

**Michigan Department of Environmental Quality
Water Bureau
August 2005**

**Total Maximum Daily Load for *E. coli* for
The River Raisin
Lenawee and Monroe Counties**

INTRODUCTION

Section 303(d) of the federal Clean Water Act 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 states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their 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 River Raisin, tributary of Lake Erie, located in Lenawee and Monroe Counties, Michigan.

PROBLEM STATEMENT

This TMDL addresses two listings: The River Raisin in the vicinity of Deerfield upstream to Blissfield in Lenawee County and the River Raisin downstream of Dundee in Monroe County. The TMDL reaches for the River Raisin appear on the Section 303(d) list as:

RIVER RAISIN

County: Lenawee

Location: Lenawee County line (vicinity of Deerfield) u/s to Blissfield

HUC: 4100002 RF3RchID: 4100002 11

Problem: Pathogens (Rule 100).

TMDL YEAR(s): 2005

WBID#: 061101E

Size: 16 M

RIVER RAISIN

County: Monroe

Location: Dundee d/s 1 Mile

HUC: 4100002 RF3RchID: 4100002 9

Problem: Pathogens (Rule 100).

TMDL YEAR(s): 2005

WBID#: 061101G

Size: 1 M

The River Raisin 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* (Wolf and Wuycheck, 2004). Monitoring data collected by the Michigan Department of Environmental Quality (MDEQ) in 2003 documented random exceedances of the WQS for *E. coli* at several sampling locations during the total body contact recreational season of May 1 through October 31 (Figure 1 and Tables 1-3).

NUMERIC TARGET

The impaired designated use addressed by this TMDL is total body contact recreation. The designated use rule (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 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 *E. coli* per 100 milliliters (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 milliliters (ml) if their National Pollutant Discharge Elimination System (NPDES) permit limit of 200 fecal coliform 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 concentrations are substantially higher than *E. coli* concentrations when the wastewater of concern is sewage (Whitman, 2001). Therefore, 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.

For this TMDL, 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 geometric mean are the target levels for the TMDL reach from May 1 to October 31. As previously stated, the 2003 monitoring data indicated exceedances of WQS at several locations sampled.

DATA DISCUSSION

The River Raisin was sampled at nine locations to address the TMDL listing in the vicinity of Deerfield and Blissfield, and met the 30-day geometric mean WQS at all stations sampled (Figure 2, Tables 1 and 2). Thirty-day geometric mean *E. coli* concentrations in the vicinity of Blissfield and Deerfield ranged from 22 *E. coli* per 100 ml in June at US-223 (RRB-2) and Iffland Road (RRB-3) to 103 *E. coli* per 100 ml in July at Rouget Road (RRB-5) (Table 1, Figure 3).

The daily geometric mean was exceeded on 8 occasions out of 120 samples collected. Daily geometric mean concentrations ranged from 20 *E. coli* per 100 ml at various locations to 1,074 *E. coli* per 100 ml in August at US-223 (RRB-2). US-223 (RRB-2) exceeded the daily geometric mean three times over the sampling season. Two of the three exceedances were within 24 hours of a rain event (Table 1).

One unnamed tributary to the River Raisin was also sampled (RRB-4, Figure 2). Despite dry and/or stagnant conditions, available data indicate both the 30-day and daily geometric mean WQS were met during the sampling season. Thirty-day geometric mean *E. coli* concentrations ranged from 46 *E. coli* per 100 ml in June to 76 *E. coli* per 100 ml in June and July (Table 2). Daily geometric means ranged from 20 *E. coli* per 100 ml on multiple occasions to 198 *E. coli* per 100 ml in June (Table 2, Figure 4).

The second portion of this TMDL listing is the River Raisin in the vicinity of Dundee (Figure 5). With the exception of one event, the 30-day geometric mean WQS was met the entire sampling season, with *E. coli* concentrations ranging from 22 *E. coli* per 100 ml in August at M-50 (RRD-2) to 167 *E. coli* per 100 ml in September at Davis Road (RRD-1) (Table 3, Figure 6).

The daily geometric mean was exceeded on 6 occasions out of 63 samples collected. Daily geometric means ranged from 20 *E. coli* per 100 ml at multiple locations to 4,294 *E. coli* per 100 ml in August at Davis Road (RRD-1) (Table 3). The two upstream stations (RRD-1 and RRD-2) had concurrent exceedances. The highest concentration, 4,294 *E. coli* per 100 ml, found at the Davis Road station (RRD-1) on August 12, 2003, did not appear to be related to a precipitation event.

SOURCE ASSESSMENT

The official listed reach for the River Raisin is approximately 16 miles in the vicinity of Deerfield upstream to Blissfield in Lenawee County; and the River Raisin from Dundee to approximately one mile downstream in Monroe County. The municipalities making up the largest portion of the TMDL watershed include Deerfield, Summerfield, and Blissfield Townships. The municipalities in the TMDL watershed are represented by the shaded area in Figure 1. Table 4 shows the distribution of land for each municipality.

The primary pathogen sources for these water bodies are agricultural and to a lesser degree, suburban land uses. Specific sources include agricultural runoff, urban runoff, and failing septic systems.

Agriculture accounts for approximately 58% of the land use in the TMDL watershed (Purdue University, 2005). *E. coli* has been shown to enter water bodies from pastureland and land applications of manure via field drainage systems, such as tiles. Field tiles have shown significant transport of enteric bacteria through tile drainage systems under all manure application protocols and environmental conditions (Jamieson et al., 2002). Another possible source of *E. coli* from agriculture is runoff from land application of manure (Oliver et al., 2005).

One sample on the River Raisin was collected for Deoxyribonucleic acid (DNA) ribotyping analysis. This is a relatively new technology that extracts DNA from *E. coli* isolates and compares the DNA to a library of known source isolates. The sample was collected at US-223 in the vicinity of Blissfield (RRB-2) on August 7, 2003. The results from this sample indicate four isolates were of nonhuman origin and one isolate was indeterminate (unknown origin) (Table 5).

There are 23 NPDES permitted discharges to the River Raisin in the TMDL reach (Table 6, Figure 7): 3 individual permits, 13 general permits, and 7 permits-by-rule. The Blissfield Wastewater Treatment Plant (WWTP) (MI0021695), Deerfield WWTP (MI0023442), Dundee WWTP (MI0020401), and Petersburg WWTP (MIG570217) are permitted to discharge treated human waste. The village of Blissfield had 1 combined sewer overflow (CSO) to the TMDL reach between the dates of May 9 and 11, 2003, when approximately 0.17 million gallons of diluted raw sewage were released to the River Raisin. This event may have contributed to the isolated daily geometric mean exceedance found at the Iffland Road station (RRB-3) on May 12,

2003. Both combined sewer outfall locations and associated discharges were eliminated in late 2004. The village of Deerfield has recently completed an infiltration and inflow (I/I) study on their wastewater collection system. The purpose of the study was to identify and eliminate excess sources of I/I to the collection system (i.e., additional water making its way into the collection system which decreases the capacity to carry sanitary sewage). The village of Deerfield is required under their NPDES permit to have capacity to adequately treat all flows generated during a 25-year/24-hour storm event without bypass.

The general permit discharges are not considered to contain treated or untreated human sewage or animal waste; therefore, they are not deemed a significant source of *E. coli* to the River Raisin TMDL watershed. The permits-by-rule involve earthwork in the TMDL watershed, which is not considered a significant source of *E. coli*.

LINKAGE ANALYSIS

Determining the link between the *E. coli* concentrations in the River Raisin and the potential sources are necessary to develop the TMDL. This link provides the basis for estimating the total assimilative capacity of the water body and any needed load reductions. For this TMDL, the loading of pathogens appears to enter the River Raisin during all weather conditions (i.e., wet and dry weather events). Potential sources include agricultural runoff, urban runoff, and failing septic systems.

The guiding water quality management principle used to develop the TMDL was that compliance with the numeric pathogen target in the River Raisin depends on the control of *E. coli* from wet and dry weather sources. If the *E. coli* inputs can be controlled to meet the numeric standards, then total body contact recreation in the River Raisin will be restored and 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 targets for this pathogen TMDL are the 30-day geometric mean WQS of 130 *E. coli* per 100 ml and daily geometric mean of 300 *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 example, the critical conditions for the control of point sources in Michigan are given in R 323.1082 (Mixing zones) and R 323.1090 (Applicability of water quality standards). In general, the lowest monthly 95% exceedance flow for streams is used as a design condition for point source discharges. However, for pathogens in point source discharges of treated or untreated human sewage, levels are restricted to a monthly average limit of 200 fecal coliform per 100 ml regardless of stream flow. Therefore, the design stream flow is not a critical condition for determining the allowable loading of pathogen for WWTPs. In addition, sources of pathogens to the River Raisin arise from a mixture of wet and dry weather-driven nonpoint sources. For these sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed.

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

and daily geometric mean of 300 *E. coli* per 100 ml 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 and loading conditions; therefore, a critical condition is not applicable for this TMDL.

ALLOCATIONS

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

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. This pathogen TMDL will not be expressed on a mass loading basis and is concentration-based consistent with USEPA regulations in 40 CFR, Section 130.2(i).

WLAs

There are 23 permitted point source discharges to the listed reaches of the River Raisin: 3 individual permits, 13 general permits, and 7 permits-by-rule for earthwork. Each individual permit and one general permit (Petersburg WWTP) authorizes discharge of treated human waste in the TMDL reach and contains fecal coliform limits. The Blissfield Mfg. Co. general permit is for noncontact cooling water and does not contain treated or untreated human waste. All 4 WWTPs discharge to the River Raisin and will be considered in compliance with the WQS of 130 *E. coli* per 100 ml if their NPDES permit limit of 200 fecal coliform per 100 ml as a monthly average is met.

The WLA for the Blissfield WWTP, Deerfield WWTP, Dundee WWTP, the Petersburg WWTP, and the general permits are equal to 130 *E. coli* per 100 ml during the recreational season between May 1 and October 31. The permitted storm water discharges are not considered significant sources of *E. coli* to the River Raisin due to best management practices (BMPs) required in the permit. These permits do not authorize the discharge of non-storm water and require a certified storm water operator for the facility. The permits-by-rule involve earthwork in the watershed and, due to the nature of the permit, are not considered a significant source of *E. coli* to the TMDL watershed.

LAs

Because this TMDL is concentration-based, the LA is equal to 130 *E. coli* per 100 ml. This LA is based on the assumption that all land, regardless of use, will be required to meet the WQS. 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 local unit of government in the watershed. This TMDL reach is located in 13 municipalities (Table 4). The townships making up the largest portion are Deerfield Township (17.2%), Summerfield Township (14.8%), and Blissfield Township (14.3%).

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 WLA or LA 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 was used. Pathogen organisms ordinarily have a limited capability of surviving outside of their hosts and a rate of decay could be developed. However, applying a rate of decay could result in an allocation that would be greater than the WQS, thus no rate of decay is applied to provide for a greater protection of water quality. The MDEQ has determined that the use of the WQS of 130 *E. coli* per 100 ml for the WLA and LA is a more conservative approach than developing an explicit MOS and accounts for the uncertainty in the relationship between pollutant loading and water quality, based on available data and the assumption to not use a rate of decay. Applying the WQS to be met under all flow conditions also adds to the assurance that an explicit MOS is unnecessary.

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. In addition, because this is a concentration-based TMDL, WQS will be met regardless of flow conditions in the applicable season.

MONITORING

Pathogens were monitored weekly at a total of 9 stations on the River Raisin and 1 unnamed tributary from May through September 2003. Future monitoring will take place as part of the 5-year rotating 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 Blissfield WWTP, Deerfield WWTP, Dundee WWTP, and the Petersburg WWTP are presently meeting their NPDES permit limits for fecal coliform. Compliance is determined by the MDEQ based on a monthly review of discharge monitoring report data. The village of Blissfield has eliminated their two CSO outfalls and is no longer a source of *E. coli* to the TMDL reach. The village of Deerfield has completed a sanitary sewer evaluation study and sewer rehabilitation study for their collection system. Under their NPDES permit, the village of Deerfield was required to adequately treat all flows generated during a 25-year/24-hour storm event without bypass by March 2004.

A Clean Michigan Initiative Clean Water Fund project (Grant No. 2001-0037) was awarded to the Lenawee County Drain Commission in 2001. This project involved the Pollard Drain watershed, a small tributary to the River Raisin in the vicinity of the village of Blissfield. The objective of the project was to reduce nonpoint source pollution to Pollard Drain via the construction of storm water detention basins and bank stabilization on the River Raisin. Prior to the improvements, the village of Blissfield was contributing a large volume of storm water containing pollutants such as sediment, nutrients, and litter. Sediment is a known mechanism for delivering *E. coli* to a waterbody (Durham, 2002). The detention basins will allow the water to be released at a controlled rate after solids settle. Bank stabilization on the River Raisin will also benefit water quality by controlling sedimentation.

A federal Clean Water Act Section 319 grant was awarded to the Lenawee Conservation District. The project began on October 1, 1999, and concluded on September 30, 2004. The grant focused on four main concepts: fostering community action, information and education,

adopt-a-stream program, and implementation of BMPs. Water quality benefits from the project, particularly from BMPs, will have lasting effects in the watershed. Projects included urban stream bank erosion correction, stream and road crossing stabilization, and the installation of a subirrigation system for dairy milk house water. Reductions in sediment and agricultural waste will decrease pathogens entering the Raisin River and its tributaries. Another benefit of the grant was the development of Geo-Book, a software tool made specifically for decision makers in the watershed. The software contains spatial data that was collected with the help of local committees to assist in land use decision-making. The multiyear project has facilitated local involvement and community pride throughout the watershed. Partners, such as the River Raisin Watershed Council, have been instrumental in assuming responsibility of the programs at the conclusion of the grant.

The River Raisin Watershed Council (Council) is an active council dedicated to improvement of water quality and promoting the use of the River Raisin watershed for the common good. The Council is in the process of a planning project with the ultimate goal of implementing a watershed management plan. Components of the plan will include better stakeholder coordination and dissemination of information to support resource planning and watershed improvement efforts, identification of watershed-wide and subwatershed priorities, improvement of public education and a public involvement process, and creating a sustainable watershed plan. Additional information on the Council can be found at the following Web site: <https://www.riverraisin.org/>.

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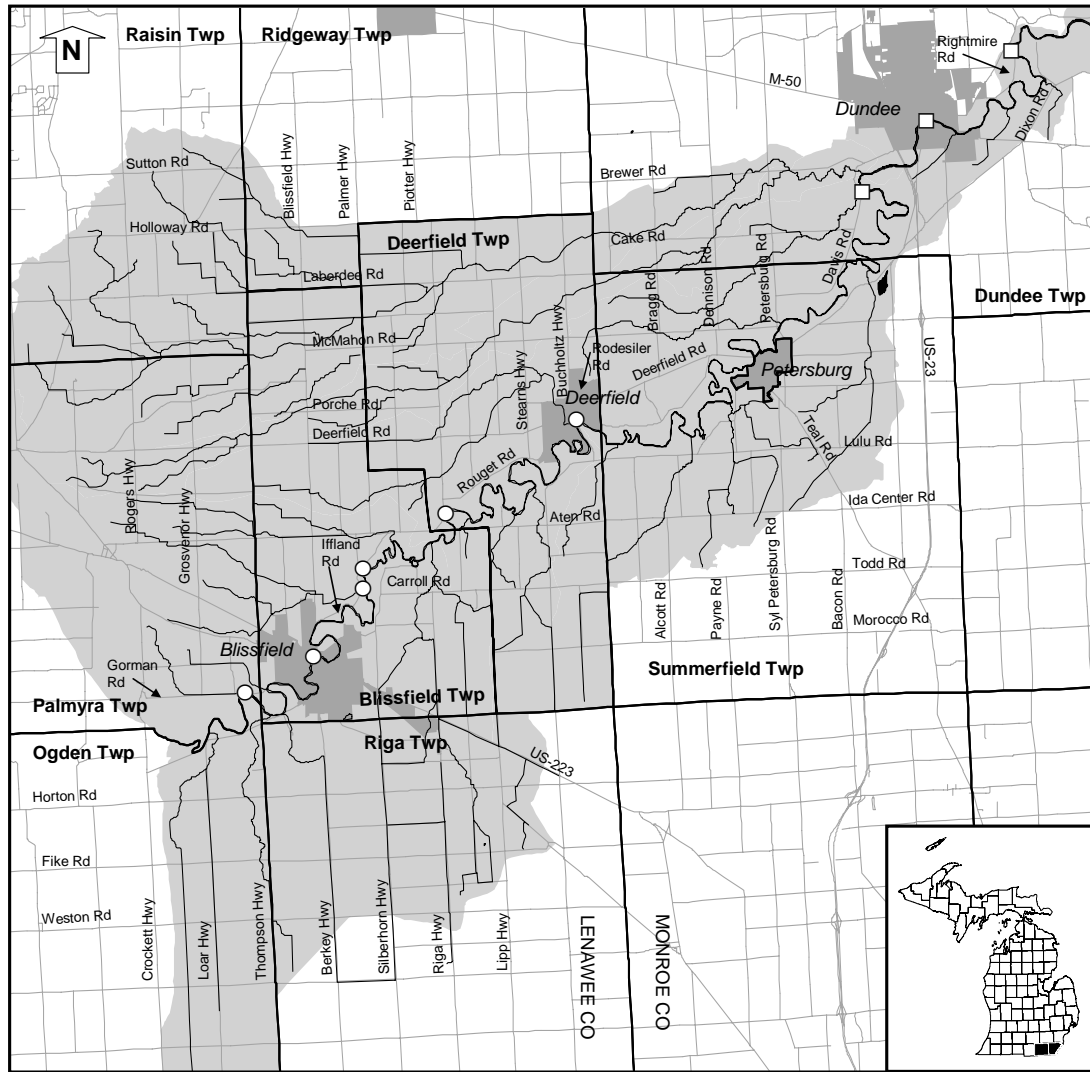


Figure 1. The River Raisin *E. coli* sampling locations, vicinity of Blissfield, Deerfield, and Dundee, Michigan, 2003.

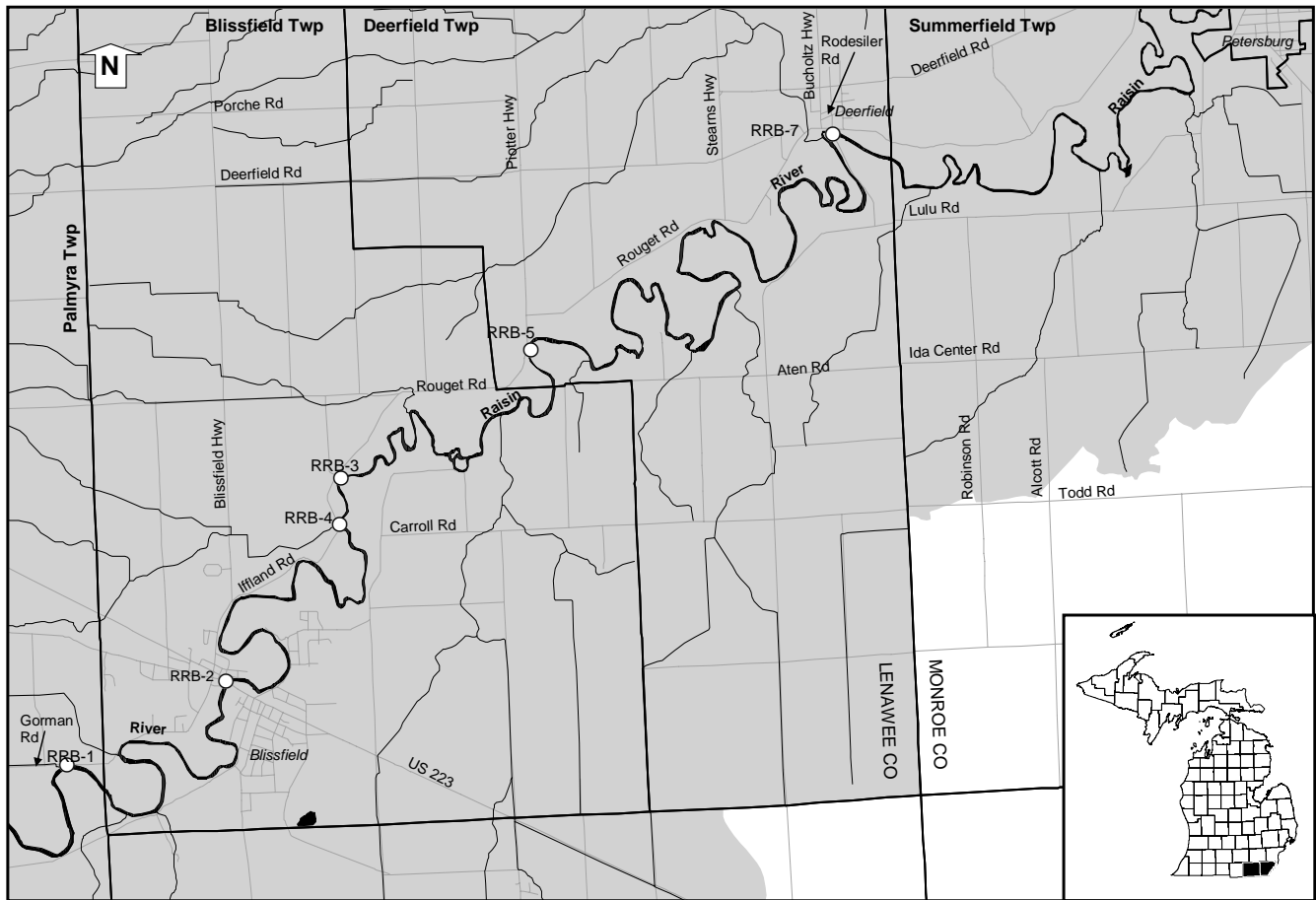


Figure 2. The River Raisin *E. coli* sampling locations, including the unnamed tributary, vicinity of Blissfield and Deerfield, Lenawee County, Michigan, 2003.

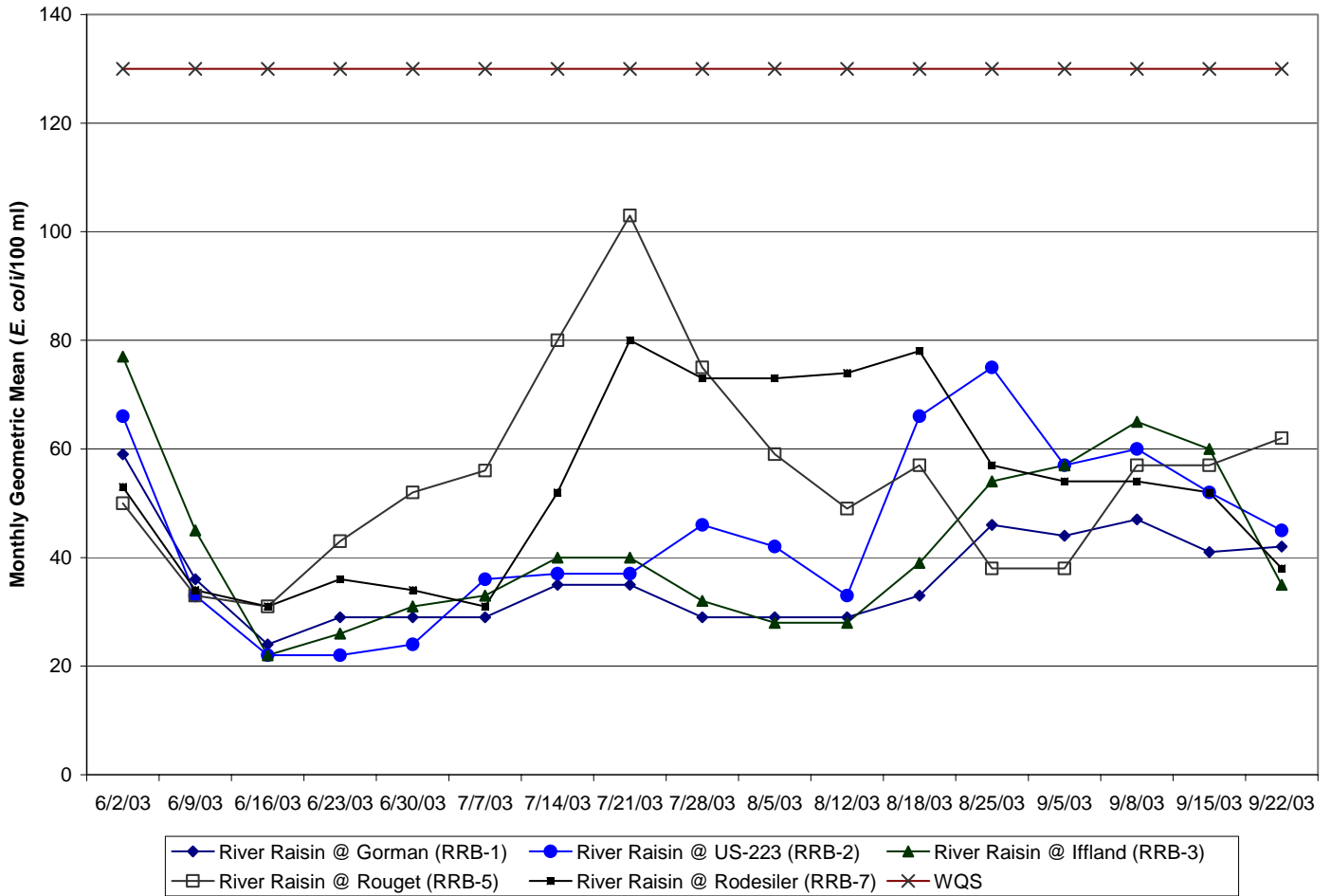


Figure 3. Thirty-day geometric mean for *E. coli* in River Raisin, vicinity of Blissfield and Deerfield, Lenawee County, Michigan, 2003.

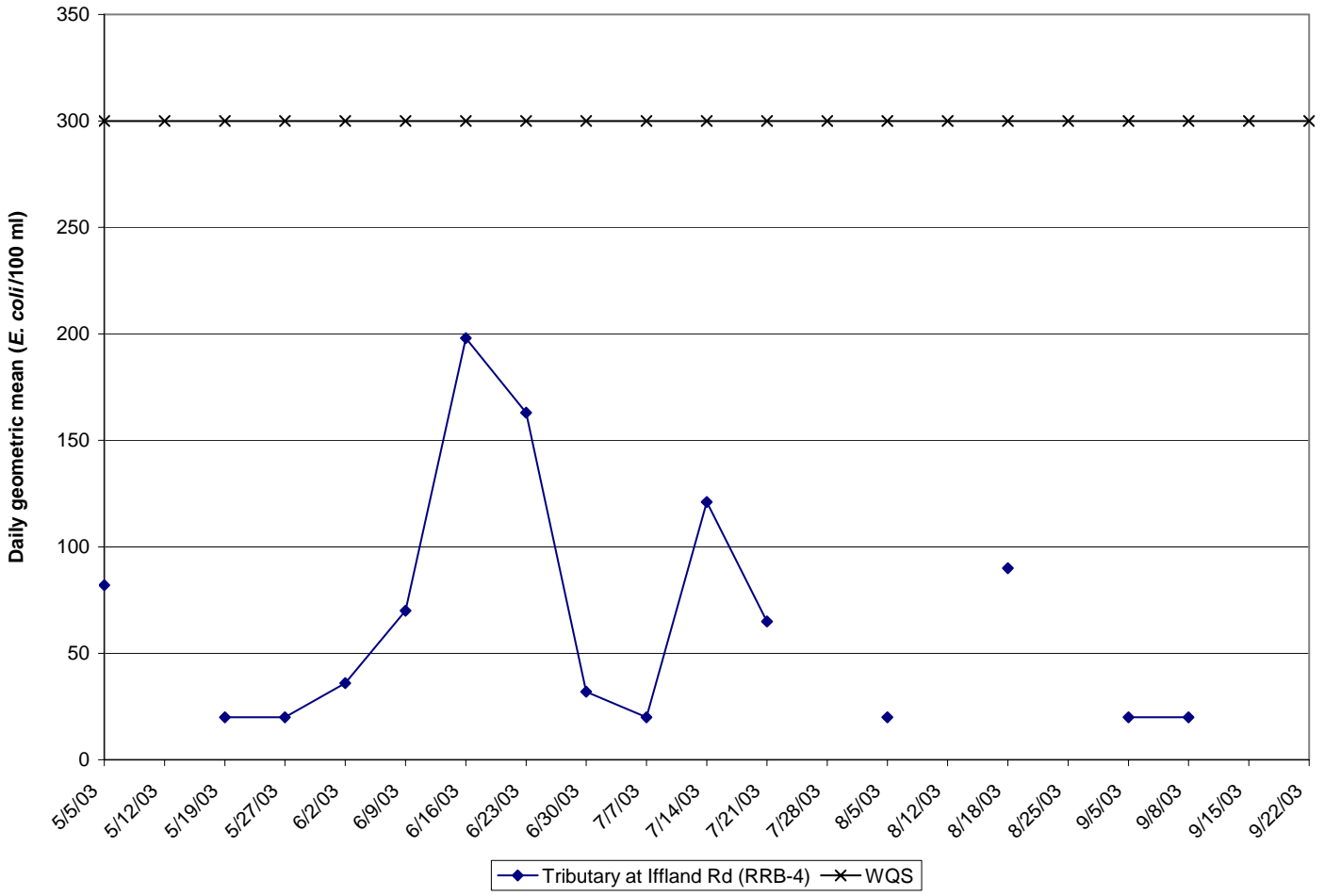


Figure 4. Daily geometric mean for *E. coli* in an unnamed River Raisin tributary, vicinity of Blissfield, Lenawee County, Michigan, 2003.



Figure 5. The River Raisin *E. coli* sampling locations, vicinity of Dundee, Monroe County, Michigan, 2003.

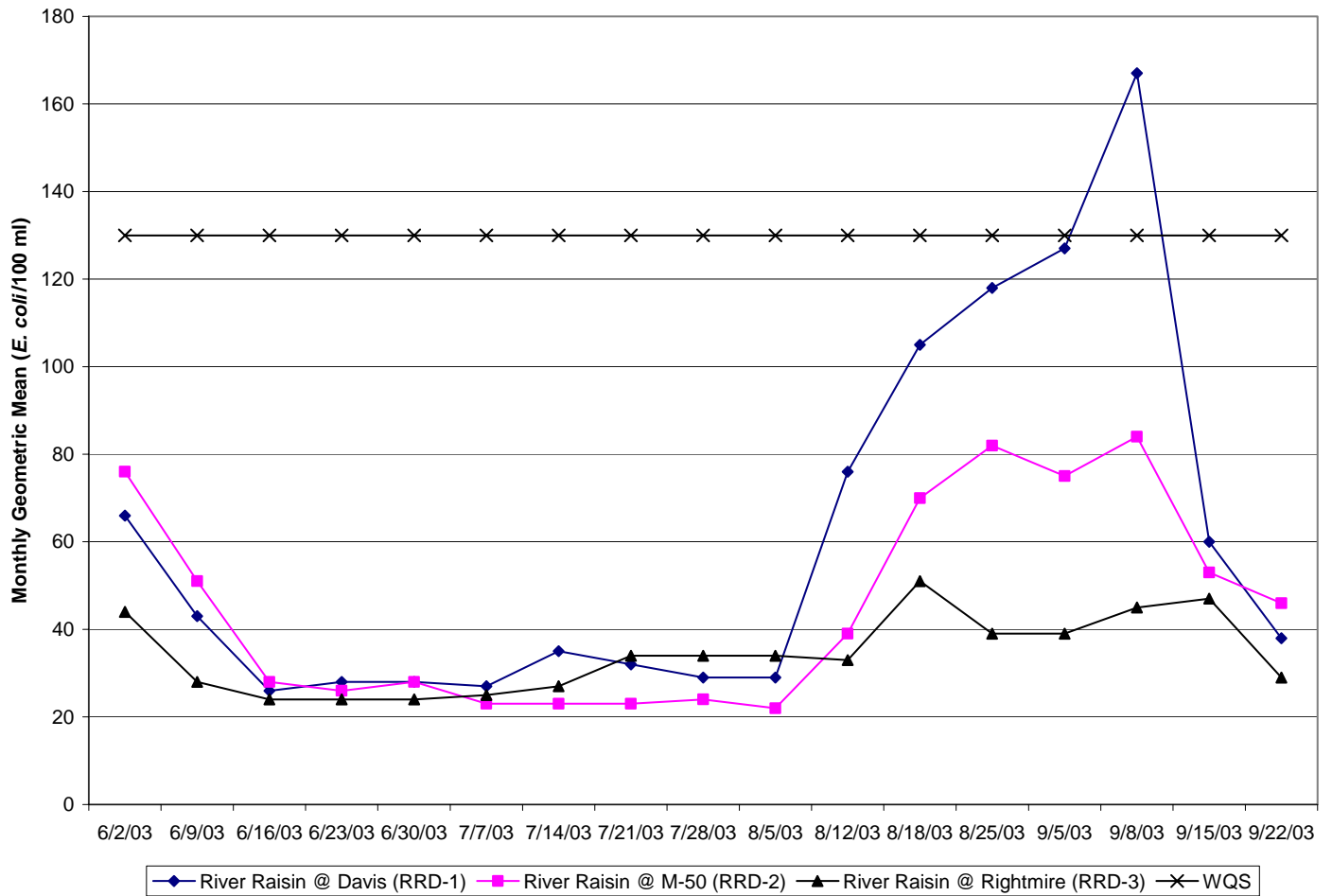


Figure 6. Thirty-day geometric mean for *E. coli* in the River Raisin, vicinity of Dundee, Monroe County, Michigan, 2003.

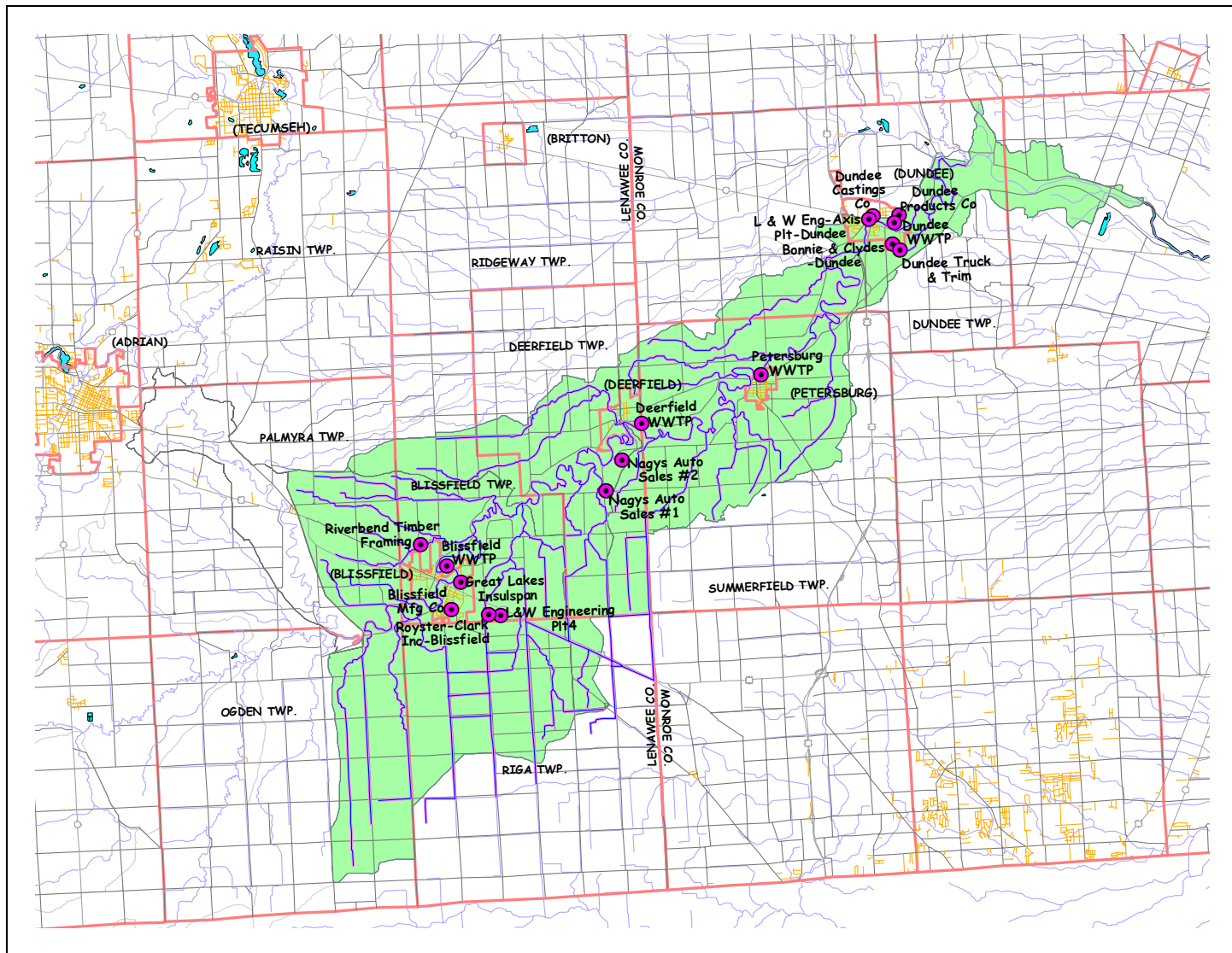


Figure 7. NPDES permitted discharges to the River Raisin TMDL reach, Lenawee and Monroe Counties, Michigan, 2003. (Note: figure does not contain NOC permits).

Table 1. MDEQ 2003 *E. coli* monitoring data for the River Raisin (*E. coli*/100 ml) in the vicinity of Blissfield and Deerfield. Shaded areas indicate exceedances of the WQS. Data are presented upstream to downstream. Note: precipitation is noted for 24 hours preceding sampling.

	River Raisin @ Gorman Rd. (RRB-1)			River Raisin @ US-223 (RRB-2)			River Raisin @ Iffland Rd. (RRB-3)			
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/Precip.
5/5/2003	300	244	---	800	755	---	360	290	---	rain, 65° 1.5"
	220			840			200			
	220			640			340			
5/12/2003	20	155	---	500	160	---	880	755	---	overcast, 65°
	620			20			720			
	300			410			680			
5/19/2003	20	25	---	20	25	---	20	25	---	cloudy, 55°
	40			20			40			
	20			40			20			
5/27/2003	20	20	---	20	20	---	20	20	---	sunny, 65°
	20			20			20			
	20			20			20			
6/2/2003	20	36	59	20	20	66	40	25	77	sunny, 70°
	120			20			20			
	20			20			20			
6/9/2003	20	20	36	40	25	33	20	20	45	sunny, 70°
	20			20			20			
	20			20			20			
6/16/2003	20	20	24	20	20	22	20	20	22	sunny, 80°
	20			20			20			
	20			20			20			
6/23/2003	20	66	29	20	25	22	20	62	26	sunny, 80°
	120			40			120			
	120			20			100			

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

	River Raisin @ Gorman Rd. (RRB-1)			River Raisin @ US-223 (RRB-2)			River Raisin @ Iffland Rd. (RRB-3)					
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/Precip.		
6/30/2003	20	20	29	100	34	24	220	44	31	sunny, 70°		
	20			20							20	
	20			20							20	
7/7/2003	20	40	29	20	132	36	20	36	33	rain, 80° 0.5"		
	160						240					20
	20						480					120
7/14/2003	120	52	35	20	32	37	20	50	40	sunny, 85°		
	20						80					20
	60						20					320
7/21/2003	20	20	35	20	20	37	20	20	40	rain, 65°		
	20						20					20
	20						20					20
7/28/2003	20	25	29	100	74	46	20	20	32	cloudy, 70°		
	40						40					20
	20						100					20
8/5/2003	20	20	29	20	20	42	20	25	28	sunny, 85°		
	20						20					20
	20						20					40
8/12/2003	160	40	29	20	40	33	20	32	28	cloudy, 75°		
	20						160					80
	20						20					20
8/18/2003	20	101	33	960	1074	66	200	290	39	cloudy, 90°		
	260						1040					380
	200						1240					320

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

	River Raisin @ Gorman Rd. (RRB-1)			River Raisin @ US-223 (RRB-2)			River Raisin @ Iffland Rd. (RRB-3)			
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/Precip.
8/25/2003	20	100	46	60	36	75	20	99	54	sunny, 80°
	180			40			240			
	280			20			200			
9/5/2003	20	20	44	20	20	57	40	25	57	sunny, 70°
	20			20			20			
	20			20			20			
9/8/2003	20	29	47	40	25	60	20	52	65	foggy, 75°
	60			20			20			
	20			20			360			
9/15/2003	20	20	41	20	20	52	20	20	60	partly cloudy, 70°
	20			20			20			
	20			20			20			
9/22/2003	20	115	42	1160	532	45	20	20	35	rain, 65° > 3.0"
	480			1080			20			
	160			120			20			

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

DATE	River Raisin @ Rouget Rd. (RRB-5)			River Raisin @ Rodesiler Rd. (RRB-7)			Weather data/Precip.
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
5/5/2003	100	142	---	180	192	---	rain, 65° 1.5"
	360			140			
	80			280			
5/12/2003	300	122	---	20	54	---	overcast, 65°
	20			20			
	300			400			
5/19/2003	20	20	---	20	20	---	cloudy, 55°
	20			20			
	20			20			
5/27/2003	20	25	---	20	25	---	sunny, 65°
	20			20			
	40			40			
6/2/2003	100	34	50	140	80	53	sunny, 70°
	20			20			
	20			180			
6/9/2003	20	20	33	20	20	34	sunny, 70°
	20			20			
	20			20			
6/16/2003	100	86	31	20	38	31	sunny, 80°
	160			20			
	40			140			
6/23/2003	100	100	43	40	40	36	sunny, 80°
	100			40			
	100			40			

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

DATE	River Raisin @ Rouget Rd. (RRB-5)			River Raisin @ Rodesiler Rd. (RRB-7)			Weather data/Precip.
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
6/30/2003	80 180 20	66	52	20 20 20	20	34	sunny, 70°
7/7/2003	20 40 140	48	56	300 20 20	49	31	rain, 80° 0.5"
7/14/2003	20 280 300	119	80	320 280 180	253	52	sunny, 85°
7/21/2003	760 160 240	308	103	1400 1300 20	331	80	rain, 65°
7/28/2003	20 20 20	20	75	20 20 40	25	73	cloudy, 70°
8/5/2003	20 20 20	20	59	20 20 20	20	73	sunny, 85°
8/12/2003	20 20 20	20	49	20 20 380	53	74	cloudy, 75°
8/18/2003	240 300 180	235	57	180 480 420	331	78	cloudy, 90°

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

	River Raisin @ Rouget Rd. (RRB-5)			River Raisin @ Rodesiler Rd. (RRB-7)			
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Weather data/Precip.
8/25/2003	80	40	38	20	65	57	sunny, 80°
	20			140			
	40			100			
9/5/2003	20	20	38	20	20	54	sunny, 70°
	20			20			
	20			20			
9/8/2003	360	166	57	20	20	54	foggy, 75°
	160			20			
	80			20			
9/15/2003	20	20	57	20	43	52	partly cloudy, 70°
	20			200			
	20			20			
9/22/2003	20	338	62	20	68	38	rain, 65° > 3.0"
	2600			20			
	740			800			

Table 2. MDEQ 2003 *E. coli* monitoring data for an unnamed tributary (*E. coli*/100 ml) of the River Raisin, in the vicinity of Blissfield. Shaded areas indicate exceedances of the WQS. Data are presented upstream to downstream. Note: precipitation is noted for 24 hours preceding sampling.

DATE	Tributary @ Iffland Rd. (RRB-4)			Weather data/Precip.
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
5/5/2003	200 20 140	82	---	rain, 65° 1.5"
5/12/2003	# # #	---	---	overcast, 65°
5/19/2003	20 20 20	20	---	cloudy, 55°
5/27/2003	20 20 20	20	---	sunny, 65°
6/2/2003	20 120 20	36	---	sunny, 70°
6/9/2003	140 120 20	70	---	sunny, 70°
6/16/2003	220 220 160	198	46	sunny, 80°
6/23/2003	280 260 60	163	70	sunny, 80°

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

DATE	Tributary @ Iffland Rd. (RRB-4)			Weather data/Precip.
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
6/30/2003	80 20 20	32	76	sunny, 70°
7/7/2003	20 20 20	20	68	rain, 80° 0.5"
7/14/2003	160 20 560	121	76	sunny, 85°
7/21/2003	20 20 680	65	61	rain, 65°
7/28/2003	* * *	--	--	cloudy, 70°
8/5/2003	20 20 20	20	---	sunny, 85°
8/12/2003	# # #	--	---	cloudy, 75°
8/18/2003	120 100 60	90	---	cloudy, 90°

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

	Tributary @ Iffland Rd. (RRB-4)			
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Weather data/Precip.
8/25/2003	* * *	---	---	sunny, 80°
9/5/2003	20 20 20	20	---	sunny, 70°
9/8/2003	20 20 20	20	---	foggy, 75°
9/15/2003	# # #	---	---	partly cloudy, 70°
9/22/2003	* * *	---	---	rain, 65° > 3.0"

sample not collected due to stagnant conditions

* sample not collected due to dry conditions

Table 3. MDEQ 2003 *E. coli* monitoring data for the River Raisin (*E. coli*/100 ml) in the vicinity of Dundee. Shaded areas indicate exceedances of the WQS. Data are presented upstream to downstream. Note: precipitation is noted for 24 hours preceding sampling.

DATE	River Raisin @ Davis Rd. (RRD-1)			River Raisin @ M-50 (RRD-2)			River Raisin @ Rightmire Rd. (RRD-3)			Weather data
	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	
5/5/2003	180 140 200	171	---	260 180 60	141	---	220 200 200	206	---	rain, 65° 1.5"
5/12/2003	460 400 340	397	---	240 600 420	393	---	200 40 140	104	---	overcast, 65°
5/19/2003	20 20 20	20	---	20 20 120	36	---	20 20 20	20	---	cloudy, 55°
5/27/2003	20 20 20	20	---	20 20 20	20	---	20 20 20	20	---	sunny, 65°
6/2/2003	20 120 40	46	66	20 20 600	62	76	20 20 20	20	44	sunny, 70°
6/9/2003	20 20 20	20	43	20 20 20	20	51	20 20 20	20	28	sunny, 70°
6/16/2003	80 20 20	32	26	20 20 20	20	28	120 20 60	52	24	sunny, 80°
6/23/2003	20 40 40	32	28	40 20 20	25	26	20 20 20	20	24	sunny, 80°

Table 3. continued (*E. coli*/100 ml).

DATE	River Raisin @ Davis Rd. (RRD-1)			River Raisin @ M-50 (RRD-2)			River Raisin @ Rightmire Rd. (RRD-3)			Weather data
	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	
6/30/2003	20 20 20	20	28	20 20 60	29	28	20 20 20	20	24	sunny, 70°
7/7/2003	20 120 20	36	27	20 20 20	20	23	20 40 20	25	25	rain, 80° 0.5"
7/14/2003	40 160 60	73	35	20 20 20	20	23	20 60 20	29	27	sunny, 85°
7/21/2003	20 20 20	20	32	20 20 20	20	23	480 140 60	159	34	rain, 65°
7/28/2003	20 20 20	20	29	80 20 20	32	24	20 20 20	20	34	cloudy, 70°
8/5/2003	20 20 20	20	29	20 20 20	20	22	20 20 20	20	34	sunny, 85°
8/12/2003	25000 14400 220	4294	76	20 2800 920	372	39	20 20 20	20	33	cloudy, 75°
8/18/2003	1020 160 300	366	105	260 440 420	364	70	340 220 260	269	51	cloudy, 90°
8/25/2003	20 40 60	36	118	20 20 220	44	82	100 40 20	43	39	sunny, 80°

Table 3. continued (*E. coli*/100 ml).

	River Raisin @ Davis Rd. (RRD-1)			River Raisin @ M-50 (RRD-2)			River Raisin @ Rightmire Rd. (RRD-3)			
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
9/5/2003	20	29	127	20	20	75	20	20	39	sunny, 70°
	60			20			20			
	20			20			20			
9/8/2003	140	80	167	20	34	84	140	38	45	foggy, 75°
	180		20	20						
	20		100	20						
9/15/2003	20	25	60	120	36	53	20	25	47	partly cloudy, 70°
	20			20			20			
	40			20			40			
9/22/2003	80	40	38	200	178	46	20	25	29	rain, 65° > 3.0"
	40			100			40			
	20			280			20			

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

Municipality	County	Square Miles	Percent
Deerfield Township	Lenawee	25.2	17.2
Summerfield Township	Monroe	21.9	14.8
Blissfield Township	Lenawee	21.0	14.3
Palmyra Township	Lenawee	18.0	12.3
Riga Township	Lenawee	15.2	10.4
Dundee Township	Monroe	13.5	9.2
Raisin Township	Lenawee	11.6	7.9
Ogden Township	Lenawee	10.5	7.2
Village of Dundee	Monroe	3.5	2.4
Ridgeway Township	Lenawee	2.6	1.8
Village of Blissfield	Lenawee	2.3	1.6
Village of Deerfield	Lenawee	0.9	0.6
Village of Petersburg	Monroe	0.5	0.3
TOTAL		147.5	100

Table 5. Discriminant analysis of ribotype profiles of *E. coli* isolates from water sample collected from the River Raisin at US-223 (RRB-2) on August 7, 2003.

Fecal coliform mpn*/100 ml	<i>E. coli</i> isolate number (5 colonies of cultured <i>E. coli</i> were analyzed)	Probable Source
=15	1 2 3 4 5	Non-human Non-human Non-human Non-human Indeterminate

*mpn = most probable number of fecal coliforms in 100 mL of sample after 20 hrs of cultivation at 44.5 degrees Celcius.

Table 6. Permitted outfalls to the River Raisin TMDL watershed. Source: MDEQ, Water Bureau's NPDES Permit Management System.

Facility	Permit Number	Receiving Water	Latitude	Longitude
Blissfield WWTP	MI0021695	River Raisin	41.83940	-83.86290
Deerfield WWTP	MI0023442	River Raisin	41.88750	-83.76972
Dundee WWTP	MI0020401	River Raisin	41.95583	-83.64806

Table 6. continued.

Facility	Permit Number	Receiving Water	Latitude	Longitude
Petersburg WWTP	MIG570217	River Raisin	41.90333	-83.71278
Blissfield Mfg. Co.	MIG250410	River Raisin	41.82389	-83.86111
Great Lakes Insulspan	MIS510069	River Raisin	41.83360	-83.85640
L & W Engineering Plt. 4	MIS510599	River Raisin	41.82150	-83.83790
Nagys Auto Sales #1	MIS510147	River Raisin	41.86440	-83.78690
Nagys Auto Sales #2	MIS510227	River Raisin	41.87500	-83.77920
Riverbend Timber Framing	MIS510070	River Raisin	41.84690	-83.87500
Royster-Clark Inc. - Blissfield	MIS510485	Macon Creek	41.82194	-83.84389
Dundee Castings Co.	MIS510334	River Raisin	41.95830	-83.65830
L & W Eng-Axis Plt – Dundee	MIS510603	Woodruff Drain	41.95690	-83.66000
Bonnie & Clyde – Dundee	MIS510519	River Raisin	41.94810	-83.64920
Dundee Products Co.	MIS510305	River Raisin	41.95830	-83.64580
Dundee Truck & Trim	MIS510443	River Raisin	41.94583	-83.64583
Tompson Prop - Riverbend Villas	MIR108686	----		
Stonebrook – Dundee	MIR108473	----		
BRG Dundee – Arbor Chase	MIR108541	----		
Courtyards of Dundee	MIR108363	----		

Table 6. continued.

Facility	Permit Number	Receiving Water	Latitude	Longitude
Dundee Industrial Subdivision	MIR108223	----		
Adams Lake – Petersburg	MIR106565	----		
Kirkman – Village Park	MIR107112	----		

