Michigan Department of Environmental Quality

Water Bureau

Total Maximum Daily Load for *E. coli* For the Ecorse River Watershed

Wayne County, Michigan

Public Notice Draft
May 8, 2008

1.0 INTRODUCTION

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (U.S. EPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, 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 non-point sources to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the allowable levels of *E. coli* that will result in the attainment of the applicable WQS in the Ecorse River, located in Wayne County, Michigan.

2.0 PROBLEM STATEMENT

The TMDL reach for the Ecorse River appears on the Section 303(d) list as:

ECORSE RIVER AUID#: 040900040501-01
County: WAYNE Size: 41.89 miles
Location: Ecorse River watershed
Use impairments: partial and total body contact recreation
Cause: *E. coli*

The Ecorse River including the North and South Branches of Ecorse Creek was placed on the Section 303(d) list during the 1998 listing cycle due to impairment of recreational uses as indicated by the presence of elevated levels of *E. coli.* It also appears on the most recent 2008 303(d) list (LeSage and Smith, 2008). The source of the impairment is untreated sewage discharges. The 2008 Integrated Report incorrectly identifies the source as combined sewer overflows. This error will be corrected for the 2010 Integrated Report. Monitoring data collected by the Michigan Department of Environmental Quality (MDEQ) in 2007 confirmed exceedences of the WQS for *E. coli* at all sampling locations during the total body contact recreational season of May 1 through October 31. Elevated *E. coli* levels have been observed through the years in sampling conducted on this water body.

The Ecorse River watershed drains 27,672 acres (43 square miles) of Wayne County, Michigan and watershed is home to approximately 160,000 people. There are two primary watercourses within the Ecorse River watershed; the North Branch of Ecorse Creek extends 17 miles in the northern portion of the watershed and the South Branch Ecorse Creek (also known as the Sexton-Kilfoil Drain) extends 13 miles draining the southern portion of the watershed. In addition to these two open watercourses, the LeBlanc Drain, an enclosed storm sewer, runs 9.6 miles and drains the central portion of the watershed.

3.0 NUMERIC TARGET

The impaired designated uses addressed by this TMDL are total and partial 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 is to be protected for total body

contact recreation from May 1 to October 31 and year round for partial body contact recreation. 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, as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during 5 or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of 3 or more samples taken at 2 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 milliliters. Compliance shall be based on the geometric mean of 3 or more samples taken during the same sampling event at representative locations within a defined sampling area. Rule 62(2) All surface waters of the state protected for partial body contact recreation shall not contain more than a maximum of 1,000 E. coli per 100 milliliters. Compliance shall be based on the geometric mean of 3 or more samples, taken during the same sampling event, at representative locations within a defined sampling area.*

The target for sanitary wastewater discharges is:

> *Rule 62. (3) Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 milliliters, based on the geometric mean of all of 5 or more samples taken over a 30-day period, nor more than 400 fecal coliform bacteria per 100 milliliters, based on the geometric mean of all of 3 or more samples taken during any period of discharge not to exceed 7 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 (APHA, 1995). Fecal coliform concentrations are substantially higher than *E. coli* concentrations alone when the wastewater of concern is sewage (Whitman, 2001). Therefore, it can reasonably be assumed that there are fewer 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 targets for this TMDL are 300 *E. coli* per 100 ml expressed as a daily maximum load and concentration from May 1 to October 31 (i.e., daily target) and 130 *E. coli* per 100 ml as a 30-day geometric mean, expressed as a concentration (i.e., monthly target). An additional target is the partial body contact standard of 1,000 *E. coli* per 100 ml as a daily maximum concentration year round. Achievement of the total body contact daily maximum target is expected to result in attainment of the partial body contact standard.

3.1 Linkage Analysis

Determining the link between the *E. coli* concentrations in the Ecorse River and the potential sources is necessary to develop the TMDL. TMDLs must be established at a level necessary to attain and maintain the applicable WQS. In Michigan, the applicable total body contact recreation WQS for *E. coli* consists of 2 criteria values: a daily maximum of 300 *E. coli* colony

forming units (cfu) per 100 ml (daily target) and a 30-day geometric mean of 130 *E. coli* cfu per 100 ml (monthly target). A partial body contact WQS of 1,000 *E. coli* cfu per 100 ml applies year round. Because the waste load allocations (WLA) - the loading associated with point source discharges - provided herein are based on the daily target, a linkage analysis is needed to demonstrate these allocations also assure attainment of the monthly target. It is expected that achievement of the total body contact daily maximum target will result in attainment of the partial body contact standard.

The U.S. EPA's development of ambient water quality criteria for bacteria, as contained in the "Ambient Water Quality Criteria for Bacteria – 1986" (U.S. EPA 1986), defines the statistical relationship between the daily maximum and 30-day geometric mean criteria values. The assumption used to develop the 30-day geometric mean of 126 cfu per 100 ml (rounded to 130 cfu per 100 ml as the Michigan criterion) is a log-normal distribution using a log standard deviation of 0.4. Using this assumption and a comparable recurrence interval (e.g., 30 days), a daily maximum projected from the 30-day geometric mean would be 713 cfu per 100 ml. Conversely, the Michigan daily maximum criterion of 300 cfu per 100 ml is comparable to a 30-day geometric mean of approximately 55 cfu per 100 ml. This relationship provides the basis for demonstrating that attaining the daily target in the TMDL will also achieve the monthly target. A further conservative assumption is the log standard deviation of 0.4. The log standard deviation observed in most riverine systems is generally at least 0.3, and often quite larger (Cleland 2006). The greater the variability, the more protective the daily maximum is relative to the monthly target.

Michigan regulates discharges containing treated or untreated human waste (i.e., sanitary wastewater) using fecal coliform. Sanitary wastewater discharges are required to meet 200 fecal coliform per 100 ml as a monthly average and 400 fecal coliform per 100 ml as a maximum. The MDEQ believes the sanitary wastewater discharges are in compliance with the daily and monthly targets and the allocations associated with the daily target, if their NPDES permit limits for fecal coliform are met. The *E. coli* criteria contained in the 1986 document were derived to approximate the degree of protection (i.e., 8 illnesses per 1,000 swimmers) provided by the fecal coliform indicator level of 200 cfu per 100 ml recommended by the U.S. EPA prior to the adoption of the 1986 criteria. All wastewater treatment plants (WWTPs) provide year-round disinfection, providing another level of confidence that these sources will not contribute to *E. coli* WQS exceedences in the receiving waters.

4.0 DATA DISCUSSION

This portion of the document is divided into two main sections: hydrologic data and *E. coli* data. The hydrology section describes the available flow data for the watershed and how flow estimates were made for the ungaged portions of the watershed.

The *E. coli* section presents and summarizes the ambient *E. coli* data that were collected during 2007. Further information on the *E. coli* data collection effort can be found in the document *Detroit River and Ecorse River E. coli Monitoring to Support TMDL Development Final Report*, which is included as Attachment A.

4.1 Hydrology Data

Hydrology data were obtained from the United States Geological Survey (USGS) for gaging station 04168580 on the North Branch Ecorse River at Beech Daly Road. The gage became operational on July 1, 2002, and was established and is operated by the USGS in cooperation with the City of Dearborn Heights. Discharge data from this gage were obtained for the period July 1, 2002 to October 8, 2007. Discharge data were not available for the South Branch Ecorse River, LeBlanc Drain, or main branch Ecorse River and were not collected at the *E. coli* sampling stations during routine monitoring conducted in 2007. Therefore, it was necessary to construct flow time series for other locations within the watershed from data collected on the North Branch Ecorse River.

The drainage area ratio (DAR) method is a simple, widely used analytical approach to developing flow time series for ungaged watersheds/sites using flow data from gaged watersheds. The DAR is defined in the following equation.

$$DAR = \frac{A_{ungaged}}{A_{gaged}}$$

Where:

$A_{ungaged}$	=	Area of ungaged watershed/site
A_{gaged}	=	Area of gaged watershed/site

Using the DAR method, flows can be estimated for ungaged watersheds/sites using the following equation.

$$Q_{ungaged} = DAR \times Q_{gaged}$$

Where:

DAR	=	Drainage Area Ratio
Q_{gaged}	=	Discharge at gaged watershed/site
$Q_{ungaged}$	=	Discharged at ungaged watershed/site

The DAR method is most reliable when land use characteristics of the ungaged and gaged watersheds are similar, as is the case for the Ecorse River watershed.

The Ecorse River watershed was divided into 4 drainage areas: Ecorse River, North Branch Ecorse River, South Branch Ecorse River and LeBlanc Drain. Impervious surface area and runoff coefficient values were obtained from the Ecorse River Watershed Management Plan (ECIC 2006) for each drainage area to evaluate differences in watershed hydrology and reduce uncertainty in DAR flow estimates (Table 1). An area-weighted runoff coefficient was calculated for each drainage area as an indicator of watershed yield. The area-weighted coefficients for the South Branch and entire Ecorse River watersheds were then compared to that of the North Branch to determine if its watershed yield (i.e. hydrology) is substantially different. The area-weighted runoff coefficient for the entire watershed was calculated by summing the results from all four drainage areas.

Using this watershed yield analysis, the flows estimated from the drainage area ratio method were adjusted based on differences in watershed yield. The South Branch flows were increased by a factor of 1.13 [(0.326-0.288)/0.288], while flows estimated for the entire Ecorse River watershed were increased by a factor of 1.05 [(0.302-0.288)/0.288] to adjust for differences in watershed yield. Table 2 contains the drainage areas, drainage area ratios, and correction factors used to develop the flow time series.

The resulting flow time series and flow duration curves for each monitoring station and the mouth of the Ecorse River are provided in Attachment B. Figures B1 through B11 show the estimated flow time series for each monitoring station. The time series are for the period 7/1/2002 to 10/8/07; however, only the flow data for the total body contact recreation season were used to construct the flow duration curves. The flow duration curves (Figures B12 to B14) display the statistically determined flow that exceeds a specific percentage of time. For example, the 95% exceedence flow represents a flow expected to be exceeded 95% of the time and, therefore, represents low flow conditions. A 5% exceedence flow would be expected to be exceeded only 5% of the time and, therefore, represents high flow conditions. The plotted flows and flow percentiles are tabulated in Table B1 of Attachment B.

Table 1. Total Impervious Area and Runoff Coefficients by Land Use Category[1]

	Ecorse River		North Branch		South Branch		LeBlanc Drain	
Land Use	Area (ac)	Runoff Coefficient	Area (ac)	Runoff Coefficient	Area (ac)	Runoff Coefficient	Area (ac)	Runoff Coefficient
Low Density Residential	13043.1	0.219	5192.2	0.219	2971.4	0.219	4879.5	0.219
Medium Density Residential	0.0	0.390	0.0	0.390	0.0	0.390	0.0	0.390
High Density Residential	539.9	0.513	127.1	0.513	325.8	0.513	87	0.513
Transportation	2284.5	0.526	976.4	0.526	993	0.526	315.1	0.526
Commercial	3291.1	0.556	1260.6	0.556	876	0.556	1154.5	0.556
Mixed Residential/ Commercial	0.0	0.473	0.0	0.473	0.0	0.473	0.0	0.473
Forest & Rural Open	2101.3	0.067	1096.5	0.067	613.8	0.067	391	0.067
Wetland	2183.7	0.072	1282.1	0.072	665.8	0.072	235.8	0.072
Water	151.4	0.95	10.6	0.95	132.1	0.95	8.7	0.950
Active Agriculture	1281.7	0.068	609.7	0.068	643.3	0.068	28.7	0.068
Urban Open	754.4	0.148	313.7	0.148	197.8	0.148	242.9	0.148
Industrial	2192.4	0.733	999.9	0.733	739.4	0.733	453.1	0.733
Area-Weighted Runoff Coefficients[2]		0.302		0.288		0.326		0.300

[1]From Ecorse Creek Watershed Management Plan, Appendix G-2 (ECIC 2006) for total impervious area
[2]The area-weighted runoff coefficients were calculated from land use areas and runoff coefficients reported in the Ecorse Creek Watershed Management Plan

Table 2. Drainage Areas, Drainage Area Ratios (DAR) and Correction Factors used to develop Flow Time Series Data at Ungaged Sites

Location	Area (sq miles)	DAR	Correction Factor
North Branch of Ecorse Creek			
At USGS Gaging Station 04168580	10.0	1.00	0
Confluence with South Branch	18.3	1.83	0
EC4 - Smith Street	4.0	0.40	0
EC3 - Beech Daly Road	9.9	0.99	0
EC2 - Pelham Road	13.5	1.35	0
EC1 - Fort Street	15.7	1.57	0
South Branch of Ecorse Creek			
Confluence with North Branch	12.8	1.28	1.13
EC7 - Beech Daly Road	5.1	0.51	1.13
EC6 - Pelham Road	8.8	0.88	1.13
EC5 - Fort Street	11.9	1.19	1.13
Ecorse River			
EC0 - Main stem at W. Jefferson Ave.	43.3	4.33	1.05

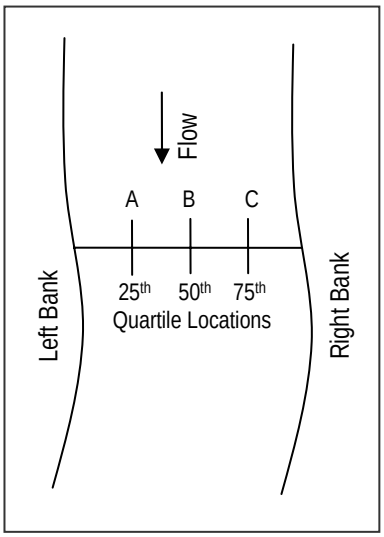
4.2 *E. coli* Data

4.2.1 Study Design

Eleven sites were monitored for *E. coli* in the Ecorse River watershed: four sites on the North Branch, three sites on the South Branch, three on the LeBlanc Drain and one on the Main stem of the Ecorse River near its outlet to the Detroit River. A subset of these sites was also evaluated for the presence of *E. coli* from human sources using bacterial source tracking analysis. The sampling site locations are depicted in Table 3 and in Figure 1.

All monitoring sites were sampled for *E. coli* for 23 weeks, from May 1, 2007, through October 2, 2007, when positive flow (toward the Detroit River) was present. Sites EC0, EC2, EC4, EC5, EC9 and EC10 occasionally did not display positive river flow (based on visual observation). At those times samples were not collected from these sites.

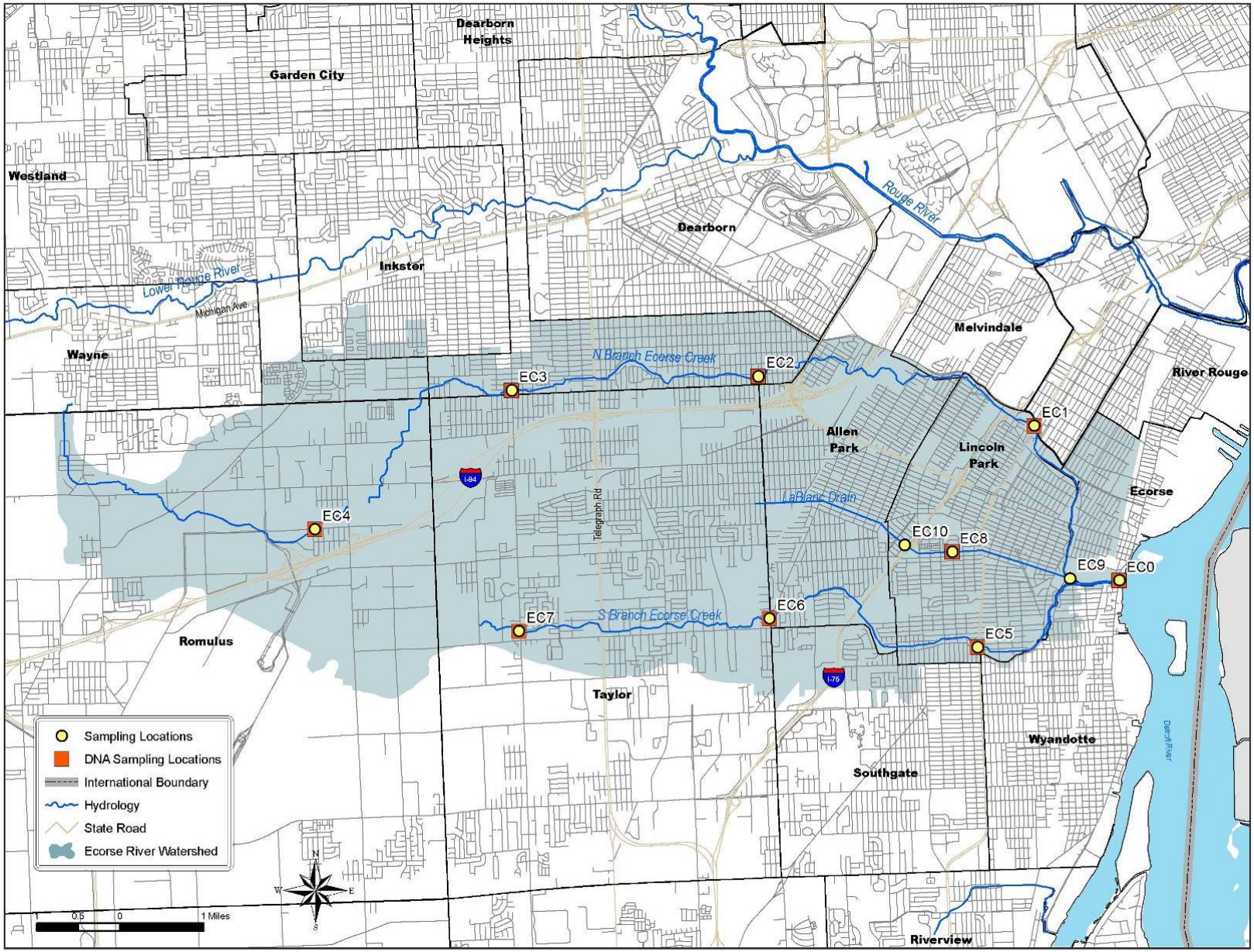
For the North and South Branches of Ecorse Creek, in conformance with Rule 62, three grab samples were taken at every monitoring station. Samples were collected across the stream width at the 25th, 50th and 75th quartile locations identified as A, B and C, respectively (See sidebar). Throughout this document, a single sample result is represented by the geometric mean of the three discrete samples collected across the quartile locations. Compliance with the daily maximum WQS is determined by comparison of any single sample result with the daily maximum WQS.



Depiction of Quartile Locations

Since the LeBlanc Drain is an enclosed storm drain that flows within twin, side by side concrete pipes, it is not considered a surface water of the state to which WQSs apply. Therefore it was only sampled to determine *E. coli* source locations, not to determine compliance with the WQSs. Since it did not appear that the twin pipes of the LeBlanc Drain were hydraulically

Figure 1. Ecorse River Monitoring Locations



connected to one another, discrete samples were collected from each pipe at EC8 and EC10.

An illegal sanitary sewer connection emanating from a mobile home park was discovered discharging to the LeBlanc Drain by the Wayne County Department of Environment in mid-June 2007. This connection was located just upstream of monitoring station EC8B. Upon this discovery, sampling was halted at EC8B, and station EC10 was added about a half of a mile upstream of EC8 to further delineate potential sources.

Backwater conditions from the Detroit River impacted the flow at the LeBlanc Drain (EC9) and on the Main stem of Ecorse River (EC0). Therefore these sites were only sampled for informational purposes, not to determine compliance with the WQSs. As such, only single discrete samples were collected at each site.

A total of 500 grab samples were collected in the watershed during the 23 week study. Seven of the twenty-three monitoring events occurred during wet weather conditions. Wet weather was defined as events with rainfall volumes that totaled 0.2" or more over the 30 hour period that preceded the start of a sampling event.

Table 3. Ecorse River Monitoring Site Descriptions (listed downstream to upstream)

Site ID	Site Description
Ecorse River	
EC0	Main stem at W. Jefferson Ave.
North Branch of Ecorse Creek	
EC4	at Smith Street
EC3	at Beech Daly Road
EC2	at Pelham Road
EC1	at Fort Street
South Branch of Ecorse Creek	
EC7	at Beech Daly Road
EC6	at Pelham Road
EC5	at Fort Street
LeBlanc Drain	
EC10A EC10B	South pipe at Hartwick Road and N. Wayne Street North pipe at Hartwick Road and N. Wayne Street
EC9	Drain outlet at Council Pointe Park
EC8A EC8B	South pipe at Capitol Road and Howard Street North pipe at Capitol Road and Howard Street

4.2.2 *E. coli* Results

The *E. coli* analytical data is presented in a variety of different manners. Summary statistics are provided in tables and graphs displaying the measure of central tendency (number of samples, median and range) for each monitoring site. The distribution of the data is graphically displayed by weather condition in pie charts that are overlaid on the project maps. Spatial variation from location to location was also considered. The frequency of WQS exceedences is also calculated and displayed. All of the raw *E. coli* data and the corresponding daily and monthly geometric means are included in pages C-1 to C-4 of Attachment A.

The *E. coli* concentrations in the North and South Branches of Ecorse Creek were typically very high. The minimum, maximum, median and 90th percentile values for each sampling location are shown in Table 4. Based on the median values, the highest *E. coli* concentrations in the North Branch and South Branch were found at Pelham Road (EC2) and Fort Street (EC5), respectively, where median values were above 5,000 cfu/100mL.

The enclosed LeBlanc Drain concentrations were high as well. The minimum *E. coli* values on the LeBlanc Drain for three of the five sites were above 1,000 cfu/100mL. The median concentration at the Drain outlet (EC9) was 7,000 cfu/100mL. As mentioned earlier, a sanitary sewer from a mobile home park was found discharging upstream of EC8B. Sampling stopped at this site when this illicit connection was discovered.[1] *E. coli* results at EC10A and EC10B (located upstream of the illicit sanitary sewer connection) also were elevated with median results at 5,050 and 30,000 cfu/100mL, respectively.

Table 4. Ecorse River *E. coli* Statistics (sites listed upstream to downstream)

Sampling Sites	*E. coli* Sample Results (cfu/100mL)				
	Number of Values	Minimum	Maximum	Median	90th Percentile
Ecorse River					
EC0 – Main stem at W. Jefferson Ave.	3	2,500*	11,000*	2,900*	9,380*
North Branch Ecorse Creek					
EC4 - Smith Street	17	62	30,300	2,257	7,995
EC3 - Beech Daly Road	23	191	15,715	1,651	11,782
EC2 - Pelham Road	16	22	108,774	5,227	41,051
EC1 - Fort Street	23	136	21,828	1,305	11,703
South Branch Ecorse Creek					
EC7 - Beech Daly Road	23	148	19,480	1,843	4,923
EC6 - Pelham Road	23	17	15,874	2,280	5,825
EC5 - Fort Street	21	1,437	105,762	7,013	31,748
LeBlanc Drain					
EC10A - South pipe at Hartwick Rd. and N. Wayne St.	16	420*	40,000*	5,050*	30,000*
EC10B - North pipe at Hartwick Rd. and N. Wayne St.	14	2,200*	590,000*	30,000*	294,000*
EC8A - South pipe at Capitol Rd. and Howard St.	23	1,100*	180,000*	7,600*	46,000*
EC8B - North pipe at Capitol Rd. and Howard St.	8	5,800*	280,000*	70,000*	203,000*
EC9 - Drain outlet @ Council Pt. Park	9	700*	70,000*	7,000*	30,800*

*Based on single grab sample, not a calculated daily geometric mean

The *E. coli* results were further evaluated based on weather conditions. These values are displayed on box plots that were developed for the North Branch, South Branch and the LeBlanc Drain. Attachment A (page 20) provides guidance on how to interpret box plots. This analysis reveals an unusual phenomenon at some of the monitoring locations. Dry weather values were generally the same as the wet weather values at sites EC2, EC5, EC8 and EC10. In most urban watersheds in southeast Michigan, dry weather values are much lower than wet

[1] It should be noted that this illicit connection was upstream of sampling sites of EC8B, EC9 and EC0 only. No other sampling sites were impacted by this discharge.

weather values. The elevated concentrations during dry weather conditions indicate the presence of significant dry weather sources upstream of these locations (See Figures 2a, 2b and 2c).

The median values of the wet weather samples are fairly constant on the North Branch at around 4,000 to 5,000 cfu/100mL. The median dry weather values were the highest at the Pelham Road site (EC2) at approximately 5,000 cfu/100mL. The dry weather *E. coli* concentrations appear to drop at the next downstream site, Fort Street (EC1), where the median value was around 800 cfu/100mL. On the South Branch, the wet weather median values were in the same range as the North Branch, where they varied between 3,000 and 6,500 cfu/100mL. The highest median dry and wet weather values were at the most downstream location, Fort Street (EC5).

Figure 2a. North Branch Ecorse Creek *E. coli* Results

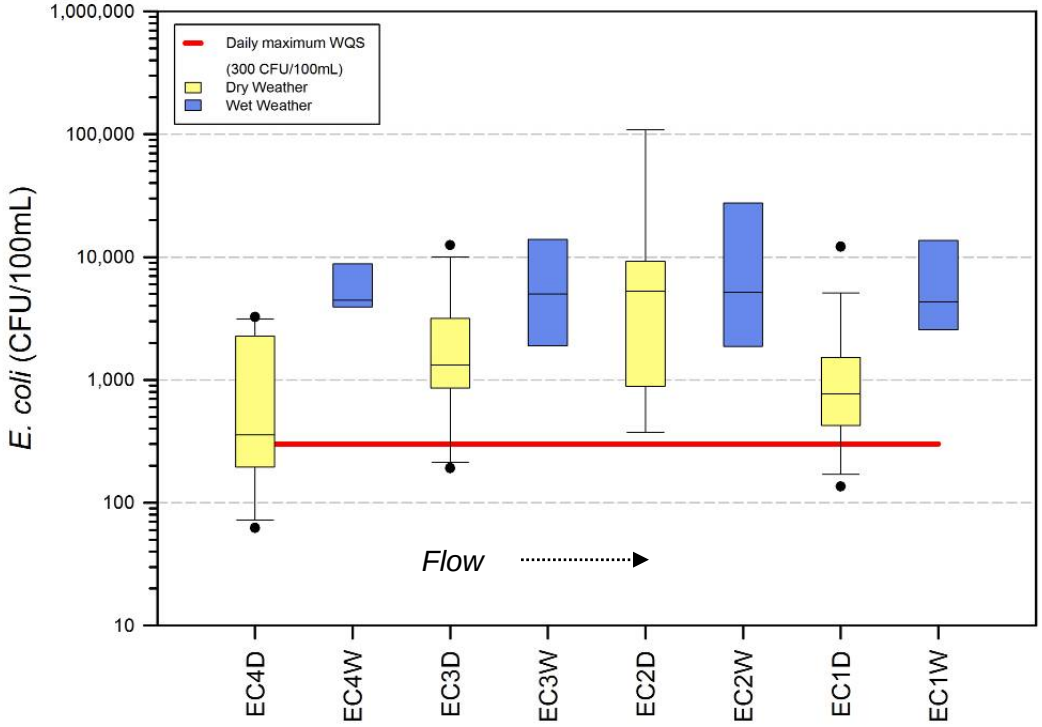


Figure 2b. South Branch Ecorse Creek *E. coli* Results

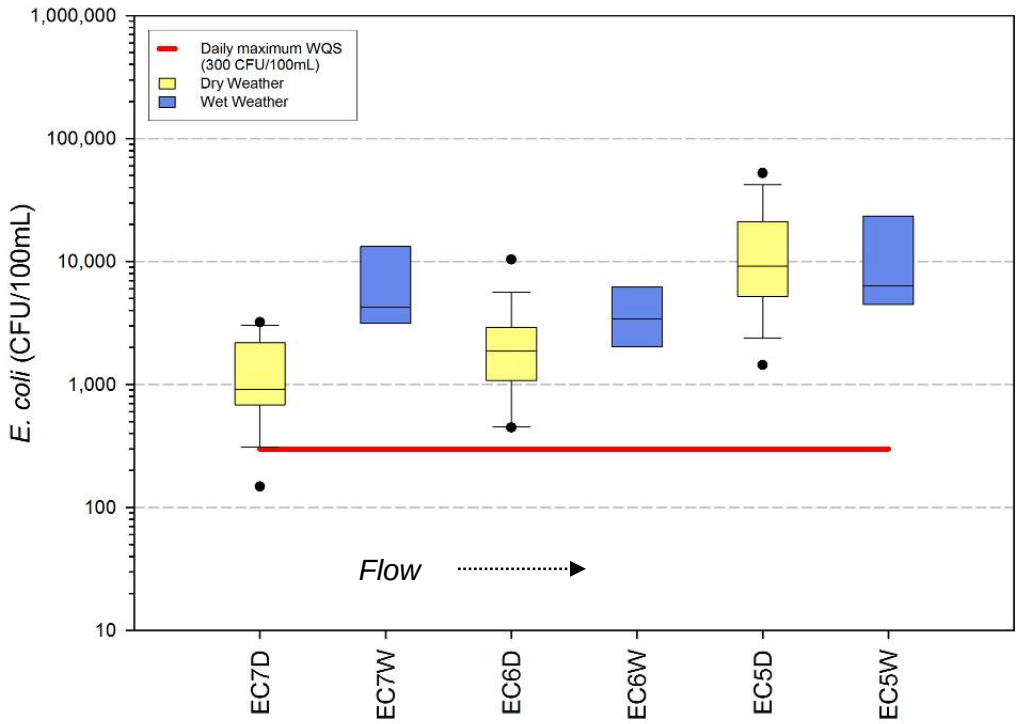
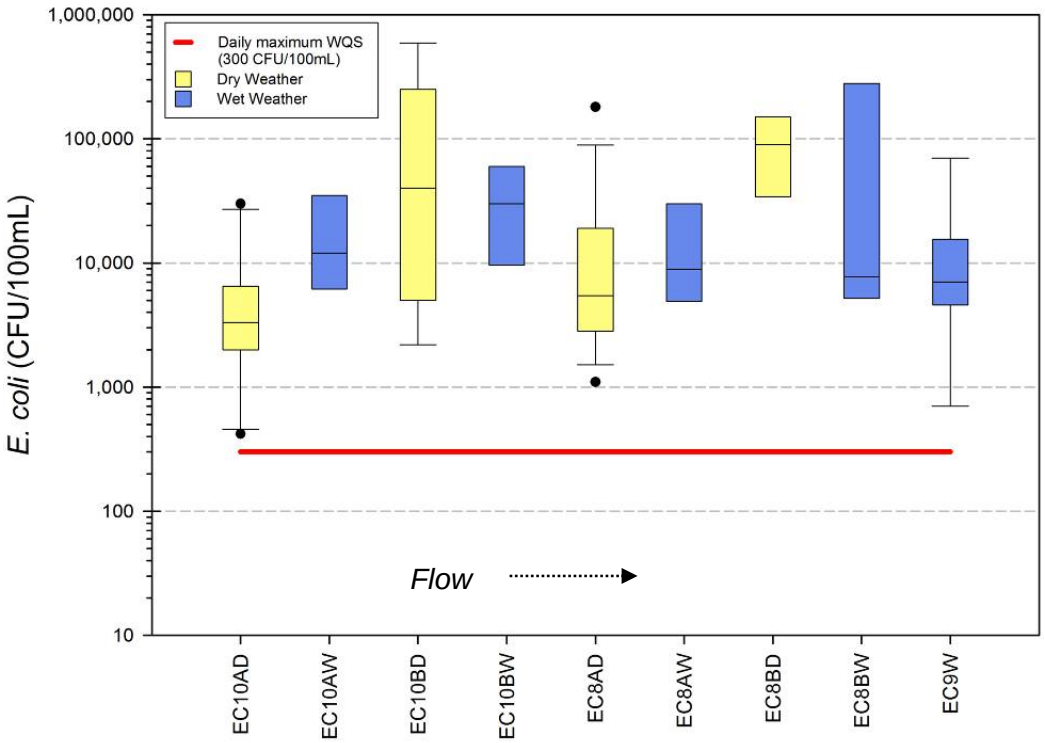


Figure 2c. LeBlanc Drain *E. coli* Results



Analysis of the Ecorse River data revealed that both the North and South Branches of Ecorse Creek rarely met WQSs (See Table 5 and Figures 3a and 3b). Note the LeBlanc Drain samples were not collected for compliance purposes; therefore, they are not included in Table 5 and Figures 3a and 3b. Seventy-six to 100% of the values exceeded the full body contact standard of 300 cfu/100mL and 52% to 100% of the values exceeded Michigan's partial body contact standard of 1,000 cfu/100mL. Further emphasis of the water quality problems are shown in the 30-day geometric mean comparisons, where all of the values exceeded the 30-day standard of 130 cfu/100mL at all sites. Table 5 depicts the comparison of the sample results to the WQSs, while Figures 3a and 3b depict the distribution of the geometric mean data graphically.

Table 5. Ecorse River Water Quality Exceedences

Sampling Sites	Daily Geometric Mean		30-Day Geometric Means	
	Total No. of Values	>300 cfu/100mL (%)	Total No. of Values	>130 cfu/100mL) (%)
North Branch Ecorse Creek				
EC4 - Smith Street	17	76%	6	100%
EC3 - Beech Daly Road	23	91%	19	100%
EC2 - Pelham Road	16	94%	2	100%
EC1 - Fort Street	23	91%	19	100%
South Branch Ecorse Creek				
EC7 - Beech Daly Road	23	96%	19	100%
EC6 - Pelham Road	23	96%	19	100%
EC5 - Fort Street	21	100%	12	100%
Totals	**146**	**92%**	**86**	**100%**

The LeBlanc Drain had higher *E. coli* concentrations than found in the other sampled branches of Ecorse Creek. In fact, 95% of the samples exceeded 1,000 cfu/100mL and 41% of the samples exceeded 10,000 cfu/100mL (See Table 6).

Table 6. LeBlanc Drain *E. coli* Concentration Distribution

Sampling Sites	Total No. of Values	*E. coli* Range (cfu/100mL)			
		0 - 300	301 – 1,000	1,001 – 10,000	> 10,000
EC10A - South pipe at Hartwick Rd. and N. Wayne St.	16	0	2	9	5
EC10B - North pipe at Hartwick Rd. and N. Wayne St.	14	0	0	6	8
EC8A - South pipe at Capitol Rd. and Howard St.	23	0	0	14	9
EC8B - North pipe at Capitol Rd. and Howard St.	8	0	0	3	5
EC9 - Drain outlet	9	0	1	6	2
Totals	**70**	**0**	**3 (4%)**	**38 (54%)**	**29 (41%)**

Figure 3a. Ecorse River Daily Geometric Mean Frequency Distribution – Dry Conditions

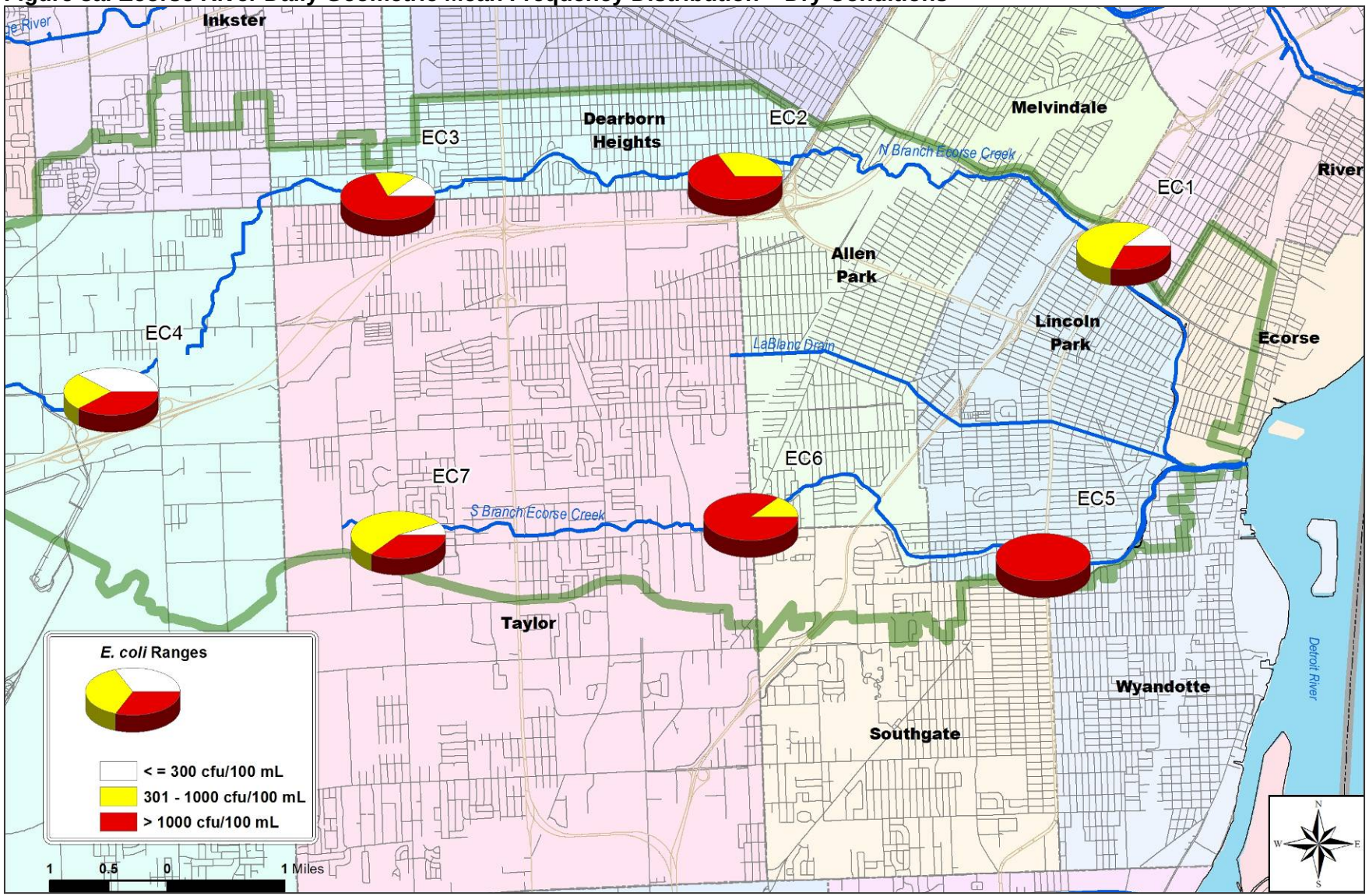
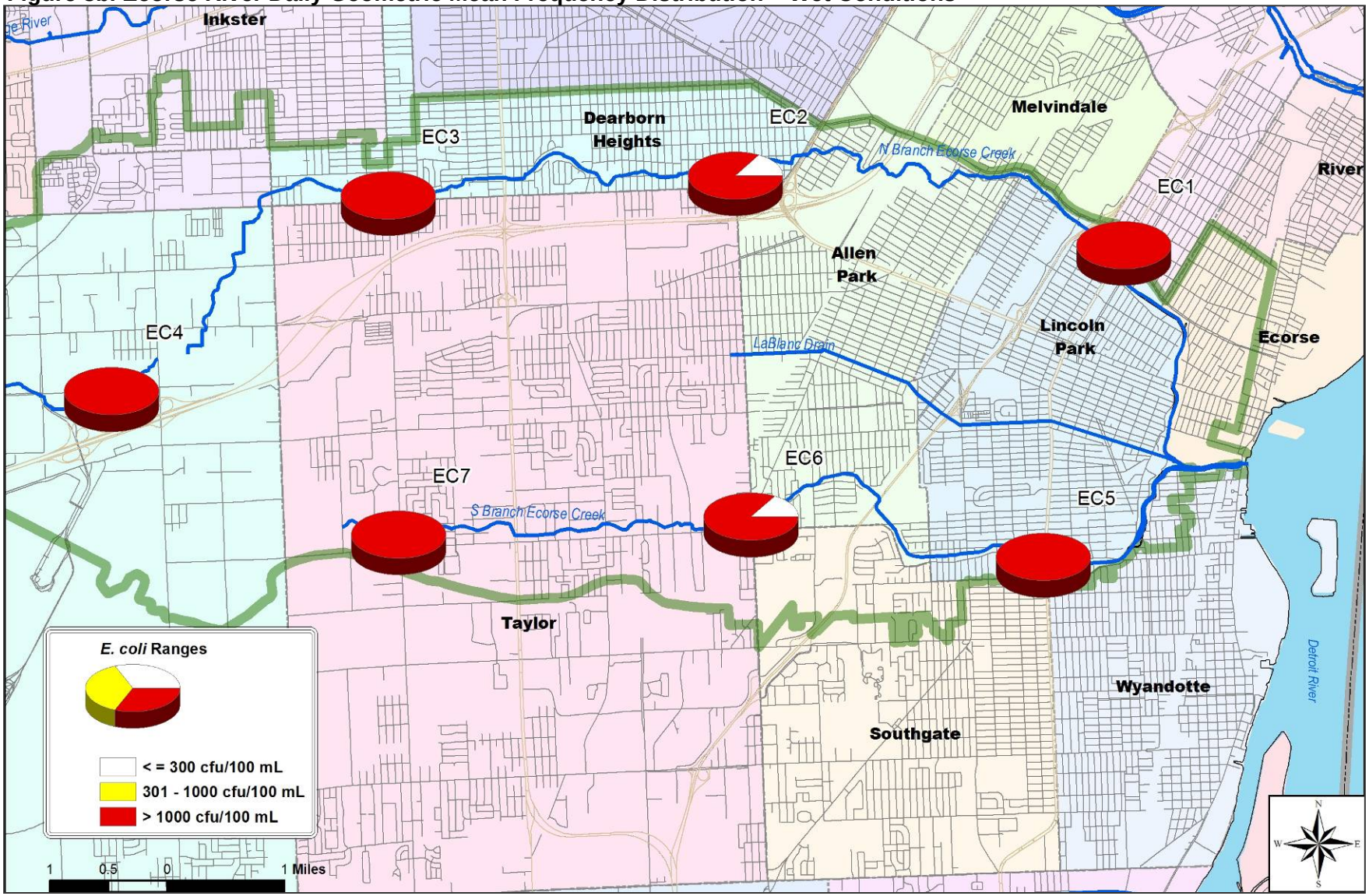


Figure 3b. Ecorse River Daily Geometric Mean Frequency Distribution – Wet Conditions



4.2.3 *E. coli* Results Summary

There were frequent, almost consistent, exceedences of water quality standards on the Ecorse River during the 2007 study. Collectively the North Branch and South Branches of Ecorse Creek exceeded Michigan's WQSs for the daily and 30-day standard 92% and 100% of the time, respectively. Furthermore, seventy-three percent of the daily geometric means were above the partial body contact standard of 1,000 cfu/100mL.

The LeBlanc Drain had higher *E. coli* concentrations than found in the other branches of Ecorse Creek. Ninety-five percent of the samples were above 1,000 cfu/100mL and 41% of the samples were above 10,000 cfu/100mL. These elevated *E. coli* levels were associated with both dry and wet weather conditions.

5.0 SOURCE ASSESSMENT

The section 303(d) listed reach of the Ecorse River watershed is approximately 42 miles. This reach includes open channels: the Main stem, North and South Branches, and eight miles of enclosed channel: the LeBlanc Drain. There are numerous other small open drains and enclosed drains operated by Wayne County and the local communities. The watershed is largely urbanized. Table 7 summarizes the land use distribution within the watershed based on 2000 Data obtained from the Southeast Michigan Council of Governments (SEMCOG 2003).

Potential sources of *E. coli* associated with urban land uses are illicit connections and discharges to storm sewers, domestic pets, wildlife, sanitary sewer overflows, storm sewer infiltration, sanitary sewer leaks, and failing on-site sewage disposal systems.

Table 7. Land Use Distribution within the Ecorse River Watershed

Land Use Category	Total	
	Acres	%
Active Agriculture	1,283	4.6
Commercial Office	1,993	7.2
Extractive	139	0.5
Grassland	2,037	7.3
Industrial	2,054	7.4
Institutional	1,300	4.7
Multiple Family	541	1.9
Outdoor	754	2.7
Single Family	12,762	45.8
Transportation	2,289	8.2
Under Development	287	1.0
Water	152	0.5
Woodland-Grassland	2,250	8.1
Total Drainage Area	**27,841**	**100%**

5.1 NPDES Permits

There are 79 NPDES-permitted discharges in the Ecorse River watershed. The discharges include 3 individual permits and 76 certificates of coverage (COC) under 8 general permits. Many of the NPDES permits authorize the direct discharge of storm water to the Ecorse River. Storm water collection systems concentrate non-point sources of *E. coli* at end-of-pipe discharges and may contain illicit discharges. Attachment C contains a list and map of the NPDES permits.

5.1.1 Combined Sewer Overflow (CSO)/Sanitary Sewer Overflow (SSO)

Combined sewer overflows (CSOs) are wet weather discharges from combined sewer systems that are designed to carry a mixture of raw or inadequately treated sewage and storm water runoff. During wet weather, the flow in combined sewers may exceed the capacity of pipes or the treatment plant. Once capacity is reached, sewage bypasses the system and is discharged directly to a receiving water body. CSOs are permitted discharges that can only exist in sewer systems with combined storm water and sanitary sewers.

Sanitary sewer overflows (SSOs) are wet weather discharges from sanitary sewer systems that contain raw or inadequately treated sewage and some unintended storm water inflow and/or ground water infiltration into the sanitary sewer system. SSOs occur when the capacity of a sanitary sewer system is exceeded. SSOs are illegal events and can occur in any sanitary sewer system served by a wastewater treatment plant.

A combined sewer study was conducted by the Michigan Department of Natural Resources in 1980 (Woods & Boerson 1980). Wet-weather sampling was conducted to evaluate the impacts of CSO discharges on water quality in the Ecorse River. Sampling conducted in April 1980 found fecal coliform counts as high as 380,000 cts/100 ml in the North Branch, 280,000 cts/100 ml in the Le Blanc Drain, and 690,000 cts/100 ml in the South Branch. Combined sewer system outfalls have since been eliminated from the Ecorse River watershed; therefore should no longer be a source of *E. coli*.

SSO events were fairly common in the Ecorse River prior to 2000. Thirteen communities, including all eleven communities in the Ecorse River watershed, own and are served by the Downriver Wastewater Treatment Facility. Wayne County manages the facility (WCDOE 2004b). Wayne County also owns and operates the interceptor and trunk sewers on behalf of the thirteen communities. Each of the thirteen communities owns and operates the lateral and collector sewers that discharge to the county interceptor sewers within their borders.

The expansion of the Downriver Facility in 2001 substantially reduced the number of SSO events. Since 2001 only one SSO was reported to MDEQ. It occurred on February 16, 2005, at the Lincoln Park Retention Basin outfall (MDEQ 2007b), and resulted in the discharge of 2.54 million gallons of partially treated sewage to the Ecorse River. There are seven emergency bypass points within the Downriver Sanitary Collection System in the Ecorse River watershed. Discharges from these points are prohibited unless in accordance with the bypass provision of the NPDES permit. The storm conditions under which the NPDES permit allows discharges were established by an Administrative Consent Order.

5.2 Non-point Sources

There are limited non-point source inputs to the Ecorse River watershed. Agricultural land uses make up approximately 1,283 acres (4.6%) of the watershed. All agricultural land is drained by Wayne County drains that appear to be covered by an municipal separate storm water sewer systems (MS4) general permit. Therefore, any loadings from this land use is attributed to the MS4 portion of the WLA.

5.3 Illicit Connections and Discharges

The following are key illicit discharge terms and their definitions in the Watershed-Based Storm Water General Permits issued in 1999 and 2002 (MDEQ, 2006):

> *Illicit discharge*: Any discharge (or seepage) to the separate storm water drainage system that is not composed entirely of storm water or uncontaminated groundwater.
>
> *Illicit connection*: A physical connection to the separate storm water drainage system that 1) primarily conveys illicit discharges into the system and/or 2) is not authorized or permitted by the local authority (where a local authority requires such authorization or permit).

Illicit connections to storm sewers can result in the discharge of untreated sanitary wastewater to separated sewer systems and surface waters within the Ecorse River watershed. In some cases, an illicit discharge may be a direct discharge of sanitary wastewater from a sanitary sewer improperly discharging to a water body. In other cases wastewater many infiltrate to a storm sewer from a dilapidated sanitary sewer.

Illicit discharges of sanitary wastewater are a dry weather source of *E. coli*. The results of sampling described in Section 4.2 strongly suggest that dry weather sources of *E. coli* are present in the Ecorse River watershed. In fact, an illicit connection was identified emanating from a mobile home park located in the City of Lincoln Park on Dix Highway north of Capitol Street during the 2007 monitoring project. As of December 31, 2007, this connection was discharging sewage via a local storm sewer running along Porter St. to the LeBlanc Drain; however, corrective action is underway.

Illicit discharges were identified when the Wayne County Department of Environment (WCDOE) conducted an illicit connection elimination project between 2002 and 2005 in partnership with nine Ecorse River watershed communities. The program, funded by a Clean Michigan Initiative grant, involved dye testing select businesses in the watershed for illicit connections and conducting an outfall survey on portions of the North and South Branches of Ecorse Creek for signs of illicit discharges.

The project resulted in the identification of 276 illicit connections and 4 illicit discharges from 79 facilities. Two-thirds of these illicit connections originated from a sanitary sewer that was mistakenly connected to the City of Southgate's storm sewer. This sanitary sewer served 37 homes and received drainage from an estimated 37 toilets, 37 showers and 111 sinks. The remaining third of the illicit connections were comprised of connections from floor drains, interior trench drains, interior catch basins and sinks, process water lines, drinking fountains and a sump pump (WCDOE 2005a).

The illicit connections from 64 of the 79 facilities mentioned above, including the ones carrying sanitary wastewater, were corrected by June 2005. The illicit connections at 11 additional facilities were subsequently corrected by February 2008. The corrections are pending at the remaining four facilities with illicit connections (Tuomari 2008).

WCDOE also identified several more areas in the watershed that showed signs of illicit discharges; however due to funding constraints, they were not able to locate the source(s) of these suspicious discharges and subsequently referred the problems to the local communities for follow-up investigations. Table 8 summarizes the additional problems noted during the project (WCDOE 2005a) and their status based on recent communication with WCDOE (Tuomari 2008).

Table 8. Suspect Discharges Discovered during the 2005 Illicit Connection Project

Community	Suspected Problem	Status
Wyandotte	Visual signs of sewage found in the storm sewer. The City identified a broken sanitary sewer infiltrating the storm sewer	City's investigation is ongoing
Westland	A suspicious discharge draining to the North Branch via a storm sewer along Van Born Road was narrowed down to four homes. The City is going to televise the storm sewer to determine the source.	City's investigation is ongoing
Ecorse	Sewage odor detected in three storm sewer manholes where the sanitary sewer crosses through and into the storm sewer	City's investigation is ongoing
Lincoln Park	A suspicious discharge found in a outfall that drains to the North Branch via a storm sewer along Russell Street	Appears corrected based on a recent inspection by WCDOE
Taylor	Residence discharging sewage to South Branch of Ecorse Creek via the Brighton Drain	Resolved
Taylor	A soapy discharge and elevated *E. coli* levels found in a outfall that drains to the South Branch via a storm sewer along Holland Road	City's investigation is ongoing

Given the number of problems previously identified in the Ecorse River watershed, it is suspected that illicit discharges from direct misconnections and poorly maintained sanitary sewers exist and are a major source of the *E. coli* problems in the watershed.

5.4 On-Site Sewage Disposal Systems

Failing on-site sewage disposal systems (OSDSs) can produce illicit discharges containing untreated or partially treated human fecal matter. This can happed when failing OSDSs are located adjacent to water bodies, are seeping into a storm sewer, or have been illegally connected to a storm sewer by the land owner to avoid repair or replacement costs.

The Wayne County Health Department estimates that there are 10,000 active septic systems in the County (WCDOE 2007). Active septic systems are concentrated in Huron, Sumpter, and Van Buren Townships. Systems are present to a lesser degree in Canton, Northville, and Plymouth Townships and there are some active systems scattered throughout the unsewered areas of Romulus, Taylor, Redford, Livonia, and Brownstown Township. Although there are no accurate records of the current number of active OSDSs in the Ecorse River watershed, some likely exist.

OSDS inspections are conducted by Wayne County at the time of home sale and in response to citizen complaints. In 2006, Wayne County identified 33 failed systems while conducting 147 of these inspections, a 22.4% failure rate (WCDOE 2007). Another 26 failed systems were identified while investigating 35 pollution complaints (WCDOE 2007).

Of the failures described above, three failed OSDSs were found in Romulus, three in Taylor, and one in Dearborn Heights (WCDOE 2007). The exact locations of these failed systems were not disclosed, but they could be within the Ecorse River watershed.

Although the number of OSDSs in the watershed is not known, it is suspected that there are few. Given the limited number of OSDSs that are present, they are likely only a minor source of the *E. coli* problems in the watershed.

5.5 Bacterial Source Tracking

Bacterial source tracking (BST) was conducted in 2007 to further investigate sources of the *E. coli* detected in samples collected from sites throughout the Ecorse River watershed. The BST analyses were conducted by Source Molecular Corporation (Miami, Florida) using the Human Bacteroidetes ID™ Method and Human Enterococcus ID Method™. These DNA-based methods screen for the presence of specific genes in samples suspected of containing human fecal matter.

Generally, each site was sampled once during dry and once during wet conditions. A “positive” result for either test indicates the presence of *E. coli* from human source(s) at a given monitoring site. Since only a limited amount of BST testing was performed, a “negative” result at any given site doesn’t mean that human contamination is not present at that site, only that it was not present in that particular sample.

During dry conditions, the human biomarker was present at all sites on the North and South Branches and on LeBlanc Drain, except EC7 (South Branch at Beech Daly). This is depicted in Figure 5a. To confirm the negative result initially found at EC7, the site was sampled two more times for BST analysis. The results were always negative for the human biomarker, giving a strong indication that *E. coli* from human sources was not impacting this site during dry conditions. Positive results for the other sites suggest that there are dry weather sources of *E. coli* of human origin.

During wet conditions, fewer positive results were found in the watershed. The human biomarker was found at sites EC7, EC8A and EC10B indicating the presence of *E. coli* from human sources at these sites during wet weather (See Figure 5b). Based on experience in other watersheds and the positive indicator during dry weather, it is likely that positive results would have been found at all sites if repeated sampling could have been performed during wet conditions.

These human sources of *E. coli* could include cross-connections between the sanitary and storm sewer systems, illicit discharges to storm sewers, failed on-site sewage disposal systems, and leaking sanitary sewers.

All project BST data and the associated *E. coli* and *Enterococcus* concentrations are reported in Table 9, by weather condition.

Table 9. Bacterial Source Tracking Data Summary

Sampling Sites	Site	*E. coli* Conc. (cfu/100mL)	Enterococcus Conc. (cfu/100mL)	Human Enterococcus Marker (+/-)	Human Bacteroidetes Marker (+/-)	Weather Condition
North Branch Ecorse Creek						
EC4	**B**	90	TNTC	+	-	Dry
	C	2,800	TNTC	-	-	Wet
EC3	**A**	2,400	TNTC	-	-	Dry
	A	1,600	TNTC	+	+	Dry
	B	5,100	TNTC	-	-	Wet
EC2	**B**	2,400	TNTC	+	-	Dry
		10,000	TNTC	-	-	Wet
EC1	**B**	10	TNTC	+	-	Dry
		900	TNTC	-	-	Wet
South Branch Ecorse Creek						
EC7	**A**	930	132	-	-	Dry
	A	6,500	TNTC	-	-	Wet
	B	690	158	-	-	Dry
	B	800	TNTC	-	-	Dry
	B	16,000	TNTC	+	+	Wet
	C	12,000	TNTC	+	+	Wet
EC6	**A**	1,300	TNTC	+	-	Dry
	B	5,550	TNTC	-	-	Wet
	C	2,900	TNTC	-	-	Dry
EC5	**B**	60,000	TNTC	+	+	Dry
	C	6,200	TNTC	-	-	Wet
LeBlanc Drain						
EC10	**A**	2,300	TNTC	+	+	Dry
	A	8,300	TNTC	-	-	Wet
	B	590,000	TNTC	+	+	Dry
	B	30,000	TNTC	+	+	Wet
EC8	**A**	50,000	146	-	-	Dry
	A	8,700	118	+	+	Dry
	A	8,900	TNTC	+	+	Wet

TNTC = Colonies were to numerous to count.
+/- = human biomarker present/absent
Site Descriptions:
A = 25% quartile location
B = 50% quartile location (center of the stream)
C = 75% quartile location

Figure 5a. Bacterial Source Tracking Results (Dry Weather)

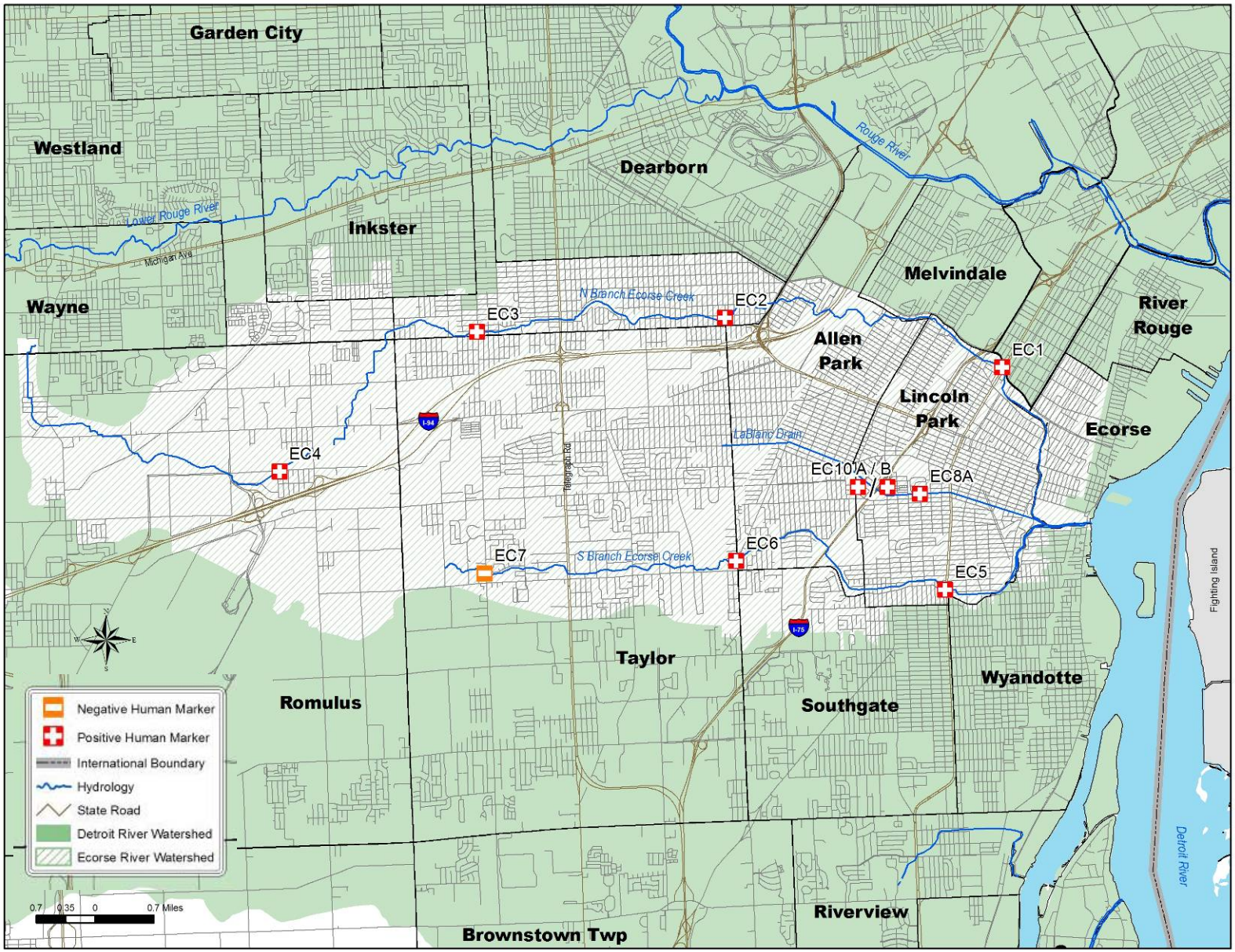
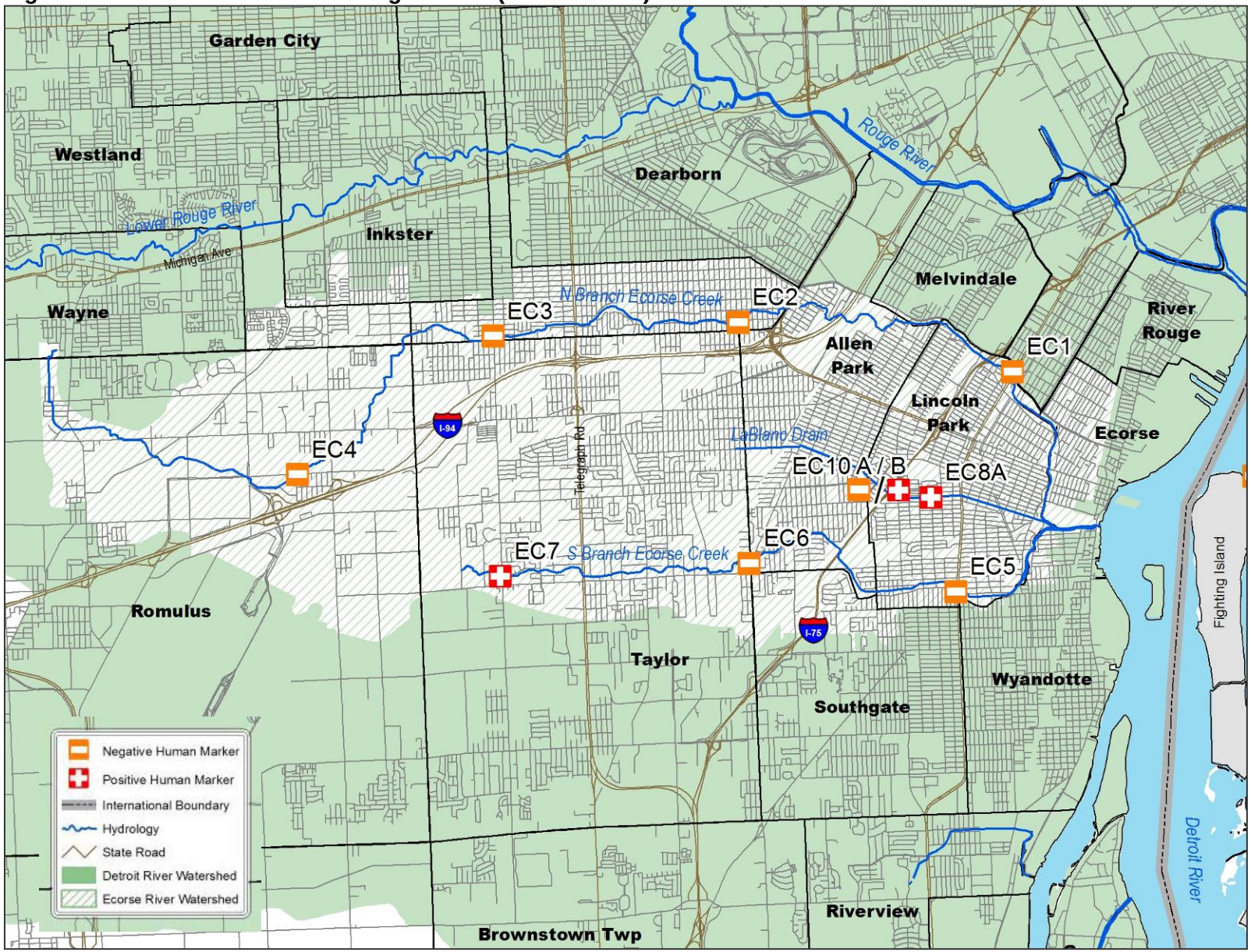


Figure 5b. Bacterial Source Tracking Results (Wet Weather)



5.6 Load Duration Curves

Load duration curves (LDCs) were developed for each sampling location to assist with source assessment and link *E. coli* data collected in 2007 to potential sources. LDCs help assess under what stream flow conditions, ranging from low dry weather flows to peak wet weather flows, the daily target is most frequently exceeded (and by how much), giving investigators insight into the possible sources of contaminants (U.S. EPA 2007).

E. coli LDCs developed from MDEQ *E. coli* data collected in 2007 are presented in Attachment D. The curves shown on each figure are based on the water quality standard criteria: the daily maximum of 300 cfu/100 ml for total body contact recreation and 1,000 cfu/100 ml for partial body contact. The loads are calculated using USGS historical flow data and the following equation.

The daily load of *E. coli* ($\frac{cfu}{day}$) = Criteria x Flow x Y;

Where:

Criteria = WQS (300 cfu/100 ml for total body contact; 1,000 cfu/100 ml for partial body contact) for each sampling event

Flow = River discharge ($\frac{ft^3}{\sec}$)

Y= conversion factor ($\frac{28{,}317 mL}{ft^3} \times \frac{86{,}400 \sec}{day}$)

The LDCs were evaluated for the number and magnitude of exceedences of the daily target under all flow conditions (wet to dry). Note that data points above the curves show exceedences of the water quality standard criteria on those dates. Points above the curves toward the left side of the figures suggest water quality exceedences during wet weather conditions (higher flows). Points above the curves toward the middle and right side of the figures suggest water quality exceedences during midflow to dry weather conditions (lower flows).

The data trends in Table 10 show that all sites commonly experience water quality exceedences during dry and wet weather conditions. (This is consistent with the results of the dry and wet weather analysis discussed in Section 4.2) This trend is also true of mid-range flows for some sites. However, sites EC4, EC3, EC1, and EC6 had fewer exceedences during mid-range flows relative to the number of samples collected. This pattern may be due to dilution of dry weather *E. coli* loads at those sites during wet weather conditions that do not generate significant wet weather *E. coli* loads. It should be noted that the LDC evaluation for sites EC2 and EC4 were influenced by a reduced number of samples due to a lack of flow at these sites.

Table 10. Load Duration Curve Evaluation of Water Quality Exceedences

Sampling Site	Wet Weather High Flow & Moist Conditions		Mid-Range Flow		Dry Weather Dry & Low Flow Conditions		Weather Condition Associated With Exceedences
	Percent Greater Than Target	Percent Less Than or Equal to Target	Percent Greater Than Target	Percent Less Than or Equal to Target	Percent Greater Than Target	Percent Less Than or Equal to Target	
North Branch Ecorse Creek							
EC4	100	0	0	100	75	25	Wet & Dry
EC3	90	10	80	20	100	0	All
EC2	90	10	100	0	100	0	All
EC1	100	0	60	40	100	0	All
South Branch Ecorse Creek							
EC7	90	10	100	0	100	0	All
EC6	90	10	80	20	100	0	All
EC5	100	0	100	0	100	0	All

6.0 LOADING CAPACITY DEVELOPMENT

The Loading Capacity (LC) represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The LC is defined as

LC ($\frac{cfu}{day}$) = Criteria x Flow x Y;

Where:

Criteria = WQS for *E. coli* (300 cfu/100 ml)

Flow = River discharge ($\frac{ft^3}{\sec}$)

Y= conversion factor ($\frac{28{,}317 mL}{ft^3} \times \frac{86{,}400 \sec}{day}$)

The LC was calculated for the mouth of the Ecorse River based on the formula above using flow data from the USGS gage located on the North Branch of Ecorse Creek at Beech Daly Road and watershed scaling using the Drainage Area Ratio method. Development of the flow time series data was previously described under Section 4.1.

Concurrent with the selection of numerical limits, development of the LC requires identification of the critical conditions. The critical conditions are the set of environmental conditions (e.g., flow) used in developing the TMDL that have an acceptably low frequency of occurrence. The total daily load allocations must be less that the LC during the occurrence of the critical conditions.

The critical conditions for the applicability of the WQSs in Michigan are given in Rule 323.1090 (Applicability of WQS). Rule 323.1090 requires that the WQS apply at all flows equal to or exceeding the water body design flow. In general, the lowest monthly 95% exceedence flow is

used as the design condition for developing pollutant loadings. As described further in Section 7.0, this TMDL provides allowable *E. coli* loadings under a variety of flow conditions. The critical conditions are addressed by the margin of safety, which results in allocation of loads at the lowest possible flow in each flow category. This insures that the load allocations will not exceed the LC at any point throughout the range of flows in each flow category. In essence, the critical condition is defined as the lowest flow in each flow category including the 95% exceedence flow in the dry flow category.

The Loading Capacities (LC) for the watershed are presented in Table 13.

Table 13. Loading Capacity and Load Allocation for the Ecorse River

	NPDES Permit (if applicable)	High	Moist	Mid	Low	Dry
Flow Exceedence Interval		5%	25%	50%	75%	95%
Flow (cfs)		122.9	22.5	6.1	2.4	0.8
		Daily Load of *E. coli* (cfu/day)				
Loading Capacity (LC)		9.02E+11	1.65E+11	4.48E+10	1.76E+10	5.87E+09
Margin of Safety (MOS)		4.01E+11	8.51E+10	1.17E+10	8.07E+09	2.94E+09
LC minus MOS		5.01E+11	7.99E+10	3.31E+10	9.53E+09	2.93E+09
Waste Load Allocations (WLA)						
WLA – General Industrial storm water permits and individual permits authorizing storm water	MIS210000 MIS310000 MIS410000 MIS320000 MI0036846 MI0046264	5.48E+08	3.96E+08	2.97E+08	2.51E+08	1.57E+08
WLA – General MS4 Permits and MDOT individual permit	MI0057364 MIG619000 MIS040000	5.00E+11	7.95E+10	3.28E+10	9.28E+09	2.77E+09
WLA – Individual or general permits not authorizing discharge of storm water	MIG640000 MIG670000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Load Allocations (LA) (nonpoint sources)	None	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

7.0 LOAD ALLOCATION

The overall LC is allocated into waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and the margin of safety (MOS). The LC is the sum of the individual WLAs for point sources, and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the LC 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:

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

The allowable *E. coli* loads are presented under a variety of flow conditions, each of which assures attainment of the targets. The Ecorse River flow conditions range from the 5% to 95% exceedence flows. An exceedence flow is a statistically determined flow that is exceeded a specific percentage of time. For example, the 95% exceedence flow represents a flow expected to be exceeded 95% of the time and, therefore, represents low flow conditions. A 5% exceedence flow would be expected to be exceeded only 5% of the time and, therefore, represents high flow conditions. Five flows (i.e., 5%, 25%, 50%, 75%, and 95%) were selected to develop LCs based upon the approach developed by Cleland (Cleland 2006). Flows along a gradient of 0% to 100% were partitioned into flow zones (e.g., high, moist, midrange, dry, and low, respectively) and the 5 exceedence flows represent the midpoint of their respective flow conditions (i.e., 5% is the midpoint of the high flow zone).

The MOS, WLAs, and LAs for the Ecorse River are presented in Table 13. A detailed description of each allocation follows along with a summary of the rationale behind each load allocation (See Table 14).

Table 14. Load Allocation Rationale

Allocation	Rationale
Margin of Safety (MOS)	Difference between median flow exceedence interval value and minimum flow exceedence interval value
Waste Load Allocations (WLA)	
General industrial storm water permits & individual permits authorizing storm water	Load based on 2000 SEMCOG industrial land-use data and L-THIA model
General municipal storm water permits (MS4) Including MDOT individual permit	Remainder of allocation after allocation to the industrial permit minus margin of safety
Individual or general permits not authorizing storm water	No allocation – these permits are not considered a source of *E. coli*
Load Allocations (LA) (nonpoint sources)	No allocation – the entire watershed falls within the jurisdiction of municipal or industrial NPDES permits

7.1 Margin of Safety

The margin of safety (MOS) is a required element of the TMDL and accounts for the uncertainty associated with the relationship between the pollutant load and receiving water quality. Uncertainty may be associated with the estimation of pollutant loads, estimation of flows, the fate and transport of the pollutant once it enters the receiving water body, and/or the effectiveness of control measures.

The uncertainties in this TMDL are associated with the industrial storm water waste load allocation based on the LTHIA model and the calculation of the LC. The inherent uncertainty in the LTHIA model stems from the assumed *E. coli* concentrations in the runoff and the runoff flow values. The uncertainty in the LC calculation is associated with the flow estimation for the outlet. Since there is only one gaging station in the watershed, which is located on the North Branch approximately 6 miles from the mouth, the outlet flow can only be estimated as described in Section 4.1.

The margin of safety was calculated explicitly as the difference between the median load and minimum load for each flow category using the approach developed by Cleland (Cleland 2006). The results of this calculation are shown in Table 15.

Table 15. Calculation of the Margin of Safety (MOS)

Flow Condition	Median Flow Value (cfs)	Lower Flow Value (cfs)	Median Load (cfu/day)	Lower Load (cfu/day)	MOS (cfu/day)
High	122.9	68.3	9.02E+11	5.01E+11	4.01E+11
Moist	22.5	10.9	1.65E+11	8.00E+10	8.51E+10
Mid	6.1	4.5	4.48E+10	3.30E+10	1.17E+10
Low	2.4	1.3	1.76E+10	9.54E+09	8.07E+09
Dry	0.8	0.4	5.87E+09	2.94E+09	2.94E+09

7.2 Waste Load Allocations

Waste load allocations (WLA) were assigned to all industrial storm water and municipal storm water discharges permitted by an individual NPDES permit or general NPDES permit as described in the sections below.

7.2.1 Individual NPDES Permits

There are three individual permits for facilities within the Ecorse River watershed. They are Buckeye Pipe Line-Taylor, MDOT State-wide MS4 and Detroit Metro Wayne County Airport. The MDOT MS4 permit did not receive a separate waste load allocation, but is instead included with the other General MS4 permits (See Section 7.7.3). Individual allocations were not assigned to Buckeye Pipe Line and Detroit Wayne County Airport either. These permits are grouped with the industrial storm water permit waste load allocation (See Section 7.2.2).

7.2.2 Industrial Storm Water NPDES Permits

The WLA for industrial storm water permits was assigned based on the anticipated *E. coli* loading from storm water runoff associated with the industrial areas under various flow conditions. The Long Term Hydrologic Impact Analysis (LTHIA) web application developed by Purdue University available through the Local Government Environmental Assistance Network was used to approximate *E. coli* loadings associated with industrial storm water runoff. LTHIA is a curve number-based model that uses land use and hydrologic soil group data to predict long term runoff and non-point source pollution from watersheds. Each land use and hydrologic soil combination is assigned an average curve number. The model uses precipitation data to estimate Antecedent Moisture Conditions (AMC) in the soil and the curve number is adjusted according the AMC conditions. Long-term daily precipitation data is used to predict average annual runoff for each curve number assigned to the various land use/soil group combinations. Dust and dirt accumulation in urban areas and its wash-off are used to estimate non-point source pollution, including fecal coliform.

With land use, hydrologic soil information and site location information provided by the user and long-term daily precipitation data queried from an Oracle® database, LTHIA generates runoff and non-point source pollution output in tabular and graphical forms. Non-point source pollution is indicated as an average annual load in tabular form and as a function of percent exceedence of the rainfall in graphical form. The user is able to extract the estimated non-point source pollution loading associated with any given rainfall event based on percent exceedence.

The total industrial land use area for the Ecorse River watershed was determined using the 2000 SEMCOG land use data. This area includes the Buckeye Pipe Line and Detroit Wayne County Airport facilities (two facilities with individual NPDES permits). The existing available soil information (obtained from the Michigan Center for Geographic Information) was identified for all of the industrial land use area using GIS. The LTHIA tabular output includes a value for average annual fecal coliform loading in million of fecal coliform (MFC) units per year. A conversion factor as shown in the following formula was applied to convert fecal daily loads to *E. coli* daily loads.

$$E.coli(\frac{cfu}{day}) = \frac{MFC}{year} \times \frac{1year}{365days} \times \frac{1{,}000{,}000FC}{MFC} \times 0.77\frac{E.coli}{FC}$$

The LTHIA modeled loadings of *E. coli* to the Ecorse River watershed from industrial land uses are summarized in Table 16.

Table 16. Modeled *E. coli* Loadings from Industrial Land Uses by Soil Type

Model Input		Model Output	
Soil Type	Area (ac)	Average Annual Fecal Coliform (M FC/year)	Average Annual *E. coli* (cfu/day)
Soil Group A	42.0	1,109	2.34E+06
Soil Group B	731.9	40,867	8.62E+07
Soil Group C	1,256.9	96,625	2.04E+08
Soil Group D	23.1	2,259	4.77E+06
TOTAL	**2,054**	**140,860**	**2.97E+08**

The LTHIA model also determines fecal coliform loading relative to the percent exceedence of rainfall. Stream flow within the Ecorse River is correlated to storm water runoff. As the load allocations are a function of total stream flow, and total stream flow is primarily a function of storm water runoff, it is appropriate to vary the load allocations for the industrial storm water permits for various stream flow percent exceedences using the precipitation-based percent exceedence figure generated by LTHIA. The fecal coliform and *E. coli* loadings associated with various percent exceedences for stream flow are summarized Table 17. These values are the WLAs for the general industrial storm water permits and individual permits authorizing storm water category.

Table 17. *E. coli* Loading for Various Percent Flow Exceedences from Industrial Land Uses

Percent Exceedence	Fecal Coliform Load (M FC/year)	*E. coli* Load (cfu/day)
5%	260,000	5.48E+08
25%	188,000	3.96E+08
50%	140,860	2.97E+08
75%	119,000	2.51E+08
95%	75,000	1.57E+08

7.2.3 Municipal Storm Water NPDES Permits

All Phase I and Phase II MS4 communities and the Michigan Department of Transportation MS4 receive a combined WLA. The municipal storm water WLA is equal to the balance of the LC after deducting the MOS and industrial storm water WLA.

8.0 SEASONALITY

Seasonality is addressed by expressing the TMDL in terms of both a total body contact recreation season that is defined as May 1 through October 31 by R 323.1100(2) and a partial body contact standard that applies year round as defined by R 323.1100(1) of the WQS. *E. coli* allocations developed to protect during the total body contact season are expected to assure attainment of the partial body contact standard.

USGS flow data were obtained for the period July 1, 2002 to October 8, 2008. The data are representative of a range of flow conditions including wet and dry years as compared to normal total annual precipitation for the region (See Section 4.1 and Attachment B). The discharge data also include numerous wet weather events and dry periods occurring during the total body contact recreation season. Flow duration curves were developed using data collected between May 1 and October 31 of each year so that they were most representative of TMDL critical conditions, which occur during the summer season.

9.0 MONITORING

E. coli was monitored weekly at 8 stations on the Ecorse River and tributaries from May through October 2007. Future monitoring will take place as part of the 5-year rotating basin monitoring as resources allow, and when corrective actions have occurred to suggest that WQS may be met. 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 targets are being met.

10.0 REASONABLE ASSURANCE ACTIVITIES

The permittees listed in Attachment C are responsible for meeting their NPDES permit limits. The statewide Michigan Department of Transportation (MDOT) MS4 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. In addition, the general permits for wastewater discharges from municipal potable water supplies and hydrostatic pressure test waters require that Michigan's WQS are not violated as a result of the discharge. The MDEQ may require the permittee to provide additional sampling or monitoring as deemed necessary to assure adequate operation of the treatment system.

10.1 Industrial Storm Water

Federal regulations require certain industries to apply for an NPDES permit if storm water associated with industrial activity at the facility discharges into a separate storm sewer system or directly to surface water. A storm water permit is not required if storm water does not discharge from the facility or is discharged into a sewer system that leads to a wastewater treatment plant (WWTP). The general industrial storm water permits identified in Attachment C (i.e. MIS210000, MIS310000, MIS410000, MIS320000) 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 estimate the current annual load of those materials via storm water discharges to the receiving stream.

Michigan's storm water permit authorization requires facilities to obtain a certified operator who will have supervision and control over the control structures at the facility, eliminate any unauthorized non-storm water discharges, and develop and implement a storm water pollution prevention plan for their facility that includes structural and nonstructural control measures. Prior to obtaining permit coverage, applicants must certify that they do not have any unauthorized discharges.

MDEQ staff conducts inspections of a percentage of permitted industrial facilities annually to ensure that facilities comply with their permits. These inspections result in a reduction in unauthorized discharges and illicit connections. As additional facilities obtain industrial storm water permits, more illicit discharges will be eliminated.

10.1.1 CSO/SSO Control

Combined sewer system outfalls have been eliminated from the Ecorse River watershed.

Wayne County expanded the Wyandotte Wastewater Treatment Facility (Downriver WWTP) in 2000-2001 in response to a Federal Court Order. The plant expansion has substantially reduced the number of sanitary sewer overflow (SSO) events. Wayne County is planning more capital improvements to sewers and equipment that will make the system more efficient, cost effective, and reliable, further reducing the occurrences of SSO discharges.

10.2 Municipal Storm Water

The U.S. EPA's Storm Water Phase II Rules require that all public entities operating MS4s within urbanized areas obtain municipal storm water permits, unless this requirement is waived by the NPDES permitting authority. The State of Michigan's Phase II Watershed-Based Storm Water General Permit (MIG610000) and the Phase II Jurisdictional Storm Water General Permit (MIS040000**)** have been developed to meet the federal requirement.

Beginning in 2008, both the MS4 permits will have additional requirements for MS4s draining to water bodies with approved *E. coli* TMDLs. These requirements will likely include *E. coli* monitoring at major storm water outfalls and development of a plan to reduce *E. coli* concentrations based on monitoring data.

The Ecorse River watershed encompasses eleven communities and a portion of the Detroit Metropolitan Wayne County Airport (See Table 18).

Table 18. Land Area Distribution by Community within the Watershed

Community	Area within the Watershed (acres)	Percent of Total Watershed
Allen Park	3,596	12.9%
Dearborn Heights	2,151	7.7%
Ecorse	670	2.4%
Inkster	265	1.0%
Lincoln Park	3,758	13.5%
Melvindale	123	0.4%

Community	Area within the Watershed (acres)	Percent of Total Watershed
Romulus	6,329	22.8%
Southgate	790	2.8%
Taylor	8,436	30.4%
Westland	671	2.4%
Wyandotte	180	0.6%
Total	**26,969**	**96.9%***

*The remaining 3.1% of the watershed is within the boundaries of Detroit Metropolitan Wayne County Airport, which is covered under an Individual NPDES Permit.

All of the communities are Phase II MS4 communities that have applied for coverage under the watershed-based storm water permit. The communities, along with Wayne County formed the Ecorse Creek Inter-Municipality Committee (ECIC). While the Detroit Metropolitan Wayne County Airport holds an individual permit, they are also a member of the ECIC. The ECIC completed a Phase II watershed management plan in 2006 as required under the permit. In addition to establishing storm water management goals and actions, the watershed management plan includes goals and actions focused on biota impairments addressed in the biota TMDL for the Ecorse River (Goodwin 2003).

Much of the Ecorse River drainage system is comprised of county drains under the jurisdiction of the Wayne County Department of Environment as shown in Table 19 (ECIC 2006). There is an estimated 116 miles of county drains in the Ecorse River watershed. Wayne County's coverage under the General Permit (MIG610040) applies to its operations, facilities, and functions throughout the approximately 626 square mile county (WCDOE 2004a). The County's Watershed Management Division coordinates Wayne County General Permit activities with watershed communities, counties, agencies, subwatershed advisory groups, and other interested parties.

Table 19. County Drains within the Ecorse River Watershed

Length (est. miles)	Drain Name	Drain Number
0.22	Austin & Corey	A013
0.49	Barton	B008
3.15	Black Creek	B029
1.99	Bondie	B037
0.92	Bondie Extension #2	B038
3.25	Brighton	B047
2.99	Butler	B060
1.6	Carter	C010
2.38	Douglas & Kelly	D014
16.21	Ecorse Creek North Branch	E003
1.01	Ensign	E010
2.20	Freeman	F013
1.47	Gamong Br. McConologue	G001
2.16	Ganong &S loss	G002
2.74	German	G005
0.86	Godfrey	G008
1.92	Grams	G014

Length (est. miles)	Drain Name	Drain Number
1.95	Guidot Lateral Line	G028
0.34	Gumtow Storm	G040
0.98	Harris	H013
3.09	Hand	H038
0.69	Holland	H040
1.30	Kenneday	K016
0.47	Leverance B. Ecorse Creek	L015
2.79	Long	L019
0.49	Lukas Storm	L048
9.66	Le Blanc No1 San Arm	L062
1.14	McConologue	M005
1.32	McGee	M007
0.79	Milo	M055
1.72	Quandt	Q001
1.38	Rawson	R004
3.99	Reeck	R0011
4.17	Rosenworth	R027
1.55	Schloff	S004
13.19	Sexton-Kilfoil	S006
4.93	Snow	S023
2.92	Snow Tile	S024
1.23	Stevenson	S030
1.08	Strachen	S068
2.21	Trouton	T015
0.62	Watsonia Park	W007
1.92	Wick Road or Le Blanc	W040
1.80	Wilkie Lateral #1	W049
2.65	Wilkie Lateral #2	W050

The communities and other stakeholders in the Ecorse River watershed have been working together for several years to manage the area's water resources on a watershed basis and to comply with federal regulations regarding the discharge of storm water. The communities and stakeholders in the Ecorse River watershed and communities of the neighboring Combined Downriver and Lower Huron River watersheds have formed the Alliance of Downriver Watersheds under the Watershed Alliance Act (P.A. 517 of 2004). Ten of the eleven MS4 communities in the watershed are members of the Alliance. Inkster is the only community that is not participating in the Alliance as of March 28, 2008. Wayne County and Detroit Metropolitan Wayne County Airport are also members of the Alliance.

The Alliance of Downriver Watersheds provides services to its members and to the existing Advisory Group for each watershed in order to facilitate implementation of the watershed management plans.

10.2.1 Illicit Discharge Elimination

Under municipal storm water permits, permittees are required to develop and implement illicit discharge elimination programs (IDEPs) to prohibit and effectively eliminate illicit discharges

(including discharges of sanitary wastewater) to MS4s. Communities throughout the watershed have responded to this permit requirement by implementing various activities including:

- Inspection of storm water outfalls and screening storm water discharges for signs of pollution;
- Enacting a report-a-polluter hotline at the county-level to field pollution complaints;
- Training municipal staff at the county and local level on how to detect illicit discharges; and
- Conducting dye testing of various businesses to ensure they are properly connected to the sanitary sewer system.

Through each community's and the county's IDEP, the illicit connections in the Ecorse River watershed should be eliminated.

10.2.2 On-Site Sewage Disposal System (OSDS) Management

Through the time of sale OSDS inspections required by the Wayne County Health Department and the illicit discharge elimination programs required by all MS4 communities, any illicit discharges from the few remaining OSDSs in the watershed should be eliminated.

10.2.3 Public Education & Involvement

Under the MS4 regulations, municipalities are required to develop a public education plan for the purpose of encouraging the public to reduce the discharge of pollutants in storm water to the maximum extent practicable. In response to the MS4 regulations, Wayne County has instituted a 24-hour pollution complaint telephone line to encourage the public to report illegal dumping and water quality problems. Wayne County has also trained many of their field staff on how to identify illicit discharges in storm sewers. Programs like these help reduce the number of water quality problems in the watershed.

11.0 PUBLIC PARTICIPATION

The U.S. EPA and MDEQ have sponsored three public meetings prior to the release of the draft TMDL. The first meeting was held prior to the onset of the 2007 sampling on March 22, 2007, in conjunction with a regular meeting of the Alliance of Downriver Communities. The second meeting was held on December 19, 2007, in the City of Melvindale where the 2007 monitoring data and the TMDL development process was discussed. A one-page fact sheet summarizing the monitoring results was prepared and distributed via email prior to this meeting. A third public meeting was held in the City of Dearborn Heights on March 19, 2008, at the request of residents.

A final public meeting is planned for spring 2008 to discuss the draft TMDL document.

All meeting dates were advertised on the MDEQ's calendar and meeting announcements were sent via email to numerous stakeholders.

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Attachment A
Detroit River & Ecorse River *E. coli* Monitoring to Support TMDL Development
Final Report

Attachment B
Flow Time Series, Flow Duration Curves and Table of Percentile Flows

Figure B1. Flow time series based on data collected at USGS gaging station 04168580 located on the North Branch at Beech Daly Road

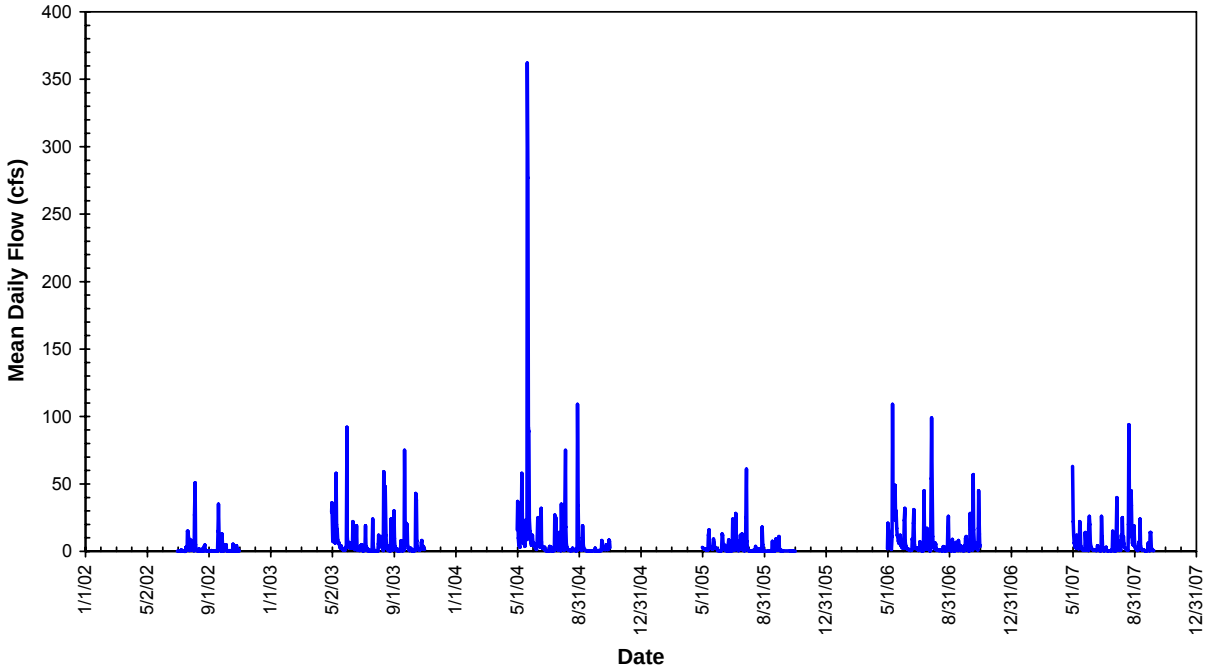


Figure B2. Estimated flow time series for the Ecorse River Main stem at the Detroit River confluence

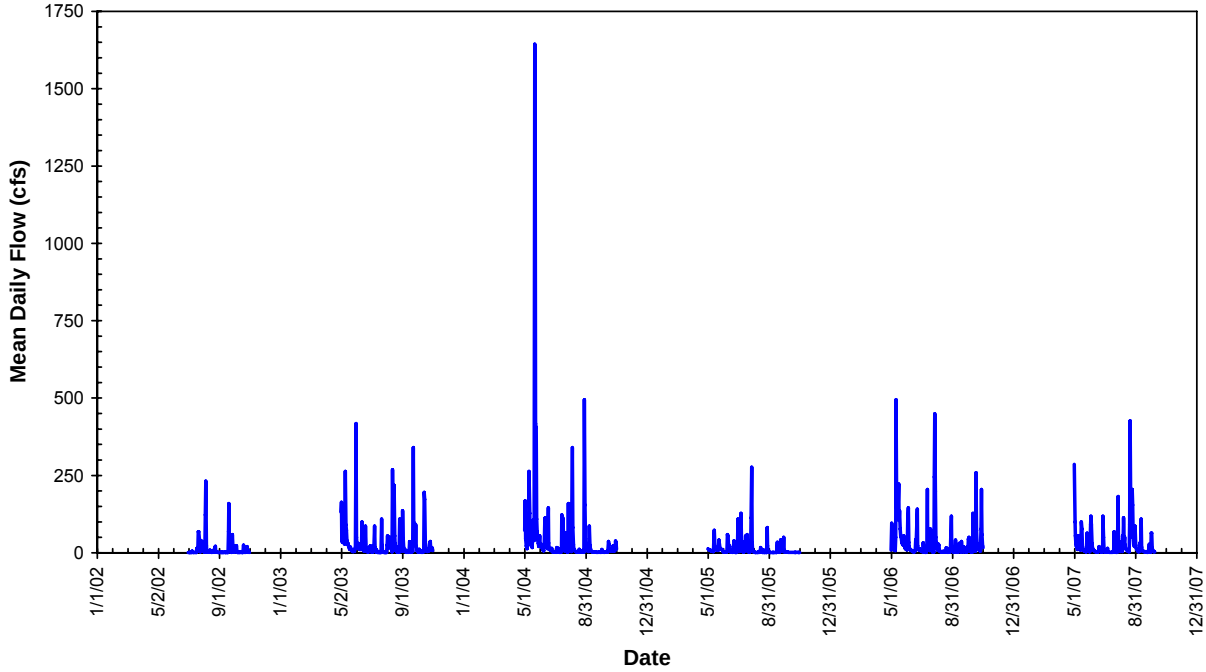


Figure B3. Estimated flow time series for the South Branch Ecorse Creek at its confluence with the North Branch

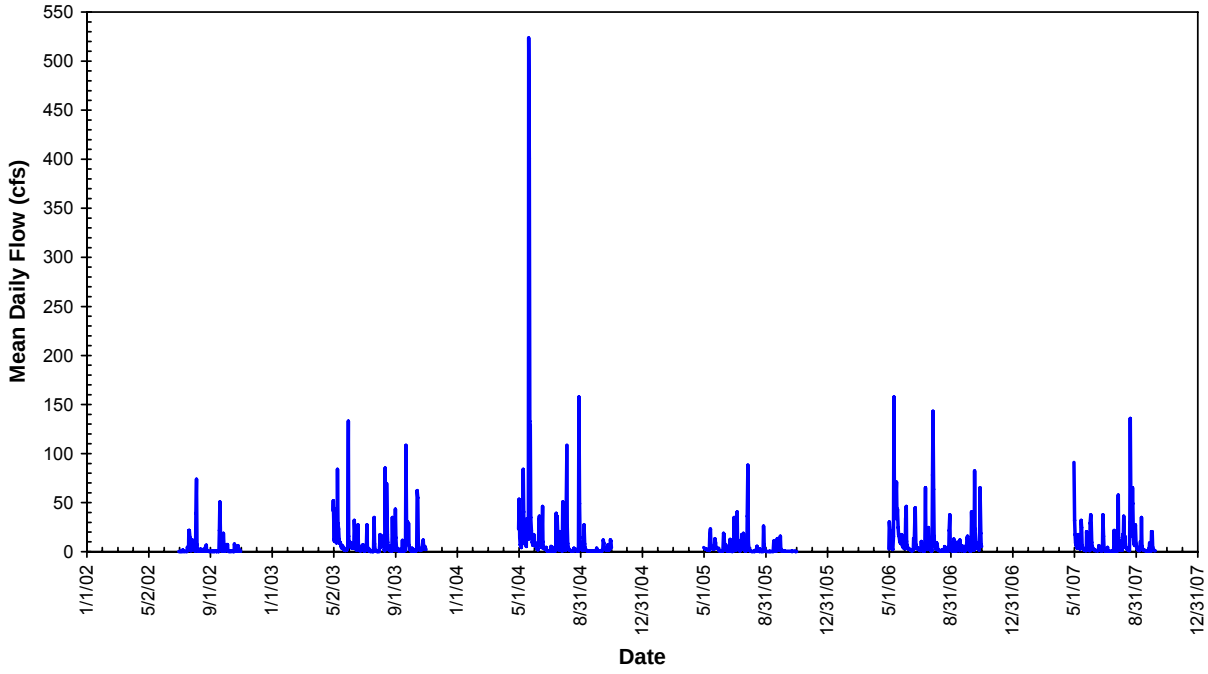


Figure B4. Estimated flow time series for the North Branch Ecorse Creek at its confluence with the South Branch

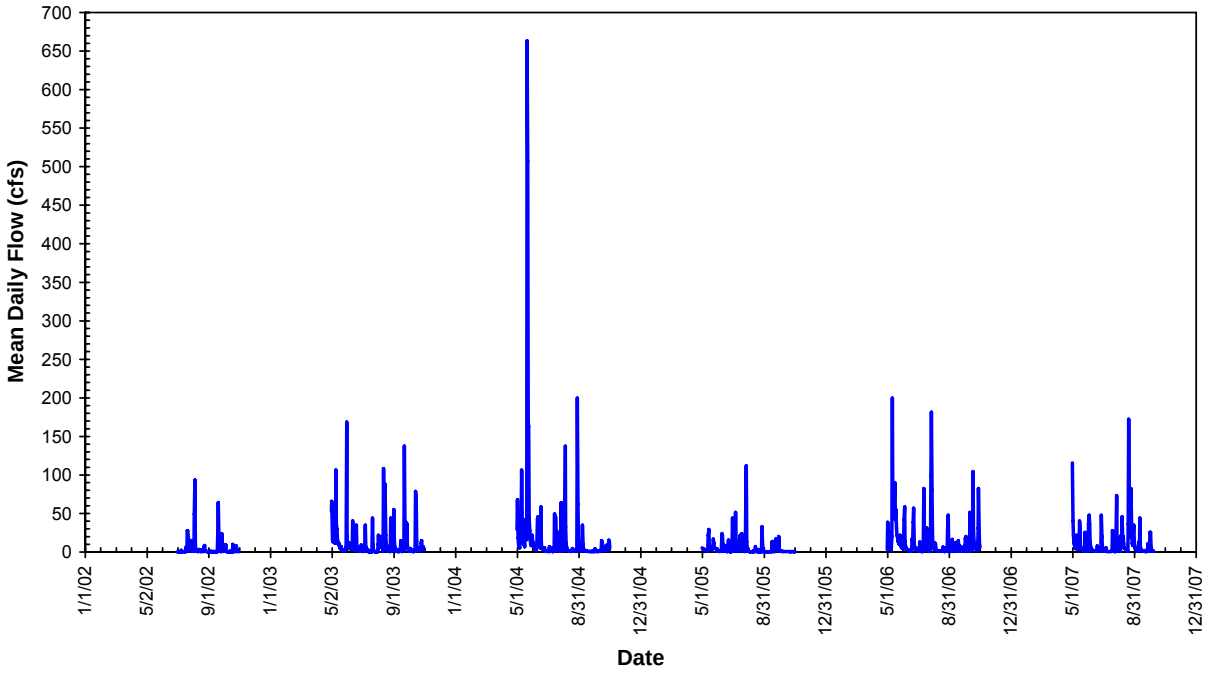


Figure B5. Estimated flow time series for the North Branch Ecorse Creek at EC1 (Fort Street)

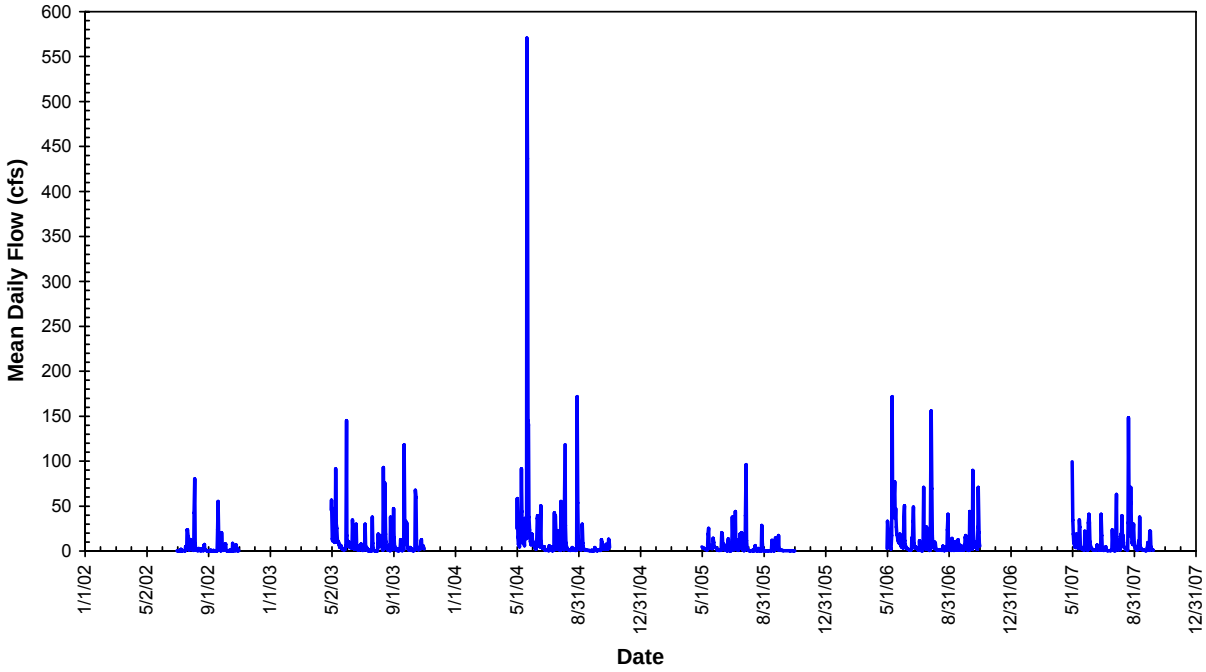


Figure B6. Estimated flow time series for the North Branch Ecorse Creek at EC2 (Pelham Road)

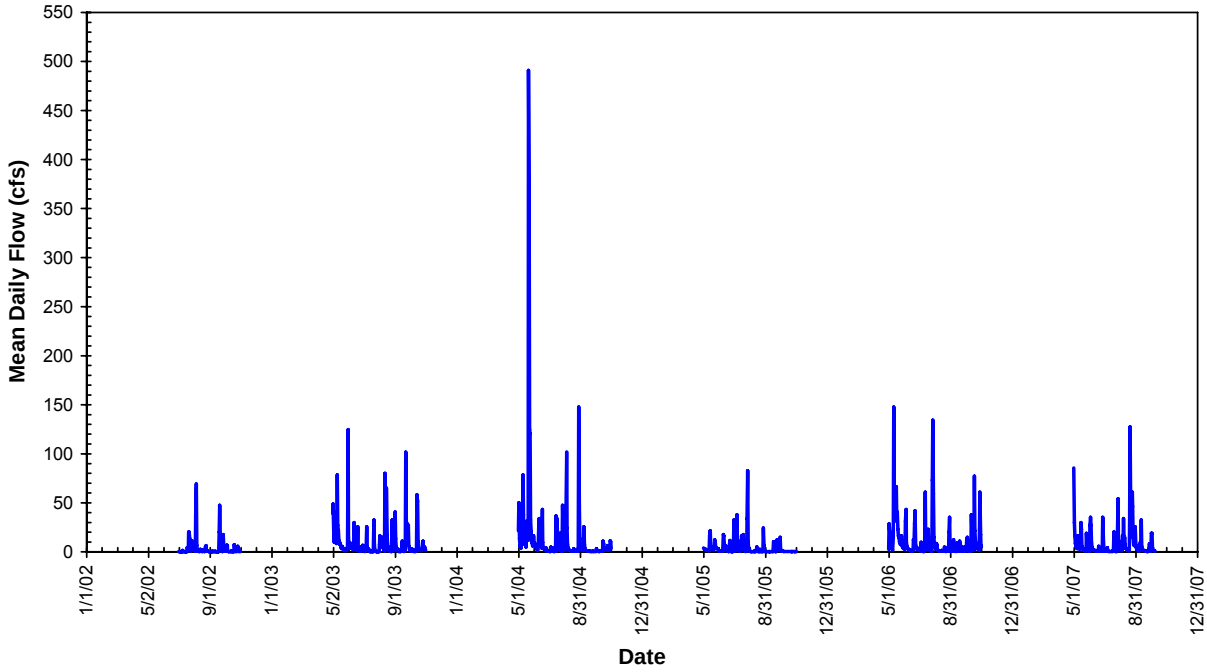


Figure B7. Estimated flow time series for the North Branch Ecorse Creek at EC3 (Beech Daly Road)

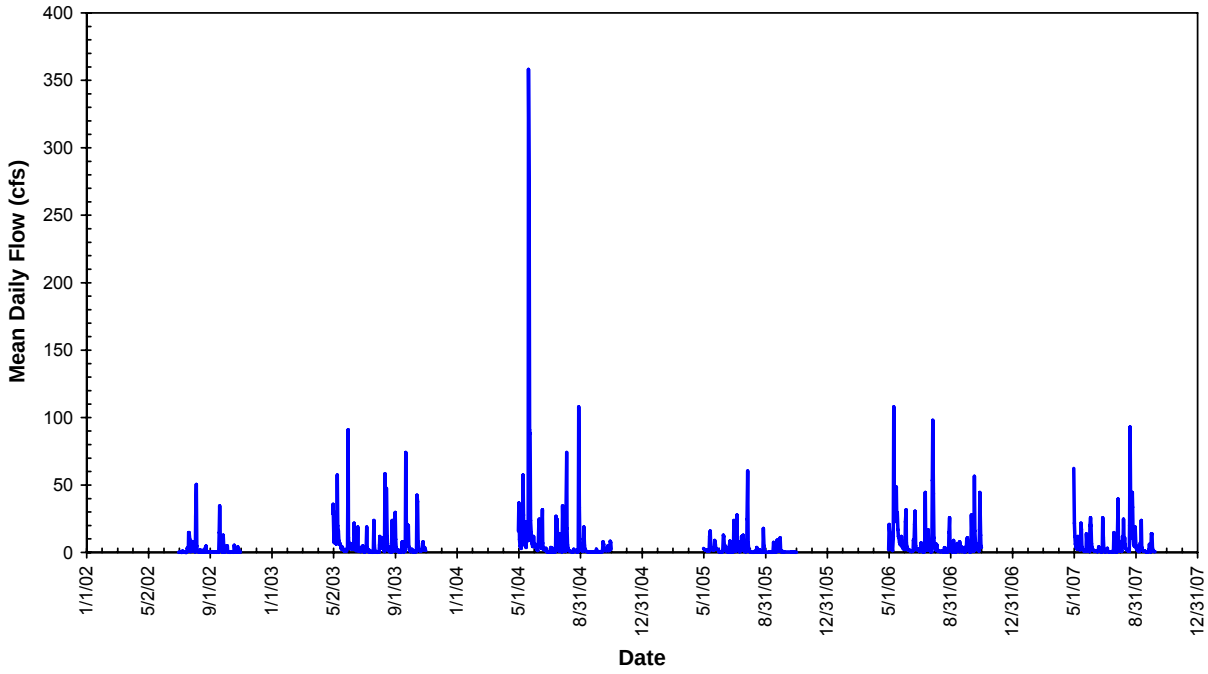


Figure B8. Estimated flow time series for the North Branch Ecorse Creek at EC4 (Smith Street)

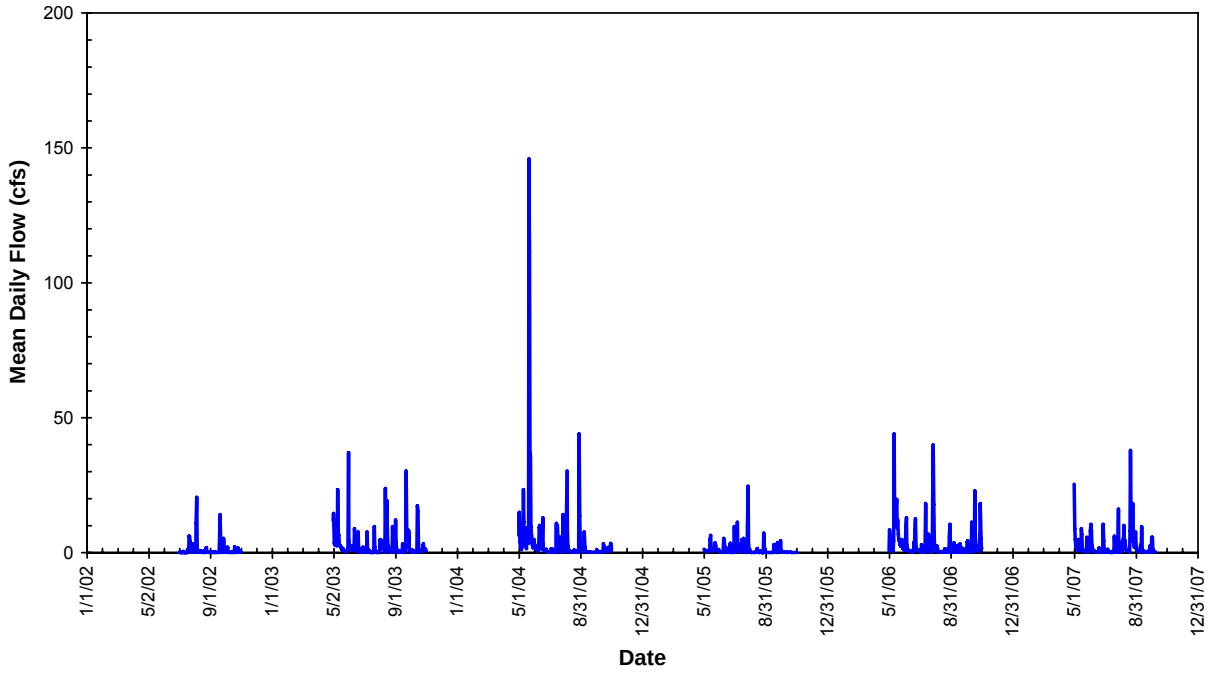


Figure B9. Estimated flow time series for the South Branch Ecorse Creek at EC5 (Fort Street)

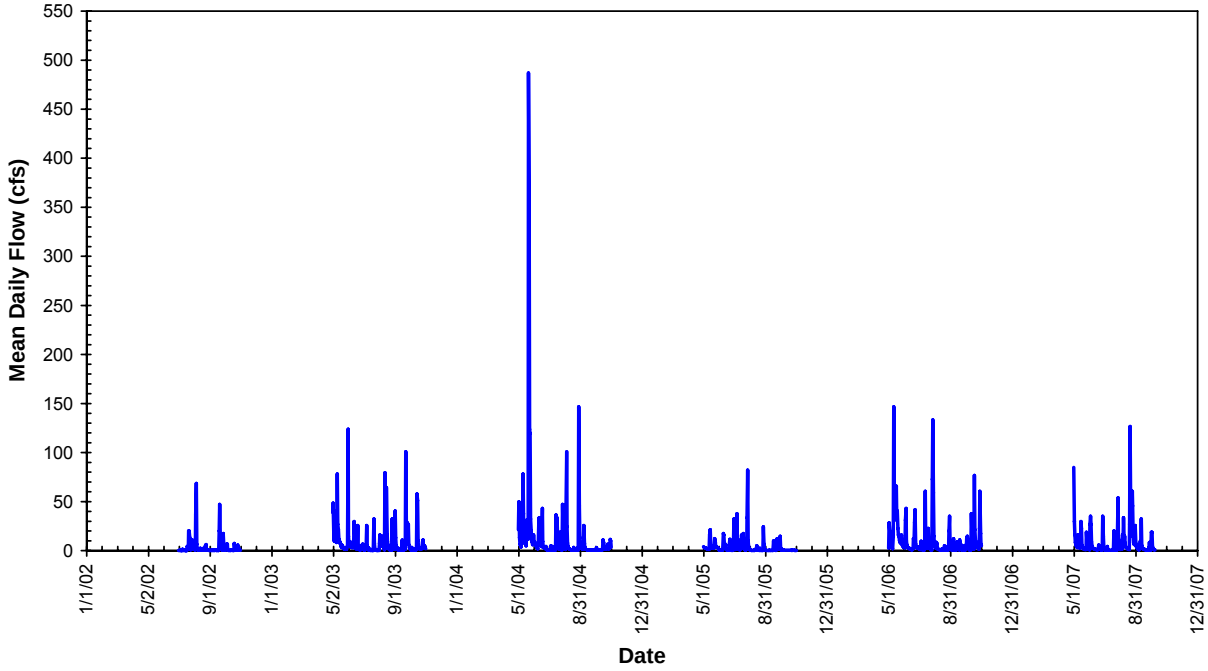


Figure B10. Estimated flow time series for the South Branch Ecorse Creek at EC6 (Pelham Road)

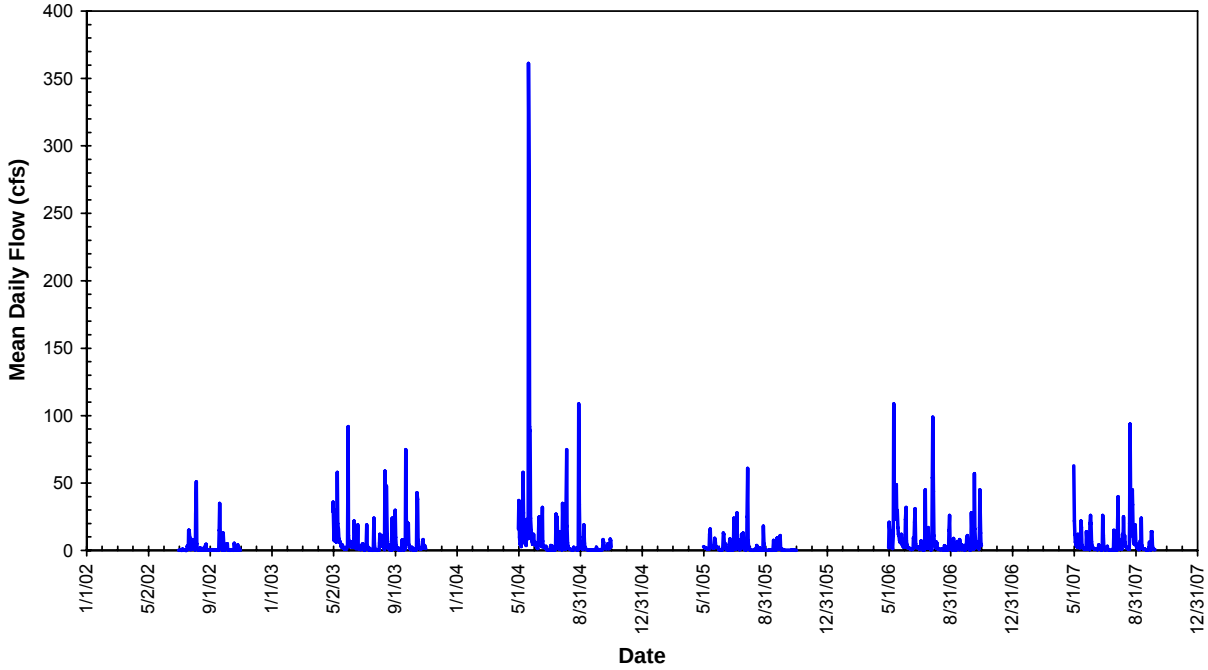


Figure B11. Estimated flow time series for the South Branch Ecorse Creek at EC7 (Beech Daly Road)

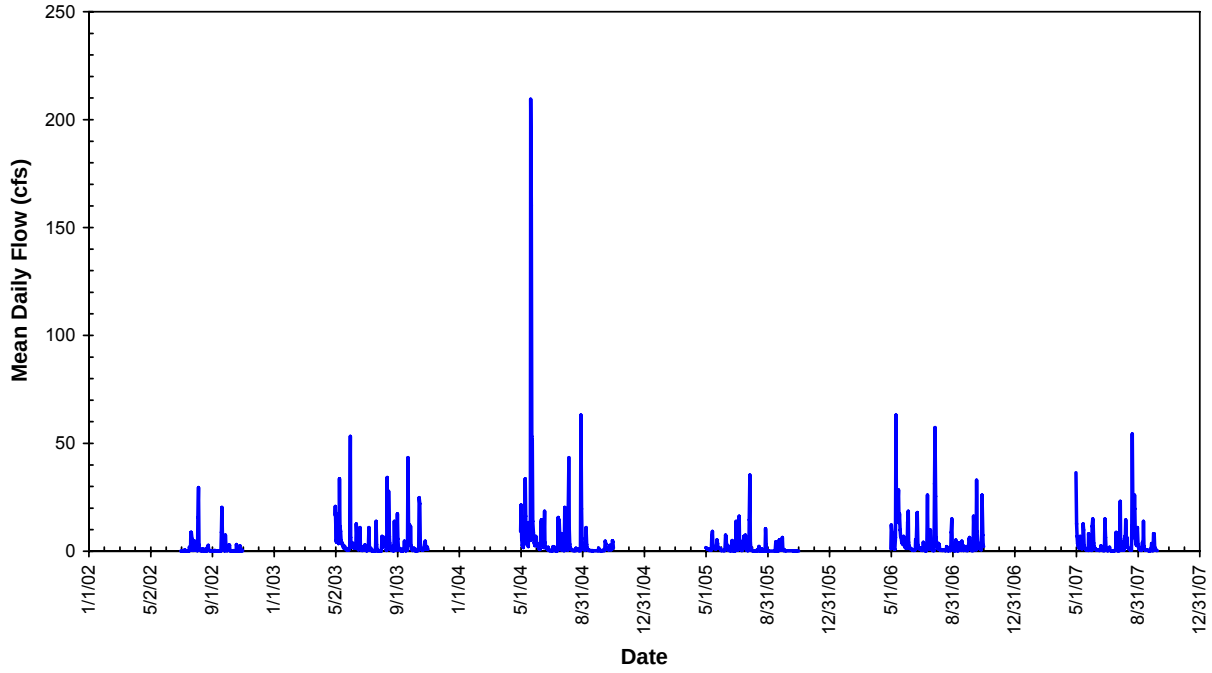


Figure B12. Flow duration curves for the Ecorse River Main stem and branches

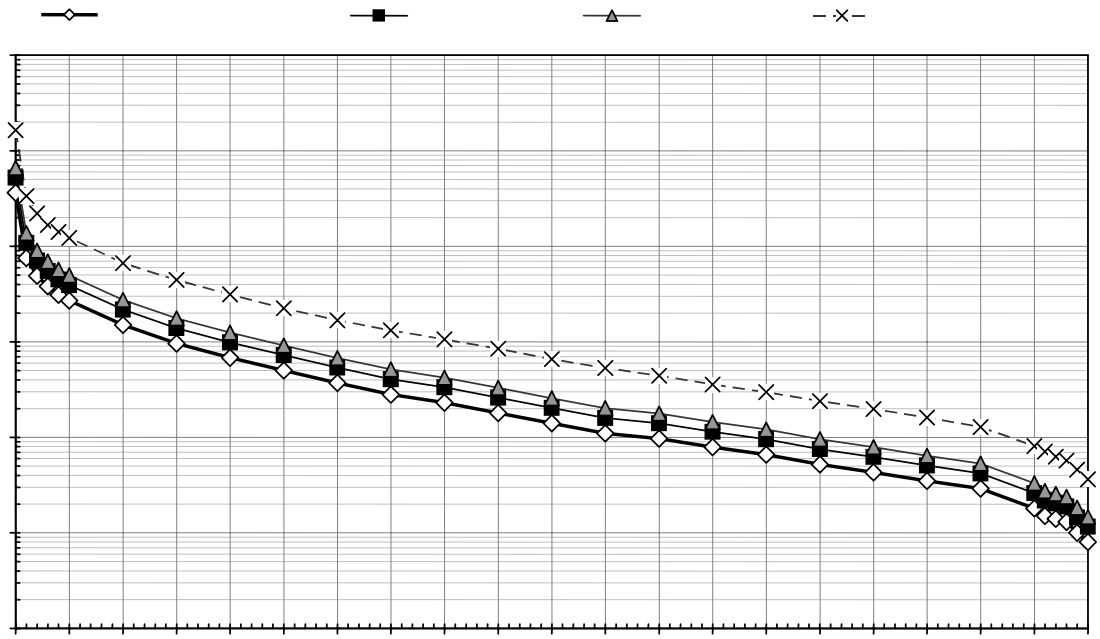


Figure B13. Flow duration curves for the South Branch Ecorse River

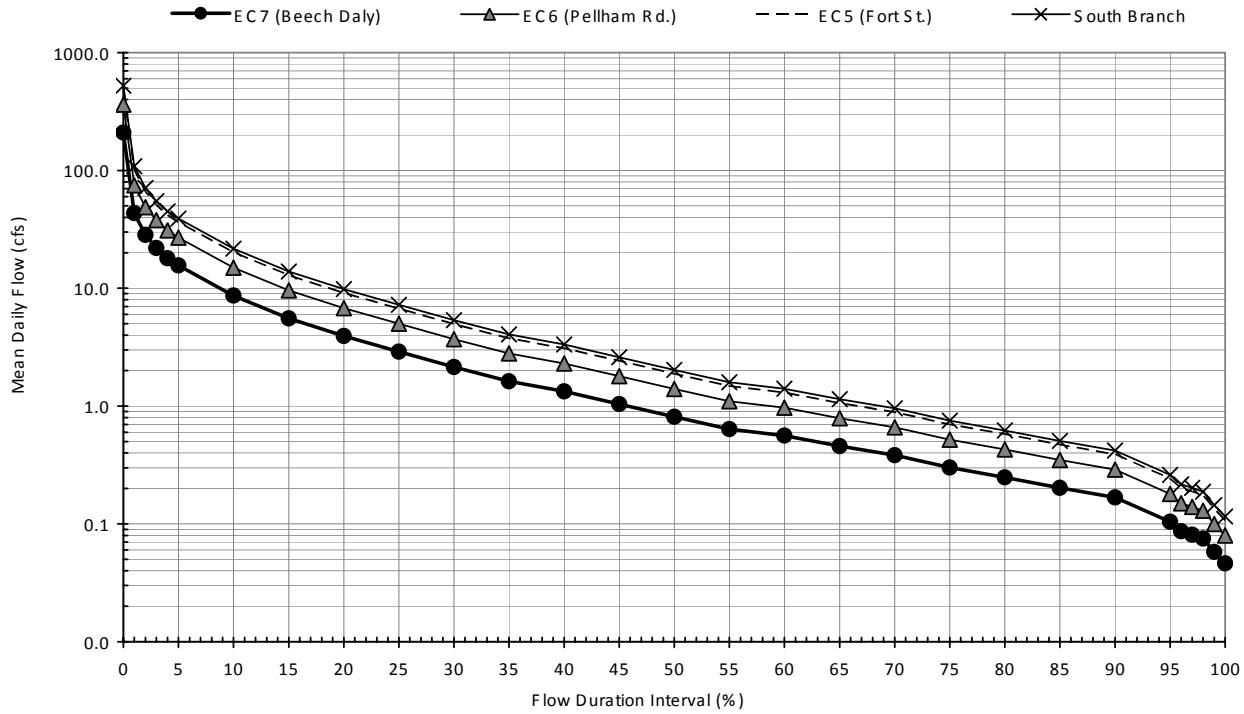


Figure B14. Flow duration curves for the North Branch Ecorse River

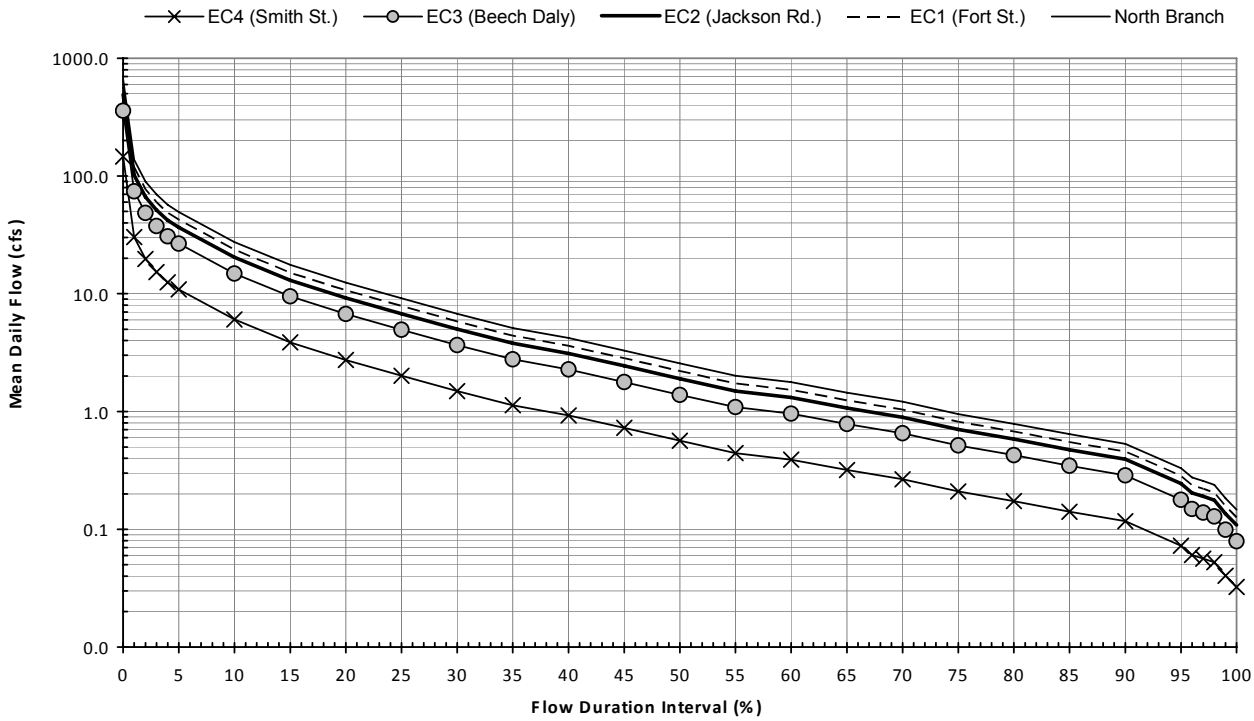


Table B1. Flow percentiles for the Ecorse River watershed

Percentile	USGS Station (cfs)	Ecorse River (cfs)	South Branch (cfs)	EC7 (cfs)	EC6 (cfs)	EC5 (cfs)	North Branch (cfs)	EC4 (cfs)	EC3 (cfs)	EC2 (cfs)	EC1 (cfs)
Maximum	362.0	1643.6	523.6	209.4	361.3	486.9	663.3	145.9	358.2	490.9	570.5
1	75.0	334.8	108.5	43.4	74.8	100.9	137.4	30.2	74.2	101.7	118.2
5	27.0	122.5	39.1	15.6	26.9	36.3	49.5	10.9	26.7	36.6	42.5
10	15.0	66.4	21.7	8.7	15.0	20.2	27.5	6.0	14.8	20.3	23.6
15	9.6	44.4	13.9	5.6	9.6	12.9	17.6	3.9	9.5	13.0	15.1
20	6.8	31.2	9.8	3.9	6.8	9.1	12.5	2.7	6.7	9.2	10.7
25	5.0	22.4	7.2	2.9	5.0	6.7	9.2	2.0	4.9	6.8	7.9
30	3.7	16.7	5.4	2.1	3.7	5.0	6.8	1.5	3.7	5.0	5.8
35	2.8	13.1	4.0	1.6	2.8	3.8	5.1	1.1	2.8	3.8	4.4
40	2.3	10.6	3.3	1.3	2.3	3.1	4.2	0.9	2.3	3.1	3.6
45	1.8	8.4	2.6	1.0	1.8	2.4	3.3	0.7	1.8	2.4	2.8
50	1.4	6.6	2.0	0.8	1.4	1.9	2.6	0.6	1.4	1.9	2.2
55	1.1	5.3	1.6	0.6	1.1	1.5	2.0	0.4	1.1	1.5	1.7
60	1.0	4.4	1.4	0.6	1.0	1.3	1.8	0.4	1.0	1.3	1.5
65	0.8	3.6	1.1	0.5	0.8	1.1	1.4	0.3	0.8	1.1	1.2
70	0.7	3.0	1.0	0.4	0.7	0.9	1.2	0.3	0.7	0.9	1.0
75	0.5	2.4	0.8	0.3	0.5	0.7	1.0	0.2	0.5	0.7	0.8
80	0.4	2.0	0.6	0.2	0.4	0.6	0.8	0.2	0.4	0.6	0.7
85	0.4	1.6	0.5	0.2	0.3	0.5	0.6	0.1	0.3	0.5	0.6
90	0.3	1.3	0.4	0.2	0.3	0.4	0.5	0.1	0.3	0.4	0.5
95	0.2	0.8	0.3	0.1	0.2	0.2	0.3	0.1	0.2	0.2	0.3
99	0.1	0.5	0.1	0.1	0.1	0.1	0.2	0.0	0.1	0.1	0.2
100	0.1	0.4	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1

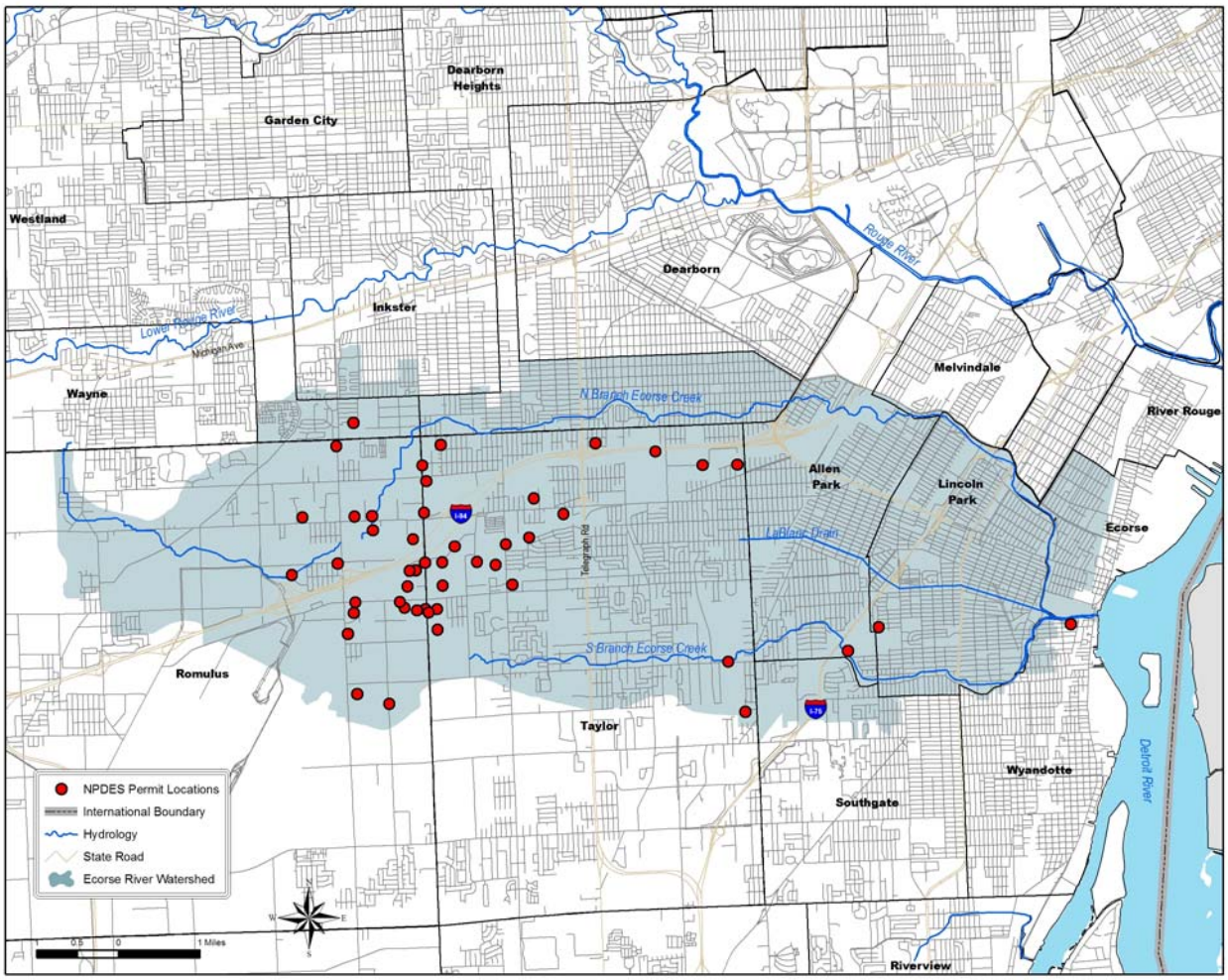
Attachment C
NPDES Permits and Map

Table C1. NPDES Individual Permits and Certificates of Coverage in the Ecorse River Watershed

Permit/ Certificate of Coverage Number	Facility Name
Individual Permits	
MI0046264	Buckeye Pipe Line-Taylor
MI0057364	MDOT State-wide MS4
MI0036846	Detroit Metro Wayne Co Airport
General Permit MIG619000 - Municipal Separate Storm Sewer System (Watershed-Based)	
MIG610001	Westland MS4-Wayne
MIG610009	Dearborn Heights MS4-Wayne
MIG610014	Inkster MS4-Wayne
MIG610017	Romulus MS4-Wayne
MIG610020	Allen Park MS4-Wayne
MIG610029	Melvindale MS4-Wayne
MIG610040	Wayne Co MS4
MIG610347	Southgate MS4-Wayne
MIG610348	Taylor MS4-Wayne
MIG610349	Wyandotte MS4-Wayne
MIG610350	Lincoln Park MS4-Wayne
MIG610352	Ecorse MS4-Wayne
General Permit MIS040000 - Municipal Separate Storm Sewer System (6 Min. Measures)	
MIS040060	Wayne-Westland PS MS4-Wayne
General Permit MIG640000 - Wastewater Discharge from Municipal Potable Water Supply	
MIG640029	Southwest WTP
General Permit MIG670000 - Hydrostatic Pressure Test Water	
MIG670013	Buckeye-Detroit Taylor
MIG670283	Equilon Enterprises-Metro
MIG670291	Marathon Petro Co-Romulus
MIG670320	BP Products-Dearborn Terminal
General Permit MIS210000 - Storm Water from Industrial Activities (2-Yr Cycle Watersheds)	
MIS210300	Ajax Materials-Plt 5
MIS210341	Worthington Steel-Taylor
MIS210840	Ajax Paving-M-711
MIS210845	Saturn Electronics Corp
MIS210904	Oakwood Plastics Div
MIS210914	Taylor Recycling Inc
MIS210418	Reilly Plating Co-Melvindale
MIS210540	Means Industries-Melvindale
MIS210542	USPS-Detroit VMF
MIS210618	Delray Steel Castings
MIS210815	Norfolk Southern-Triple Crown
MIS210816	Norfolk Southern-Auto Ramp
MIS210909	Norfolk & Western RR-Melvinda
MIS210917	Vinewood Metalcraft Co
General Permit MIS310000 - Storm Water from Industrial Activities (3-Yr Cycle Watersheds)	
MIS310008	Nor-Dic Tool-Romulus
MIS310011	FedEx Freight East-Detroit
MIS310039	Van Born Auto Wrecking
MIS310045	ABF Freight System Inc-Romulus
MIS310047	Modern Cam & Tool-Taylor
MIS310084	Link Tool & Mfg-Taylor

Permit/ Certificate of Coverage Number	Facility Name
MIS310138	Indian Trails-Romulus
MIS310141	Vacuum Orna Metal-Romulus
MIS310181	Glens Car & Truck Parts
MIS310182	Downriver Deburring Inc
MIS310185	USF Holland Inc-Romulus
MIS310187	Mich Steel Prop-Ecorse
MIS310188	Mid-Lakes Recycling-Taylor
MIS310214	Voss Industries-Taylor
MIS310223	Great Lakes Agg-Taylor
MIS310240	Plastech-Romulus Facility
MIS310275	Cousins Petroleum-Taylor
MIS310282	Con-way Freight-XDE
MIS310285	Air Conditioning Prod-Romulus
MIS310290	GKN Sinter Metals-Romulus
MIS310046	Roadway Express-Taylor
MIS310219	Woodbridge Corp-Romulus
MIS310286	EFTEC North America LLC-Taylor
MIS310398	Ford-Allen Park Clay Mine LF
MIS310592	Metro Machine Works Inc
MIS310603	Americane Sugar Refining LLC
MIS310291	Murray Grinding-Dearborn Hgts
MIS310317	Quality Wire Processing-Taylor
MIS310380	Abdite Industries Inc-Taylor
MIS310381	Kerr Corp-Romulus
MIS310394	Future Tool & Machine-Romulus
MIS310420	UPS Freight-Romulus
MIS310432	Trimac Transportation East Inc
MIS310435	Dix Automotive Recyclers
MIS310516	Co Pipe Products-Taylor
MIS310543	Penske Logistics-Romulus
MIS310563	St James Leasing
MIS310574	Central Transport-Romulus
MIS310596	FedEx Nat LTL Inc
General Permit MIS410000 - Storm Water from Industrial Activities (4-Yr Cycle Watersheds)	
MIS410510	Process Prototype-Romulus
General Permit MIS320000 - Storm Water Discharges with Required Monitoring	
MIS320008	BP Products
MIS320009	RKA Petroleum
MIS320010	Marathon Petro Co
MIS320017	Buckeye Terminals

Figure C1. NPDES Permit Locations (note the depicted locations are not necessarily the outfall locations)



Attachment D
Load Duration Curves

Figure D1. Load duration curve for EC1 - North Branch of Ecorse Creek at Fort Street

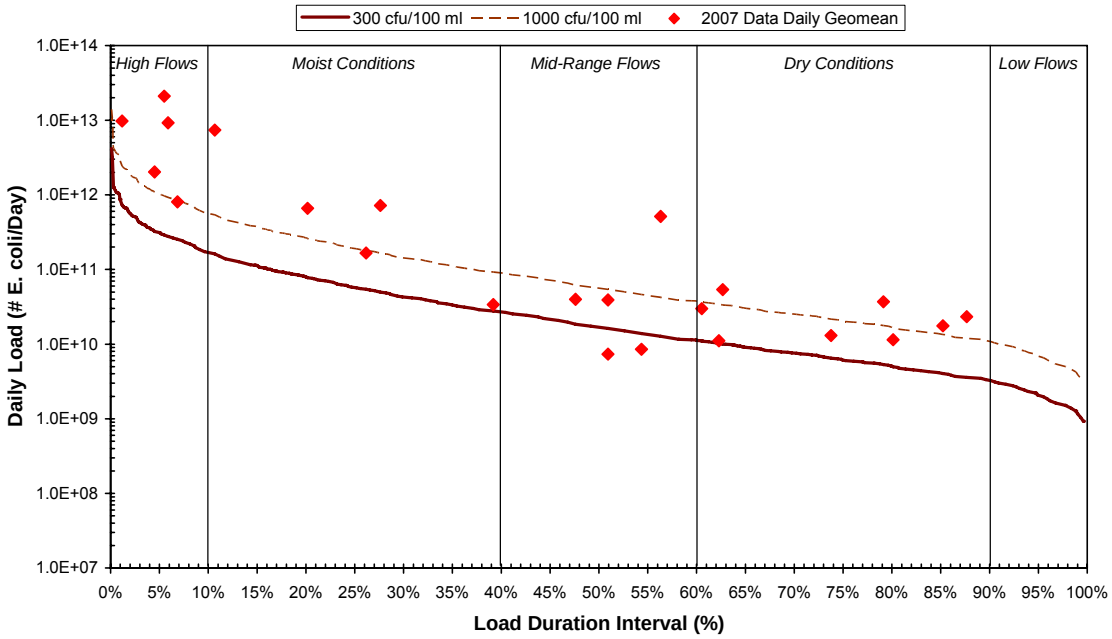


Figure D2. Load duration curve for EC2 - North Branch of Ecorse Creek at Pelham Road

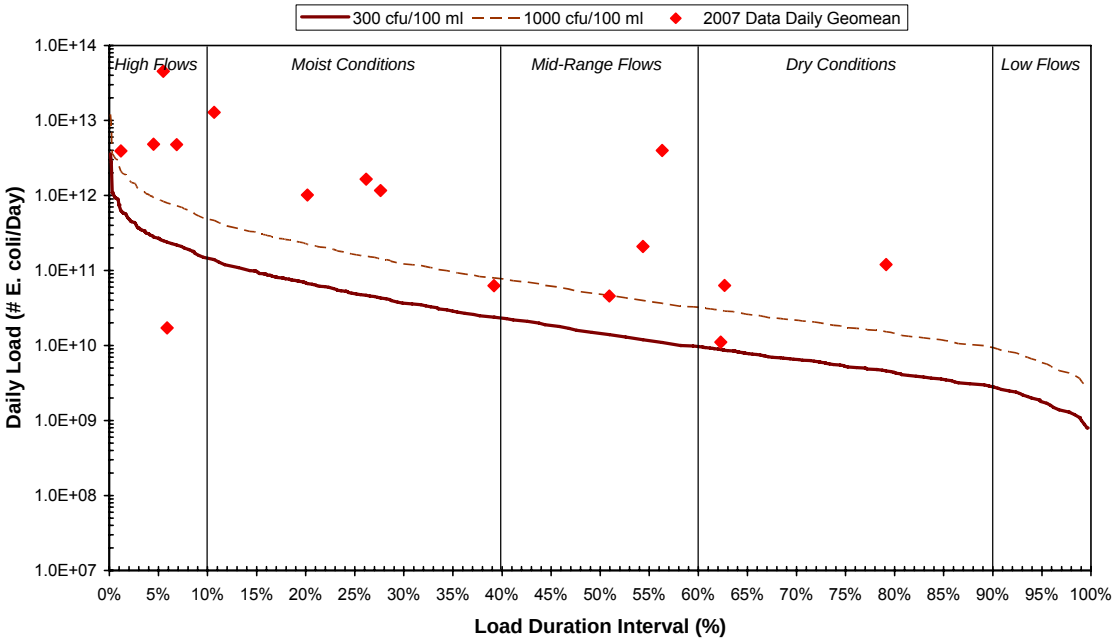


Figure D3. Load duration curve for EC3 - North Branch of Ecorse Creek at Beech Daly Road

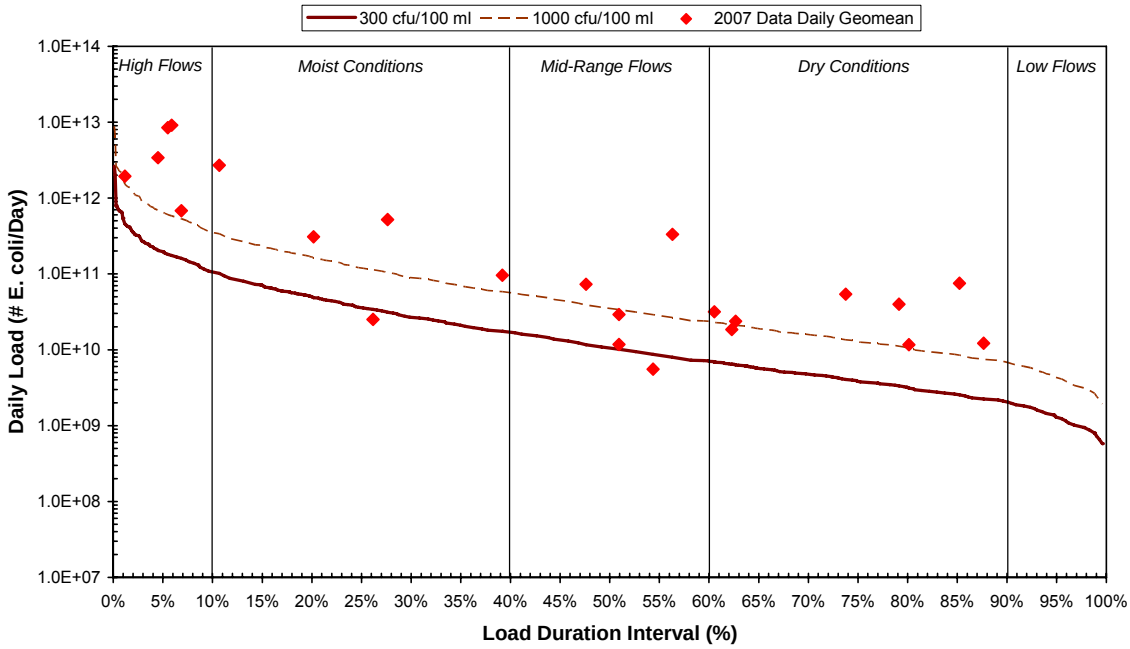


Figure D4. Load duration curve for EC4 – North Branch of Ecorse Creek at Smith Street

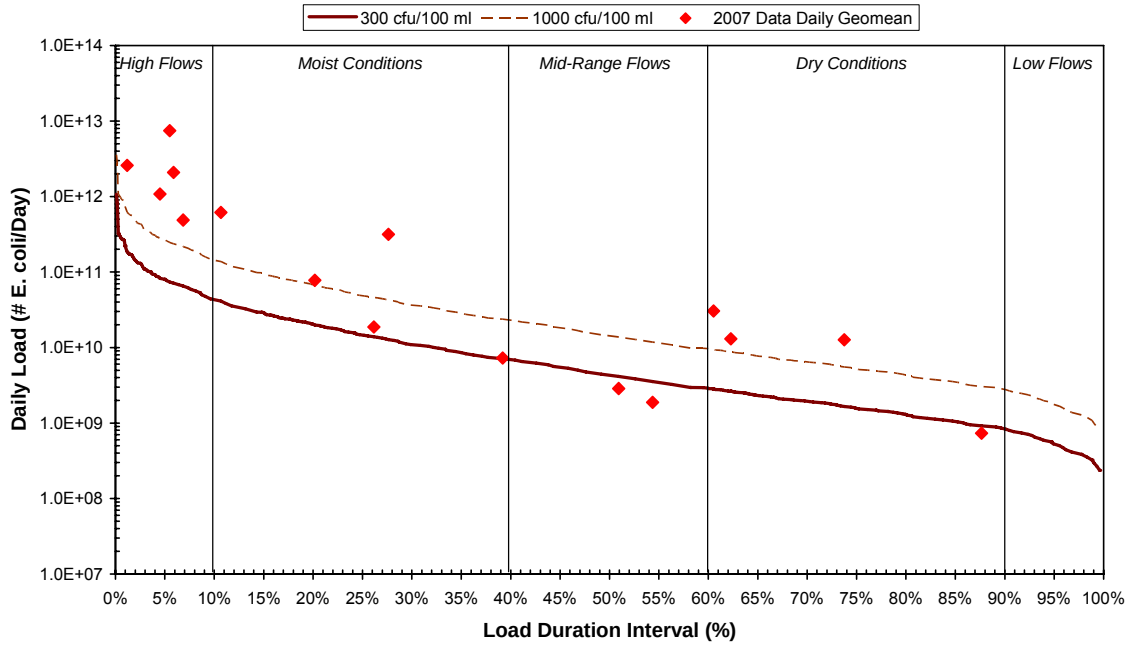


Figure D5. Load duration curve for EC5 – South Branch of Ecorse Creek at Fort Street

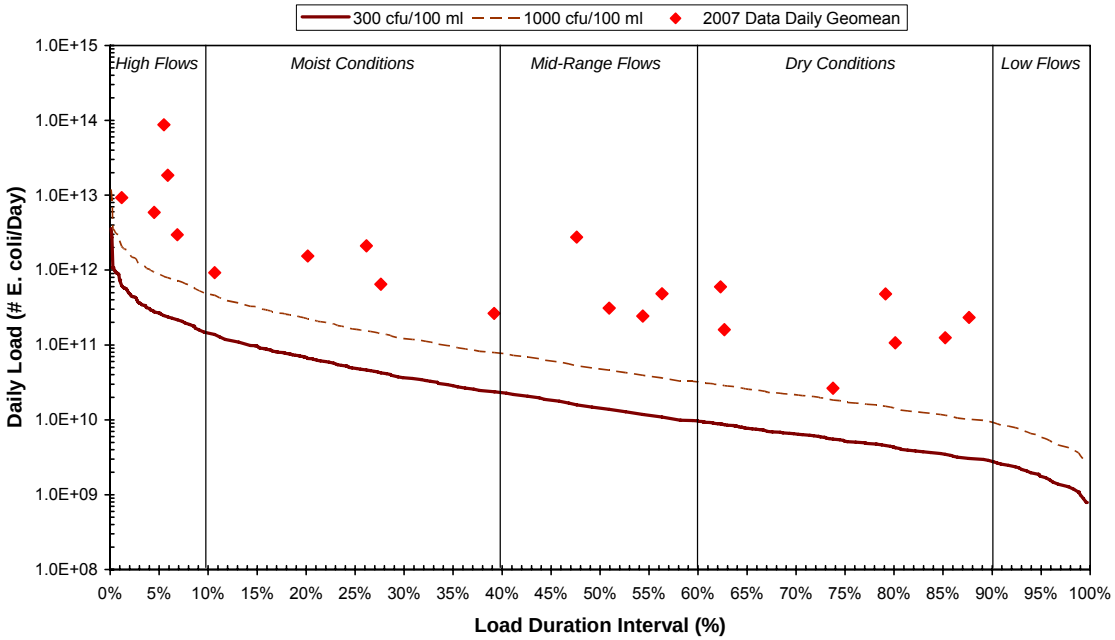


Figure D6. Load duration curve for EC6 – South Branch of Ecorse Creek at Pelham Road

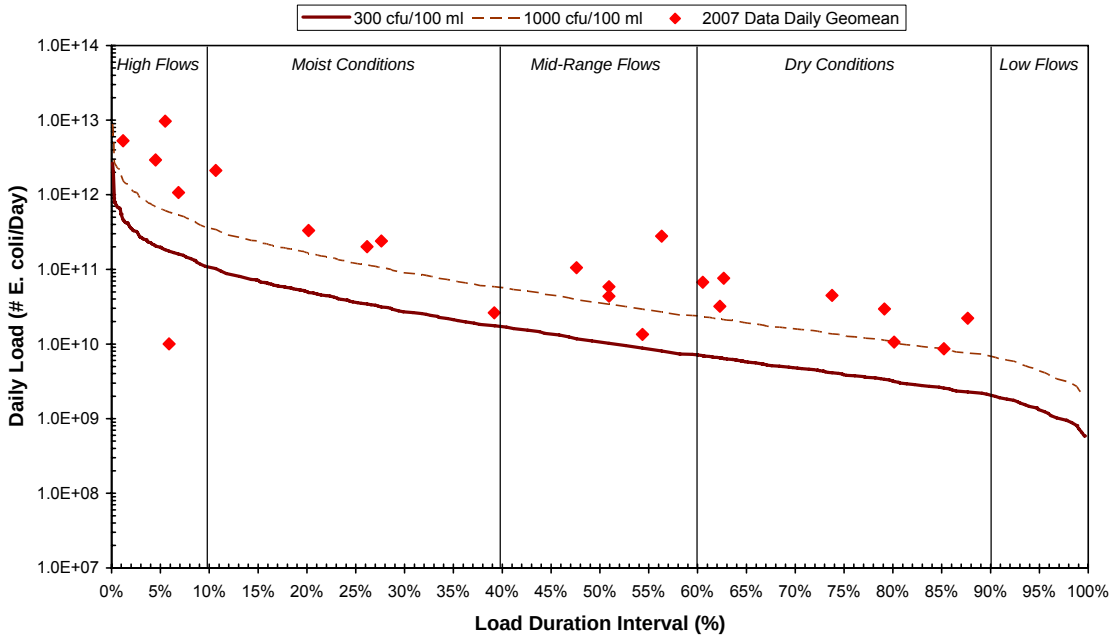
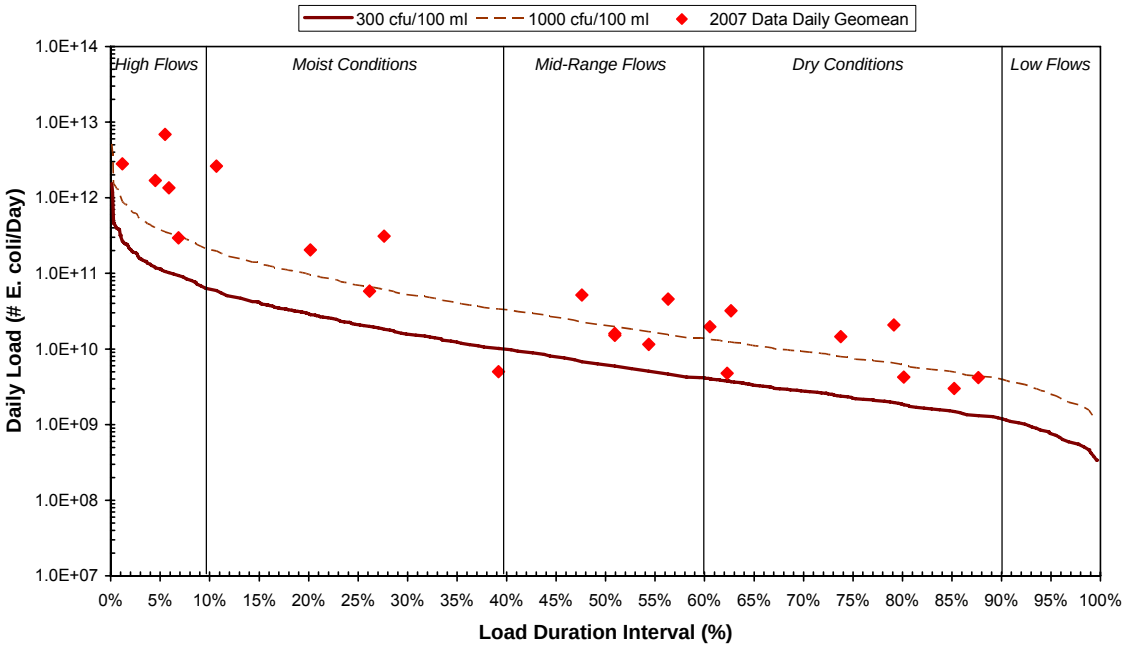



Figure D7. Load duration curve for EC7 - South Branch Ecorse Creek at Beech Daly Road