			

unable to collect sample

Table 1. continued (*E. coli*/100 ml).

	Cedar River @ Gladwin City Park CR-5A			Cedar River @ River/Campbell Rd. CR-7A			Cedar River @ Howard Rd. CR-8A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
7/8/2002	80	80	69	20	36	44	20	40	56	sunny, 80°
	80			60			80			
	80			40			40			
7/15/2002	80	63	45	120	46	40	20	71	56	sunny, 85°
	80			40			100			
	40			20			180			
7/22/2002	160	58	52	100	148	46	100	43	53	humid, 90°
	60			180			40			
	20			180			20			
7/29/2002	760	948	98	280	259	66	240	271	72	thunderstorms, 90°
	1000			260			320			
	1120			240			260			
8/5/2002	80	105	124	40	82	88	140	158	88	sunny, 80°
	120			140			200			
	120			100			140			
8/12/2002	80	92	127	100	68	100	140	55	94	hazy, 75°
	80			160			20			
	120			20			60			
8/19/2002	100	78	133	20	58	105	120	126	105	thunderstorms, 70°
	80			100			120			
	60			100			140			
8/26/2002	20	25	112	20	20	70	60	46	106	sunny, 65°
	40			20			80			
	20			20			20			

Table 1. continued (*E. coli*/100 ml).

	Cedar River @ Gladwin City Park CR-5A			Cedar River @ River/Campbell Rd. CR-7A			Cedar River @ Howard Rd. CR-8A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
9/3/2002	60	29	56	210	44	49	20	34	70	cloudy, 75°
	20			20			20			
	20			20			100			
9/9/2002	40	46	47	180	132	54	120	132	68	sunny, 80°
	60			160			160			
	40			80			120			
9/16/2002	20	20	35	220	145	63	60	29	60	sunny, 75°
	20			140			20			
	20			100			20			
9/23/2002	20	65	34	40	46	60	160	40	47	sunny, 60°
	100			40			20			
	140			60			20			
9/30/2002	120	126	47	200	113	85	200	179	62	partly, 70°
	140			120			160			
	120			60			180			

Table 2. MDEQ 2002 *E. coli* monitoring data for selected tributaries of the Cedar River in the vicinity of Gladwin (*E. coli*/100 ml). Shaded areas indicate exceedances of the WQS.

	Trib. to Cedar River @ N. Park Canoe Launch CR-1A			Farm Drain @ M-18 CR-6A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
5/13/2002	400	517	---	40	32	---	overcast, 50°
	640			40			
	540			20			
5/20/2002	20	25	---	20	80	---	overcast, 45°
	40			100			
	20			260			
5/28/2002	1000	517	---	20	46	---	sunny, 80°
	300			80			
	460			60			
6/3/2002	20	20	---	200	234	---	rain, 50°
	20			160			
	20			400			
6/10/2002	40	46	91	880	672	113	hazy, 75°
	60			720			
	40			480			
6/17/2002	40	40	54	320	278	174	sunny, 70°
	80			280			
	20			240			
6/24/2002	20	32	57	20	55	162	humid, 80°
	80			60			
	20			140			
7/1/2002	160	238	49	120	189	215	hazy, 80°
	280			200			
	300			280			

Table 2. continued (*E. coli*/100 ml).

	Trib. to Cedar River @ N. Park Canoe Launch CR-1A			Farm Drain @ M-18 CR-6A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
7/8/2002	40	40	56	320	137	193	sunny, 80°
	20			200			
	80			40			
7/15/2002	40	46	56	*	---	---	sunny, 85°
	60			*			
	40			*			
7/22/2002	180	90	66	140	38	---	humid, 90°
	40			20			
	100			20			
7/29/2002	4400	4388	176	1800	1065	---	thunderstorms, 90°
	4800			560			
	4000			1200			
8/5/2002	20	32	118	*	---	---	sunny, 80°
	80			*			
	20			*			
8/12/2002	60	36	116	*	---	---	hazy, 75°
	20			*			
	40			*			
8/19/2002	120	139	145	340	284	---	thunderstorms, 70°
	140			240			
	160			280			
8/26/2002	40	32	117	*	---	---	sunny, 65°
	20			*			
	40			*			

*data not collected due to dry conditions

Table 2. continued (*E. coli*/100 ml).

	Trib. to Cedar River @ N. Park Canoe Launch CR-1A			Farm Drain @ M-18 CR-6A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
9/3/2002	20	32	44	180	42	---	cloudy, 75°
	80			20			
	20			20			
9/9/2002	120	126	58	*	---	---	sunny, 80°
	120			*			
	140			*			
9/16/2002	20	25	54	*	---	---	sunny, 75°
	20			*			
	40			*			
9/23/2002	40	25	38	*	---	---	sunny, 60°
	20			*			
	20			*			
9/30/2002	120	66	44	*	---	---	partly, 70°
	120			*			
	20			*			

*data not collected due to dry conditions

Table 3. The Cedar River average flows (cubic feet per second) at M-61, Gladwin County, Michigan.

May	June	July	August	September	October
98	77	65	61	66	74

Table 4. Distribution of land for each municipality in the TMDL reach.

Municipality	Square miles	Percent
Sage Township	26.4	43
Grout Township	16.5	27
Hamilton Township	9.3	15
Buckeye Township	3.0	5
Arthur Township	2.4	4
City of Gladwin	2.4	4
Gladwin Township	0.5	1
Sherman Township	0.5	1
TOTAL	**61**	**100**

Table 5. Permitted outfalls to the Cedar River TMDL watershed.
Source: MDEQ/WD NPDES Permit Management System.

Facility	Permit Number	Receiving Water	Discharge	Latitude	Longitude
Gladwin WWTP	MI0023001	Cedar River	sanitary	43.97611	-84.49083
Dura Automotive Systems, Inc.	MIS410066	Canham Drain	storm water	43.98750	-84.47500
Franks Auto Salvage	MIS410067	Cedar River	storm water	44.01667	-84.57083
Gladwin Tank Mfg Inc – Gladwin	MIS410315	Canham Drain	storm water	43.98139	-84.47833