

**Michigan Department of Environmental Quality  
Water Bureau  
March 2006**

**Total Maximum Daily Load for *E. coli* for  
East Branch Coon Creek  
Macomb County**

**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 with 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 East Branch Coon Creek, tributary of the Clinton River, located in Macomb County, Michigan.

**PROBLEM STATEMENT**

The TMDL reach for East Branch Coon Creek appears on the Section 303(d) list as:

**EAST BRANCH COON CREEK**

WBID#: 061408C

County: Macomb

Size: 12 M

Location: Highbank Creek confluence to u/s of Armada

HUC: 4090003

RF3RchID: 04090003000016

Problem: CSO, Pathogens (Rule 100); WQS exceedances for D.O.

TMDL YEAR(s): 2006

East Branch Coon Creek 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). *E. coli* sampling by the Macomb County Health Department has revealed frequent and persistent problems with bacterial contamination in many lakes and streams in Macomb County, including East Branch Coon Creek (Macomb County Health Department, 2006). Monitoring data collected by the Michigan Department of Environmental Quality (MDEQ) in 2004 documented exceedances of the WQS for *E. coli* at all sampling locations during the total body contact recreational season of May 1 through October 31 (Figures 1-3, Tables 1 and 2).

**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.

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 coliform per 100 ml as a monthly average is met. This is assumed because *E. coli* is 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 2004 monitoring data indicated exceedances of WQS at all locations sampled.

## DATA DISCUSSION

The East Branch Coon Creek and Highbank Creek, a tributary to the East Branch Coon Creek, were sampled at eight locations in Armada Township in northern Macomb County to address this TMDL listing (Figure 1). Five of the seven sampling stations in the East Branch Coon Creek exceeded the 30-day geometric mean WQS on multiple occasions (Figures 2a and 2b, Tables 1 and 2). Thirty-day geometric mean *E. coli* concentrations in East Branch Coon Creek ranged from 22 *E. coli* per 100 ml in June at Armada Center Road (EBC2) to 672 *E. coli* per 100 ml in August at Main Street west of Fulton (EBC3) (Figures 2a and 2b, Table 1). The daily geometric mean was also exceeded at least once at every sampling location on East Branch Coon Creek. Daily geometric mean concentrations ranged from a low of 20 *E. coli* per 100 ml at Stations EBC2 downstream to EBC6 to a high of 9,706 *E. coli* per 100 ml in August at EBC-3. *E. coli* concentrations of greater than 1,000 per 100 ml were found five times on the East Branch Coon Creek but did not occur more than one time at any single sampling location.

*E. coli* concentrations in Highbank Creek were relatively low throughout the sampling season with only one exceedance of the daily geometric mean. Thirty-day geometric means ranged from 27 *E. coli* per 100 ml on July 15, 2004, to 118 *E. coli* per 100 ml on August 5, 2004. Daily geometric means ranged from 20 *E. coli* per 100 ml on numerous occasions to 623 *E. coli* per 100 ml on July 22, 2004 (Figure 2b, Table 2).

## SOURCE ASSESSMENT

The official listed reach for the East Branch Coon Creek is from the Highbank Creek confluence to upstream of Armada. This 12 mile reach of the TMDL watershed falls within 6 municipalities as shown by the shaded area in Figure 1. Table 3 shows the distribution of land for each municipality.

The primary pathogen sources for this water body are largely nonpoint source pollution related. Agricultural runoff, illicit connections, failing or poorly operating septic systems and urban runoff are all possible sources of *E. coli* to the TMDL watershed.

Agriculture, including grass/pasture, accounts for approximately 80 percent of the land use in the TMDL watershed (Table 4) and can cause bacterial contamination in streams (Purdue University and USEPA, 2005). *E. coli* have been shown to enter water bodies from pastureland runoff and land applications of manure via field drainage systems, such as tiles. Field tiles provide for significant transport of enteric bacteria through tile drainage systems under all manure application protocols and environmental conditions (Jamieson et al., 2002). Overland runoff from land application of manure is another possible source of *E. coli* to surface water (Oliver et al., 2005).

Residential land uses make up a portion (2.5 percent) of the TMDL watershed (Purdue University and USEPA, 2005). Research indicates that bacterial levels in urban runoff exceed public health standards for water contact recreation almost without exception (Schueler, 1987). Source area sampling in Marquette, Michigan, indicated that commercial parking lots, streets, residential lawns, and residential driveways were major source areas for bacteria (Steuer et al. 1997). A large portion of Macomb County utilizes on-site septic systems for waste treatment. One hundred fifty septic systems suspected of failing were investigated in Macomb County in 2003 (Macomb County, 2003). Thirteen percent of all sewage disposal evaluations in Macomb County in 2004 and 2005 failed inspection (Macomb County, 2005). In a study by Francy et al. (2000), the presence of septic systems near a surface water sampling site was positively correlated with the detection of coliforms.

There are nine NPDES permitted discharges to the East Branch Coon Creek, or its tributaries, in the TMDL reach (Table 5, Figure 3). The individual permit for the Armada Wastewater Treatment Plant (WWTP) authorizes the discharge of treated sanitary waste. The WWTP has a limit for fecal coliform and when the facility is meeting their fecal coliform permit limit, it is assumed the WQS for *E. coli* will be met in the discharge. The Municipal Separate Storm Sewer System (MS4) permit for the Michigan Department of Transportation (MDOT) and Macomb County includes a prohibition of discharges that would cause an exceedance of WQS. The two general storm water permitted discharges require an evaluation of the potential for polluting materials to runoff to the receiving water, such as runoff from areas where animals are known to congregate. This information is used by the permittee to estimate the annual load of pollutants to the water body and identify the level of control necessary to comply with the TMDL. The four notices of coverage (NOCs) under permit-by-rule authorize storm water discharges from construction activity and are not considered a significant source of *E. coli*. Table 5 contains information on the general permits and the permits-by-rule. There are no combined sewers or concentrated animal feeding operations in the East Branch Coon Creek TMDL Watershed.

## LINKAGE ANALYSIS

Determining the link between the *E. coli* concentrations in East Branch Coon Creek and the potential sources is 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 East Branch Coon Creek during all weather conditions (i.e., wet and dry weather events). Potential sources include agricultural runoff, illicit connections, failing or poorly operating septic systems, and urban runoff.

To further investigate the potential sources mentioned above, a load duration curve analysis was developed for each sampling station as outlined in a paper by Cleland (2002). A load duration curve is a relatively new method utilized in TMDL development and considers how flow conditions relate to a variety of pollutant sources (point and nonpoint sources).

The load duration curves for each station sampled on East Branch Coon Creek are included in Appendix A. The United States Geological Survey gage used to determine the load duration curves discussed here is located on East Branch Coon Creek at Armada, downstream of Prospect Avenue (gage number 04164300). The data indicate that exceedances of the WQS are noted during both wet and dry events. Several exceedances, or near exceedances, are observed during dry weather events, such as those found at EBC1 – EBC5 (Appendix A1-A5) (note that dots above the curve to the middle and right side of the figures indicate WQS exceedances during dry weather conditions [lower flows] and dots above the curve on the left side of the figure are indicative of WQS exceedances during wet weather conditions [higher flows]). The results found during low flow periods may be due to failing septic systems upstream of Armada and/or illicit connections in Armada. The WQS exceedances observed during higher flow events at station EBC1 may be indicative of agricultural runoff upstream of Armada (Appendix A1). Exceedances observed at station EBC3 in Armada and immediately downstream at stations, EBC4 and EBC5 are likely due to urban runoff from Armada (Appendices A3-A5).

The guiding water quality management principle used to develop the TMDL was that compliance with the numeric pathogen target in East Branch Coon Creek 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 East Branch Coon Creek 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 WQS Rules R 323.1082 (Mixing zones) and R 323.1090 (Applicability of water quality standards). In general, the lowest monthly 95 percent 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 East Branch Coon Creek 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

Table 5 outlines the nine permitted point source discharges to the listed reach of East Branch Coon Creek. The discharges include two individual permits, three general permits and four NOC's under one permit-by-rule. The Armada WWTP is permitted to discharge sanitary waste. As previously stated, the WWTP has limits for fecal coliform and when the facility is meeting their fecal coliform permit limit, it is assumed the WQS for *E. coli* will be met in the discharge. The individual MS4 permit for MDOT statewide permit and the Macomb County MS4 requires the permittee to reduce the discharge of pollutants to the maximum extent practicable and employ best management practices to comply with TMDL requirements. The MS4 permit requirements include an Illicit Discharge Elimination Plan (IDEP) and a voluntary Public Education Plan, a Storm Water Pollution Prevention Initiative, a Public Participation Process, a Watershed Management Plan, and a revised Storm Water Pollution Prevention Initiative. The remaining two general permitted discharges are required to establish a Storm Water Pollution Prevention Plan (SWPPP). If a source of *E. coli* is found, the permittee is required to address the pollutant in their SWPPP. The NOCs, due to the nature of the discharges, are not a source of *E. coli* to the TMDL watershed. No illicit connections were found; however, if an illicit connection to East Branch Coon Creek is discovered, the discharge will be eliminated and therefore the discharge will not be included in the WLA. The WLA for the above mentioned permits is equal to 130 *E. coli* per 100 ml as a 30-day geometric mean and 300 *E. coli* per 100 ml as a daily geometric mean during the recreational season between May 1 and October 31.

### LAs

Because this TMDL is concentration-based, the LA is equal to 130 *E. coli* per 100 ml as a 30 day geometric mean and a daily geometric of 300 *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. The majority of the TMDL reach lies in Macomb County. The municipalities making up the largest portion of the watershed are Richmond (30.8 percent) and Armada Townships (28.2 percent).

## 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 seven stations on East Branch Coon Creek and one station on Highbank Creek, a tributary to the East Branch Coon Creek, from May through September 2004 (Table 1). Future monitoring will take place as part of the 5-year rotating basin monitoring as resources allow. 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 Armada WWTP is responsible for meeting its NPDES permit limits for fecal coliform. Compliance is determined based on review of Discharge Monitoring Report data by the MDEQ. The WWTP is presently meeting its permit limits for fecal coliform.

The general industrial storm water permits identified in Table 5 require that if there is a TMDL established by the MDEQ for the receiving water that restricts a material that could impair or degrade water quality, then the required storm water pollution prevention plan shall identify the level of control for those materials necessary to comply with the TMDL and an estimate developed of the current annual load of those materials via storm water discharges to the receiving stream.

The MDOT statewide permit requires the permittee to reduce the discharge of pollutants to the maximum extent practicable and employ best management practices to comply with TMDL requirements.

Macomb County is in the fourth year of required activities under their MS4 storm water permit. East Branch Coon Creek, which falls in the North Branch Clinton River subwatershed, was granted deferment from many requirements of the MS4 permits because only a small portion of the watershed is urbanized (Macomb County, 2005). Many watershed management activities are voluntary, with exception to the IDEP. The Macomb County Public Works Office is the entity responsible for sampling all legally established county drain outfalls to locate illicit discharges. The MS4 permit requires activities that reduce *E. coli* inputs to surface water by finding and eliminating sources in the subwatersheds, such as in East Branch Coon Creek. In addition, Macomb County has a point of sale regulation that requires on-site sewage disposal and/or on-site water supply systems be evaluated prior to property transfer. This program identifies and requires correction for on-site sewage disposal systems that may be failing or working improperly. Proper maintenance of sewage disposal systems prevents *E. coli* from entering surface and ground water. In 2004 and 2005, 726 septic repair permits were issued (Macomb County, 2005).

The village of Armada began a sewer mapping project in 2004 as part of the village's storm sewer separation project that involved video reconnaissance of their entire storm sewer collection system. This process identified a number of illicit sewer collections that have been or are in the process of being removed from the village's storm water collection system. In addition, an illicit sewer connection was found and removed from the Woodbeck Drain which is tributary to the East Branch Coon Creek.

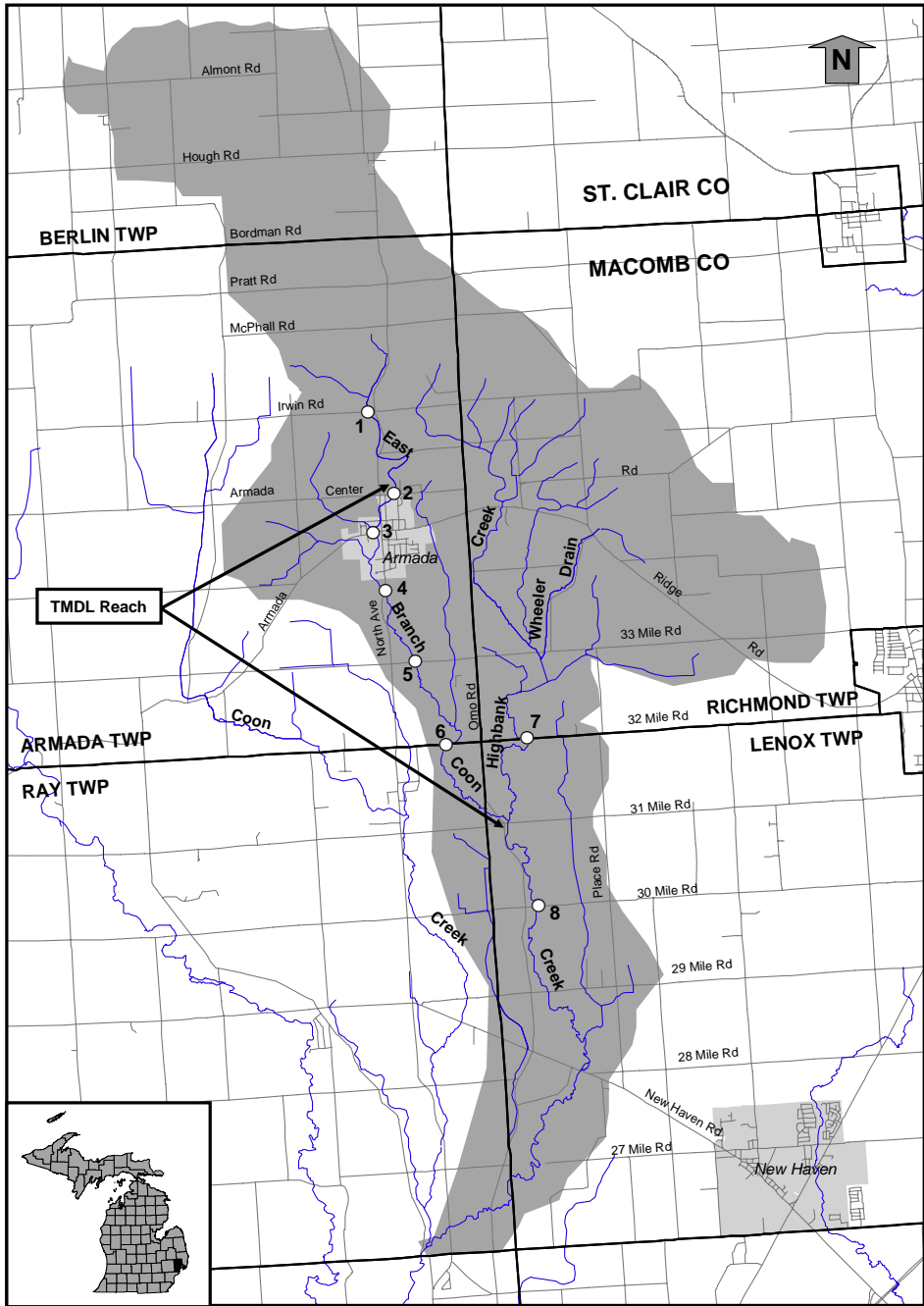
The Macomb County Health Department conducts weekly *E. coli* monitoring at 64 locations in the county, two of which are located on East Branch Coon Creek and one on High Bank Creek. Samples are collected in relation to rain events or in areas where potential water quality problems are anticipated (i.e., combined sewer overflows). These data were used by the MDEQ to choose sample locations for the development of this document and is available to the public at the following link: <http://macombcountymi.gov/publichealth/surfacesamples.asp>.

A stakeholder meeting was held on April 11, 2006, at the Lenox Township Hall in New Haven, Michigan. Stakeholders were determined by identifying municipalities (i.e., counties, townships, and cities) in the TMDL watershed. Copies of the draft TMDL were available upon request and posted on the MDEQ's Web site. Copies of the draft TMDL were also sent out with the stakeholder meeting invitations and available at the stakeholder meeting.

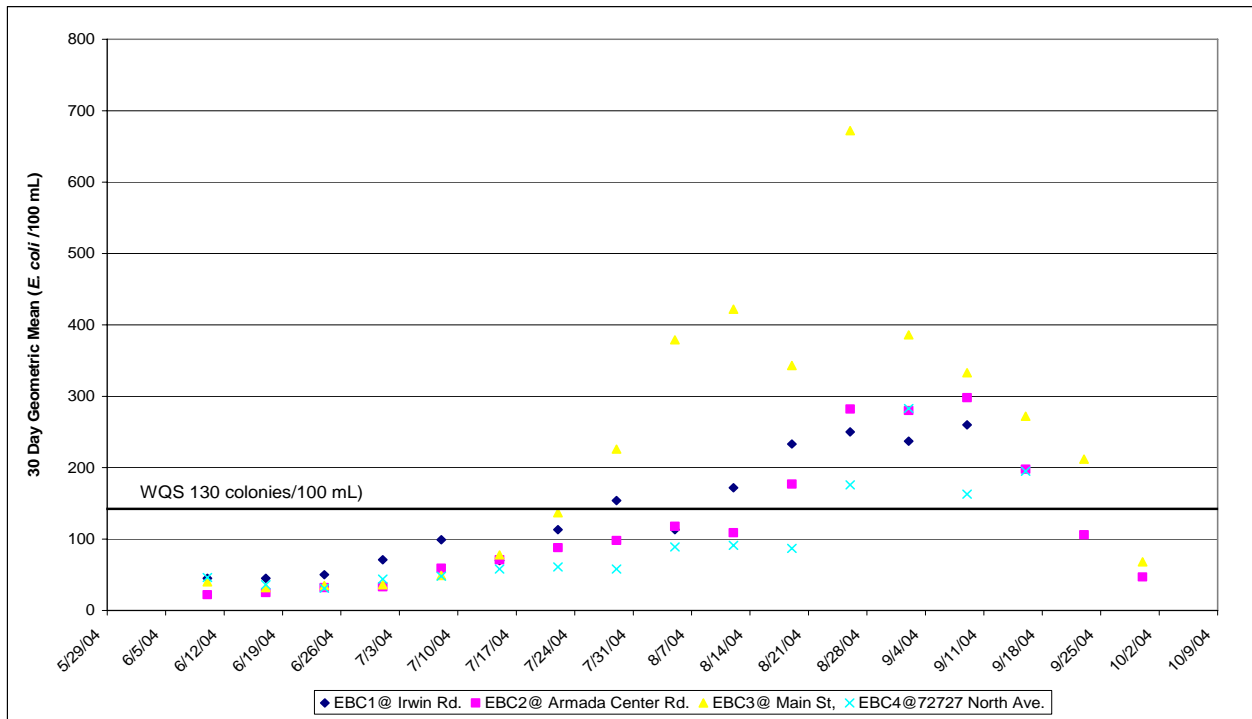
Prepared by: Jeff Cooper and Christine Alexander, Aquatic Biologists  
Surface Water Assessment Section  
Water Bureau  
Michigan Department of Environmental Quality  
March 31, 2006

## REFERENCES

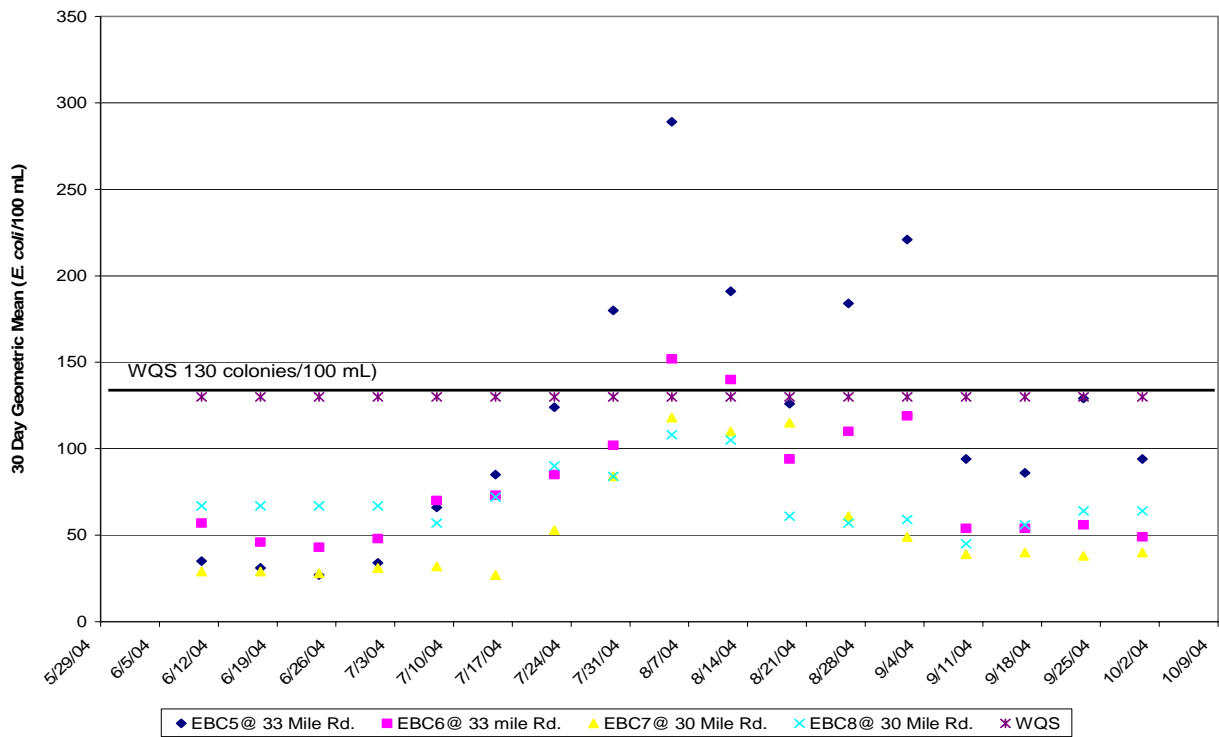
- American Public Health Association. 1995. Standard Methods for the Examination of Water and Wastewater. 19th Edition.
- Cleland, B. 2002. TMDL Development from the “Bottom Up” – Part II. Using Duration Curves to Connect the Pieces. America’s Clean Water Foundation.
- Francy, D.S., D. Helsel, and R. Nally. 2000. Occurrence and distribution of microbiological indicators in groundwater and stream water. *Water Environment Research* 72:2: 152-161.
- Jamieson, R.C., R.J. Gordon, K.E. Sharples, G.W. Stratton, and A. Madani. 2002. Movement and Persistence of Fecal Bacteria in Agricultural Soils and Subsurface Drainage Water: A Review. *Canadian Biosystems Engineering*, Volume 44.
- Macomb County, 2003. Macomb County, Michigan, NPDES Phase 2 Watershed Permit Annual Report – Year 2 (August 1, 2002 – July 31, 2003). Certificate of Coverage MIG610052.
- Macomb County, 2005. Macomb County, Michigan, NPDES Phase 2 Watershed Permit Annual Report – Year 2 (October 1, 2004– September 30, 2005). Certificate of Coverage MIG610052.
- Macomb County Health Department, 2006. Macomb County Health Department Surface Water Sampling sites. <http://macombcountymi.gov/publichealth/surfacesamples.asp>.
- Oliver, D.M., L. Heathwaite, P.M. Haygarth, and C.D. Clegg. 2005. Transfer of *Escherichia coli* to Water from Drained and Undrained Grassland after Grazing. *Journal of Environmental Quality* 34: 918-925.
- Purdue University and USEPA. Long-Term Hydrological Impact Assessments (L-THIA) Web site, November 9, 2005. <http://www.ecn.purdue.edu/runoff/lthianew>
- Schueler, T.R. 1987. Controlling Urban Runoff: A practical manual for planning and designing urban BMPs. Department of Environmental Programs. Metropolitan Washington Council of Governments. Water Resource Planning Board.
- Steuer, J., W. Selbig, N. Hornewer and J. Prey. 1997. Sources of contamination in an urban basin in Marquette, Michigan and an analysis of concentrations, loads, and data quality. USGS Water Resources Investigation Report 97-4242, Middletown, MI 26pp.
- United States Department of Agriculture, 1986. Urban Hydrology for Small Watersheds. Technical Release 55.
- USEPA. 2001. Protocol for Developing Pathogen TMDLs. United States Environmental Protection Agency, 841-R-00-002.
- Whitman, R. Personal Communication. United States Geological Survey, October 2001.
- Wolf, S. and J. Wuycheck. 2004. Water Quality and Pollution Control in Michigan: 2004 Sections 303(d) and 305(b) Integrated Report. Michigan Department of Environmental Quality, Report Number MI/DEQ/WD-04/029.



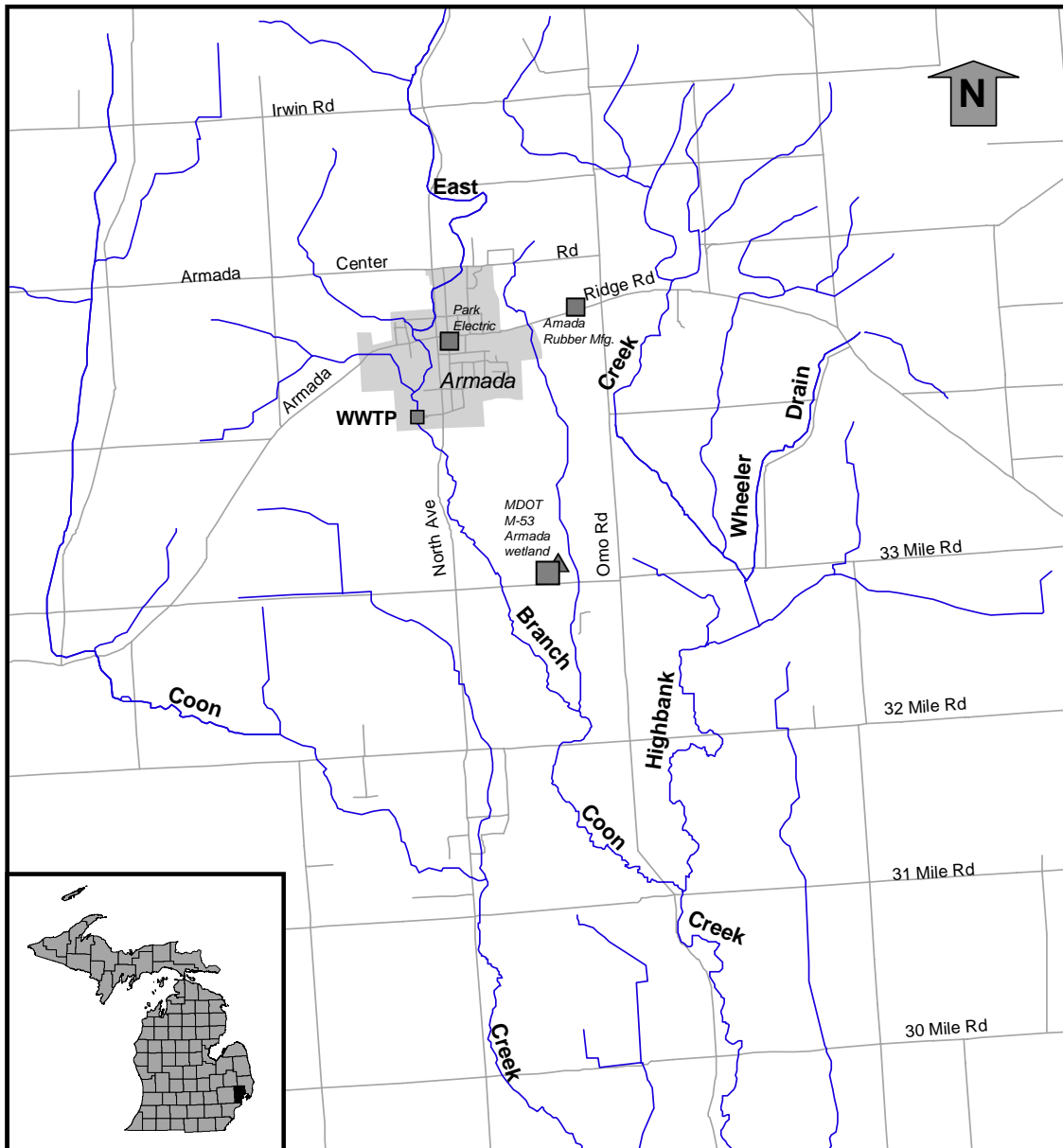
**Figure 1. East Branch Coon Creek *E. coli* sampling locations, including High Bank Creek, in the vicinity of Armada, Macomb County, Michigan, 2004.**



**Figure 2a. Thirty-day geometric mean for *E. coli* in the East Branch Coon Creek in Macomb County Michigan, 2004 at stations EBC1 – EBC4.**



**Figure 2b. Thirty-day geometric mean for *E. coli* at sampling Stations EBC5, EBC6, and EBC8 in the East Branch Coon Creek and Station EBC7 in Highbank Creek, all in Macomb County Michigan, 2004.**



**Figure 3: East Branch Coon Creek NPDES locations in northern Macomb County, Michigan, 2004. (Note: figure does not contain permits-by-rule and the MDOT MS4 permit).**

**Table 1. MDEQ 2004 *E. coli* monitoring data (*E. coli*/100 ml) for East Branch Coon Creek in northern Macomb County. Shaded areas indicate exceedances of the WQS. Data are presented upstream to downstream. Note: precipitation is noted for 24 hours preceding sampling.**

DATE	East Branch Coon Ck. EBC1@Irwin Rd.			East Branch Coon Ck. EBC2@ Armada Center Rd.			East Branch Coon Ck. EBC3@Main St. west of Fulton			Precip. data
	SAMPLE RESULT S	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULT S	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULT S	DAILY G. MEAN	30-day G. MEAN	
5/12/2004	29 60 20	33		20 20 20	20	---	20 100 120	62		0.04
5/18/2004	20 40 20	25	---	20 20 20	20	---	20 360 20	52	---	0.2
5/28/2004	20 20 60	29	---	20 20 60	29	---	160 180 20	83	---	0
6/3/2004	20 180 100	71	---	20 20 20	20	---	20 20 20	20	---	0
6/10/2004	20 200 360	113	45	20 20 20	20	22	20 20 20	20	40	1.06
6/17/2004	80 20 20	32	45	20 80 40	40	25	20 20 20	20	32	0.24
6/24/2004	20 20 180	42	50	20 80 200	68	32	20 80 320	80	35	0
7/1/2004	20 800 320	172	71	20 120 20	36	33	20 20 2500	100	36	0
7/8/2004	280 1620 120	379	99	400 340 380	372	59	180 20 220	93	49	0.51
7/15/2004	20 20 20	20	70	20 300 20	49	71	20 660 580	197	78	0.08

**Table 1. MDEQ 2004 *E. coli* monitoring data (*E. coli*/100 ml) continued**

DATE	East Branch Coon Ck. EBC1@Irwin Rd.			East Branch Coon Ck. EBC2@ Armada Center Rd.			East Branch Coon Ck. EBC3@Main St. west of Fulton			Precip. 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	
7/22/2004	360	123	92	360	117	88	440	336	137	0.59
	20			220			180			
	260			20			480			
7/29/2004	160	114	113	20	116	98	600	968	226	0.04
	460			120			1180			
	20			650			1280			
8/5/2004	380	824	154	20	93	118	1220	1324	379	0.91
	1840			60			2800			
	800			680			680			
8/12/2004	60	78	113	200	241	109	20	158	422	0.08
	100			320			300			
	80			220			660			
8/19/2004	140	168	172	560	565	177	60	70	343	0
	240			460			20			
	140			700			280			
8/26/2004	500	564	233	5400	1208	282	5400	9706	672	0
	620			480			10200			
	580			680			16600			
9/2/2004	60	160	250	20	113	280	20	61	386	0
	200			890			560			
	340			80			20			
9/9/2004	480	629	237	20	126	298	980	632	333	0.08
	740			20			560			
	700			5000			460			
9/16/2004	60	125	260	20	32	198	120	58	272	0
	180			80			20			
	180			20			80			
9/23/2004	*	*	*	20	25	106	20	20	212	0
				40			20			
				20			20			
9/30/2004	20	20	**	20	20	47	20	32	68	0
	20			20			20			
	20			20			80			

\*Site not sampled due to stagnant conditions

\*\* 30 day geometric mean not calculated

**Table 1. MDEQ 2004 *E. coli* monitoring data (*E. coli*/100 ml) continued**

DATE	East Branch Coon Ck. EBC4@72727 North Ave.			East Branch Coon Ck. EBC5@ 33 Mile Rd. East of North Ave.			East Branch Coon Ck. EBC6@33 Mile Rd. West of OMO Rd.			Precip. 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	
5/12/2004	120	66		20	36	---	20	61		
	120			60			140			
	20			40			80			
5/18/2004	20	88	---	140	38	---	100	34	---	1.3"
	80			20			20			
	420			20			20			
5/28/2004	20	25	---	20	42	---	120	81	---	0.5"
	40			180			20			
	20			20			220			
6/3/2004	480	58	---	20	20	---	60	29	---	0.9"
	20			20			20			
	20			20			20			
6/10/2004	20	25	46	20	43	35	320	124	57	0.6"
	20			20			300			
	40			200			20			
6/17/2004	20	20	36	20	20	31	20	20	46	0
	20			20			20			
	20			20			20			
6/24/2004	140	38	31	20	20	27	20	25	43	0.5"
	20			20			40			
	20			20			20			
7/1/2004	40	146	44	80	134	34	200	142	48	2.3"
	300			380			60			
	260			80			240			
7/8/2004	20	90	48	260	549	66	220	188	70	0
	20			600			500			
	1800			1060			60			
7/15/2004	760	67	58	440	147	85	600	150	73	0
	20			360			20			
	20			20			280			

**Table 1. MDEQ 2004 *E. coli* monitoring data (*E. coli*/100 ml) continued**

East Branch Coon Ck. EBC4@72727 North Ave.			East Branch Coon Ck. EBC5@ 33 Mile Rd. East of North Ave.				East Branch Coon Ck. EBC6@33 Mile Rd. West of OMO Rd.			
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	Precip. data
7/22/2004	40	25	61	20	137	124	20	44	85	0
	20			360			220			
	20			360			20			
7/29/2004	20	29	58	260	125	180	20	63	102	0
	60			380			620			
	20			20			20			
8/5/2004	1480	1256	89	1400	1456	289	1460	1046	152	0
	1340			1620			800			
	1000			1360			980			
8/12/2004	20	104	91	20	68	191	300	124	140	0
	400			200			320			
	140			80			20			
8/19/2004	20	52	87	20	20	126	20	20	94	0
	360			20			20			
	20			20			20			
8/26/2004	700	849	176	700	849	184	140	100	110	0
	1120			1120			120			
	780			780			60			
9/2/2004	640	313	283	640	313	221	20	90	119	0
	100			100			600			
	480			480			60			
9/9/2004	40	50	163	20	20	94	20	20	54	0
	20			20			20			
	160			20			20			
9/16/2004	*	*	195	20	44	86	60	129	54	0
	*			20			180			
	*			220			200			
9/23/2004	320	160	**	400	447	129	20	25	56	0
	640			700			40			
	20			320			20			
9/30/2004	200	353	**	300	113	94	80	50	49	0
	380			20			40			
	580			240			40			

\*Site not sampled due to stagnant conditions

\*\* 30 day geometric mean not calculated

**Table 1. MDEQ 2004 *E. coli* monitoring data (*E. coli*/100 ml) continued**

East Branch Coon Ck. EBC8@30 Mile Rd. east of OMO Rd.				
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Precip. data
5/12/2004	40	32	---	
	40			
	20			
5/18/2004	140	106	---	1.3"
	140			
	60			
5/28/2004	20	42	---	0.5"
	180			
	20			
6/3/2004	20	98	---	0.9"
	140			
	340			
6/10/2004	20	101	67	0.6"
	20			
	2600			
6/17/2004	40	32	67	0
	40			
	20			
6/24/2004	140	106	67	0.5"
	140			
	60			
7/1/2004	20	40	67	2.3"
	20			
	160			
7/8/2004	20	44	57	0
	220			
	20			
7/15/2004	300	326	72	0
	580			
	200			

**Table 1. MDEQ 2004 *E. coli* monitoring data (*E. coli*/100 ml) continued**

<b>East Branch Coon Ck. EBC8@30 Mile Rd. east of OMO Rd.</b>				
<b>DATE</b>	<b>SAMPLE RESULTS</b>	<b>DAILY G. MEAN</b>	<b>30-day G. MEAN</b>	<b>Precip. data</b>
<b>7/22/2004</b>	40 120 180	95	90	0.59
<b>7/29/2004</b>	520 40 20	75	84	0.04
<b>8/5/2004</b>	580 20 260	144	108	0.91
<b>8/12/2004</b>	20 140 20	38	105	0.08
<b>8/19/2004</b>	20 20 100	34	61	0
<b>8/26/2004</b>	20 20 200	43	57	0
<b>9/2/2004</b>	400 80 20	86	59	0
<b>9/9/2004</b>	20 160 20	40	45	0.08
<b>9/16/2004</b>	240 280 20	110	56	0
<b>9/23/2004</b>	60 240 20	66	64	0
<b>9/30/2004</b>	20 200 20	43	64	0

**Table 2. MDEQ 2004 *E. coli* monitoring data (*E. coli*/100 ml) for Highbank Creek, a tributary of East Branch Coon Creek, in northern Macomb County, Michigan. Shaded areas indicate exceedances of the WQS. Note: precipitation is noted for 24 hours preceding sampling.**

Highbank Creek EBC7@30 Mile Rd. east of OMO Rd.				
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Precip. data
5/12/2004	20	20		
	20			
	20			
5/18/2004	20	20	---	1.3"
	20			
	20			
5/28/2004	20	25	---	0.5"
	40			
	20			
6/3/2004	20	42	---	0.9"
	20			
	180			
6/10/2004	20	48	29	0.6"
	280			
	20			
6/17/2004	20	20	29	0
	20			
	20			
6/24/2004	20	20	28	0.5"
	20			
	20			
7/1/2004	120	36	31	2.3"
	20			
	20			
7/8/2004	20	48	32	0
	20			
	280			
7/15/2004	20	20	27	0
	20			
	20			

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

<b>Highbank Creek                      EBC7@30 Mile Rd. east of OMO Rd.</b>				
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Precip. data
<b>7/22/2004</b>	260	623	53	0.59
	1080			
	860			
<b>7/29/2004</b>	80	197	84	0.04
	280			
	340			
<b>8/5/2004</b>	140	194	118	0.91
	2600			
	20			
<b>8/12/2004</b>	100	34	110	0.08
	20			
	20			
<b>8/19/2004</b>	20	25	115	0
	20			
	40			
<b>8/26/2004</b>	40	25	61	0
	20			
	20			
<b>9/2/2004</b>	80	71	49	0
	20			
	220			
<b>9/9/2004</b>	220	56	39	0.08
	40			
	20			
<b>9/16/2004</b>	40	40	40	
	40			
	40			
<b>9/23/2004</b>	20	20	38	
	20			
	20			
<b>9/30/2004</b>	40	32	40	
	20			
	40			

**Table 3. Distribution of land for each municipality in the East Branch Coon Creek TMDL reach.**

<b>Municipality</b>	<b>County</b>	<b>Square Miles</b>	<b>Percent</b>
Richmond Township	Macomb	14.2	30.8
Armada Township	Macomb	13.0	28.2
Berlin Township	St. Clair	7.6	16.5
Lenox Township	Macomb	7.6	16.5
Ray Township	Macomb	2.9	6.3
Armada	Macomb	0.8	1.7
<b>TOTAL</b>		<b>46.1</b>	<b>100</b>

**Table 4. Distribution of land use in the East Branch Coon Creek TMDL reach.**

<b>Land use Classification</b>	<b>Hydrologic Soil Group*</b>	<b>Area (acres)</b>	<b>Percent of Watershed</b>
Water	n/a	488	4.0%
Commercial	C	20	0.1%
Agriculture	C	7944	64.0%
High Density Residential	C	40	0.3%
Low Density Residential	C	267	2.2%
Grass / Pasture	C	2002	16.1%
Forest	C	1651	13.3%
Total TMDL Watershed Area (acres)		12,412	

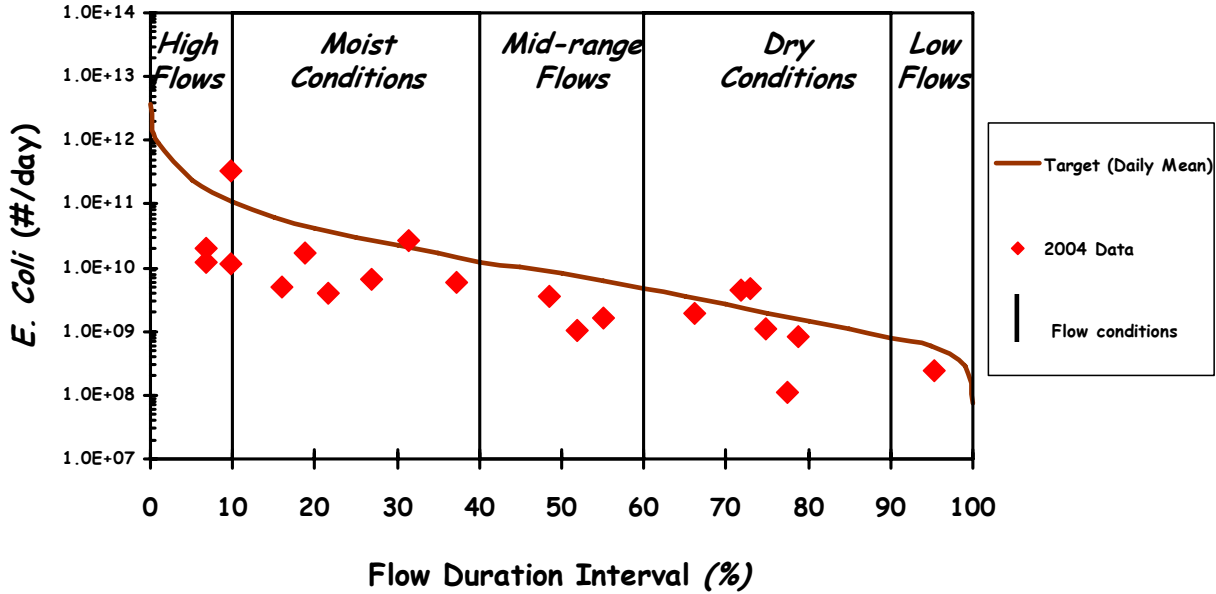
\*Group C soils have low infiltration rates when wet and consist chiefly of soils having a layer that impedes downward movement of water with moderately fine to fine texture (USDA, 1986).

**Table 5. Permitted discharges to the East Branch Coon Creek TMDL watershed. Source: MDEQ, Water Bureau's NPDES Permit Management System. Outfall locations are illustrated in Figure 4.**

<b>Facility</b>	<b>Number</b>	<b>County</b>	<b>Receiving Water</b>	<b>Latitude</b>	<b>Longitude</b>
<b>Individual Permit</b>					
MDOT MS4	MI0057364	Statewide	---	---	---
Armada WWTP	MI0022225	Macomb	East Branch Coon Ck.	42.8358	-82.8861
<b>MIS110000 General Permit</b>					
<b>Storm water from industrial activities</b>					
Armada Rubber Mfg.	MIS110066	Macomb	East Branch Coon Ck.	42.8463	82.8677
Park Electric	MIS110962	Macomb	East Branch Coon Ck.	42.8436	82.8833
<b>MIG610000 General Permit</b>					
<b>Municipal Separate Storm Sewer System</b>					
Macomb County MS4	MIG610052	Macomb	Countywide		
<b>Permit-by-Rule (R323.2190)</b>					
<b>Storm water discharges from construction activities</b>					
Ansana Castle Court	MIR109178	Macomb	---	---	---
Blakes-Agg Irrigation Pond	MIR106865	Macomb	---	---	---
John Deere Landscapes	MIR106428	Macomb	---	---	---
MDOT M-53 Armada Wetland	MIR110383	Macomb	---	---	---

## APPENDIX A

# E. Br. Coon Creek at Irwin Rd. Load Duration Curve (2004 Monitoring Data) Site: EBC1

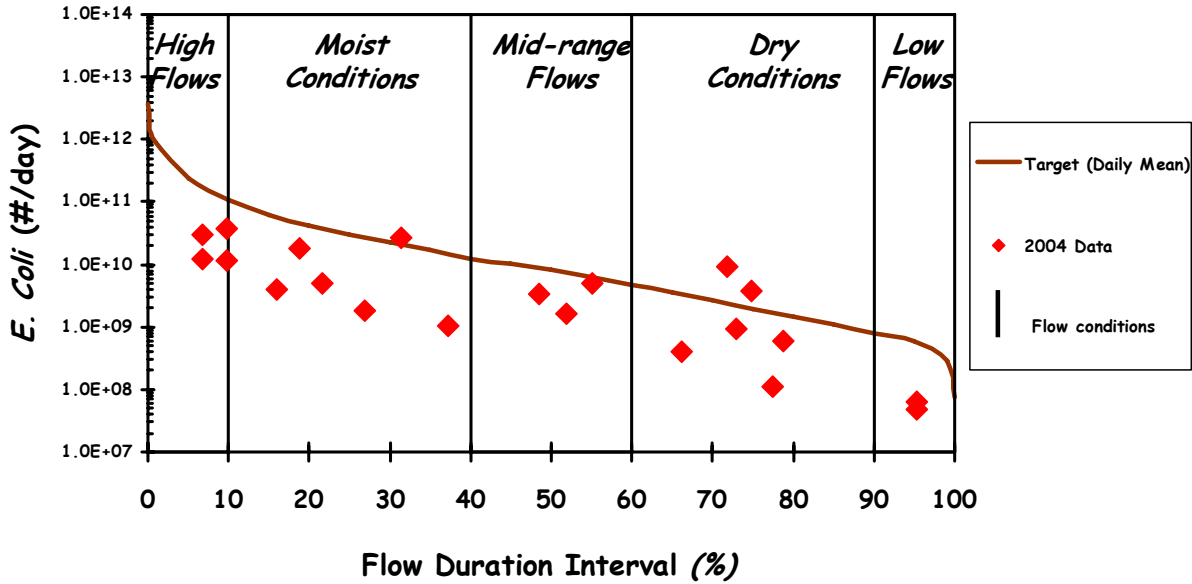


*E. Coli Data & USGS Gage Duration Interval*

*13 square miles*

A-1. East Branch Coon Creek at Irwin Road. Load duration curve based on daily geometric mean. Site: EBC1.

# E. Br. Coon Creek at Armada Center Rd. Load Duration Curve (2004 Monitoring Data) Site: EBC2

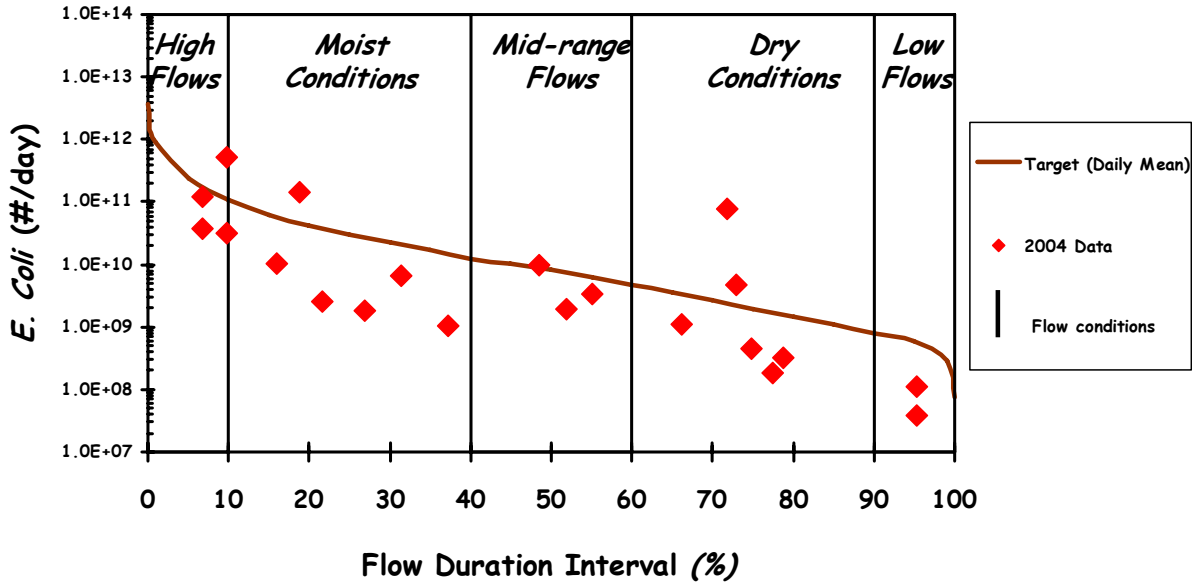


*E. Coli Data & USGS Gage Duration Interval*

*13 square miles*

A-2. East Branch Coon Creek at Armada Center Road. Load duration curve based on daily geometric mean.  
Site: EBC2.

# E. Br. Coon Creek at Main St. Load Duration Curve (2004 Monitoring Data) Site: EBC3



*E. Coli Data & USGS Gage Duration Interval*

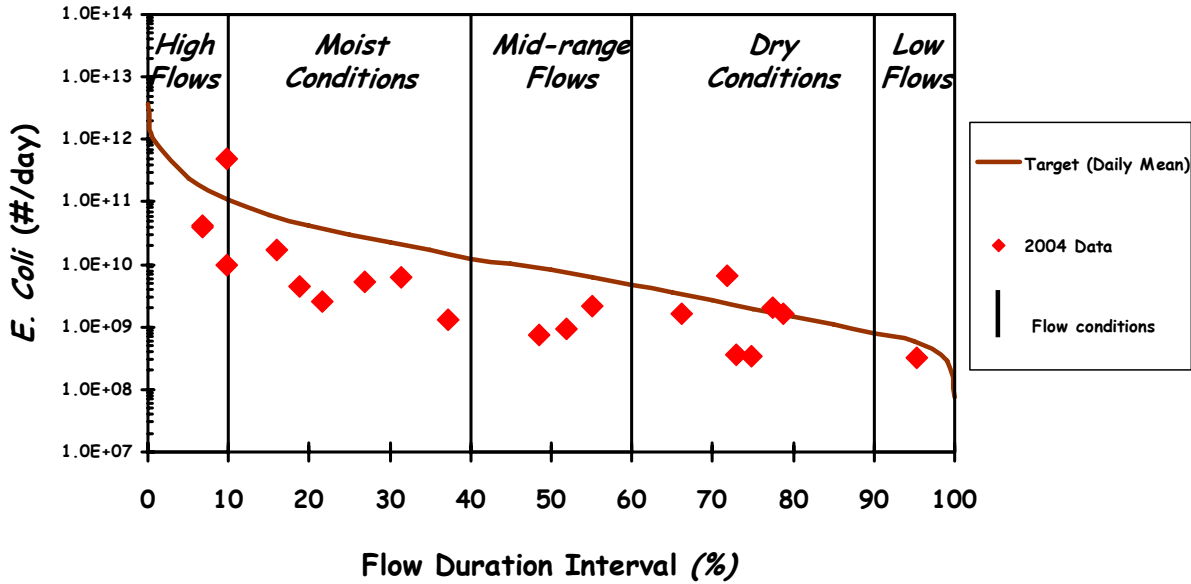
*13 square miles*

A-3. East Branch Coon Creek at Main Street. Load duration curve based on daily geometric mean. Site: EBC3.

# E. Br. Coon Creek at 72727 North Ave.

## Load Duration Curve (2004 Monitoring Data)

### Site: EBC4

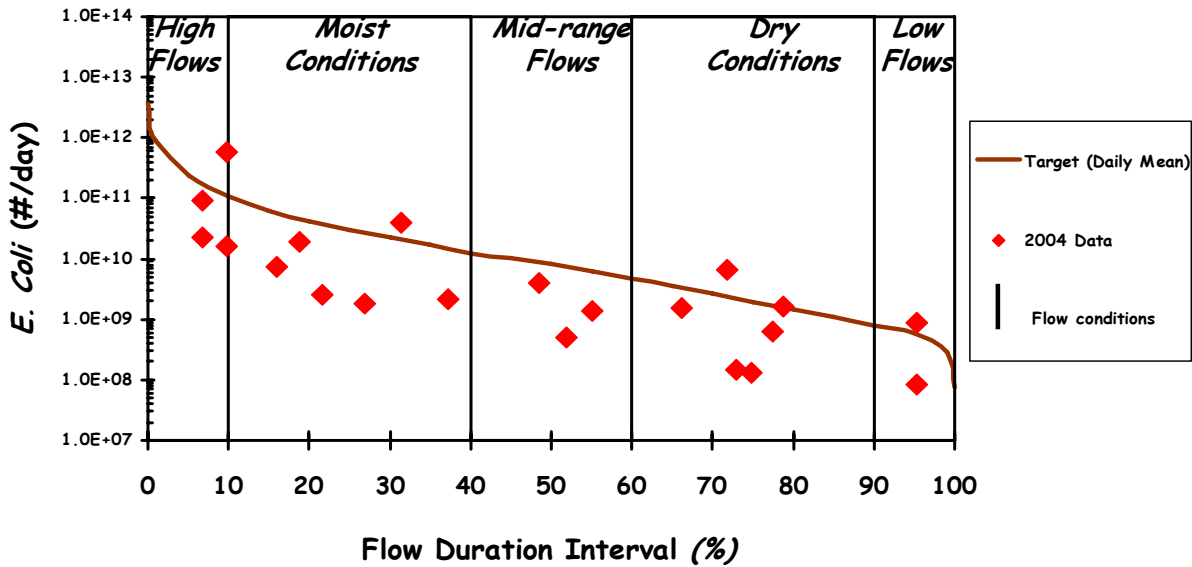


*E. Coli Data & USGS Gage Duration Interval*

*13 square miles*

A-4. East Branch Coon Creek at 72727 North Avenue. Load duration curve based on daily geometric mean.  
Site: EBC4.

**E. Br. Coon Creek at 33 Mile Rd. east of North Ave.  
 Load Duration Curve (2004 Monitoring Data)  
 Site: EBC5**

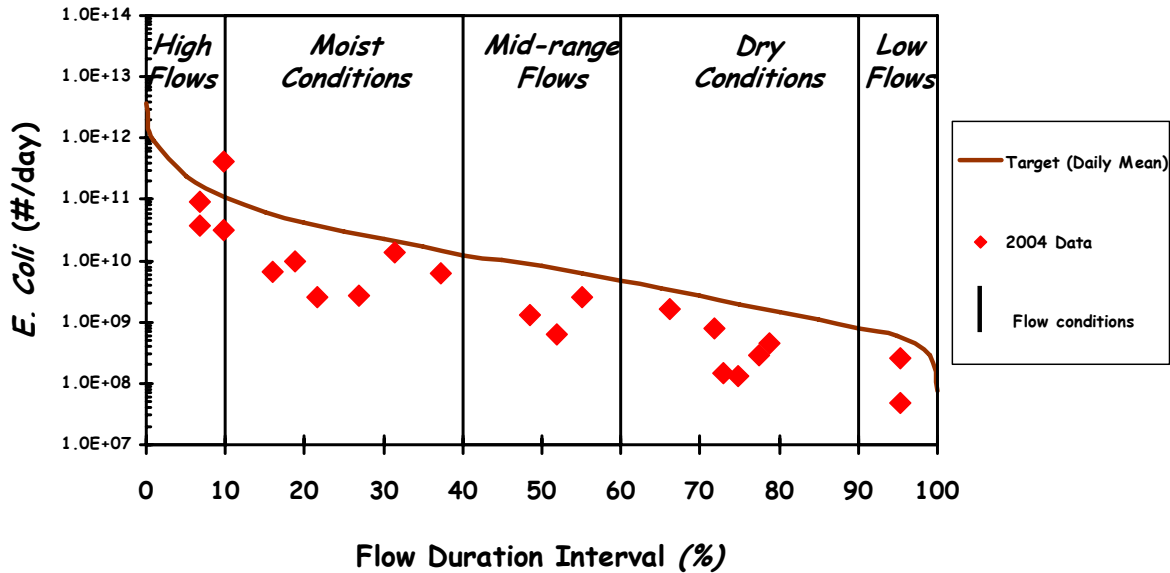


*E. coli Data & USGS Gage Duration Interval*

*13 square miles*

A-5. East Branch Coon Creek at 33 Mile Road east of North Avenue. Load duration curve based on daily geometric mean.  
 Site: EBC5.

**E. Br. Coon Creek at 33 Mile Rd. west of Omo Rd.  
 Load Duration Curve (2004 Monitoring Data)  
 Site: EBC6**

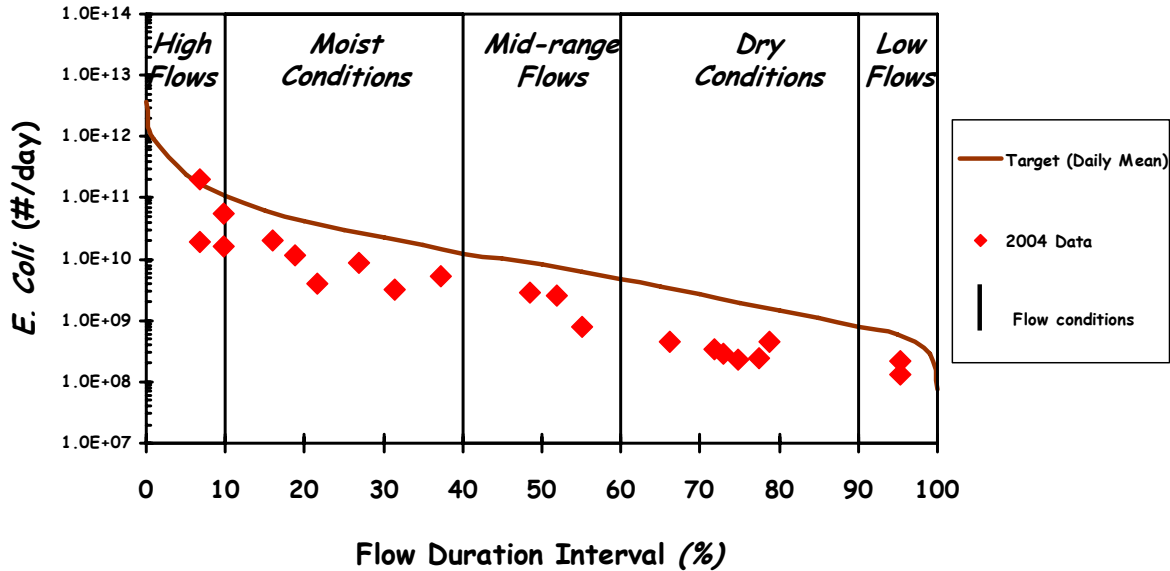


*E. coli Data & USGS Gage Duration Interval*

*13 square miles*

- A-6. East Branch Coon Creek at 33 Mile Road west of Omo Road. Load duration curve based on daily geometric mean.  
 Site: EBC6.

# E. Br. Coon Creek at 30 Mile Rd. Load Duration Curve (2004 Monitoring Data) Site: EBC8



*E. Coli Data & USGS Gage Duration Interval*

*13 square miles*

A-7. East Branch Coon Creek at 30 Mile Road. Load duration curve based on daily geometric mean. Site: EBC8.