Total Maximum Daily Load for *E. coli* in the Lower Clinton River

Macomb, Oakland, and St. Clair Counties

Michigan Department of Natural Resources and Environment

Water Resources Division

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List of Tables

Table 1. Weekly *E. coli* sampling results (counts per 100 mL) from the North Branch Clinton River (Stations NB1-NB8); June 5-October 1, 2008.

Table 2. Weekly *E. coli* sampling results (counts per 100 mL) from the Main Branch Clinton River (Stations CR1-CR13); June 5-October 1, 2008.

Table 3. Weekly *E. coli* sampling results (counts per 100 mL) from the Middle Branch Clinton River (Stations MB1-MB4); June 5-October 1, 2008.

Table 4. Summary of data for all stations, including station geometric means, the number of PBCs and daily maximum TBC WQS exceedances, and the results of bacterial source tracking at selected stations.

Table 5. 2006 Land Cover Classification of the entire TMDL watershed, and the Main Branch, Middle Branch, and North Branch, separately, as a percent of total land area.

Table 6. Percent of land area in the Lower Clinton River TMDL watershed located within each municipality. Municipalities that hold an MS4 permit are marked with an "X."

Table 7. Percent of land area in the Lower Clinton River TMDL watershed located within each county. Counties that hold an MS4 permit are marked with an "X."

Table 8. NPDES facilities discharging to the Clinton River watershed. Certificates of Coverage under the General Storm Water Permit are listed in Appendix 2.

Table 9. USGS gauge locations for each station and the period of record for each gauge used in load duration curve development.

List of Figures

Figure 1. Overview of the 2010 TMDL watershed, 2008 sample locations, approved *E. coli* TMDLs and future *E. coli* TMDL areas.

Figure 2. Locations of sampling stations, NPDES permitted discharges, and municipalities within the TMDL watershed.

Figure 3. Map of chronic SSOs (under the jurisdictions of Center Line, Fraser, and Clinton Townships) in relation to DNRE sampling stations.

Figure 4. Generalized 2006-era land cover of the TMDL watershed.

Figure 5. Thirty-day geometric mean *E. coli* sampling results from Main Branch Clinton River (Stations CR1-CR13).

Figure 6. Thirty-day geometric mean *E. coli* sampling results from Middle Branch Clinton River (Stations MB1-MB4).

Figure 7. Thirty-day geometric mean *E. coli* sampling results from North Branch Clinton River (Stations NB1-NB8).

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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, Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting water quality standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the allowable levels of *Escherichia coli* (*E. coli)* that will result in the attainment of the applicable WQS in the Clinton River, located in Macomb, Oakland, and St. Clair Counties, Michigan (Figure 1).

PROBLEM STATEMENT

This TMDL addresses the assessment units (AUIDs) and listings that appear on the 2008 Section 303(d) list (LeSage and Smith, 2008) as:

CLINTON RIVER **AUID**: 040900030402-01
County: Macomb SIZE: 43.3 M
Location: Clinton River and Unnamed Tributaries to Clinton River.
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Combined Sewer Overflows from Pontiac.
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030402-02
County: Macomb SIZE: 10.3 M
Location: Clinton River from Gratiot Avenue downstream to the mouth.
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Combined Sewer Overflows from Pontiac.
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030402-03
County: Macomb SIZE: 27.8 M
Location: Clinton River
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Combined Sewer Overflows from Pontiac.
TMDL Year(s): 2010

This TMDL also addresses the AUIDs, described in Appendix 1, proposed for inclusion on the Department of Natural Resources and Environment's (DNRE's) draft 2010 Section 303(d) list. The Main Branch Clinton River, downstream of Yates Dam near Rochester, was first placed on the Section 303(d) list in 1998 due to impairment of recreational uses by *E. coli* (Creal and Wuycheck, 1998). Monitoring data collected by the DNRE in 2008 for the Main, North, and Middle Branch Clinton River and tributaries documented multiple exceedances of the daily maximum and 30-day geometric mean WQS for *E. coli* during the total body contact (TBC) recreational season of May 1 through October 31, and periodic exceedances of the partial body contact (PBC) WQS (Tables 1-4; Figures 5-7). This TMDL addresses the entirety of the Middle Branch, Main Branch downstream of Rochester (including Harrington Drain), and the North Branch Clinton River from 33-Mile Road downstream to the confluence with the Main Branch (including tributaries) (Figure 1). Monitoring data collected by the DNRE in 2008 on Paint Creek and the Main Branch Clinton River upstream of the TMDL reach (Figure 1) indicate that these waters are also not attaining the TBC and PBC recreation designated use, and will be proposed for inclusion in the 2012 Section 303(d) list and a TMDL scheduled if appropriate. The uppermost portion of the North Branch Clinton River, upstream of 33-Mile Road, has not been assessed for attainment of the PBC and TBC WQS and will be assessed in the future. There are several water bodies with approved *E. coli* TMDLs adjacent to the water bodies addressed by this TMDL: these are, Red Run Drain and Bear Creek, East Coon Creek, Deer Creek, and East Pond Creek (Figure 1).

The TMDL reach is located in the Clinton River watershed (Hydrologic Unit Code 4090003), which flows into Lake St. Clair (Figure 1). The Clinton River TMDL watershed covers 117,700 acres (about 184 square miles) of Macomb, Oakland, and St. Clair Counties and is composed of 16 minor civil divisions (Table 6). The infrastructure for the city of Detroit alters the hydrology of the Clinton River watershed such that discharges to the municipal system within the Clinton River watershed area are routed to the Detroit River watershed. Therefore, sources of *E. coli* from the Detroit municipal boundaries are not addressed in this TMDL. The Clinton River watershed was home to a population of about 232,400 people in 2008 (United States Census Bureau, 2000 and SEMCOG, 2008) and experienced an estimated 5.4 percent increase in population from 2000-2008 (SEMCOG, 2008).

The Clinton River TMDL watershed is located within the Maumee Lake Plain ecosystem type, which is characterized by flat, clay lake plain with loamy and somewhat poorly drained soils, ideal for agriculture when artificial drainage is used (Albert, 1995). Areas of well-drained, sand-dominated soils bisect the clay plains formed by glacial drainageways. Prior to European colonization, extensive marshes occurred along the shores of Lake St. Clair and extended upstream for several miles on major rivers such as the Clinton River. Upslope of the marshes were deciduous swamps followed by beech-sugar maple forests on the upland areas (Albert, 1995). Land cover data (2006) was used to calculate the land cover types of the entire TMDL watershed, as well as a breakdown of land cover in the Main, Middle, and North Branches (Table 5) (NOAA, 2008b). The portion of the North Branch Clinton River within the TMDL watershed (Figure 1) is largely agricultural with 37 percent of the land area used for cultivated row crops, and an additional 17 percent as pasture or hay. The Middle Branch Clinton River, which is entirely within the TMDL watershed, is 47 percent low, medium, and high intensity developed land, which was mainly single family residential according to land use data from 2000 (SEMCOG, 2009). Agriculture in the Middle Branch Clinton River occupies 16 percent of the land area (cultivated cropland and pasture/hay combined). Land cover in the Main Branch Clinton River area of the TMDL watershed is dominated by low, medium, and high intensity development, which together occupy 73 percent of the land area. Less than 1 percent of the land area within the Main Branch Clinton River TMDL boundary is used for agriculture;

however, this does not exclude agricultural sources to the sites located directly on the Main Branch Clinton River (Stations CR1-3, 5, 7-11, and 13), because some of the land upstream of the TMDL reach is used for agriculture and therefore *E. coli* from these upstream agricultural land practices would enter the Main Branch.

NUMERIC TARGET

The impaired designated uses addressed by this TMDL are TBC and PBC recreation. The designated use rule (Rule 100 [R 323.1100] of the Part 4 rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended) states that this water body be protected for TBC recreation from May 1 through October 31 and PBC recreation year-round. The target levels for these designated uses 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.
>
> (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 ml. 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.

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.

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 maximum to protect the TBC use are the target levels for the TMDL reach from May 1 through October 31, and 1,000 *E. coli* per 100 mL as a daily maximum year-round to protect the PBC use. The 2008 monitoring data indicated daily maximum and 30-day geometric mean exceedances at all stations. The PBC WQS was exceeded at least once at all stations.

DATA DISCUSSION

Weekly *E. coli* data were collected by the DNRE from 25 sites from June 4-October 1, 2008,

(Tables 1-3). Stations NB1-NB8 are located on the North Branch, CR1-CR13 are located on the Main Branch (and tributaries to the Main Branch), and MB1-MB4 are located on the Middle Branch Clinton River (Figure 1 and Appendix 6). The daily maximum TBC standard (300 *E. coli* per 100 mL) and PBC recreation daily maximum standard (1,000 *E. coli* per 100 mL) were exceeded at all stations and the daily maximum TBC standard was exceeded on all sample dates at three of the stations (CR3, CR6, and MB4).

Station geometric means were calculated using all weekly data collected at each station throughout the sampling period (Table 4). *E. coli* daily maximum and 30-day geometric mean data for 2008 are shown in Tables 1-3 and Figures 5-7. Based on the station geometric means of all 25 sites sampled within the TMDL reach, CR3 on Harrington Drain had the highest concentrations of *E. coli* (1,778 *E. coli* per 100 mL) followed by CR6 on Red Run Drain (1,686 *E. coli* per 100 mL) (Table 4). CR1 on the Clinton River Spillway had the lowest overall station geometric mean (249 *E. coli* per 100 mL). The highest daily maximum *E. coli* concentration of 32,166 *E. coli* per 100 mL was recorded at Station CR5 on July 8, 2008, following a minor rainfall of 0.09 inches. Station CR3, located on Harrington Drain, had the greatest number of PBC WQS exceedances of all stations in the entire TMDL watershed. Results from the three branches of the Clinton River will each be discussed separately.

Precipitation data for the two days prior to each DNRE sampling event were obtained from a weather station at Romeo, Michigan (MAWN, 2008) for the North Branch and Middle Branch Clinton River (Tables 1 and 3), and the Pontiac Wastewater Treatment Plant (WWTP) (NOAA, 2008a) for the Main Branch Clinton River (Table 2). Overall, precipitation at the Romeo-based weather station showed near average amounts of precipitation in June and July 2008. Below-average precipitation was observed in August 2008 (observed=1.82 inches; average=3.0 inches), and precipitation observed in September 2008 was more than 3 times the average amount (observed=6.81 inches; average=2.2 inches) based on 25 years of precipitation data (NOAA, 2008a). The Clinton River United States Geological Survey (USGS) gauge (4165500) located at Moravian Road shows that flows responded accordingly to the increased rainfall in September. The Main Branch Clinton River was at a near record low flow of 74 cubic feet per second (cfs) on September 1, 2008. The discharge from the Clinton River increased dramatically, from 295 cfs on September 9, 2008 (near the historic monthly mean), to 1,280 cfs on September 10, 2008. A series of storms from September 7-9, 2008, resulted in the hydrograph peaking at a maximum flow of 7,910 cfs on September 15, 2008.

In addition to weekly *E. coli* samples, samples for bacterial source tracking analysis to determine sources of fecal contamination were collected from CR3 (Harrington Drain), CR12 (Paint Creek), MB3 (Gloede Drain), NB2 (Coon Creek), and NB7 (McBride Drain). Samples from CR3, NB2, and NB7 were collected on September 3, 2008. Samples from CR12 were collected on September 24, 2008. Samples were collected from MB3 on October 1, 2008, and also on that date a second set of samples was collected from NB2. Each sample was analyzed for fecal *Bacteriodetes* human and bovine (cattle) gene biomarkers by polymerase chain reaction; these results are shown in Table 4. Since *Bacteriodetes* are strict anaerobes, and cannot survive long outside their host, the detection of this biomarker indicates recent or nearby human or bovine fecal pollution. Positive human *Bacteroidete*s results were found at Stations CR3, CR12, MB3, NB2, and NB7. Positive bovine Bacteroidetes results were found at Stations NB2 and NB7.

Main Branch Clinton River

Of the nine stations located directly on the Main Branch Clinton River, the *E. coli*

concentrations generally increased from upstream to downstream indicating that the more significant sources of *E. coli* occur in the lower reaches of the Main Branch (Tables 2 and 4). A notable increase in *E. coli* concentration occurred downstream of the Red Run Drain confluence with the main stem river (between Stations CR5 and CR7). With the exception of Station CR1 (located on the emergency spillway), the *E. coli* data from stations downstream of the Red Run Drain confluence with the Main Branch Clinton River (CR2-CR6) all followed similar trends in *E. coli* concentrations over time (Figure 5). *E. coli* concentrations at sites downstream of Red Run Drain (CR2-CR6) tended to be more variable over time and reached maximum concentrations in late July, decreased through August, and increased dramatically through late September; whereas, *E. coli* concentrations upstream of Red Run Drain (CR7-CR13) reached their maximum at the beginning of the sampling season in late June, and decreased and remained fairly stable from August through the end of September (Figure 5).

Of the 18 sampling events, 10 events were preceded by rainfall according to records kept by the Pontiac WWTP. *E. coli* concentrations at Stations CR2-CR6 (those downstream of Red Run Drain including Harrington Drain), and CR8 tended to be elevated following precipitation. All stations in the Main Branch Clinton River, except CR1 on the spillway, exceeded the PBC WQS on the June 25, 2008, sampling event, which occurred the day following a rainfall of 0.21 inches. The human *Bacteroidetes* biomarker was detected at Station CR3 on September 3, 2008, and CR12 on September 24, 2008. Bovine *Bacteroidetes* were not detected at CR3 or CR12.

Middle Branch Clinton River

Each of the four stations located on the Middle Branch Clinton River study area exceeded the daily maximum TBC WQS for most, if not all, of the sampling season. The daily maximum TBC WQS was exceeded on 100 percent of sampling events at MB4, 94 percent at Stations MB1 and MB3, and 89 percent of events at Station MB2. The 30-day geometric mean TBC WQS was exceeded throughout the sampling season at all four of the Middle Branch Clinton River stations. The number of PBC WQS exceedances at each station increased at the further downstream locations, as did the station geometric means (Table 4). Station MB3, on Gloede Drain, had the highest station geometric mean of the four Middle Branch Clinton River stations. The 30-day geometric mean of Stations MB3 and MB4 increased gradually toward the end of the sampling season (Figure 6), and Station MB4 consistently exceeded the daily maximum PBC WQS for the last 4 weeks of sampling, beginning with the September 10, 2008, sample (Table 3). Exceedances of the PBC WQS at Middle Branch Clinton River stations occurred in both wet and dry weather. The two largest rain events captured by the sampling (June 11 and September 10, 2008) resulted in exceedances of the WQS at Stations MB2, MB3, and MB4 (Table 3). Human *Bacteroidetes* were detected in a sample from MB3, from Gloede Drain, on October 1, 2008. Bovine *Bacteroidetes* were not detected at MB3.

North Branch Clinton River

Of the eight stations in the North Branch Clinton River study area, results at Station NB2 on Coon Creek were consistently the highest, resulting in exceedances of the PBC WQS on 44 percent of sampling events (Table 1). McBride Drain, Station NB7, had a notably higher station geometric mean when compared with the four stations on the North Branch Clinton River (NB1, NB5, NB6, and NB8) (Table 4). Station NB1, the station located furthest upstream in the watershed, had the lowest station geometric mean (279 *E. coli* per 100 mL) of all stations in the North Branch Clinton River. This station exceeded the PBC WQS on 4 of the 18 sampling dates. *E. coli* concentrations at Stations NB1, NB2, and NB7 were noticeably

affected by wet weather. Of the 7 rain events, which occurred within 2 days prior to sampling, Station NB2 (Coon Creek) exceeded the PBC WQS on 6 events, and Stations NB1 (North Branch Clinton River at 29-Mile) and NB7 (McBride Drain) exceeded the PBC WQS on 4 events. Bovine *Bacteroidetes* biomarkers were detected on September 3, 2008, at Stations NB2 and NB7. Positive human *Bacteroidetes* results were found at NB2 (Coon Creek) on October 1, 2008, and NB7 (McBride Drain) on September 3, 2008.

SOURCE ASSESSMENT

Potential sources to all three branches of the TMDL watershed include illicit connections, failing on-site sewage disposal systems (OSDS), agricultural operations, wildlife and pet waste, dumping of trash, contaminated groundwater, National Pollutant Discharge Elimination System (NPDES) permitted discharges of storm water, as well as unregulated urban runoff. General sources are discussed here, while sources specific to each of the three branches (Main Branch, Middle Branch, and North Branch Clinton River) are discussed separately below.

To assist in determining potential sources to TMDL water bodies, the DNRE conducted a load duration curve analysis for each sampling station as outlined by Cleland (2002). A load duration curve considers how flow conditions relate to a variety of pollutant sources (point and nonpoint sources). The load duration curves for each station show the flow conditions that occurred during sampling, and can be used to make rough determinations as to which conditions result in exceedances of the WQS. The load duration curves for each station sampled in the Clinton River TMDL watershed are included in Appendices 3-5. The USGS gauges, which were used to determine the load duration curves for this TMDL are listed and described in Table 9. A ratio of the drainage area of the station locations to the drainage area of the gauged watersheds (defined as the drainage area ratio) was calculated for each of the 25 stations for this TMDL. The curves were generated by applying these drainage area ratios to gauged flows for the period of record (Table 9).

Exceedances that occur during high flows are generally linked with rainfall events, such as surface runoff contaminated with fecal material, a flush of accumulated wildlife feces, or trash from the storm sewers or septic tank failures involving failing drainage fields that no longer percolate properly (surface failures). Exceedances that occur during low flows or dry conditions can generally be attributed to a constant source that is independent of the weather. Examples of constant sources include illicit connections (either directly to surface waters or to storm sewers), some types of OSDS failures, groundwater contamination, and pasture animals with direct stream access. Groundwater contamination of surface water with *E. coli* can occur in areas where septic tanks are too close to surface waters or in areas where livestock or animal waste is allowed to accumulate in close proximity to surface waters.

OSDS are a common method of treatment where sanitary sewers are not available, including Armada, Chesterfield, Clinton, Harrison, Macomb, Ray, Shelby, Sterling Heights, and Washington Townships. These systems become a potential source of *E. coli* to surface waters when they fail or are poorly designed. Failures occur at varying degrees, resulting in a range of contamination severity, with major failures such as sewage on the ground surface and tanks connected directly to surface waters (also considered illicit discharges) at one end of the scale, and minor failures such as laundry or sinks bypassing the treatment systems at the other end of the scale. The Macomb County Health Department (MCHD) maintains a Point of Sale inspection for OSDS to enforce their Property Transfer Ordinance. The overall rate of OSDS failure for Macomb County was 12 percent during 2008 (this figure does not include laundry and sink violations) (personal communication with MCHD). Oakland County has over

80,000 OSDS in its jurisdiction, but does not have a Point of Sale Ordinance; therefore, the precise failure rate is unknown. However, it is estimated that the OSDS failure rate (including laundry and sink violations) is about 10 percent across Michigan, based on an average of existing Point of Sale programs throughout the state (*E. coli* Work Group, 2008).

Of the entire TMDL watershed, 38 percent of the land coverage is a combination of high, low, and medium intensity development, with an additional 10 percent developed open space (Figure 4; NOAA, 2008b). Residences and industrial and commercial buildings within this area are largely connected to the sanitary sewers and are served by storm sewers. The sewers in the TMDL watershed are all separated, meaning that sanitary waste and storm water are transported in separate systems. Sanitary waste is transported to a WWTP, where the effluent is subject to fecal coliform limits (as described in the Reasonable Assurance section). The USEPA's Storm Water Phase II Rules require that all public entities operating Municipal Separate Storm Sewers (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-Based Storm Water General Permit (MIS040000) have been developed to meet the federal requirement. The TMDL watershed receives MS4 permitted storm water from 13 minor civil divisions (townships, villages, and cities), 2 counties, and the Selfridge Air National Guard base (Table 8). Macomb County is responsible for approximately 5,895 surface water discharge points according to their 2008 MS4 permit application. Oakland County's permit application states that they have 1,499 known outfalls, though few of these are located within the TMDL watershed. While portions of St. Clair County are within the boundary of this TMDL watershed, the land area makes up less than 1 percent of the TMDL watershed and no MS4 outfalls from St. Clair County discharge to the watershed; therefore, the St. Clair County MS4 has not been included in Table 8. In addition to MS4 permitted discharges within the TMDL watershed, there are 4 individual NPDES permits, 182 Certificates of Coverage (COCs) under the industrial storm water general permit (MIS110000), 1 COC for petroleum groundwater cleanup (MIG080000), 1 COC for noncontact cooling water (MIS110000), and 1 COC for storm water discharge with required monitoring (MIS120000) (Figure 2, Table 8, and Appendix 2).

Approximately 20 percent of the Clinton River watershed land cover is cultivated row crops or hay/pasture land, and is available for manure spreading or grazing. While this area seems relatively small compared with the amount of developed land in the watershed (41 percent), manure spreading is considered a significant potential source. Many factors affect the amount of *E. coli* transported from fields where it is deposited; chief among them is the amount of *E. coli* present in the manure at the time of application. Liquid cattle manure has been shown to contain *E. coli* concentrations from 4,500 to 15,000,000 *E. coli* per mL (Unc and Goss, 2004). *E. coli* have been shown to enter water bodies from pastureland runoff and land applications of manure via field drainage systems, such as tiles, and surface runoff (Abu-Ashour and Lee, 2000). Enteric bacteria in agricultural soil amended by manure usually decline to preapplication levels within 1 to 6 months depending on conditions (Stoddard et al., 1998; Jamieson et al., 2002; Unc and Goss, 2004; and Oliver et al., 2005); however, under laboratory conditions, *E. coli* has survived for 231 days in manure amended soils (Jiang et al., 2002). According to the 2007 Census of Agriculture, there are 4,271 cattle, 1,356 horses, and 301 swine living in Macomb County (United States Department of Agriculture, 2007).

The large percentage of area with impervious surface within the Clinton River watershed causes a flush of storm water following precipitation, which can cause storm water to become contaminated with *E. coli* from human litter (such as diapers) and pet and wildlife fecal waste. In addition to pet and wildlife fecal waste on the ground surface, wildlife, including raccoons,

opossums, rats, and mice are residents of the storm sewers. Bacteria from these warm-blooded mammals are a certain contributor to the WQS exceedances observed in the urban subwatersheds.

Main Branch Clinton River

Sanitary Sewer Overflows (SSOs) are illegal events that occur when a sanitary sewer discharges raw or inadequately treated sewage to the ground surface or waters of the state rather than being transported to a WWTP. Chronic SSOs usually occur at a predictable location on a somewhat regular basis and can be caused by infiltration or inflow of groundwater into sewers during precipitation events, which in turn causes the system to overload. Three municipalities are responsible for chronic SSOs in the TMDL watershed. These are: Fraser (1 outfall), Center Line (1 outfall), and Clinton Township (7 outfalls) (Figure 3). The municipality of Fraser was responsible for 10 SSO events in 2008 and 12 in 2009. These chronic SSOs all occurred at the Beacon Lift Station and in 2008 resulted in approximately 1.2 million gallons of diluted raw sewage entering Sweeney Drain, a tributary to Harrington Drain, upstream of Station CR3. As an example of the potential impact of this SSO, the MCHD sampling on Harrington Drain after a June 10, 2008, Fraser SSO event, had a result of 54,750 *E. coli* per 100 mL (MCHD, 2008). The DNRE sampling event at the same location (Station CR3) on the day following this Fraser SSO event showed an elevated result (3,806 *E. coli* per 100 mL) and may reflect residual contamination from the SSO event. Clinton Township was responsible for 4 SSO events in 2008 (totaling approximately 0.2 million gallons of diluted raw sewage) and 2 SSO events in 2009. The Clinton Township chronic SSO outfalls discharge to the Clinton River and Harrington Drain. Center Line was responsible for 2 SSO events in 2008 and 2 SSO events in 2009. The 2008 events resulted in about 1.1 million gallons of diluted raw sewage entering a tributary to Bear Creek (Red Run Drain), upstream of Station CR6. Due to timing of the events and sampling, DNRE data would not have captured potentially elevated *E. coli* levels from the 2008 events from the Clinton Township or Center Line SSOs. Sampling by the MCHD targeted the September 13, 2008, Center Line event, which occurred after 3.72 inches of rain. Macomb County collected a sample just downstream of the Center Line SSO location and found an *E. coli* concentration of 34,480 *E. coli* per 100 mL (MCHD, 2008). The Pontiac municipal collection system, upstream of this TMDL reach, is also prone to chronic SSOs and is a source of *E. coli* to the impaired reach. During the sampling period to support this TMDL, one SSO from Pontiac occurred on September 14, 2008. The DNRE sampling at the furthest upstream sampling station (CR11, 8 miles downstream of Pontiac) on September 18, 2008, did not reflect an increased *E. coli* contamination from this event, but the Pontiac SSOs remain a potential source during heavy rainfall events.

OSDS are not a prevalent method of sanitary waste disposal in the Main Branch Clinton River TMDL watershed because the majority of this area is sewered; but, there are local areas where OSDS are common, including Shelby, Sterling Heights, and Clinton Townships. In Clinton Township, the OSDS from 347 homes were determined by the MCHD to be either failing or too close in proximity to the Clinton River. As of November 2008, the OSDS for 54 out of the 347 problem homes had been corrected by connecting the homes to a newly constructed sanitary sewer (Clinton Township, 2008). Similar situations may exist in other townships.

Seventy-three percent of the Main Branch Clinton River TMDL watershed is a combination of high, medium, and low intensity developed land, plus an additional 10 percent is categorized as developed open space (Figure 4). This developed land area is largely drained by storm sewers. MS4 permitted discharges for the Main Branch Clinton River include Shelby, Clinton, Macomb, and Chesterfield Townships, Macomb and Oakland Counties, and the cities of

Fraser, Utica, Mount Clemens, Rochester, and Rochester Hills. Illicit connections to regulated storm sewers are a likely source of *E. coli* to the Main Branch, including tributaries. Positive detections of human *Bacteroidetes* were found in Harrington Drain (CR3). No SSOs occurred prior to the collection of these samples, suggesting that illicit connections or failing OSDS are a source of the pathogens. Harrington Drain also was found to have the overall highest *E. coli* concentrations of all sampling stations. Due to these factors, sewers in the Harrington Drain subwatershed deserve close scrutiny for illicit discharges.

In addition to MS4 permitted discharges, other point sources include the Mount Clemens WWTP (treated sanitary wastewater - MI0023647), Selfridge ANGB (treated sanitary wastewater - MI0055328), DuPont-Mount Clemens (industrial storm water - MIS120007), and an additional 148 NPDES permitted industrial storm water discharges to the Main Branch Clinton River and its tributaries (Figure 2 and Appendix 2). Treated sanitary discharges are not expected to contribute to exceedances of the WQS because they are subject to strict permit limitations and disinfection (see Reasonable Assurance section). Illicit connections to the storm sewers regulated under MS4 permits are a potential source of *E. coli* to the Main Branch Clinton River. It is not expected that industrial storm water discharges listed in Appendix 2 would be a source of *E. coli* due to the nature of the discharge (e.g., parking lot and rooftop runoff) and because the discharge of this contaminant is prohibited by the permit.

As mentioned in the Data Discussion section of this TMDL, sources of *E. coli* within the Red Run Drain subwatershed are apparently contributing to the impairment of the lower Clinton River downstream of the confluence. This is evident in the great increase in the magnitude of *E. coli* concentrations and the number of PBC WQS found at Stations CR2-CR6 downstream of the Red Run Drain confluence. Detailed sampling of the Red Run Drain watershed was conducted for the *E. coli* TMDL approved in 2006 (Lipsey, 2006). Analysis of these data lead the DNRE to conclude that wet weather sources within the Red Run Drain and Bear Creek watersheds were having a significant influence over *E. coli* exceedances in the downstream stations on the Main Branch Clinton River. The data collected in 2008 at Station CR6 for this TMDL support this conclusion.

Based on the 2008 DNRE data, wet weather sources appear to be having a bigger impact on Station CR8 than nearby, upstream Station CR9. Exceedances of the PBC WQS occurred at Station CR8 after the majority of the recorded rain events (Table 2), while few wet weather exceedances occurred at Station CR9, which is located a few miles upstream of Station CR8. The station geometric mean of CR8 was also higher than the station mean for CR9 (Table 4). A main surface road, Van Dyke Avenue, crosses the Clinton River between these two sites. Storm sewer outfalls located between Stations CR8 and CR9 should be scrutinized for potential sources.

According to the load duration curves, low flow conditions were well represented in the sampling for most Main Branch Clinton River stations (Appendix 3). According to the load duration analysis, exceedances of the daily maximum TBC WQS did not occur under low flow conditions at Station CR1, which is likely because the spillway is an artificially constructed overflow designed as a bypass during high flows, and therefore, was not flowing under low flow conditions. At the upstream end of the watershed (Station CR13), only two samples were collected during high flow conditions and both attained the TBC WQS. With the noted exception of Stations CR1 and CR13, exceedances occurred under all flow conditions sampled, at all sites in the Main Branch Clinton River. The dry and mid-range flow *E. coli* exceedances suggest that constant sources, often referred to as “dry weather” sources (e.g., illicit connections), are having a strong influence on the *E. coli* concentrations at the

Main Branch Clinton River stations during these flow conditions. Across all stations, very few samples were collected during high flows or moist conditions, although sampling during these conditions generally revealed exceedances of the daily maximum TBC WQS. Exceedances that occur during high flows are generally linked with rainfall events, such as surface runoff, a flush of accumulated wildlife feces, or trash from the storm sewers.

The frequent exceedances of the PBC and TBC WQS at the most upstream stations (CR11, CR12, and CR13) indicate that areas upstream of the TMDL listed reach are contributing to the *E. coli* concentrations in the TMDL watershed. Low flow exceedances were common at Stations CR11 and CR13, indicating that areas upstream of the TMDL reach are probably contaminated by sources associated with low flow conditions such as illicit connections and failing OSDS. Positive detections of human *Bacteroidetes* in Paint Creek (CR12, upstream of the TMDL reach) provides further evidence for this claim. Land use in the upstream reaches of the Clinton River varies widely based on subwatershed, from dense development around the city of Pontiac, to rural agricultural areas in the Paint and Stony Creek watersheds. As described in the Problem Statement on Page 1 of this TMDL, further investigation of sources in these areas is planned for the future.

Middle Branch Clinton River

High, medium, and low density developed land occupies 47 percent of the Middle Branch Clinton River (Table 5 and Figure 4; NOAA, 2008b), which is largely single family residential land use (SEMCOG, 2009). This land area is generally drained by storm sewers. MS4 permitted discharges that discharge to the Middle Branch Clinton River include Shelby, Macomb, Washington, Romeo, and Clinton Townships, and Macomb County. Illicit connections to the storm sewers are a potential source of *E. coli* to the Middle Branch Clinton River. In addition to the MS4s, there are 23 NPDES permitted industrial storm water discharges to the Middle Branch Clinton River (Figure 2 and Appendix 2). A positive detection of human *Bacteroidetes* was found in a sample collected from Gloede Drain (MB3) during dry conditions. No SSOs have been reported in the Middle Branch Clinton River, suggesting that illicit connections or failing OSDS are a likely source of the pathogens.

Based upon the number of repair permits issued by the MCHD in 2008, Shelby Township may have a high concentration of malfunctioning OSDS. OSDS repair permits issued within Shelby Township are consistently higher than other townships in Macomb County (personal communication with MCHD). Communities in northern Shelby Township were constructed in the 1970s with on-site systems rather than being connected to a sanitary sewer. In 2008 alone, 104 repair permits were issued in Shelby Township. To put that into context, the next highest number of permits issued within the county was 16, issued in neighboring Macomb Township in 2008 (MCHD, personal communication). Although the soils in Shelby Township are well drained and appropriate for these systems to function well, even on the small sized lots in these neighborhoods, the aging systems fail at high rates, resulting in varying degrees of groundwater and surface water contamination by sewage. It should be noted that the issuance of a repair permit does not assure that the repair was actually completed. The high number of repair permits issued is a positive sign that potential sources of fecal contamination are being remedied, but is also an indicator that a significant problem may exist in older neighborhoods of Shelby Township.

Upstream portions of the Middle Branch Clinton River are agricultural (Figure 4). Approximately 10 percent of the land cover in the Middle Branch Clinton River is categorized as row crops and an additional 6 percent is pasture or hay. This land is mainly upstream of

Station MB1 at 25-Mile Road (Figures 1 and 2), and is potentially available for manure land application or livestock and domestic animal (e.g., horses) pasture land. No bovine *Bacteroidetes* biomarker was found in the MB3 sample from October 1, 2008; however, these negative results do not exclude cattle as a source to the Middle Branch Clinton River. But, because the majority of the watershed is developed land, it is believed that livestock are likely a minor source next to the more major concerns of illicit connections and failing OSDS.

Overall for the Middle Branch Clinton River, 7 sampling dates occurred during dry conditions, 7 during mid-range conditions, 3 in moist conditions, and 1 in high conditions. No samples were collected during low flow conditions. Load duration curves for Middle Branch Clinton River stations (MB1-MB4) indicate that exceedances of the daily maximum TBC WQS occurred under all flow conditions that were sampled, from high flows to dry conditions (Appendix 4).

North Branch Clinton River

Nine percent of the land area in the North Branch Clinton River TMDL watershed is a combination of high, medium, and low density developed land, with an additional 5 percent as developed open space (Figure 4). This urbanized area is considerably less than in the Main or Middle Branches. MS4s that discharge to the North Branch Clinton River are found within Macomb, Clinton, Romeo, and Chesterfield Townships, Macomb County, and the city of Mount Clemens. Illicit connections to the storm sewers regulated under MS4 permits are a potential source to the North Branch Clinton River. In addition to the MS4 discharges, there are 4 NPDES permitted discharges to the North Branch Clinton River (Figure 2). New Haven Schools-Ray Township is the only WWTP that is permitted to discharge to the North Branch Clinton River. The majority of the land area is not served by sanitary or storm sewers. In these areas, OSDS are the only method for sanitary waste disposal. Positive detections of human *Bacteroidetes* suggest that illicit connections or failing on-site treatment systems are a source of pathogens to Coon Creek (NB2) and McBride Drain (NB7).

In the North Branch Clinton River, livestock and manure spreading are a potential source of *E. coli*. The bovine *Bacteroidetes* biomarker was detected on Coon Creek (NB2) and McBride Drain (NB7). Thirty-seven percent of the North Branch Clinton River land area is cultivated for row crops and another 17 percent are used for pasture or hay, and therefore, are potentially available for manure land application. While there are no permitted Concentrated Animal Feeding Operations (CAFOs) in the TMDL watershed, there is a CAFO upstream of the TMDL watershed near Romeo, Michigan (Figure 2). This CAFO (Ingleside – MIG010157) manifests (sells or gives away) its manure to other farmers. It is therefore not possible to know where, when, or if the manure from this operation is land applied within the TMDL watershed. Manifested manure from this CAFO, in addition to manure from other grazing and farming operations, is likely a source of *E. coli* to the North Branch Clinton River.

Station NB1, the furthest upstream station on the North Branch Clinton River, had four exceedances of the PBC WQS, and all of those samples were collected immediately following rainfall events. The daily maximum TBC and PBC WQS were generally met during other sampling events. These wet weather PBC exceedances indicate that contaminated storm runoff is a likely source of *E. coli* contamination at Station NB1. Given that the land cover upstream is largely agricultural with small towns and scattered human residences, the storm water is likely contaminated with *E. coli* due to land-applied manure, accumulated wildlife or domestic animal feces, flush from unregulated or regulated storm sewers (Macomb County MS4), or OSDS surface failures.

Three miles further downstream, at Station NB5, additional exceedances of the WQS were observed; but, these exceedances of the TBC WQS occur at lower concentrations than at NB1 and occur across all weather conditions. One major tributary (Camp Brook Drain) enters the North Branch Clinton River between Stations NB1 and NB5. Additional constant sources, of either human or animal nature, in the Camp Brook Drain subwatershed or directly to the North Branch Clinton River between NB1 and NB5, may be contributing to the persistent daily maximum TBC WQS exceedances at NB5. Sources include potential illicit connects to surface water, failing OSDS, or livestock with stream access.

According to the DNRE load duration analysis of the North Branch Clinton River stations, 7 sampling dates occurred during dry conditions, 7 during mid-range conditions, 3 in moist conditions, and 1 in high conditions (Appendix 5). No samples were collected during low flow conditions. Load duration curves for most North Branch Clinton River stations (NB1, NB2, and NB5-NB8) indicate that exceedances of the daily maximum TBC WQS occurred under all flow conditions that were sampled, from high flows to dry conditions. Exceedances during all flow conditions indicate that there are multiple sources of *E. coli* contamination to the North Branch Clinton River, e.g., nonpoint source storm runoff contaminated by manure applications, domestic animal waste, illicit connections, and failing OSDS. This pattern of exceedances at all flow conditions varied only at Station NB3 on the East Branch Coon Creek and Station NB4, immediately downstream of the confluence with the East Branch Coon Creek. At Stations NB3 and NB4, the majority of exceedances occurred during mid-range flows and dry conditions indicating a constant source originating on the East Branch Coon Creek and affecting Coon Creek. The East Branch Coon Creek sources were assessed as part of an *E. coli* TMDL approved by the USEPA in 2006. Agricultural runoff, illicit connections, failing or poorly operating OSDS, and urban runoff were all listed as possible sources of *E. coli* to the East Branch Coon Creek watershed (Cooper and Alexander, 2006). In 2010, the St. Clair County Health Department discovered a cluster of homes in the small town of Berville where untreated sanitary wastewater was illegally connected to the storm sewer, which discharged to the East Branch of Coon Creek. This illicit discharge is located upstream of Stations NB3 and NB4, and is a certain contributor to the *E. coli* exceedances seen at those stations. There is still potential for additional existing illicit connections to contribute to the *E. coli* in the North Branch Clinton River and its tributaries.

LOADING CAPACITY (LC) DEVELOPMENT

The LC 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 TBC 30-day geometric mean WQS of 130 *E. coli* per 100 mL, daily maximum of 300 *E. coli* per 100 mL, and the PBC daily maximum WQS of 1,000 *E. coli* per 100 mL. Concurrent with the selection of a numeric concentration endpoint, development of the LC requires identification of the critical condition. The “critical condition” is defined as the set of environmental conditions (e.g., flow) used in development of the TMDL that result in attaining WQS and has an acceptably low frequency of occurrence.

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). Therefore, this pathogen TMDL is concentration-based, consistent with R 323.1062, and the TMDL is equal to the TBC target concentrations of 130 *E. coli* per 100 mL as a 30-day geometric mean and daily maximum of 300 *E. coli* per 100 mL in all portions of the TMDL reach for each month of the recreational season (May through October) and PBC target concentration of 1,000 *E. coli*

per 100 mL as a daily maximum year-round. 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.

LC

The LC is 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 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 LC represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. Because this TMDL is concentration-based, the total loading for this TMDL is equal to the TBC WQS of 130 *E. coli* per 100 mL as a 30-day geometric mean and 300 *E. coli* per 100 mL as a daily maximum during the recreation season and PBC WQS of 1,000 *E. coli* per 100 mL as a daily maximum year-round.

WLAs

The WLA for the facilities listed in Table 8 and Appendix 2 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 maximum during the recreational season between May 1 and October 31, and 1,000 *E. coli* per 100 mL as a daily maximum the remainder of the year. There are 4 individual NPDES permits included in the WLA. COCs under general NPDES permits include: 148 storm water from industrial activities (MIS110000), 14 watershed-based MS4 (MIG610000), 2 jurisdictional-based MS4 (MIS040000), 1 petroleum groundwater cleanup (MIG080000), and 1 storm water discharge with required monitoring (MIS120000).

LAs

Because this TMDL is concentration-based, the LA is also equal to 130 *E. coli* per 100 mL as a 30-day geometric mean and 300 *E. coli* per 100 mL as a daily maximum during the recreational season and 1,000 *E. coli* per 100 mL as a daily maximum year-round. 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 (Tables 6 and 7). Fourteen minor civil divisions have land area within the Clinton River TMDL watershed.

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 the load and WLAs and water quality in this TMDL. The application of the TBC WQS of 130 *E. coli* per 100 mL as a 30-day geometric mean and 300 *E. coli* per 100 mL as a daily maximum during the recreational season, and the PBC WQS of 1,000 *E. coli* per 100 mL as a daily maximum year-round for the WLA and LA is a conservative approach because it assumes no dilution of

the discharge. The result is that there is no uncertainty as to whether or not the WQS will be met at the source or within the receiving water.

SEASONALITY

The WQS for *E. coli* are expressed in terms of seasons, e.g., TBC from May 1 through October 31 and PBC year-round. Allocations and controls developed for the more protective TBC season are also expected to assure attainment of the daily maximum PBC WQS of 1,000 *E. coli* per 100 mL, year-round. Because this is a concentration-based TMDL, WQS must be met regardless of flow conditions in the applicable season.

REASONABLE ASSURANCE ACTIVITIES

Point Source Discharges

The permittees listed in Table 8 and Appendix 2 are responsible for meeting their NPDES permit limits. Permits for the NPDES permitted facilities that may be a source of fecal contamination contain measures to reduce or eliminate the potential for fecal contamination of the Clinton River. 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 *E. coli* criteria contained in the USEPA's criteria document (1986), upon which Michigan's *E. coli* criteria are based, were derived to approximate the degree of protection, e.g., no more than 8 illnesses per 1,000 swimmers, provided by the fecal coliform indicator level of 200 *E. coli* per 100 mL recommended by the USEPA prior to the adoption of the 1986 criteria; therefore, the sanitary discharges are expected to be in compliance with the ambient *E. coli* PBC and TBC WQS if their NPDES permit limits for fecal coliform are met. All WWTPs provide year-round disinfection, providing another level of confidence that the WQS for *E. coli* will be met. The individual permittees identified in Table 8 with treated human waste discharges are Mount Clemens WWTP, Selfridge ANGB, and New Haven Schools-Ray Township (Table 8). They are responsible for maintaining compliance listed with their NPDES permit limitations for fecal coliform, and to monitor their effluent according to their permit requirements.

The COCs for the general industrial storm water permit (MIS110000) listed in Appendix 2, specify that if a TMDL is established by the DNRE for the receiving water that restricts the discharge of any of the identified significant materials or constituents of those materials, then the Storm Water Pollution Prevention Plan shall identify the level of control for those materials necessary to comply with the TMDL, and an estimate of the current annual load of those materials via storm water discharges to the receiving stream.

The TMDL watershed receives storm water discharges from Phase I and Phase II community MS4s (a complete list of the regulated MS4s within the TMDL watershed is included in Table 8). These regulated MS4s are required to obtain permit coverage under Michigan's NPDES MS4 Jurisdictional-Based or Watershed-Based Storm Water General Permits. In addition, the Michigan Department of Transportation has a statewide NPDES Individual Storm Water Permit (MI0057364) to cover storm water discharges from their MS4. This 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. Under the Jurisdictional and Watershed MS4 permits, permittees are required to reduce the discharge of pollutants (including *E. coli*) from their MS4 to the maximum extent practicable

through the development and implementation of a Public Involvement and Participation Process, a storm water-related Public Education Plan, an Illicit Discharge Elimination Program (IDEP), a post-construction Storm Water Control Program for new development and redevelopment project, a Construction Storm Water Runoff Control Program, and a Pollution Prevention/Good Housekeeping Program for municipal operations.

The IDEP requirements of the permits have great potential to contribute to the reduction of *E. coli* levels in the Clinton River. The IDEP requirements require permittees to develop a program to find and eliminate illicit connections and discharges to their MS4. This includes a plan to conduct dry-weather screening of each MS4 discharge point at least once every five years (unless an alternative schedule or approach is approved by the DNRE). Dry-weather screening does not require *E. coli* sampling; however, if a permittee observes evidence of any illicit connection or discharge they are required to investigate and eliminate them.

The MS4 permits also require permittees to identify and prioritize actions to be consistent with the requirements and assumptions of the TMDL. Through prioritizing TMDL actions, permittees are able to focus their efforts, which will help to make progress towards meeting Michigan's WQS.

The MS4 permit for Macomb County (MIG610052) covers all county-owned outfalls, including the County Road Commission's and Public Works Office's drains, and many Macomb County school districts, which are nested jurisdictions under the County's MS4 permit. For efficiency, Macomb County coordinates IDEP efforts between the County Departments (MCHD, Public Works Office, and Road Commission) and the nested school districts. Macomb County has been conducting IDEP activities from 2001 through 2010. Through this IDEP effort, Macomb County estimates that approximately 42 million gallons per year of wastewater have been excluded from the Clinton River and Lake St. Clair due to their efforts since 2003 (Macomb County, 2008). During the reporting period from October 2007 to September 2008, 163 illicit discharge investigations were conducted by Macomb County and resulted in the identification of 20 illicit discharges (14 of these were corrected during the reporting period) (Macomb County, 2008). From September 2008 through the end of 2009, the MCHD identified an additional 20 illicit discharges of sewage (includes septic failures), 11 of which have been corrected. The MCHD also found that trash compactor leachate had been leaking into a surface water tributary (Schroeder Drain) to the Clinton River. This situation was remedied in July 2009. Trash compactor leachate can have very high *E. coli* concentrations, and therefore, eliminating this persistent source is a particularly notable accomplishment.

Each of the MS4 communities in the TMDL watershed are required to develop and implement their own IDEP and submit annual reports identifying actions taken to find and eliminate illicit connections, as well as identify improvements to the sanitary and storm sewers, which may indicate progress to eliminate the contamination of storm water. In accordance with the MS4 permit, permittees are required to submit an approvable IDEP to the DNRE. At this time, all of the MS4 permittees within the TMDL watershed have submitted IDEP plans and have begun implementation of these plans. Permittees are required to report on the implementation status of their IDEP activities in progress reports. As detailed in the 2008 progress reports, covering the period from November 1, 2007, through October 31, 2008, individual permittees reported the following:

- Macomb, Washington, and Shelby Townships and the village of Romeo reported no suspected illicit discharges within their jurisdiction (Macomb Township, 2008; Washington Township, 2008; Shelby Township, 2008; and Village of Romeo, 2008).

- No information from this reporting period was available for Harrison Township, and the previous reporting cycle did not provide enough details to report on IDEP progress.
- Clinton Township tested outfalls in 2003 and no illicit connections were found at that time (Clinton Township, 2008).
- The city of Utica identified and corrected 1 illicit connection (laundry/sink violation) and reported that 95 percent of the city system has been inspected by the reporting date (City of Utica, 2008).
- The city of Fraser completed 70 residential, commercial, and industrial inspections, including dye testing, which resulted in the identification and correction of 2 illicit sewage discharges and numerous floor drains connected to the storm sewer (City of Fraser, 2008).
- The city of Mount Clemens identified two outfalls with evidence of illicit connections (*E. coli* concentrations in the 1,000-3,000 range) (City of Mount Clemens, 2008). Both of these outfall investigations are still unresolved due to difficulties in source identification.
- Chesterfield Township reported no illicit connections. In 2007/2008, the township cleaned and examined 36,000 feet of storm sewer (Chesterfield Township, 2008). Portions were replaced and Chesterfield Township is making plans to line sections of the sanitary sewer to reduce infiltration and leaking.
- The city of Sterling Heights reported finding and correcting 1 illicit discharge and 1 OSDS violation in 2008 (City of Sterling Heights, 2008).

The MS4 permit for Oakland County (MIG610042) covers all county-owned outfalls and outfalls under the nested jurisdiction of the county, including county road, county drain, and school district outfalls. Similar to the Macomb County IDEP, the IDEP Plan for Oakland County uses a watershed approach, which coordinates the efforts of the Oakland County departments, nested jurisdictions within Oakland County, and watershed partner communities via a committee called the Oakland County Stormwater Committee. Oakland County has been conducting IDEP activities from 2003 through 2010. During the reporting period of October 2007 to September 2008, dry weather IDEP surveys were conducted at 790 discharge points in 18 communities including: 144 discharge points on 105 county drains in the Rouge River and Clinton River watersheds, 193 discharge points on road commission drains in 67 subdivisions in the Clinton River watershed, and 126 discharge points at 43 county facilities (Oakland County, 2008). Oakland County eliminated 2 failed OSDS, 7 illicit connections to the storm sewer, and 3 broken sanitary lines during the 2008 reporting period, resulting in the exclusion of an estimated 7 million gallons per year of untreated sanitary waste to the Clinton River (Oakland County, 2008). None of these illicit discharges were located in the TMDL watershed, but the elimination of illicit discharges within the Clinton River, upstream of the TMDL reach, directly benefits the TMDL reach.

The following IDEP information was collected from the individual IDEP progress reports from each permittee, encompassing the period from November 1, 2007, through October 31, 2008:

- The city of Rochester replaced approximately 17,000 linear feet of sanitary sewer and 92 storm sewer structures in order to minimize infiltration (City of Rochester, 2008). The city of Rochester did not find any suspicious outfalls during a dry weather survey of outfalls in 2007.
- The city of Rochester Hills reported no suspected illicit discharges within their jurisdiction (City of Rochester Hills, 2008).

At the time of the Section 303(d) listing of the Clinton River in 1998, the city of Pontiac (upstream of the listed reach) was discharging untreated sewage to the Clinton River through combined sewer overflows (CSOs). Pontiac has completely separated their storm and sanitary sewers, and therefore, no longer has CSOs. While the CSOs have been eliminated, the Pontiac WWTP is prone to chronic SSOs and is under a consent order to eliminate these by 2020. There are no uncontrolled CSOs in the TMDL watershed.

Chronic SSOs represent a significant source of fecal contamination, and therefore, *E. coli* to the Clinton River TMDL watershed. In 2008, the three municipalities that were responsible for chronic SSOs (Clinton Township and the cities of Center Line and Fraser) discharged a combined approximate 2.5 million gallons of diluted raw sewage to the Clinton River TMDL watershed. Clinton Township, Center Line, and Fraser are all under an Administrative Consent Order to remedy the chronic illegal discharges of raw sewage. The city of Center Line's SSO remedy is under construction and the SSO will be eliminated by the end of 2011. Clinton Township is required to correct their SSOs by the end of 2011, leaving only one emergency SSO outfall, which can only be used during storms above specified magnitude (approved by the DNRE). The city of Fraser is working to correct their chronic SSOs by December 31, 2010. The elimination of chronic SSOs that affect the Clinton River TMDL area will help to attain the TBC and PBC WQS.

The small town of Berville, in the East Branch of Coon Creek (upstream of Station NB3), is constructing a wastewater sewage lagoon to remediate failed OSDS under a federal 'Rural Development Program' grant. The elimination of this cluster of failing OSDS will improve water quality in the East Branch Coon Creek, and therefore, the North Branch Clinton River.

Nonpoint Source Activities

Rule 323.2161 of the Part 21 administrative rules (Wastewater Discharge Permits), promulgated pursuant to Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451 (Part 31) subjects storm water dischargers to regulation through the NPDES permit program under several, specific scenarios; however, an NPDES permit may be required of an otherwise unregulated storm water discharge if controls are needed to address a pollutant of concern in a TMDL WLA or the discharge is determined to be a significant contributor of pollutants to waters of the state.

Nonpoint source pollution from unpermitted agricultural operations is generally not regulated by the DNRE, but is mitigated through voluntary programs such as Clean Michigan Initiative (CMI) and federal Clean Water Act (CWA) Section 319 funded grants for watershed management plan development and implementation; however, unregulated animal feeding operations may also be required to apply for an NPDES permit in accordance with circumstance set forth within R 323.2196 of the Part 21 administrative rules. This authority allows the DNRE to regulate pollution controls and conduct inspections, thereby reducing *E. coli* contamination from agricultural operations that have been determined to be significant contributors of pollutants.

Unpermitted discharges of pollutants to waters of the state (illicit connections), whether direct or indirect, are illegal in the State of Michigan. Section 3109(1) of Part 31 states that a person shall not directly or indirectly discharge into the waters of the state a substance that is or may become injurious to public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other uses that may be made of such waters. Section 3109(2) further specifically prohibits the discharge of raw sewage of human origin, directly or indirectly, into any of the waters of the state. The municipality in which that discharge originates is

responsible for the violation, unless the discharge is regulated by an NPDES permit issued to another party. The elimination of illicit discharges of raw human sewage to the Clinton River watershed would significantly improve water quality and constitutes the removal of a public health threat.

The MCHD has a Point of Sale Ordinance, which requires the inspection of OSDS prior to property transfer and the remediation of failing systems. Owners of systems that are found to be failing have 180 days to correct the problem after the submission of a corrective action plan to the MCHD. The MCHD responded to 77 complaints resulting in the correction of 19 violations in 2008 and issued 195 OSDS repair permits in 2008 (Macomb County, 2008). Oakland County does not have a Point of Sale Ordinance, but the Oakland County Health Department responded to 129 complaints of failing systems and issued 449 permits for the installation of new or replacement systems during 2008 (Oakland County, 2008). Failing OSDS have the potential to contaminate ground and surface water; therefore, the repair of failing systems is critical to reducing *E. coli* in the Clinton River TMDL watershed.

Watershed Management Plans, funded by CWA Section 319 grants, have been developed for the Clinton River East, Stony Creek, and Red Run Drain subwatersheds. These plans were a joint effort between Macomb County, its nested jurisdictions, cities, and townships, and the Clinton River Watershed Council. The Watershed Management Plans identify a plan of action to meet all WQS within the watershed to remediate threatened and impaired water bodies, while improving water quality in all water bodies. Reducing pathogens and meeting the *E. coli* WQS in Clinton River are listed as goals in these Watershed Management Plans. In 2008, the Macomb County Public Works Office was awarded a CWA Section 319 grant to develop a Watershed Management Plan for the North Branch Clinton River. This Watershed Management Plan has been submitted to the DNRE and is currently under review for approval. A major aspect of this project involves modeling different land management scenarios to predict future pollutant loadings in the watershed.

The Great Lakes Restoration Initiative proposal “Developing TMDL Implementation Plan for Coon Creek Michigan,” authored by Michigan State University, was selected by the USEPA in 2010 for funding. The overall goal of this project is to improve water quality through development of a TMDL implementation plan for the East Branch of Coon Creek to address the *E. coli* TMDL that builds on a Clean Water Act Section 319 plan currently under development by the Macomb County Department of Public Works for the North Branch Clinton River watershed. The goals include indentifying high priority areas within the watershed through intensive modeling, developing Best Management Practice implementation plans in order to examine pollution load reductions under alternative scenarios to achieve TMDL reduction targets, estimating the costs associated with Best Management Practice scenarios, creating an implementation schedule, milestones, and evaluating the effectiveness of the plan.

The MCHD has been awarded a Clean Michigan Initiative-Clean Water Fund grant titled, “Facility Dye Testing Project – Phase III.” The grant was awarded in 2009 and work is scheduled to be completed in 2011. This project will improve the quality of storm water by eliminating illicit connections that have been identified during dye testing of industrial, commercial, and institutional facilities located in Sterling Heights and Clinton Township. Another Clean Michigan Initiative grant titled, “IDEP City of Mount Clemens,” was awarded to the city of Mount Clemens WWTP. The goal of this project was to lower bacterial contamination in the Clinton River through identification and elimination of illicit connections within the city of Mount Clemens. This project was completed in December 2009, and resulted in the elimination of two illicit connections to the storm system, and the identification of an

additional illicit connection, which is in the enforcement phase. Also, as part of this project, 5 additional outfalls were cleaned and resampled. The total estimated dry weather daily reduction in fecal coliform from this IDEP project is 655,559,996 counts per 100 mL, or a 77 percent estimated reduction.

Other Reasonable Assurance Activities

The entire Clinton River watershed is designated as a Great Lakes Area of Concern. The lower section of the river was first designated by the International Joint Commission in 1985 and was then expanded to the entire basin in 1995. Part of the reason for the Area of Concern designation was the concern for high bacterial counts entering Lake St. Clair from CSOs in the watershed. In 1985, the Remedial Action Plan was developed by the DNRE, listing beach closings as a beneficial use impairment. The goal of the Remedial Action Plan is to identify environmental problems, establish water use goals, and provide cleanup solutions that will restore the Area of Concern's beneficial uses. In 1998, the Remedial Action Plan was updated and identified fecal contamination due to failing septic tanks and illicit connections to storm sewers, and the contamination of storm water surface runoff, as pollution concerns that remained for the Area of Concern. The 1998 Remedial Action Plan also acknowledged pollution cleanup efforts, specifically, the elimination of uncontrolled CSOs in Mount Clemens and the reduction in the number of SSOs. In 2007, the Public Advisory Committee set restoration goals for the beach closing impairment. Restoration goals are based on Michigan's TBC WQS. The designation of the Clinton River as an Area of Concern gives priority to planning and implementation projects in the watershed for funding through sources such as the Great Lakes Restoration Initiative and Section 319 federal funds.

The Clinton River is part of the Adopt-A-Stream Program, implemented by The Clinton River Watershed Council. The Adopt-A-Stream Program monitors water quality throughout the Clinton River watershed. This program does not specifically monitor for *E. coli*, but distributes educational materials and promotes a sense of public and personal responsibility to maintain water quality. Other volunteer actions include promoting proper lawn care, pet waste cleanup, investigating pollution sources, education, and land use planning.

The Blue Ribbon Commission on Lake St. Clair was established in 1997 by Macomb County. This commission determined four key elements that are required to manage water quality issues affecting Lake St. Clair. These include monitoring, education, voluntary action, and regulation and enforcement. The commission also recommended various actions at watershed, local, state, national, and international levels that should be taken to support the four key elements (MCHD, 1997). The recommendations of the commission resulted in the creation of the Lake St. Clair Regional Monitoring Project (Project). The Project was a joint effort between county governments in southeast Michigan (Macomb, Oakland, Wayne, and St. Clair Counties), the DNRE, and the USGS. Water quality data, including *E. coli*, were collected during 2004 and 2005 at 75 previously unsampled locations (including 20 sites on the Clinton River) and is available on the Internet to aid in source assessment and the improvement of water quality. The Project includes a Web site (***The link provided was broken. This online document was revised 10/13/2017.***) and the embedded database, which is intended to be "used for making decisions on prevention strategies and on priorities for remediation and for the protection of public health." The final report, which contains information on sediment and pollutant loads and identifies data gaps for Lake St. Clair tributaries, was published online in September 2007 (Fogarty, 2007). Data and conclusions from the Project have guided, and will continue to guide, community leaders in targeting improvements in the Clinton River watershed to meet the goal of WQS attainment. Also, following the recommendations of the Blue Ribbon Committee, the MCHD has led a

monitoring effort, beginning in 1998, where samples are collected once per week and tested for *E. coli* at 50 sites throughout the Macomb County portion of the Clinton River watershed. Samples are also collected at selected sites in response to rainfall events, especially in areas where SSOs have occurred or are anticipated. The data collected is entered into a database and is reviewed closely for trends that might indicate problems requiring further investigation and for reductions in pollution levels that result from corrective efforts.

MONITORING

Future monitoring by the DNRE will take place as part of the five-year rotating basin monitoring, as resources allow, once actions have occurred to address sources of *E. coli.* When these results indicate that the water body may be meeting WQS, sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100 mL and daily maximum values of 300 *E. coli* per 100 mL and 1,000 *E. coli* per 100 mL are being met.

The MCHD plans to continue their weekly and wet weather targeted surface water *E. coli* monitoring as their resources allow. These data were used by the DNRE to choose sample locations for the development of this document and are available to the public at the following link: http://health.macombgov.org/Health-Programs-EnvironmentalHealth-WaterQuality-SurfaceWaterMonitoring

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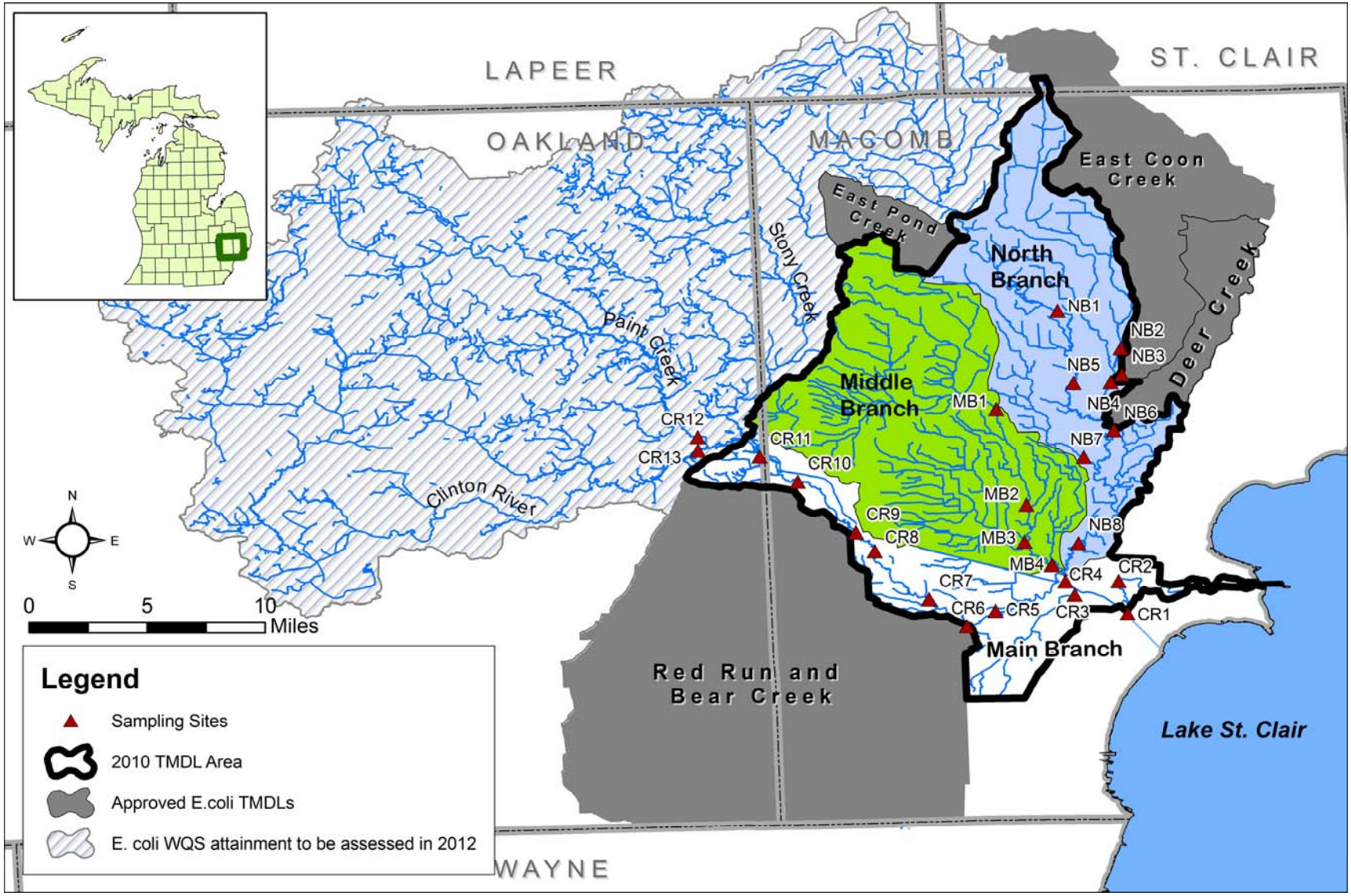


Figure 1. Overview of the 2010 TMDL watershed, 2008 sample locations, approved *E. coli* TMDLs and areas to be assessed for *E. coli* water quality standard attainment in the future.

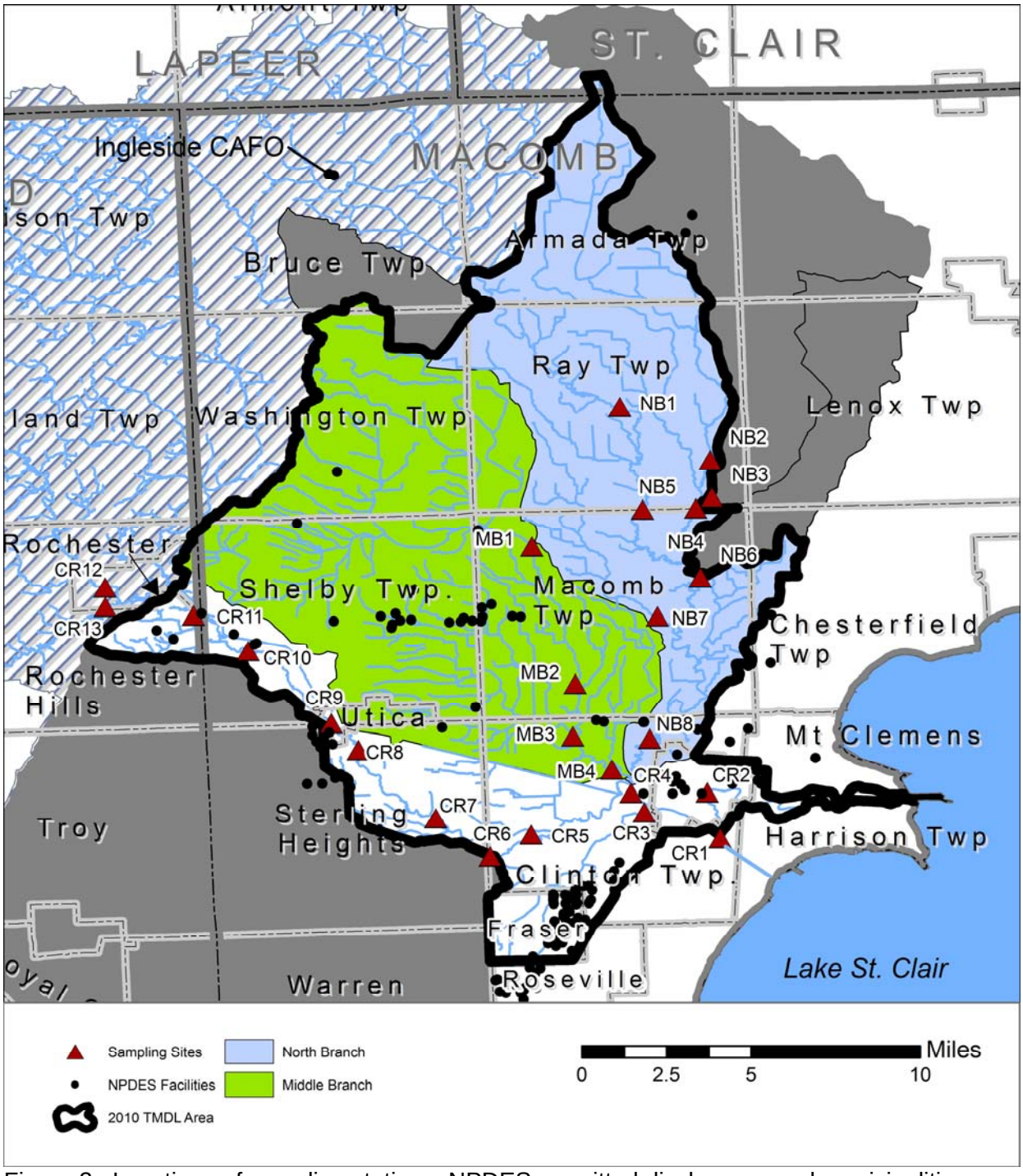


Figure 2. Locations of sampling stations, NPDES permitted discharges, and municipalities within the TMDL watershed.

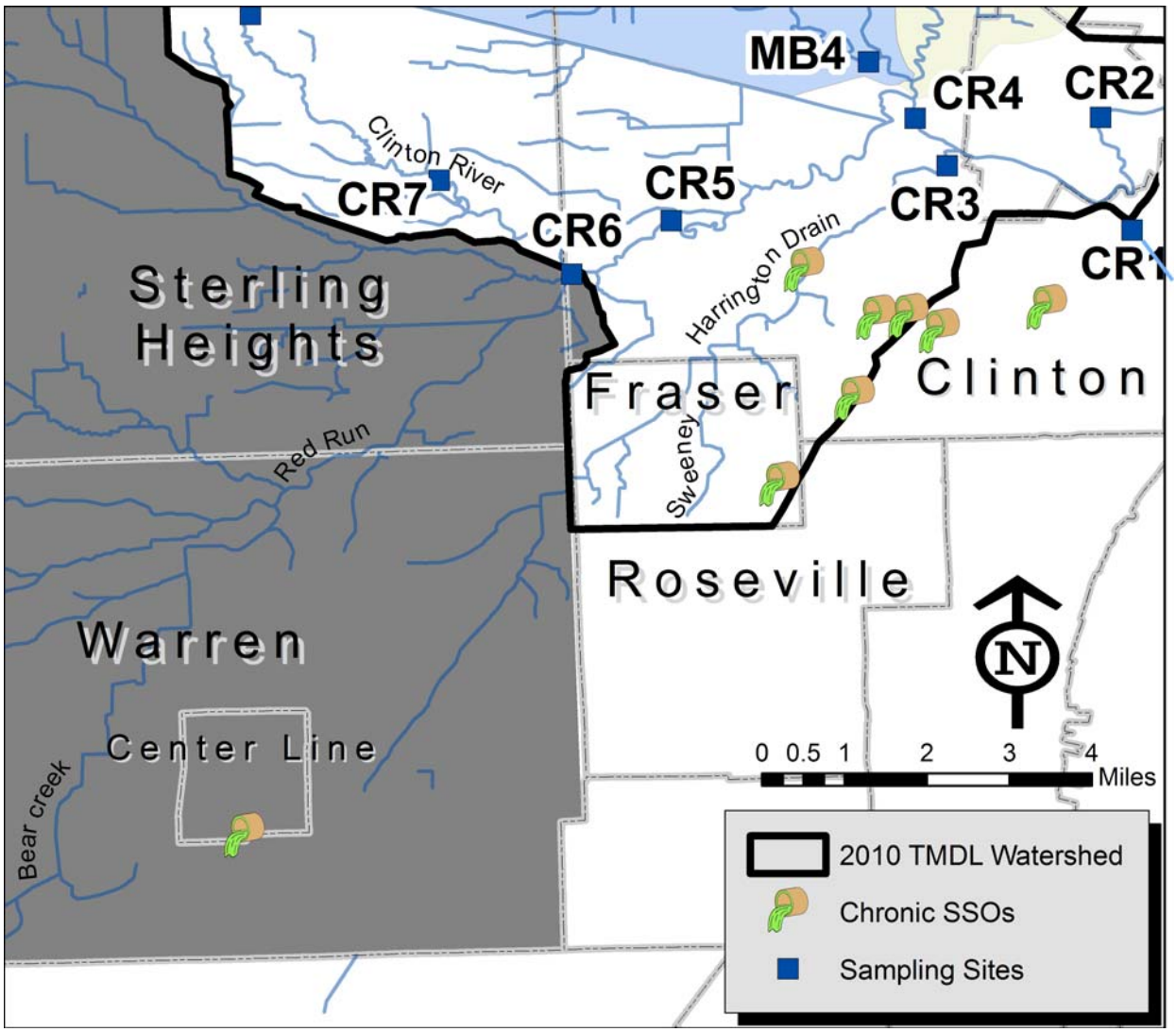


Figure 3. Map of chronic SSOs (under the jurisdictions of Center Line, Fraser, and Clinton Townships) in relation to DNRE sampling stations.

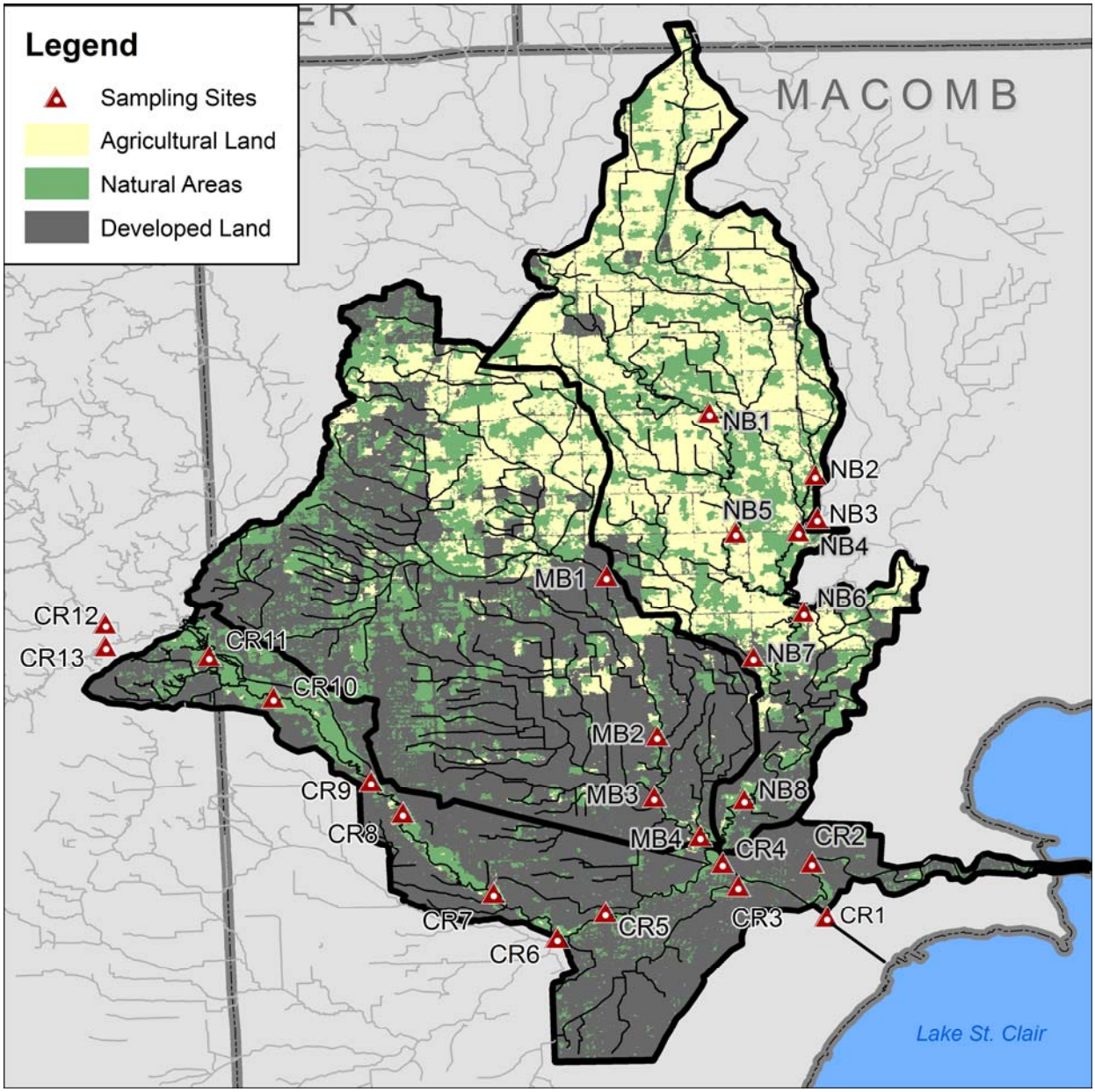


Figure 4. Generalized 2006-era land cover of the TMDL watershed (NOAA, 2008b).

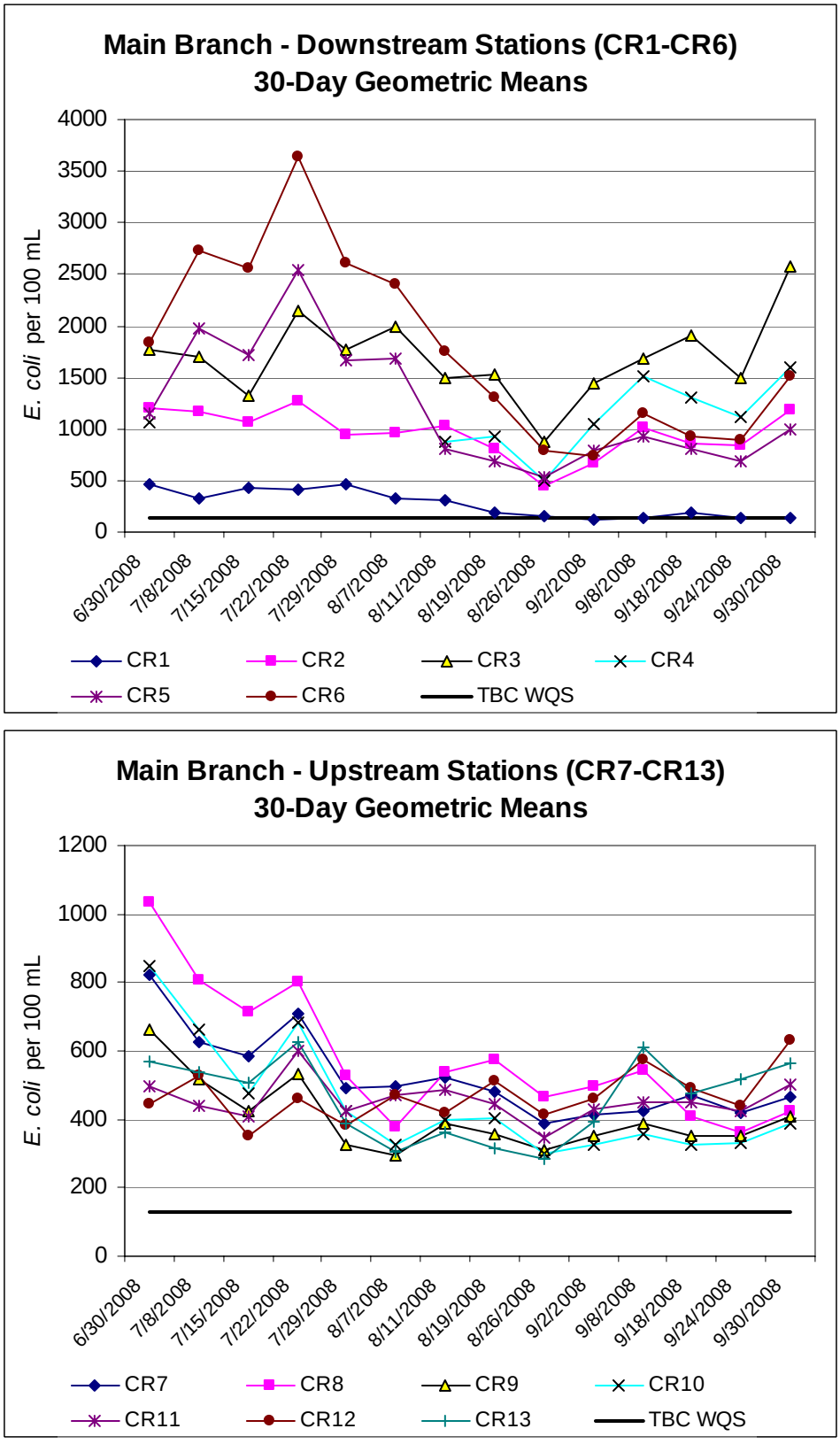


Figure 5. Thirty-day geometric mean *E. coli* sampling results from the Main Branch Clinton River (Stations CR1-CR13) in relation to the TBC WQS of 130 *E. coli* per 100 mL as a 30-day geometric mean.

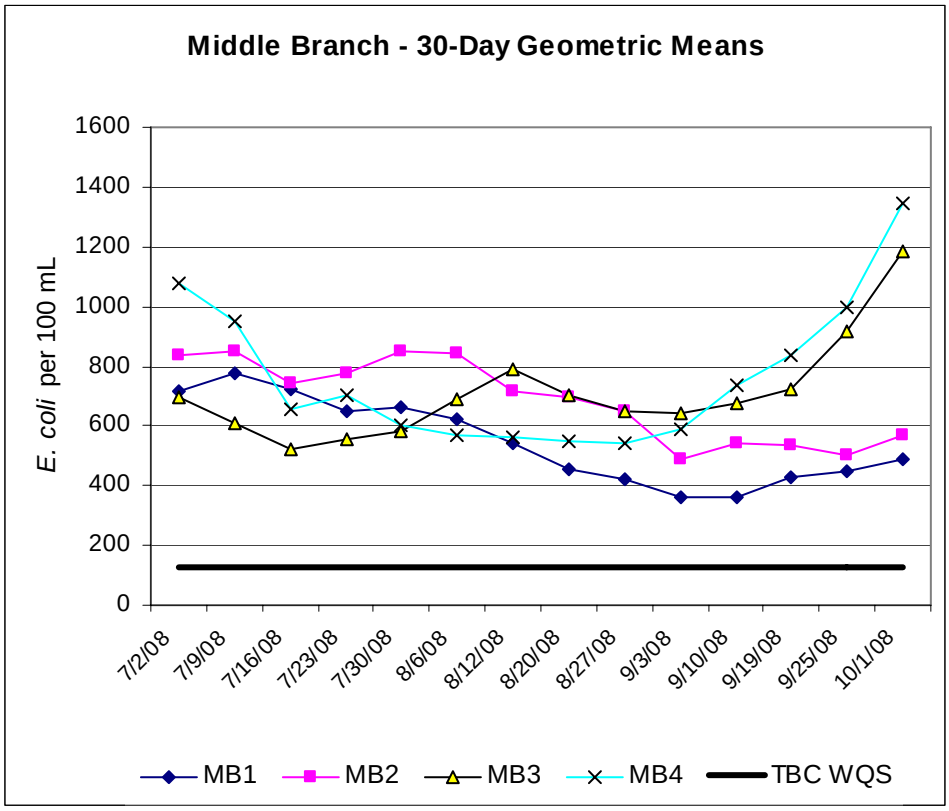


Figure 6. Thirty-day geometric mean *E. coli* sampling results from the Middle Branch Clinton River (Stations MB1-MB4) in relation to the TBC WQS of 130 *E. coli* per 100 mL as a 30-day geometric mean.

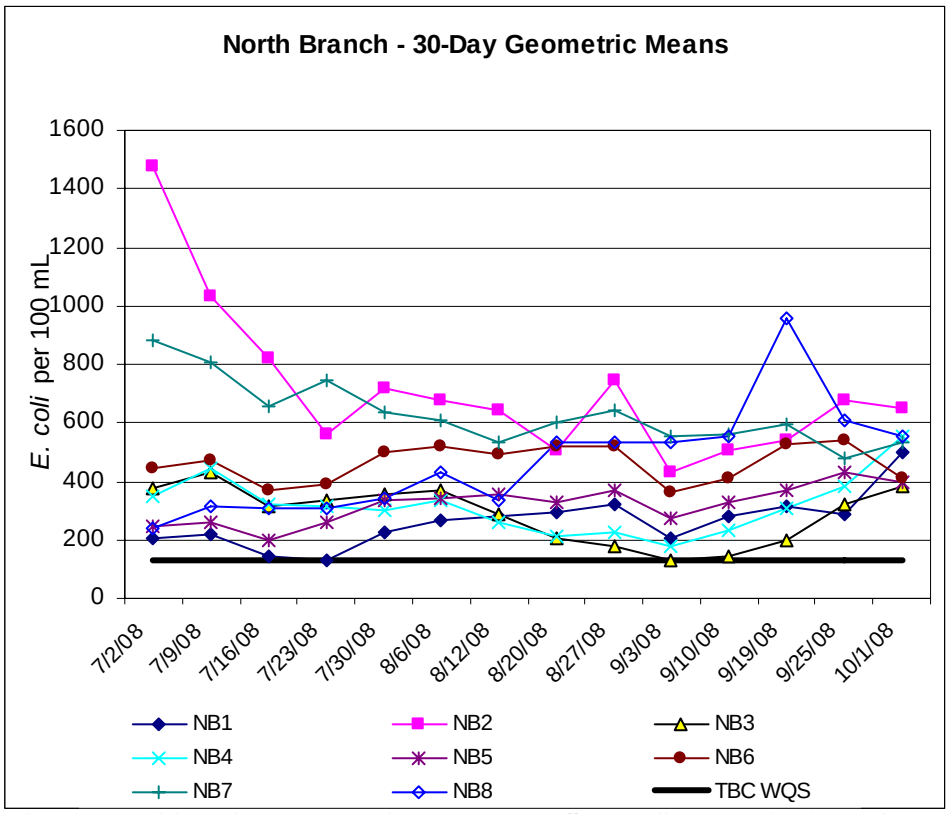


Figure 7. Thirty-day geometric mean *E. coli* sampling results from the North Branch Clinton River (Stations NB1-NB8) in relation to the TBC WQS of 130 *E. coli* per 100 mL as a 30-day geometric mean.

Table 1. Weekly *E. coli* sampling results (counts per 100 mL) from the North Branch Clinton River (Stations NB1-NB8); June 5-October 1, 2008. Exceedances of the TBC WQS are shaded gray and PBC exceedances are outlined in bold. Precipitation values are in inches.

	NB1					NB2					NB3					NB4					
	N. Br. Clinton at 29-Mile					Coon creek at North Rd.					E. Br. Coon Creek at North Rd (near 26-Mile)					Coon creek at 26-Mile					
Sample Date	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	2-day prior precip. (Romeo, MI)
6/5/2008	60	160	160	115		1000	4000	1940	1980		240	200	60	142		140	180	120	145		0.24
6/11/2008	1580	1200	1600	1448		2800	3200	2200	2701		1520	3200	1600	1982		1600	1600	1400	1530		0.65
6/19/2008	300	100	140	161		560	1000	2600	1133		240	260	100	184		180	160	100	142		0.07
6/25/2008	100	60	140	94		1000	1280	1200	1154		480	900	300	506		640	600	560	599		0.15
7/2/2008	200	200	60	134	202	700	1200	1200	1003	1476	600	200	200	288	377	200	240	400	268	347	0
7/9/2008	220	140	180	177	221	200	400	440	328	1030	800	80	340	279	431	360	520	660	498	445	0
7/16/2008	200	240	120	179	145	260	1400	1800	869	821	280	480	500	407	314	320	380	240	308	323	0
7/23/2008	120	100	60	90	129	220	200	100	164	558	300	300	200	262	337	160	140	100	131	317	0
7/30/2008	2200	1400	1200	1546	226	7800	2200	4000	4094	719	600	820	520	635	353	300	460	800	480	304	0.29
8/6/2008	400	400	160	295	265	560	1200	600	739	676	460	500	200	358	368	600	260	600	454	337	0
8/12/2008	300	260	180	241	281	160	300	340	254	642	80	60	120	83	289	140	120	140	133	259	0
8/20/2008	220	140	320	214	292	120	600	240	259	504	60	<20	80	69	203	120	100	120	113	212	0
8/27/2008	140	120	200	150	323	320	2600	1800	1144	743	140	140	140	140	179	180	160	200	179	226	0
9/3/2008	180	200	140	171	208	240	380	220	272	432	120	120	140	126	130	200	140	100	141	177	0
9/10/2008	1000	1800	1400	1361	283	1800	1200	2000	1629	506	580	740	600	636	145	2000	1400	1800	1715	230	1.1
9/19/2008	380	160	1000	393	312	140	560	600	361	543	760	480	200	418	201	1000	400	400	543	305	0
9/25/2008	200	140	100	141	287	1200	1000	380	770	676	400	1600	600	727	321	480	260	320	342	381	0
10/1/2008	2000	1600	4400	2415	500	800	1000	1000	928	648	260	480	320	342	384	2400	820	780	1154	553	0.14

Table 1 (continued). Weekly *E. coli* sampling results (counts per 100 mL) from the North Branch Clinton River (Stations NB1-NB8); June 5-October 1, 2008. Exceedances of the TBC WQS are shaded gray and PBC exceedances are outlined in bold. Precipitation values are in inches.

	NB5					NMB6					NB7					NB8					
	N. Br. Clinton at 26-Mile					N. Br. Clinton at 24-Mile					Mcbride Drain at Card Rd.					N. Br. Clinton at end of Dunham					
Sample Date	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	2-day prior precip. (Romeo, MI)
6/5/2008	280	200	240	237		280	400	200	335		1140	1020	980	1078		80	120	200	98		0.24
6/11/2008	1200	1200	1200	1200		600	3000	1200	1342		1400	2200	2400	1755		380	360	1200	370		0.65
6/19/2008	40	60	60	49		120	340	200	202		60	400	400	155		420	360	100	389		0.07
6/25/2008	180	400	240	268		560	400	460	473		3200	5000	2800	4000		260	200	300	228		0.15
7/2/2008	240	200	220	255	249	240	380	460	402	444	1000	220	2000	461	884	140	140	160	254	241	0
7/9/2008	580	100	280	295	260	540	200	400	438	469	800	820	1020	675	805	160	400	160	378	316	0
7/16/2008	240	420	240	319	200	260	320	80	392	366	1200	600	1200	641	658	160	280	220	322	307	0
7/23/2008	180	100	160	179	259	180	180	140	276	390	200	300	200	286	744	220	320	140	379	306	0
7/30/2008	1600	2000	1800	990	336	3000	2000	2400	1585	496	3400	3800	4000	1858	638	100	800	800	408	344	0.29
8/6/2008	360	200	160	290	344	500	440	800	515	521	240	400	400	369	610	1000	620	580	805	433	0
8/12/2008	420	400	280	352	356	240	280	260	332	493	240	360	420	349	535	40	40	140	105	335	0
8/20/2008	160	240	560	201	325	520	500	300	492	516	1600	1800	1000	1141	600	8200	6600	7200	3349	535	0
8/27/2008	600	280	220	336	369	260	220	240	288	521	600	220	200	410	645	260	340	400	385	536	0
9/3/2008	280	240	600	228	275	300	160	200	258	362	1400	1200	1000	848	552	200	600	180	389	531	0
9/10/2008	1800	860	340	709	329	1800	1400	1000	968	411	740	200	1600	393	559	1200	1400	1600	970	551	1.1
9/19/2008	1500	540	720	628	369	1500	2500	2500	1174	530	1600	120	200	467	592	3500	2400	3000	1648	957	0
9/25/2008	800	260	280	430	430	600	600	300	544	540	340	340	400	397	479	560	160	600	356	611	0
10/1/2008	160	140	200	231	399	20	40	200	73	410	1000	800	860	690	532	160	140	60	233	553	0.14

Table 2. Weekly *E. coli* sampling results (counts per 100 mL) from the Main Branch Clinton River (Stations CR1-CR13); June 3-September 30, 2008. Exceedances of the TBC WQS are shaded gray and PBC exceedances are outlined in bold. Precipitation values are in inches.

	CR1 Clinton River Spillway at Harper Rd.					CR2 Main Br. Clinton at Crocker Blvd.					CR3 Harrington Drain at Harrington Rd.					CR4 Main Br. Clinton at Moravian Rd.					
Sample Date	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	2-day prior precip. (Pontiac WWTP, MI)
6/4/2008	1200	1040	1000	1077		1600	1800	3800	2220		3200	4400	4800	4073		800	600	1000	783		0.48
6/9/2008	600	200	400	363		3000	1200	1000	1533		4500	3500	3500	3806		1600	2400	3200	2308		0.63
6/18/2008	1000	760	1400	1021		2400	860	1200	1353		1200	380	1000	770		1800	440	1000	925		0.04
6/24/2008	160	120	120	132		440	1800	2200	1203		1200	1600	2000	1566		1800	1800	600	1248		0.21
6/30/2008	480	400	440	439	471	540	400	440	456	1204	780	760	1400	940	1774	800	520	600	630	1056	0.06
7/8/2008	220	120	180	168	325	560	2600	4800	1912	1168	2000	8800	2000	3277	1698	ns	ns	ns	ns	na	0.09
7/15/2008	280	1400	10200	1587	436	1000	1000	860	951	1062	1400	1200	800	1104	1326	400	320	520	405	na	0
7/22/2008	580	540	1320	745	410	3200	1400	8400	3351	1273	12200	7200	6800	8422	2139	5600	8200	7400	6978	na	0.73
7/29/2008	160	280	400	262	470	240	180	400	259	936	800	480	560	599	1765	300	300	800	416	na	0
8/7/2008	180	100	20	71	326	500	800	360	524	962	3600	1000	1400	1715	1991	80	580	380	260	na	0
8/11/2008	40	210	200	119	304	2400	2400	3800	2797	1039	760	840	700	765	1488	1000	2000	2200	1639	*871*	0.34
8/19/2008	180	200	160	179	197	200	220	380	256	799	1060	1200	1600	1267	1530	600	560	460	537	921	0
8/26/2008	180	200	140	171	147	200	200	180	193	451	500	400	740	529	880	440	220	280	300	491	0
9/2/2008	140	40	140	92	119	960	380	17400	1852	669	12600	2800	9400	6922	1435	20600	18200	17000	18541	1050	0
9/8/2008	260	80	140	143	137	4800	4600	3000	4046	1007	3000	3800	4800	3796	1682	1000	1600	2600	1608	1511	0.26
9/18/2008	800	200	800	504	183	420	<20	3500	1212	852	2000	1400	1000	1409	1901	1400	560	600	778	1302	0
9/24/2008	20	60	100	49	141	180	340	200	230	834	560	200	500	383	1496	180	260	360	256	1123	0
9/30/2008	60	200	180	129	133	1020	1460	980	1134	1189	1800	17400	15800	7910	2570	1000	1600	3200	1724	1593	0.07

Table 2 (continued). Weekly *E. coli* sampling results (counts per 100 mL) from the Main Branch Clinton River (Stations CR1-CR13); June 4-September 30, 2008. Exceedances of the TBC WQS are shaded gray and PBC exceedances are outlined in bold. Precipitation values are in inches.

	CR5 Main Br. Clinton at Garfield Rd.					CR6 Red Run Drain at Utica Rd.					CR7 Main Br. Clinton at Schoenherr Rd.					CR8 Main Br. Clinton at Riverland Rd.					
Sample Date	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	2-day prior precip. (Pontiac WWTP, MI)
6/4/2008	1000	3000	3400	2169		1200	1400	1400	1330		1400	1400	1600	1464		800	800	1600	1008		0.48
6/9/2008	3500	1800	1600	2160		4500	3400	1200	2638		800	600	400	577		600	200	600	416		0.63
6/18/2008	420	400	500	438		2000	2000	2400	2125		600	860	480	628		2400	780	1000	1232		0.04
6/24/2008	2200	4200	2000	2644		3200	2600	3400	3047		1600	2200	1000	1521		2200	2000	1200	1741		0.21
6/30/2008	400	300	460	381	1156	1000	1000	820	936	1843	500	500	400	464	822	1200	1200	1600	1321	1035	0.06
7/8/2008	10000	52000	64000	32166	1983	10500	11800	6600	9351	2722	400	420	300	369	624	320	220	360	294	809	0.09
7/15/2008	1000	1500	740	1035	1711	4000	2800	660	1948	2562	360	340	600	419	585	600	100	180	221	713	0
7/22/2008	1000	4200	7800	3200	2547	13400	14800	9600	12394	3646	1800	1000	2400	1629	708	1640	3200	2040	2204	801	0.73
7/29/2008	220	400	360	316	1666	580	500	640	570	2608	220	320	220	249	493	260	200	200	218	529	0
8/7/2008	360	440	400	399	1681	1200	500	400	621	2402	360	800	400	487	498	360	220	200	251	379	0
8/11/2008	800	800	940	844	812	2800	2000	1200	1887	1744	300	600	600	476	524	1000	1600	2800	1649	535	0.34
8/19/2008	500	600	360	476	695	480	460	400	445	1299	180	380	320	280	483	500	240	240	307	572	0
8/26/2008	600	1200	1000	896	539	1600	1000	800	1086	798	360	600	740	543	388	800	1600	400	800	467	0
9/2/2008	3000	9400	380	2205	795	280	440	440	378	735	240	460	380	347	414	180	400	340	290	494	0
9/8/2008	660	780	1400	897	934	7400	6200	4600	5954	1155	620	560	500	558	426	560	440	280	410	545	0.26
9/18/2008	1500	200	200	391	801	1200	480	400	613	922	400	1200	1000	783	470	220	460	540	379	406	0
9/24/2008	160	260	260	221	687	480	440	240	370	889	180	120	180	157	419	200	140	180	171	362	0
9/30/2008	8800	10600	2000	5714	996	13600	14200	18400	15260	1508	860	600	1600	938	468	3000	2400	820	1807	426	0.07

Table 2 (continued). Weekly *E. coli* sampling results (counts per 100 mL) from the Main Branch Clinton River (Stations CR1-CR13); June 4-September 30, 2008. Exceedances of the TBC WQS are shaded gray and PBC exceedances are outlined in bold. Precipitation values are in inches.

	CR9					CR10					CR11					CR12					CR13					
	Main Br. Clinton at Auburn Rd.					Main Br. Clinton at Ryan Rd.					Main Br. Clinton at Dequidre Rd.					Paint Creek at Rochester Rd.					Main Br. Clinton at Diversion St.					
Sample Date	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	2-day prior precip. (Pontiac WWTP, MI)
6/4/2008	600	1200	800	832		1200	800	600	832		800	1200	840	931		400	500	400	431		600	400	660	541		0.48
6/9/2008	400	1200	600	660		2500	200	1000	794		400	1200	400	577		800	2000	600	986		1000	400	400	543		0.63
6/18/2008	240	400	360	326		540	400	180	339		160	180	400	226		140	120	400	189		120	200	820	270		0.04
6/24/2008	1800	3200	800	**1664**		2400	800	6200	**2283**		1200	1600	1400	**1390**		1040	1200	1000	**1077**		1600	1400	1400	**1464**		0.21
6/30/2008	200	1000	400	431	663	400	1000	1600	862	849	160	200	180	179	497	200	220	180	199	444	520	460	600	524	571	0.06
7/8/2008	280	80	600	238	516	400	600	60	243	664	600	540	380	497	438	860	1340	880	**1005**	526	240	600	420	393	536	0.09
7/15/2008	120	600	220	251	425	160	220	100	152	477	260	800	320	405	408	160	100	160	137	354	360	360	580	422	509	0
7/22/2008	1000	1200	800	986	531	3800	1800	1200	**2017**	681	1000	3000	1200	**1533**	599	660	740	740	712	462	600	600	1200	756	626	0.73
7/29/2008	120	200	140	150	328	400	160	140	208	422	240	220	280	245	423	560	420	320	422	383	220	140	80	135	389	0
8/7/2008	180	220	380	247	294	200	240	300	243	328	440	180	380	311	473	780	540	440	570	473	140	180	160	159	306	0
8/11/2008	1800	600	780	944	387	1400	520	360	640	397	700	600	420	561	484	520	600	560	559	420	1200	880	740	921	363	0.34
8/19/2008	120	260	160	171	358	120	140	240	159	401	500	160	240	268	446	380	460	280	366	512	200	180	260	211	316	0
8/26/2008	300	1000	400	493	312	300	460	800	480	301	340	400	600	434	346	240	260	220	239	411	400	440	480	439	283	0
9/2/2008	340	280	220	276	352	180	360	500	319	328	740	400	1200	708	428	900	780	600	750	461	2400	280	480	686	392	0
9/8/2008	400	400	420	407	389	340	400	400	379	358	340	500	380	401	450	1200	1800	2200	**1681**	573	1600	2400	800	**1454**	611	0.26
9/18/2008	580	800	420	580	353	360	280	600	393	325	560	480	600	544	448	260	200	340	261	492	800	120	200	268	477	0
9/24/2008	140	160	200	165	350	140	200	180	171	330	180	220	200	199	422	240	200	180	205	438	240	560	220	309	515	0
9/30/2008	540	1200	1800	**1053**	408	2200	1200	500	**1097**	389	1100	1060	880	**1009**	500	680	2200	2200	**1487**	631	1000	400	800	684	563	0.07

Table 3. Weekly *E. coli* sampling results (counts per 100 mL) from the Middle Branch Clinton River (Stations MB1-MB4); June 5-October 1, 2008. Exceedances of the TBC WQS are shaded gray and PBC exceedances are outlined in bold. Precipitation values are in inches.

	MB1 Middle Br. Clinton at 25-Mile					MB2 Middle Br. Clinton at 21-Mile					MB3 Gloede Dr. at Romeo Plank rd.					MB4 Middle Br. Clinton at Heydenreich					2-day prior precip. (Romeo, MI)
	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	Left	Center	Right	Daily Max	30-Day Geomean	
6/5/2008	460	380	60	418		860	440	600	615		1200	600	1000	849		1400	1400	1000	1400		0.24
6/11/2008	960	920	1000	940		2200	1600	2400	1876		600	2400	2000	1200		3200	2800	2400	2993		0.65
6/19/2008	800	1000	360	894		520	500	340	510		720	820	400	768		500	540	720	520		0.07
6/25/2008	1000	800	800	894		700	880	800	785		800	240	560	438		660	1000	500	812		0.15
7/2/2008	1400	600	800	593	715	600	1300	680	883	836	600	740	1000	475	696	800	1000	700	823	1078	0
7/9/2008	800	1200	1080	630	776	400	880	860	657	847	460	620	600	448	612	940	720	620	746	950	0
7/16/2008	1400	1000	600	654	721	1000	1400	800	973	743	1400	340	1000	527	519	400	520	640	476	658	0
7/23/2008	900	600	600	519	647	700	480	600	630	775	2000	2200	1400	1104	558	640	1000	1600	710	700	0
7/30/2008	2800	1120	1280	1017	664	2800	1120	1280	1260	852	600	800	820	548	584	380	240	340	376	600	0.29
8/6/2008	1000	220	340	423	620	960	1000	1200	837	843	1600	2000	1800	1115	693	600	600	780	629	569	0
8/12/2008	360	260	520	322	543	200	220	400	287	714	1600	1200	2600	863	790	400	1200	1000	724	566	0
8/20/2008	220	300	380	278	457	220	4600	4000	847	694	300	160	380	295	703	300	340	280	415	550	0
8/27/2008	260	400	160	337	419	220	600	600	440	646	780	920	800	727	647	800	580	440	670	544	0
9/3/2008	680	560	200	471	360	200	300	340	321	492	500	600	600	542	645	580	440	440	548	587	0
9/10/2008	600	380	560	422	359	3000	1600	2000	1389	544	2000	2400	2600	1383	674	3000	3600	2400	1938	735	1.1
9/19/2008	1400	1000	800	803	431	180	160	3000	257	532	2000	1000	1400	1242	725	2500	1400	1200	1364	834	0
9/25/2008	300	280	480	330	447	840	640	100	636	503	1400	1000	1600	949	915	1000	1200	900	1032	1000	0
10/1/2008	560	600	680	512	486	1600	600	580	799	567	5200	6400	5400	2640	1185	4200	5200	5400	2958	1346	0.14

Table 4. Summary of data for all stations, including station geometric means, the number of PBC and daily maximum TBC WQS exceedances, and the results of bacterial source tracking at selected stations (+ indicates that the biomarker was detected; - indicates that no biomarker was detected). Station NB2 was sampled for bacterial source tracking on two dates with mixed results.

Station ID	Sample Location	Number of PBC WQS exceedances	Number of TBC WQS exceedances	Station geometric mean	Cattle bacteroidetes biomarker	Human bacteroidetes biomarker
CR1	Clinton River Spillway at Harper Road	3	7	249		
CR2	Main Br. Clinton River at Crocker Blvd.	11	14	975		
CR3	Harrington Drain at Harrington Rd.	11	18	1778	-	+
CR4	Main Br. Clinton River at Moravian Rd	7	15	1005		
CR5	Main Br. Clinton River at Garfield Rd	8	17	1135		
CR6	Red Run Drain at Utica Rd.	11	18	1686		
CR7	Main Br. Clinton River at Schoenherr Rd.	3	15	546		
CR8	Main Br. Clinton River at Riverland Rd.	7	12	579		
CR9	Main Br. Clinton River at Auburn Rd.	2	11	430		
CR10	Main Br. Clinton River at Ryan Rd.	3	12	456		
CR11	Main Br. Clinton River at Dequindre Rd.	3	5	474		
CR12	Paint Creek at Rochester Rd.	4	6	482	-	+
CR13	Main Br. Clinton River at Diversion St.	2	5	458		
MB1	Middle Br. Clinton River at 25 Mile	1	17	582		
MB2	Middle Br. Clinton River at 21 Mile	3	16	729		
MB3	Gloede Drain at Romeo Plank Rd..	6	17	1024	-	+
MB4	Middle Br. Clinton River at Heydenreich Rd.	6	18	900		
NB1	North Br. Clinton River at 29 Mile	4	5	279		
NB2	Coon Creek at North Rd.	8	14	767	+-	-+
NB3	East Br. Coon Creek at North Rd (near 26 Mile Rd.)	1	8	306		
NB4	Coon Creek at 26 Mile Rd.	3	10	337		
NB5	North Br. Clinton River at 26 Mile	1	8	326		
NB6	North Br. Clinton River at 24 Mile.	2	13	402		
NB7	McBride Drain at Card Rd.	5	16	725	+	+
NB8	North Br. Clinton River at end of Dunham Rd	2	13	363		

Table 5. 2006 Land Cover Classification of the entire Clinton River watershed, the TMDL watershed, and the Main Branch, Middle Branch, and North Branch Clinton River (separately) as a percent of total land area.

2006 Land Cover Classification	Clinton River Watershed	TMDL Watershed (deliniated in Figure 1)	Main Branch	Middle Branch	North Branch
Developed, High Intensity	5.4%	3.7%	7.8%	4.2%	0.5%
Developed, Medium Intensity	13.1%	14.7%	27.5%	18.0%	2.5%
Developed, Low Intensity	17.5%	19.5%	30.3%	25.1%	5.8%
Developed, Open Space	9.1%	10.5%	13.2%	13.5%	4.9%
Cultivated Crops	13.1%	17.1%	0.3%	9.6%	37.1%
Pasture/Hay	7.4%	8.3%	0.3%	5.5%	16.9%
Grassland/Herbaceous	2.5%	1.3%	0.5%	1.2%	1.9%
Deciduous Forest	15.8%	14.0%	9.9%	13.7%	17.0%
Evergreen Forest	1.1%	0.8%	1.1%	0.9%	0.5%
Mixed Forest	1.2%	0.8%	1.0%	0.8%	0.6%
Scrub/Shrub	0.9%	1.0%	0.3%	0.8%	1.6%
Palustrine Forested Wetland	6.0%	4.8%	5.2%	3.3%	6.5%
Palustrine Scrub/Shrub Wetland	2.0%	1.2%	0.6%	0.8%	1.9%
Palustrine Emergent Wetland	1.2%	0.8%	0.7%	0.8%	1.0%
Bare Land	0.7%	0.1%	0.1%	0.0%	0.0%
Water	2.8%	1.4%	0.9%	1.7%	1.3%

Table 6. Percent of land area in the Lower Clinton River TMDL watershed located within each municipality. Municipalities that hold an MS4 permit are marked with an "X."

Municipality Name	County	Percent of TMDL Watershed	MS4 community
Armada Twp	Macomb	8.1%	
Berlin Twp	Macomb	<1%	
Bruce Twp	Macomb	<1%	
Chesterfield Twp	Macomb	1.0%	X
Clinton Twp	Macomb	10.9%	X
Fraser	Macomb	2.2%	X
Harrison Twp	Macomb	1.0%	X
Macomb Twp	Macomb	18.3%	X
Mt Clemens	Macomb	2.2%	X
Ray Twp	Macomb	18.0%	
Rochester	Oakland	<1%	X
Rochester Hills	Oakland	1.7%	X
Shelby Twp	Macomb	17.5%	X
Sterling Heights	Macomb	5.8%	X
Utica	Macomb	1.0%	X
Washington Twp	Macomb	11.9%	X

Table 7. Percent of land area in the Lower Clinton River TMDL watershed located within each county. Counties that hold an MS4 permit are marked with an "X."

County	Percent of TMDL Watershed	MS4 community
Macomb	98%	X
Oakland	2%	X
St. Clair	<1%	X

Table 8. NPDES facilities discharging to the Clinton River watershed. COCs under the General Storm Water Permit are listed in Appendix 2.

Facility Name			Permit No.	Receiving Water	Latitude	Longitude
Individual Permits						
Mt Clemens WWTP			MI0023647	Clinton River	42.6000	-82.8661
Selfridge ANGB			MI0055328	Clinton River	42.6111	-82.8306
MDOT - Statewide MS4			MI0057364	various	na	na
New Haven Schools-Ray Twp			MI0058039	Coon Creek	42.7203	-82.8794
Regulated Municipal Separate Storm Sewers						
Oakland Co MS4	Phase II	Watershed Permit	MIG610042	various	na	na
Macomb Co MS4	Phase II	Watershed Permit	MIG610052	various	na	na
Shelby Twp MS4-Macomb	Phase II	Watershed Permit	MIG610115	various	na	na
Rochester MS4-Oakland	Phase II	Watershed Permit	MIG610219	various	na	na
Rochester Hills MS4-Oakland	Phase II	Watershed Permit	MIG610283	various	na	na
Clinton Twp MS4-Macomb	Phase II	Watershed Permit	MIG610299	various	na	na
Washington Twp MS4-Macomb	Phase II	Watershed Permit	MIG610305	various	na	na
Utica MS4-Macomb	Phase II	Watershed Permit	MIG610306	various	na	na
Romeo MS4-Macomb	Phase II	Watershed Permit	MIG610309	various	na	na
Mount Clemens MS4-Macomb	Phase II	Watershed Permit	MIG610311	various	na	na
Macomb Twp MS4-Macomb	Phase II	Watershed Permit	MIG610312	various	na	na
Chesterfield Twp MS4-Macomb	Phase II	Watershed Permit	MIG610310	various	na	na
Fraser MS4-Macomb	Phase II	Watershed Permit	MIG610308	various	na	na
Harrison Twp MS4-Macomb	Phase II	Watershed Permit	MIG610313	various	na	na
Selfridge ANGB MS4 - Macomb	Phase II	Jurisdictional Permit	MIS040043	various	na	na
Sterling Heights MS4	Phase I	Jurisdictional Permit	MIS040085	various	na	na
Cleanup of Water Contaminated by Petroleum Products, General Permit: MIG080000						
Speedway SuperAmerica 2254			MIG081076	Unnamed near Utica	42.6716	-83.0166
Storm Water from Industrial Activities, General Permit: MIS110000						
See Appendix 2						
Storm Water Discharges With Required Monitoring, General Permit: MIS120000						
DuPont-Mt Clemens			MIS120007	Clinton River	42.6125	-82.8897

Table 9. USGS gauge locations for each station and the period of record for each gauge used in load duration curve development.

Gage Number	Location	Stations	Period of Record
4165500	Clinton River at Moravian Dr.	CR1-CR2	Oct 1968 to current year
4164500	N. Br. Clinton at Mt. Clemens	CR4, NB1, NB5-NB8 and MB1-MB4	May 1947 to current year.
4164000	Clinton near Fraser	CR5	May 1947 to current year.
4164300	East Branch Coon Creek at Armada	CR6, NB2-NB4	October 1958 to current year.
4161820	Clinton at Sterling Heights	CR7-CR11	October 1978 to December 1982, March 1996 to May 1998, July 2001 to current year.
4161540	Paint Cr. At Rochester	CR12	October 1959 to current year.
4161000	Clinton at Auburn Hills	CR13	May 1935 to June 1939 and February to September 1940 , October 1956 to September 1982 , water years 1983-91 (operated as a crest-stage partial-record station), July 2001 to September 2002, water year 2003 (operated as a crest-stage partial-record station), April 2004 to current year.

Appendix 1. Assessment units proposed to be listed as nonattaining for the PBC and TBC designated uses in the 2010 Section 303(d) list and addressed in this TMDL.

CLINTON RIVER **AUID**: 040900030306-01
County: Macomb SIZE: 51.9 M
Location: Armada and Ray Drain, Coon Creek, Priest Drain, Tupper Brook, Unnamed Tributaries to Coon Creek, and Unnamed Tributary to Priest Drain
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Agriculture and Sewage Discharges in Unsewered Areas
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030307-01
County: Macomb SIZE: 32.4 M
Location: Middle Branch Clinton River and Unnamed Tributaries to Middle Branch Clinton River
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Sewage discharges in unsewered areas and illicit connections to storm sewers
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030307-02
County: Macomb SIZE: 17.1 M
Location: Unnamed Tributaries to Yates Drain and Yates Drain
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Agriculture and Sewage Discharges in Unsewered Areas
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030308-01
County: Macomb SIZE: 32.8 M
Location: Healy Drain, Heide Drain, Miller Drain, Price Brook, Unnamed Tributaries to Healy Drain, and Unnamed Tributary to Price Brook
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Agriculture and Sewage Discharges in Unsewered Areas
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030309-01
County: Macomb SIZE: 57.7 M
Location: Bannister Drain, Crittenden Drain, Decker Drain, Dunn Drain, Harris Drain, Kenner Drain, Lewis Drain, Longstaff Drain, Longstaff Drain Number Two, Shoemaker Drain, Unnamed Tributary to Middle Branch Clinton River, and Utica Drain
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Sewage discharges in unsewered areas and illicit connections to storm sewers
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030310-01
County: Macomb SIZE: 3.8 M
Location: North Branch Clinton River
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Agriculture and Sewage Discharges in Unsewered Areas
TMDL Year(s): 2010

Appendix 1 cont.

CLINTON RIVER **AUID**: 040900030310-02
County: Macomb SIZE: 9.7 M
Location: North Branch Clinton River and Wyman Drain
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Agriculture and Sewage Discharges in Unsewered Areas
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030310-04
County: Macomb SIZE: 19.6 M
Location: North Branch Clinton River
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Agriculture and Sewage Discharges in Unsewered Areas
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030310-05
County: Macomb SIZE: 10 M
Location: CAMP BROOK DRAIN
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Agriculture and Sewage Discharges in Unsewered Areas
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030311-01
County: Macomb SIZE: 47.9 M
Location: Heydenreich Drain, Howard Drain, Middle Branch Clinton River, Miller Drain, Nicol Drain, Pingle Drain, Preston Drain, Unnamed Tributaries to Middle Branch Clinton River, and Zander Drain
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Agriculture, sewage discharges in unsewered areas and illicit connections to storm sewers
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030312-01
County: Macomb SIZE: 47.8 M
Location: Conklin Drain, Hammon Drain, Hart Drain, McBride Drain, North Branch Clinton River, Thoel Drain, Unnamed Tributary to Hart Drain, and Unnamed Tributary to McBride Drain
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Agriculture and Sewage Discharges in Unsewered Areas
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030401-01
County: Macomb SIZE: 20.2 M
Location: SWEENEY DRAIN AND HARRINGTON DRAIN
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Sanitary Sewer Overflows and illicit connections to storm sewer
TMDL Year(s): 2010

CLINTON RIVER **AUID**: 040900030402-04
County: Macomb SIZE: 14.8 M
Location: Clinton River, Cranberry Marsh Drain, Faulman Drain, Hildebrandt Drain, Kukuk Drain, and Unnamed Tributaries to Clinton River
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Combined Sewer Overflows from Pontiac
TMDL Year(s): 2010

Appendix 2. List of facilities holding Certificates of Coverage under the Industrial Stormwater Permit (MIS11000) within the TMDL watershed.

Facility Name	Permit	Latitude	Longitude	Receiving Water
Continental Plastics	MIS110061	42.54250	-82.93222	Tesk Drain
Blue Water Fabricators	MIS110067	42.62639	-82.90389	North Branch Clinton River
CBS Boring & Machining-Fraser	MIS110073	42.54417	-82.93833	Tesk Drain
Joint Production Technology	MIS110074	42.67528	-82.97333	Harris Drain
Auto-Con Corp-Clinton Twp	MIS110080	42.55594	-82.92781	Harrington Drain
Jolico-JB Tool Inc	MIS110083	42.66000	-83.06972	Clinton River
DieTech North America LLC	MIS110085	42.51250	-82.95000	Harrington Drain
A & M Industries	MIS110087	42.55833	-82.91667	Clinton River
Triumph Gear Sys-Macomb Inc	MIS110091	42.67139	-82.97306	Harris Drain
H & M Machining Inc-Roseville	MIS110094	42.51361	-82.94972	Sweeny Drain
Thread-Craft-Sterling Hgts	MIS110096	42.61694	-83.03722	Clinton River
Howard Finishing LLC	MIS110105	42.51444	-82.96000	Sweeney Drain
Barcoa Manufacturing	MIS110122	42.60194	-82.85194	Clinton River
Selfridge Plating-Mt Clemens	MIS110123	42.60306	-82.85194	Clinton River
Par-Kut International	MIS110124	42.60000	-82.85389	Clinton River
Northern Industrial Mfg	MIS110125	42.60139	-82.85528	Clinton River
Yates Cider Mill LLC	MIS110213	42.67278	-83.09333	Clinton River
Johnson Controls-Mt Clemens	MIS110224	42.60444	-82.89833	Clinton River
Mini Mix Supply-Clinton Twp	MIS110233	42.54860	-82.92752	Harrington Drain
Arlington Transit Mix	MIS110243	42.66944	-83.03667	Middle Branch Clinton River
Profile Mfg-Chesterfield	MIS110250	42.67222	-82.84944	Pitts Drain
Ernies Auto Parts	MIS110253	42.60500	-82.85167	Clinton River
Barrett Paving-Mt Clemens	MIS110256	42.60083	-82.89167	Clinton River
Don & Hanks Highway Auto Parts	MIS110259	42.51028	-82.95667	Sweeny Drain
Lunar Industries-Clinton Twp	MIS110280	42.55000	-82.92667	Tesk Drain
Burkard Industries Inc	MIS110307	42.55583	-82.93000	Harrington Drain
Superior Heat Treat LLC	MIS110333	42.56250	-82.91667	Harrington Drain
A-1 Stampings-Fraser	MIS110334	42.54167	-82.92917	Tesk Drain
Great Lakes Paper Stock Corp	MIS110340	42.52083	-82.94833	Sweeny Drain
TBL Trailer Inc-Fraser	MIS110354	42.53028	-82.94167	Sweeny Drain
Middleton Auto Parts-Fraser	MIS110361	42.54056	-82.93389	Sweeney Drain
Venture Ind-Masonic Plt	MIS110369	42.53139	-82.94500	Sweeny Drain
TM Smith Tool Intl Corp	MIS110374	42.60389	-82.89722	Clinton River
Fori Automation-Shelby Twp	MIS110381	42.67056	-82.98111	Longstaff Drain #2
Norgren Automotive-Clinton Twp	MIS110382	42.62917	-82.87583	North Branch Clinton River
Warhoops Auto & Truck Parts	MIS110387	42.60000	-83.04167	Clinton River
Van Loon Ind-Clinton Twp	MIS110400	42.56611	-82.91444	Harrington Drain
Inter-Lakes Bases-Fraser	MIS110404	42.54972	-82.94278	Tesk Drain
Ultimate Hydroforming Inc	MIS110406	42.60250	-83.03611	Clinton River
Global Rollforming Systems LLC	MIS110411	42.50736	-82.95548	Sweeny Drain
Regal Prototypes Inc	MIS110412	42.62083	-83.04583	Clinton River
A-V-R Mfg-Fraser	MIS110447	42.54850	-82.93253	Clinton River
Advance Precision Grinding	MIS110448	42.51250	-82.95472	Sweeny Drain
Grippe Machining & Mfg Co	MIS110510	42.51583	-82.96306	Sweeny Drain
US Mfg Corp-Fraser	MIS110766	42.53167	-82.93889	Sweeny Drain
SND Steel Fabrication Inc	MIS110770	42.66667	-83.01194	Decker Drain
John Carlo-Rex Model S 2017	MIS110788	42.62722	-82.92444	various receiving waters
Phalanx Inc-Roseville	MIS110790	42.51389	-82.95889	Harrington Drain
Edrich Products-Fraser	MIS110809	42.54096	-82.94229	Tesk Drain
A-1 Roll Co-Mt Clemens	MIS110876	42.59583	-82.89167	Clinton River
G & F Prototype Plasters	MIS110877	42.54306	-82.93833	Tesk Drain
Austemper-Clinton Twp	MIS110891	42.55417	-82.93333	Harrington Drain
Automated Production-Fraser	MIS110895	42.54583	-82.93639	Tesk Drain

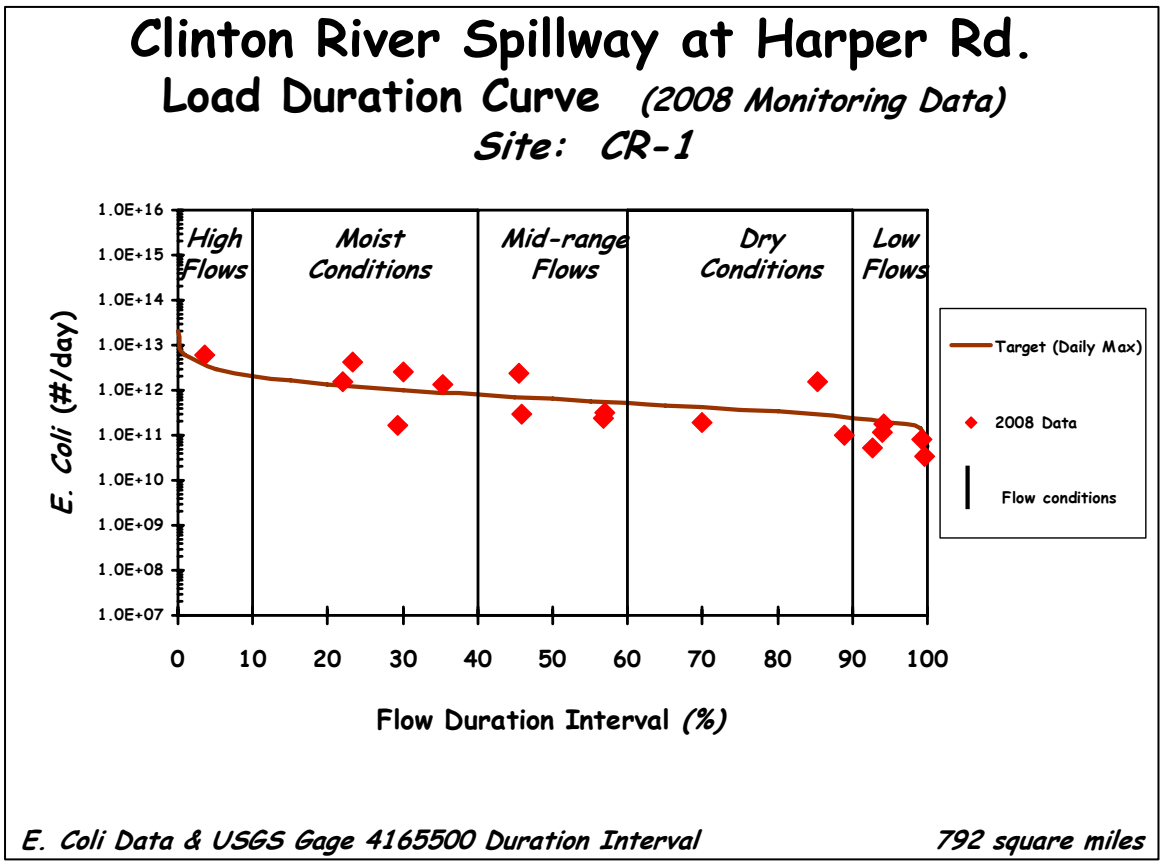
Appendix 2 cont.

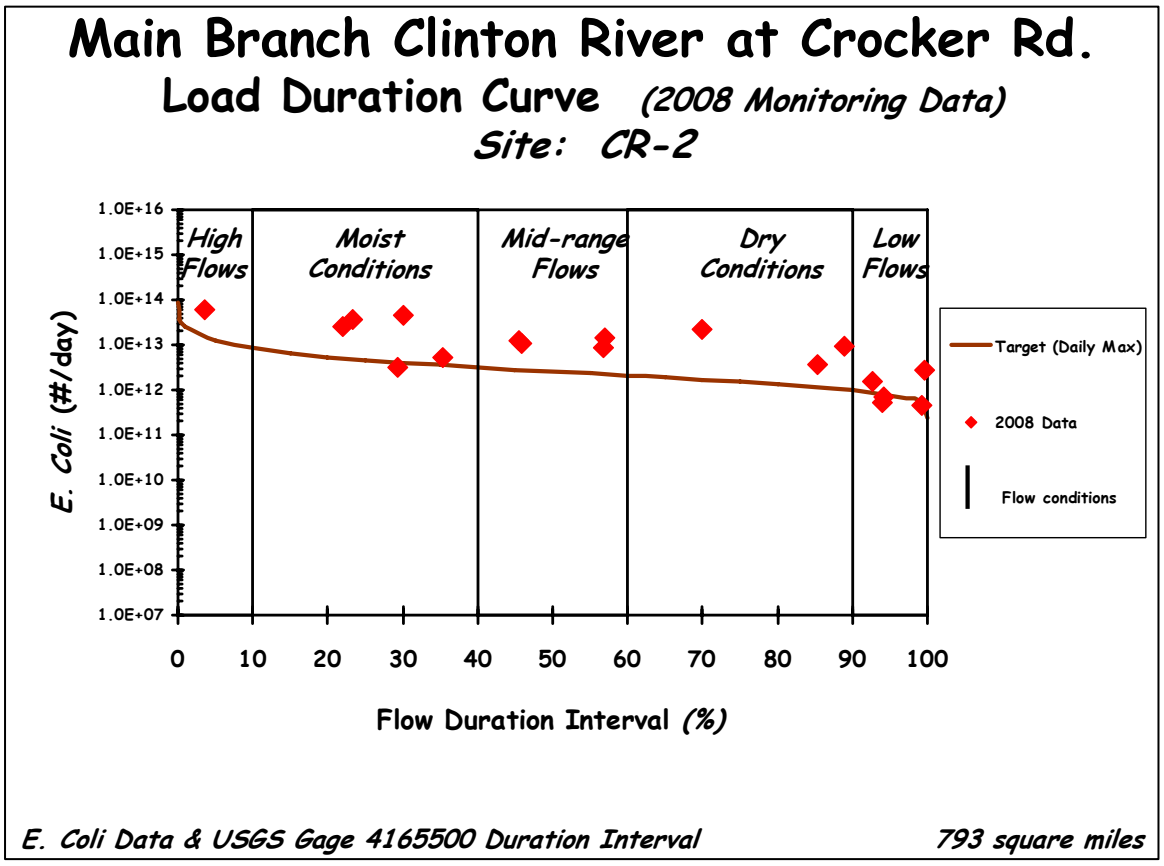
Facility Name	Permit	Latitude	Longitude	Receiving Water
Avon Broach & Production Co	MIS110898	42.66556	-83.11250	Honeywell Ditch
Electroplating Ind-Clinton Twp	MIS110914	42.62639	-82.90417	Miller Drain
Diversified Fabricators-Fraser	MIS110916	42.55205	-82.93773	Tesk Drain
Dayco Products	MIS110923	42.51611	-82.96667	Sweeny Drain
Nat Asphalt Products Inc	MIS110930	42.66972	-83.00833	Longstaff Drain
Discount Auto Salvage LLC	MIS110932	42.60306	-82.89028	Clinton River
Motor City Stamping	MIS110933	42.65167	-82.84972	Brandenburg Drain
Prototype Tooling & Mfg-Fraser	MIS110935	42.55000	-82.93333	Tesk Drain
Oakland Tool & Mfg-Fraser	MIS110936	42.55167	-82.94250	Sweeny Drain
MNP Corporation-Utica	MIS110950	42.62194	-83.03861	Clinton River
Piper Industries-Roseville	MIS110952	42.51611	-82.95972	Harrington Drain
RCO Engineering Inc-Roseville	MIS110957	42.51028	-82.96306	Harrington Drain
Shuert Industries-Sterling Hts	MIS110960	42.62444	-83.04583	Clinton River
Protocon Holdings LLC	MIS110961	42.73333	-83.03528	Yates Drain
Park Electric-Armada	MIS110962	42.84361	-82.88333	Coon Creek
Wolverine Plating-Roseville	MIS110969	42.51111	-82.95556	Harrington Drain
Specialty Steel-Fraser	MIS110977	42.55056	-82.94278	Sweeny Drain
HHI FormTech-Fraser	MIS111019	42.55028	-82.93639	Harrington Drain
John Carlo Inc-Johnson Plt 225	MIS111036	42.62722	-82.92444	various
John Carlo Inc-Plt 2721	MIS111038	42.62722	-82.92444	various
Michigan Production Machining	MIS111069	42.67139	-82.95667	Crittenden Drain
Concord Tool & Mfg-Mt Clemens	MIS111083	42.60306	-82.89917	Clinton River
Utica-Craft Industries	MIS111114	42.67000	-83.00361	Longstaff Drain
Press-Way-Clinton Twp	MIS111154	42.55417	-82.92611	Tesk Drain
CBS Boring & Machine Co Plt 3	MIS111155	42.55139	-82.93639	Tesk Drain
CBS Boring & Machine Co Plt 2	MIS111156	42.55222	-82.94278	Sweeny Drain
Roberts & Sons-Roseville	MIS111158	42.52111	-82.95278	Sweeny Drain
Hydra-Lock-Mt Clemens	MIS111163	42.59583	-82.87917	Clinton River
John Carlo Inc-2828 Rex	MIS111179	42.62722	-82.92444	various receiving waters
John Carlo-Johnson Plt 2841	MIS111195	42.62652	-82.92110	various receiving waters
Fairlane Tool Co-Groesbeck Hwy	MIS111207	42.53028	-82.94167	Clinton River
National Precast Structural	MIS111223	42.67083	-82.98111	Longstaff Drain #2
Fairlane Products-Fraser	MIS111227	42.54500	-82.93583	Tesk Drain
Vac-Met Inc-Fraser	MIS111235	42.52806	-82.93472	Sweeney Drain
JAC Products Inc Rollform	MIS111237	42.67278	-83.01028	Longstaff Drain
Casadei Structural Steel Inc	MIS111245	42.61583	-83.04250	Clinton River
Sur-Flo Plastics-Fraser	MIS111247	42.55028	-82.93417	Tesk Drain
AZ Automotive-Roseville	MIS111271	42.51583	-82.96750	Clinton River
Tower Automotive-Clinton Twp	MIS111276	42.62750	-82.87615	North Branch Clinton River
Lakeside Building Products	MIS111279	42.59751	-82.88651	Clinton River
US Farathane-Utica	MIS111281	42.66806	-83.01162	Decker Drain
Hamlin Tool & Machine Co	MIS111283	42.66186	-83.10536	Clinton River
Oakley Plt 4	MIS111290	42.54829	-82.94261	tributary of the Harrington Drain
Oakley Plt 6	MIS111291	42.55216	-82.93269	tributary of the Harrington Drain
R J Plt 3-Fraser	MIS111293	42.55195	-82.94277	tributary of the Harrington Drain
Oakley Plt 7	MIS111299	42.55216	-82.93269	tributary of the Harrington Drain
Plast-O-Foam	MIS111300	42.62360	-82.85940	Gohl Drain
Advanced Accessory Systems	MIS111310	42.66903	-82.98732	Longstaff Drain No. 2
Atlas Tool Inc-Roseville	MIS111321	42.51848	-82.95115	Roebuck Sweeny
Logghe Stamping Co-Fraser	MIS111361	42.63277	-82.97600	Sweeney Drain
First Student Inc 20197	MIS111370	42.59972	-82.88806	Clinton River
Special Tool & Engineering Inc	MIS111377	42.54806	-82.93306	Teske Drain
Rivas Inc	MIS111379	42.66933	-82.98237	Longstaff Drain

Appendix 2 cont.

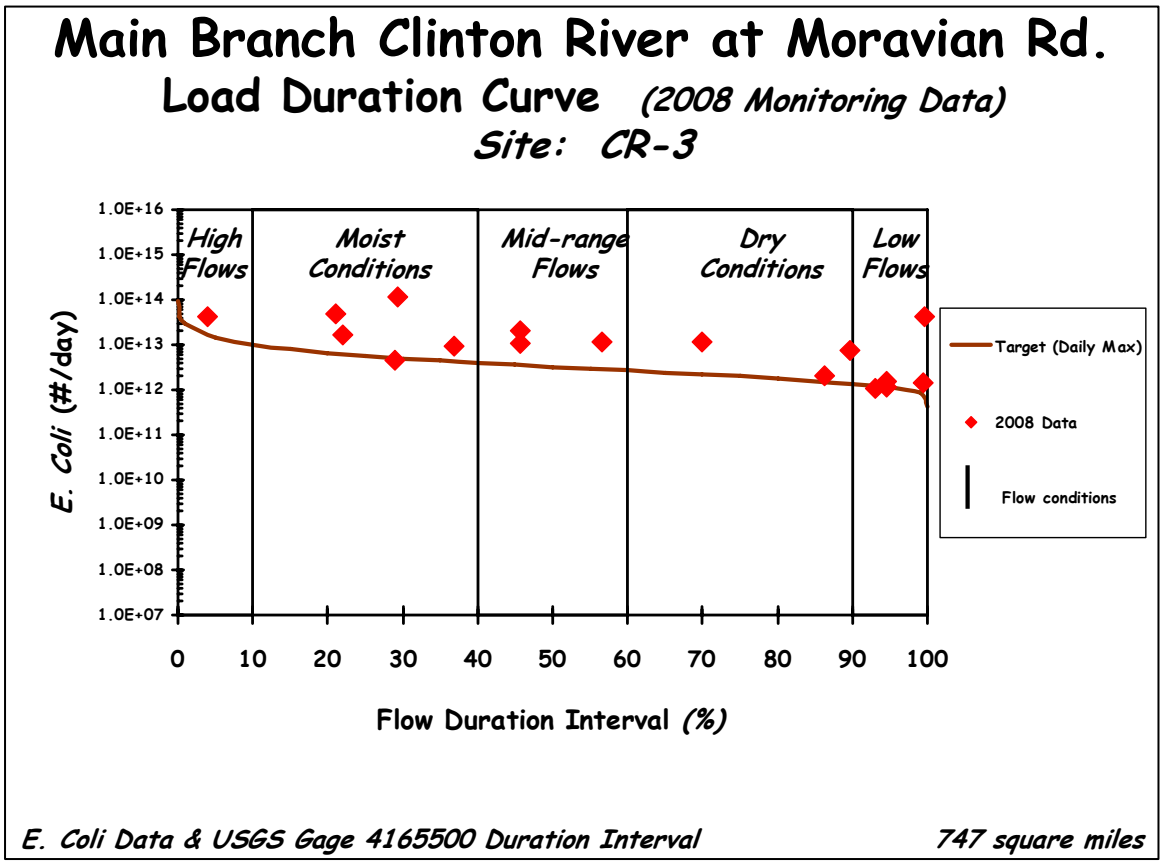
Facility Name	Permit	Latitude	Longitude	Receiving Water
Century Plastics Inc	MIS111389	42.66943	-82.97363	Harris Drain
La Fata Cabinets	MIS111402	42.66963	-82.97744	Clinton River
Powder Cote II	MIS111406	42.60306	-82.89556	City of Mount Clemens Storm Sewers
Duggan Manufacturing	MIS111416	42.65948	-83.07073	Clinton River
Pamar Ent Portable Crusher	MIS111437	42.59583	-82.90417	various receiving waters
Shelby Foam Systems	MIS111443	42.71123	-83.05242	Shooke Drain
Anderson Cook Inc	MIS111452	42.55195	-82.94277	Sweeney Drain
Sterling Die and Engineering	MIS111462	42.67675	-82.96922	Clinton River
M & W Manufacturing Company	MIS111481	42.51861	-82.95056	Rohrbeck-Sweeny Relief Drain
Deluxe Technologies LLC-Fraser	MIS111487	42.55205	-82.93773	Tesk Drain
Accurate Boring Co	MIS111489	42.54829	-82.94261	Tesk Drain
Faurecia - Fraser	MIS111490	42.54107	-82.93725	Clinton River
Avon Gear Co	MIS111500	42.68283	-83.00246	Clinton River
Marten Models and Molds	MIS111502	42.54850	-82.93253	Teske Drain
Fraser Grinding Co - Riviera	MIS111503	42.54839	-82.93757	Clinton River
Fraser Grinding Co - Groesbeck	MIS111504	42.54117	-82.93221	Clinton River
Fraser Grinding Co - James J P	MIS111505	42.54850	-82.93253	Clinton River
Visioneering	MIS111506	42.53323	-82.94194	Sweeny Drain
US Machine Co Inc	MIS111508	42.53708	-82.94212	Sweeney Drain to Clinton River
PCS Co	MIS111510	42.55205	-82.93773	Teske Drain
Eifel Mold and Engineering	MIS111512	42.52577	-82.95153	Sweeney Drain
Supreme Gear Co	MIS111516	42.54829	-82.94261	Sweeny Drain
Quality Die Sets Inc	MIS111517	42.89012	-83.00038	Sweeney Drain
Midwest Gear & Tool-Roseville	MIS111518	42.51583	-82.96250	Sweeney Drain
Dominion Tech & Viking	MIS111519	42.51458	-82.96074	Clinton River
US Farathane-Merrill Rd	MIS111538	42.59986	-83.04813	Clinton River
Mid-Michigan Recycling-Macomb	MIS111543	42.65035	-82.85941	Wacker Drain
Hi-Craft Engineering	MIS111548	42.54117	-82.93221	Sweeney Drain to Clinton River
Florence Cement Co	MIS111570	42.66996	83.00294	various receiving waters
Florence Cement Co Plt 701	MIS111572	42.62414	-82.99031	various receiving waters
LTC Roll & Eng-Clinton Twp	MIS111574	42.61806	-82.86722	Clinton River
Midwest Mold Srvs-Roseville	MIS111579	42.89012	-83.00038	Sweeny Drain
Arin Inc	MIS111580	42.51078	-82.96566	Harrington Drain
Carroll Products	MIS111586	42.61814	-83.04422	Clinton River
Plastic Molding Development	MIS111596	42.60398	-83.03380	Clinton River
Atlantic Tool	MIS111597	42.62333	-82.88099	Clinton River
MRF	MIS111599	42.54839	-82.93757	Sweeney Drain
Global Tooling Systems	MIS111603	42.67167	-82.96028	Crittenden Drain
Thermal Designs & Mfg	MIS111607	42.52577	-82.95153	Couchez Drain
Jeffrey Tool & Mfg	MIS111609	42.62730	-82.88608	North Branch of Clinton River
DuPont-Mt Clemens	MIS120007	42.61250	-82.88972	Clinton River
G & H LF PRP Group	MIU990012	42.66389	-83.07944	Clinton River

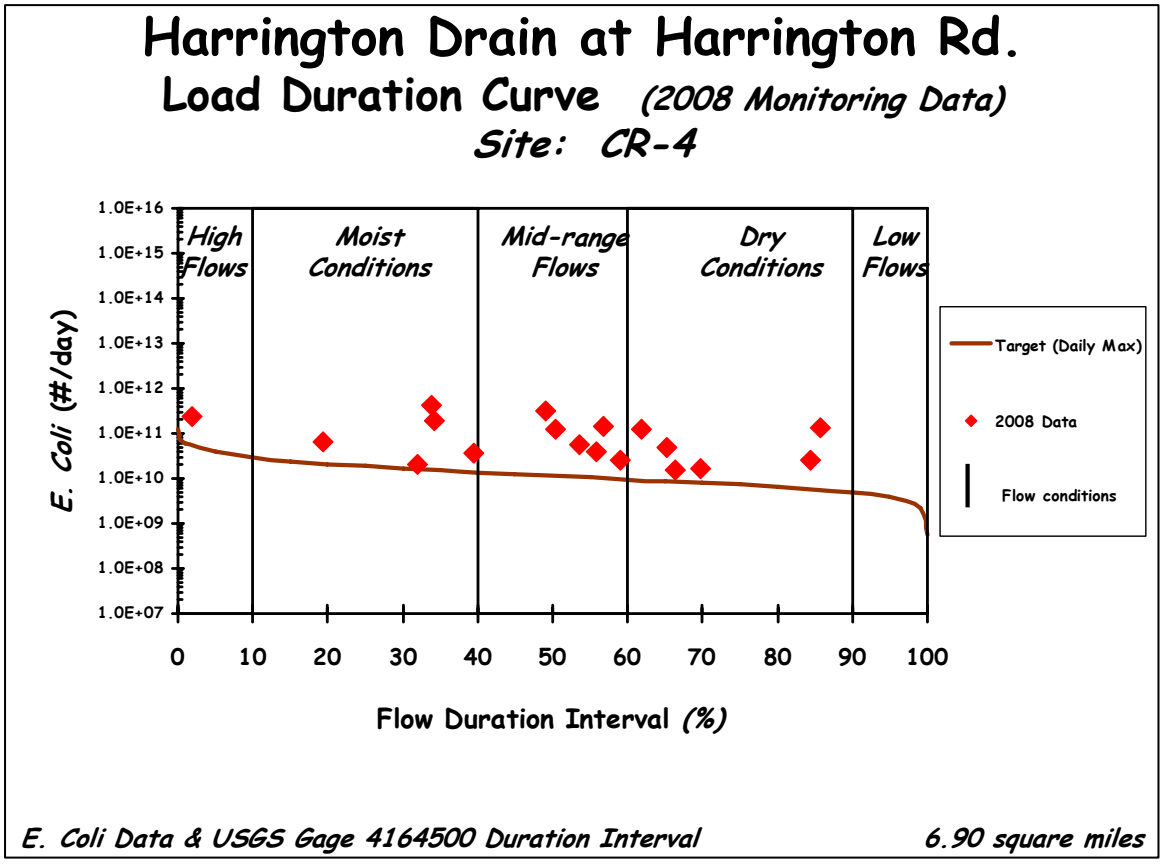
Appendix 3. Load duration curves for the Main Branch Clinton River Stations CR1-CR13. The gage used for the correlation and the drainage area size for each drainage area ratio calculation is indicated on the bottom of each chart.



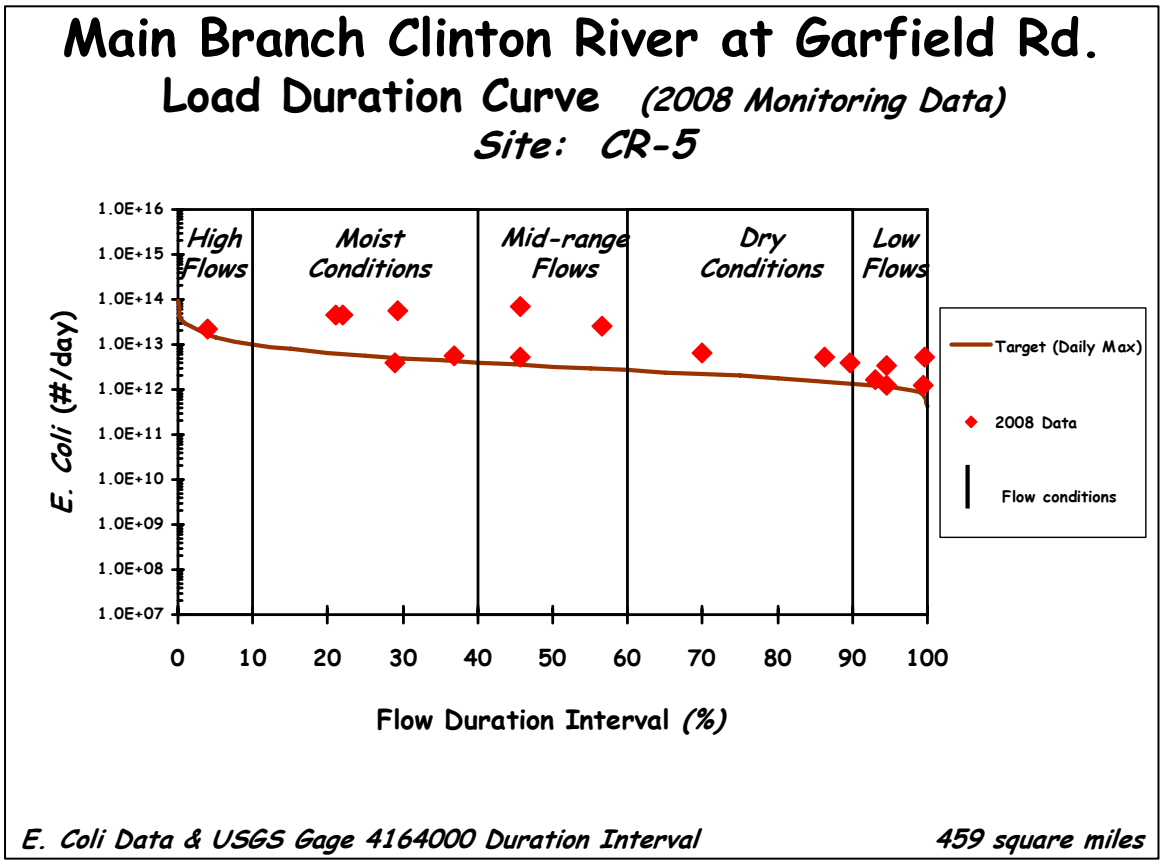


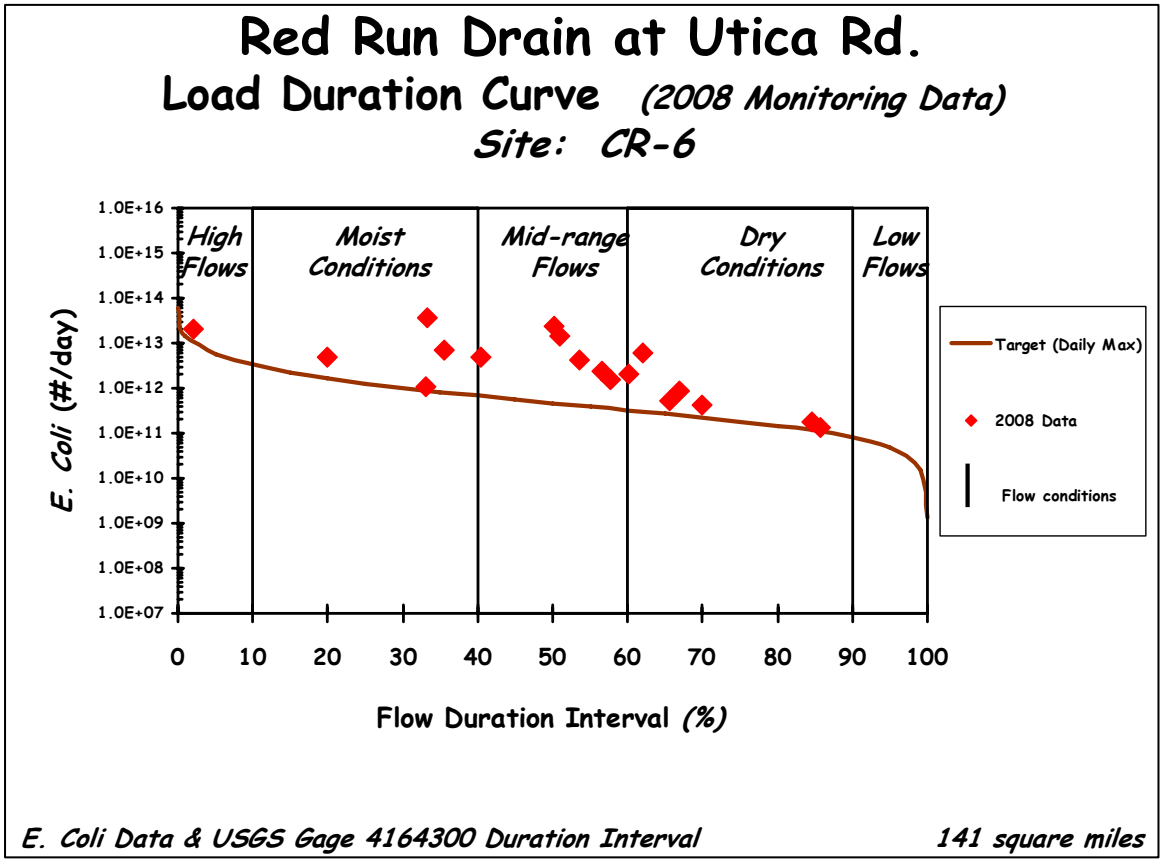
Appendix 3 cont.





Appendix 3 cont.





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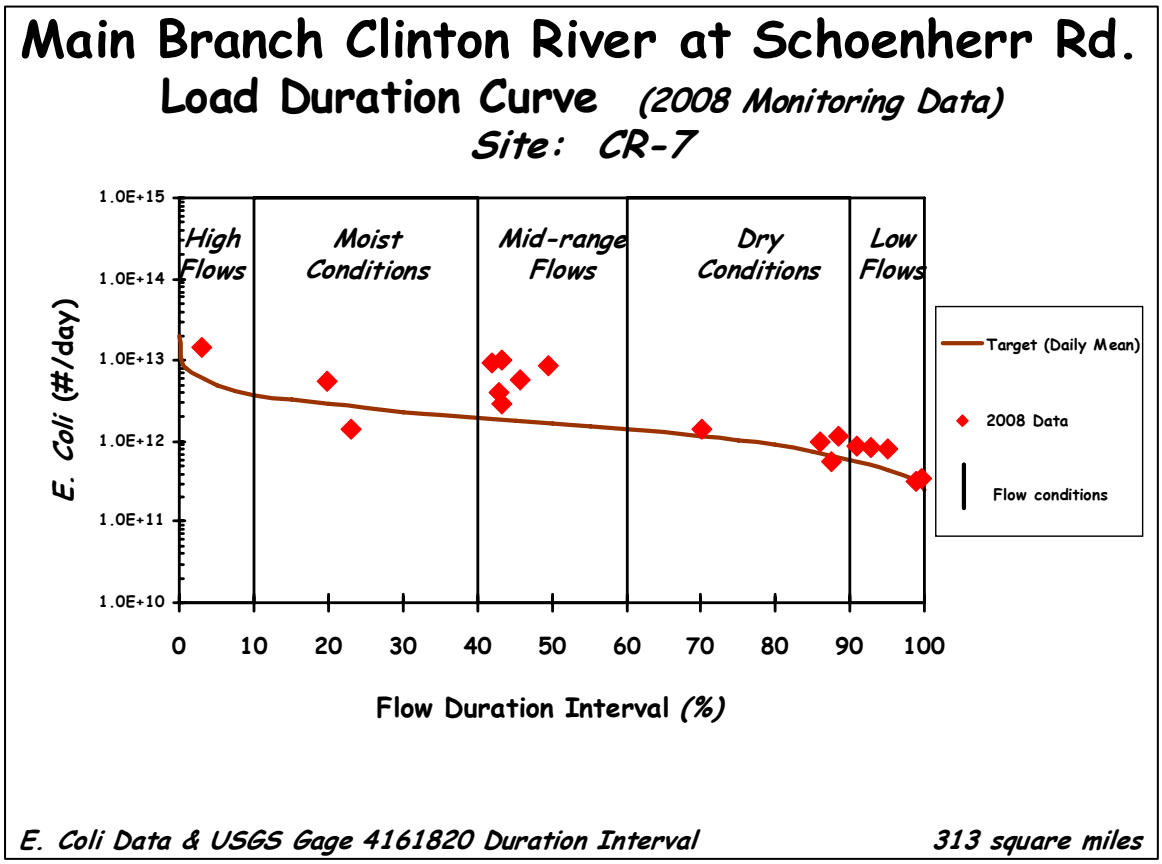
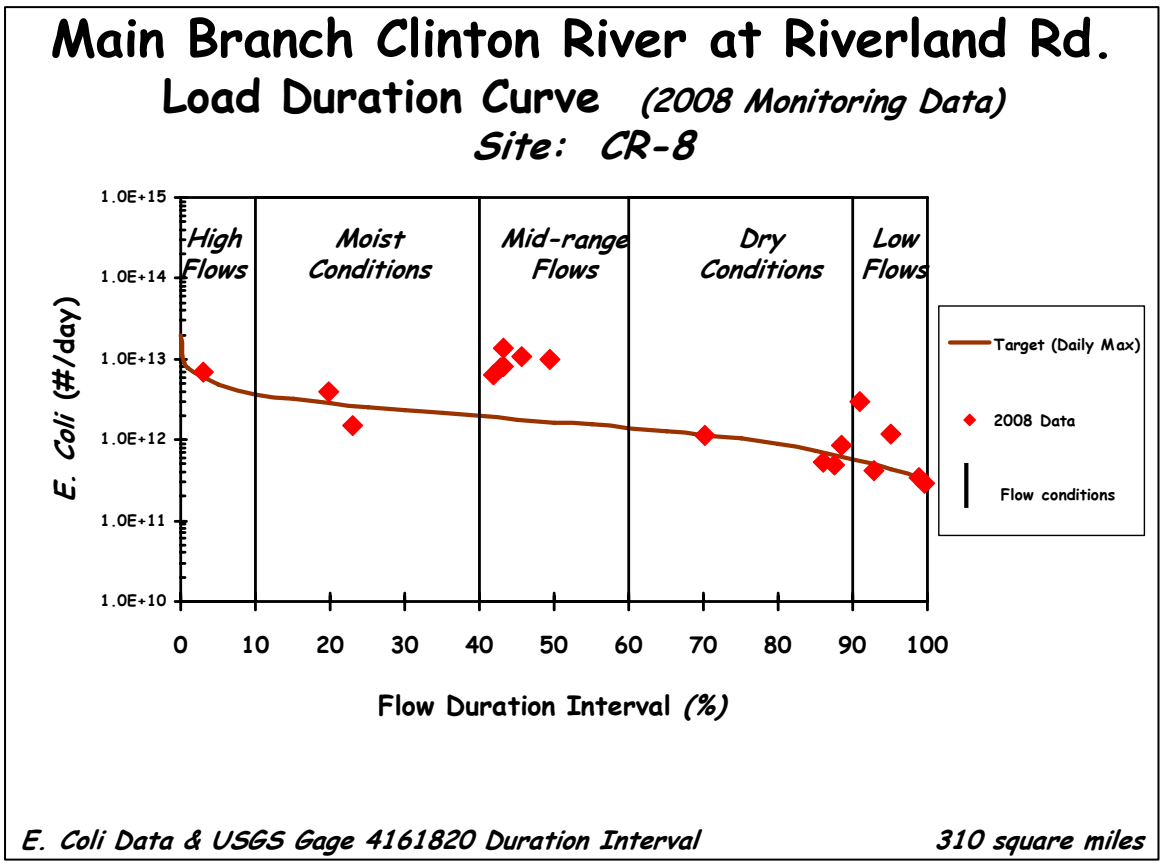
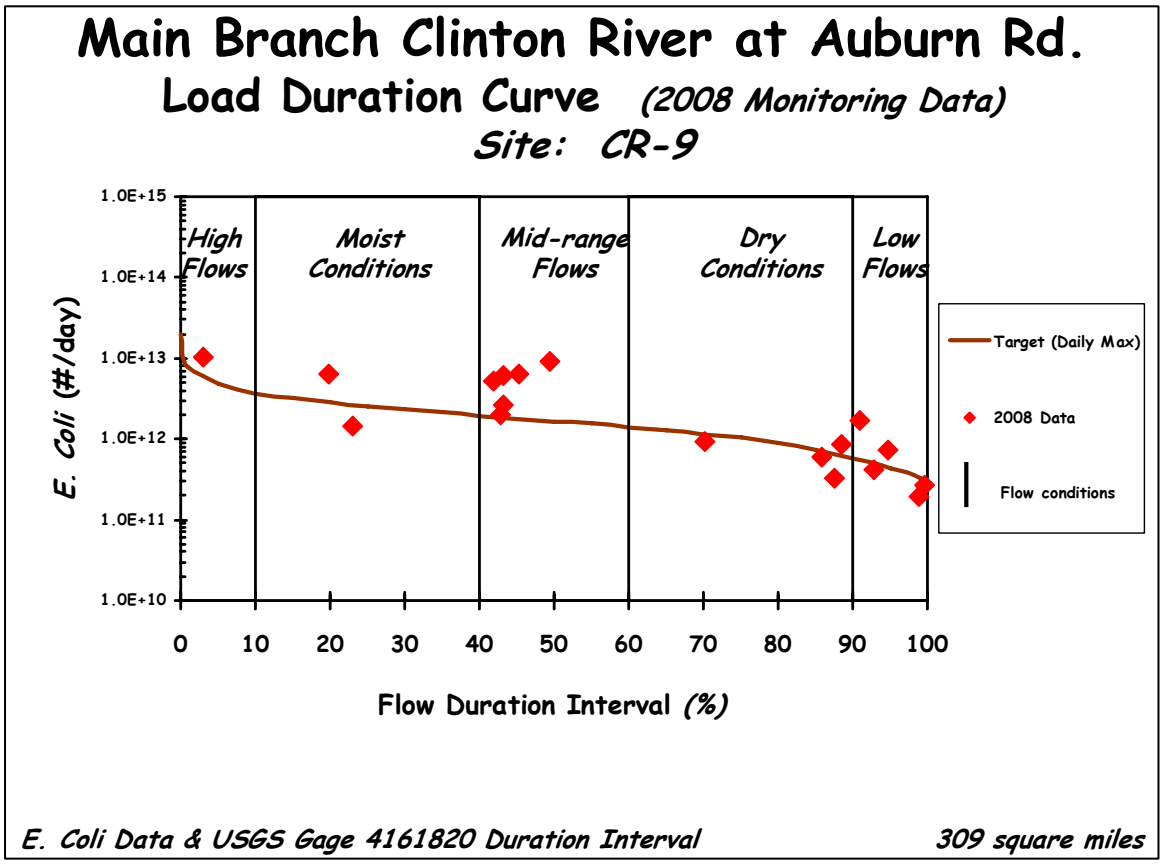
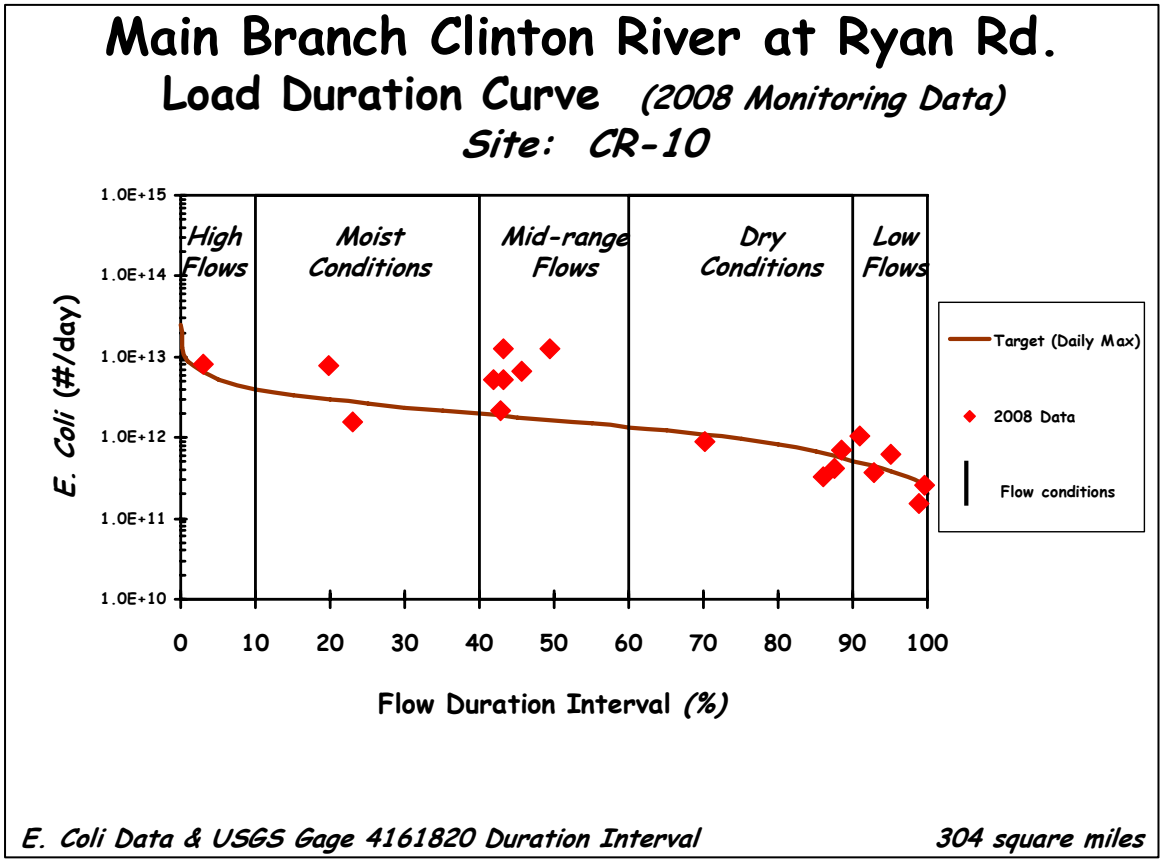




Appendix 3 cont.





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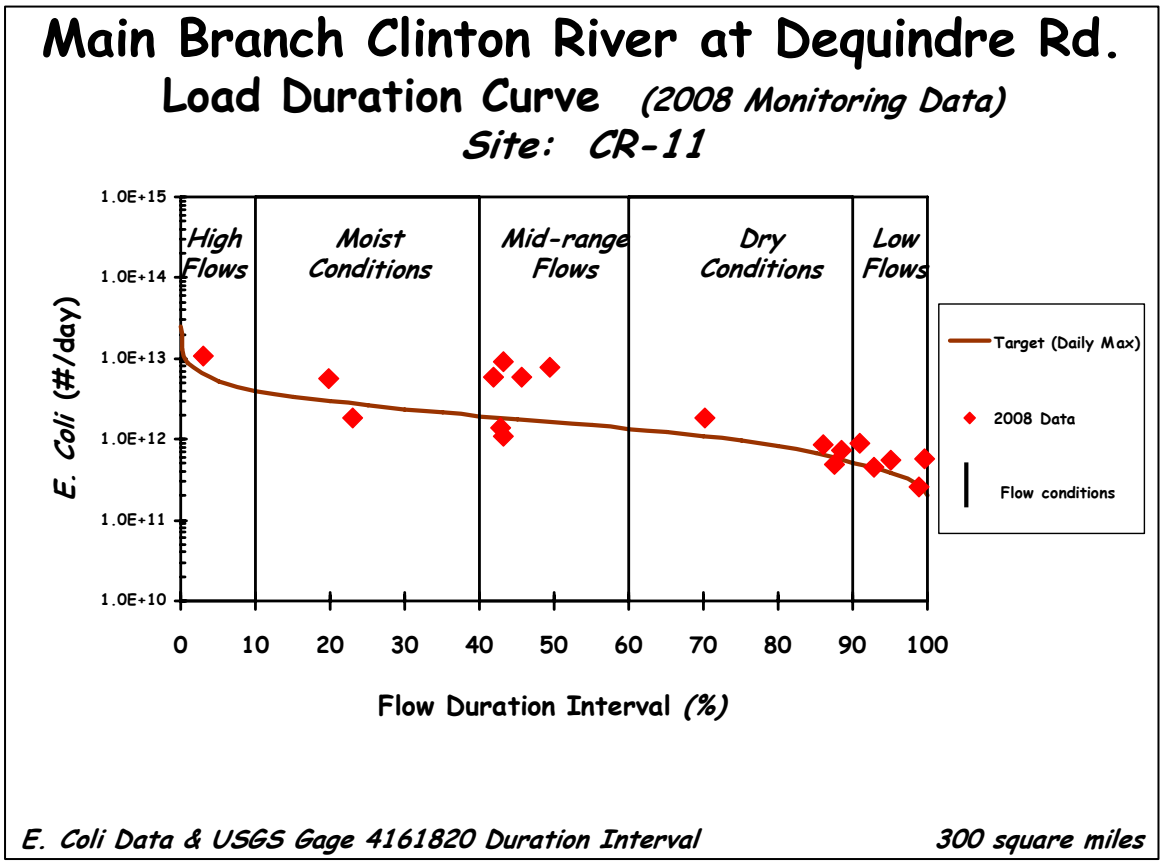

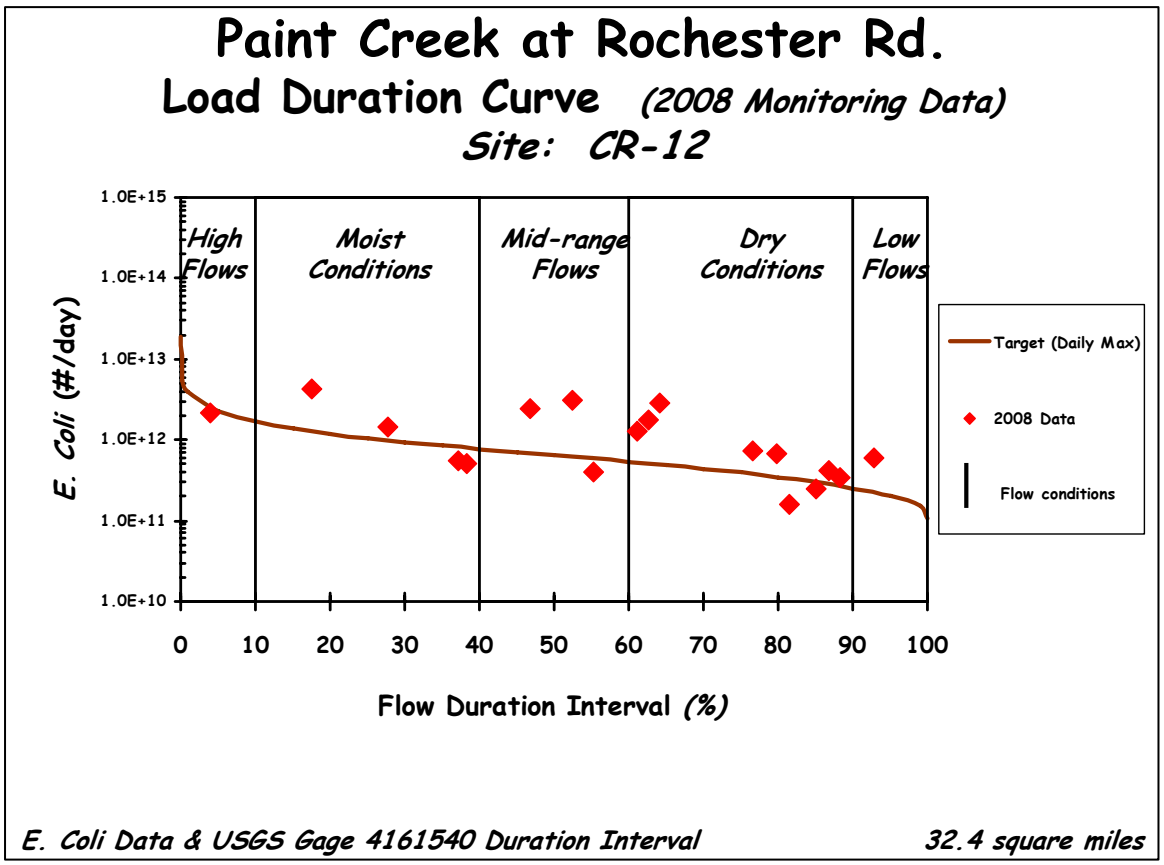

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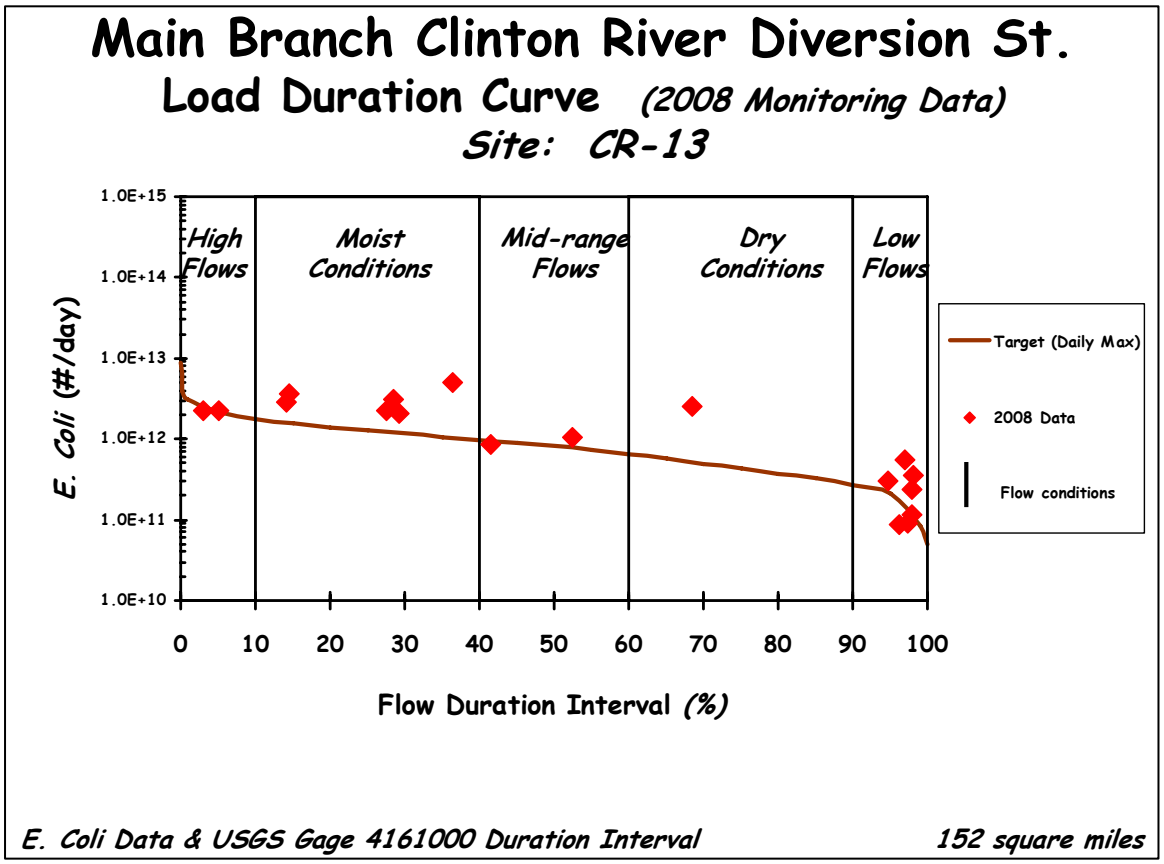
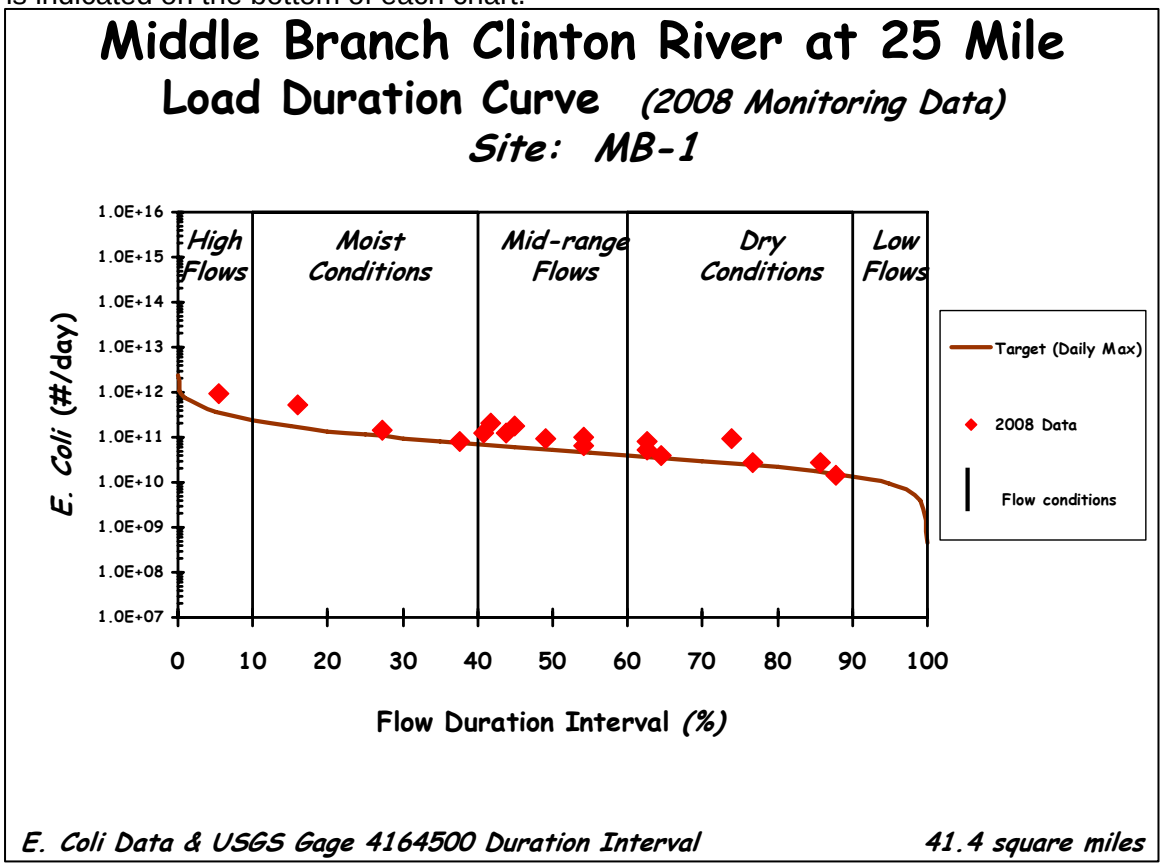
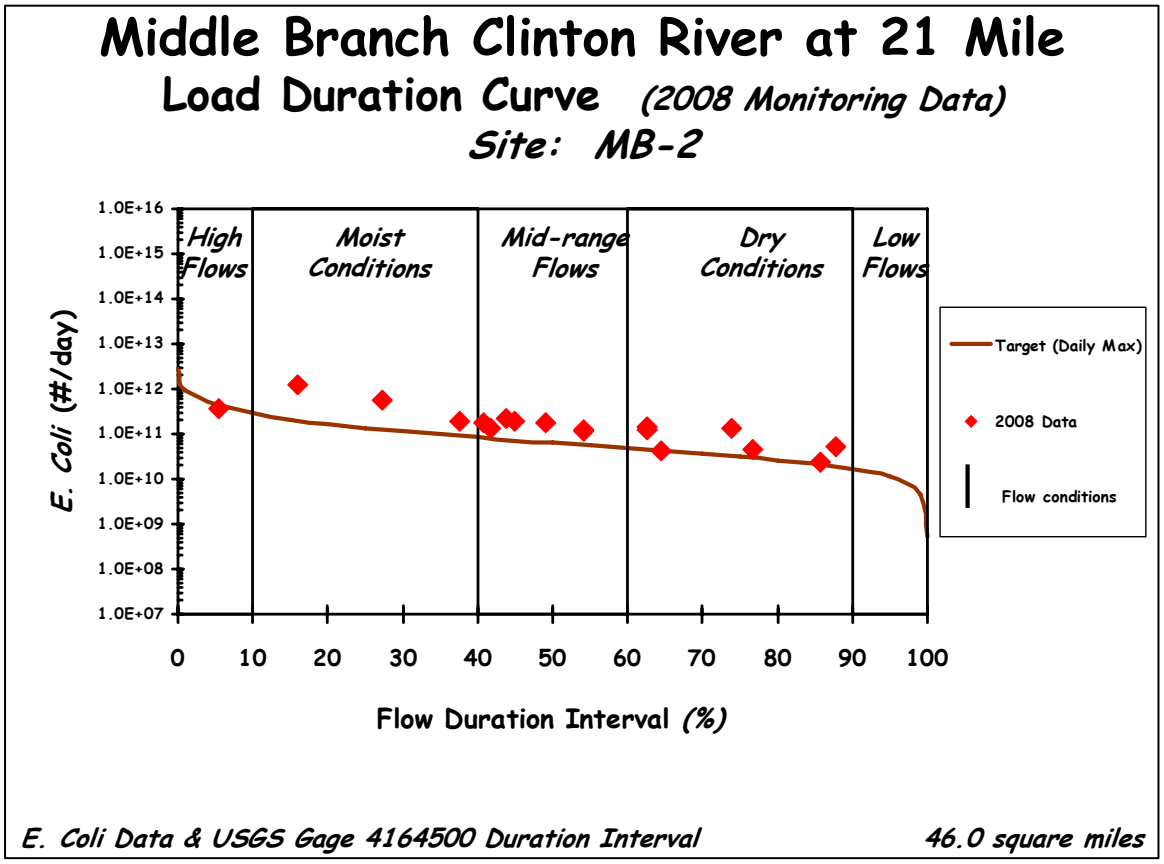


Appendix 4. Load duration curves for the Middle Branch Clinton River Stations MB1-MB4. The gage used for the correlation and the drainage area size for each drainage area ratio calculation is indicated on the bottom of each chart.





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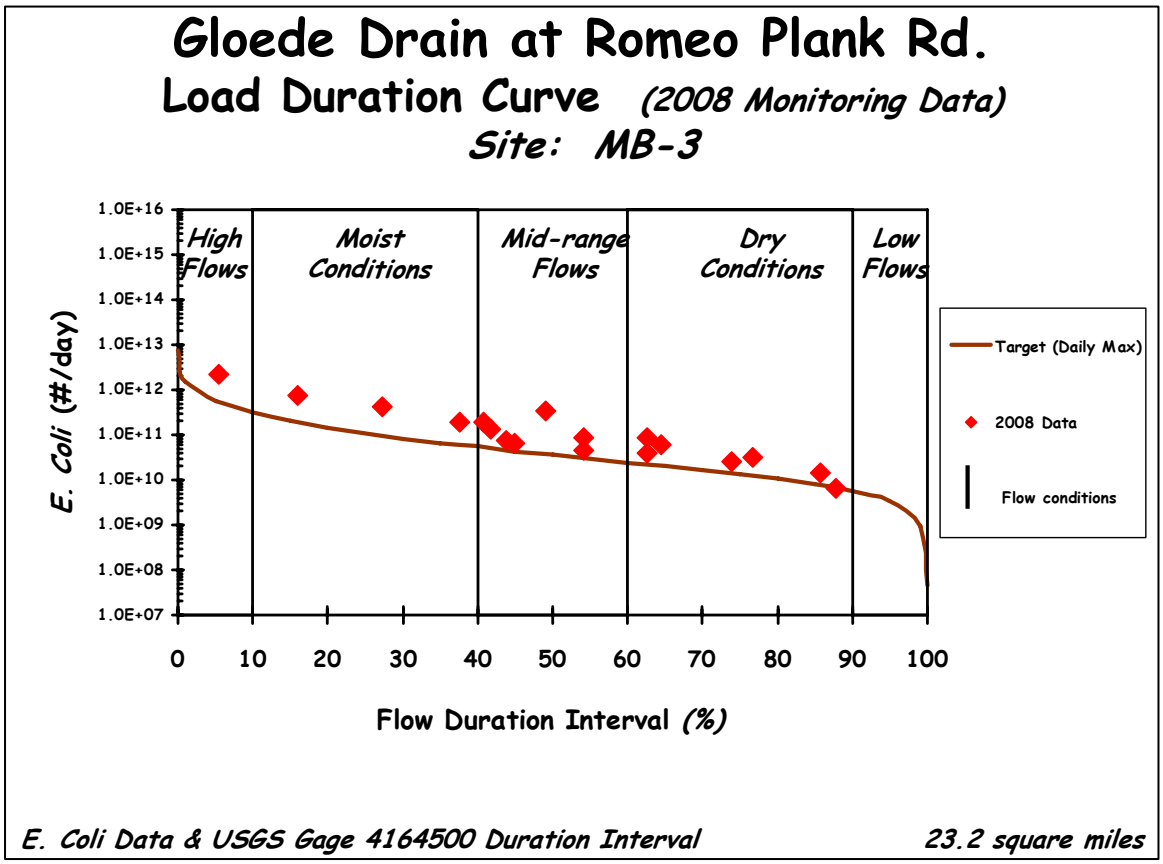
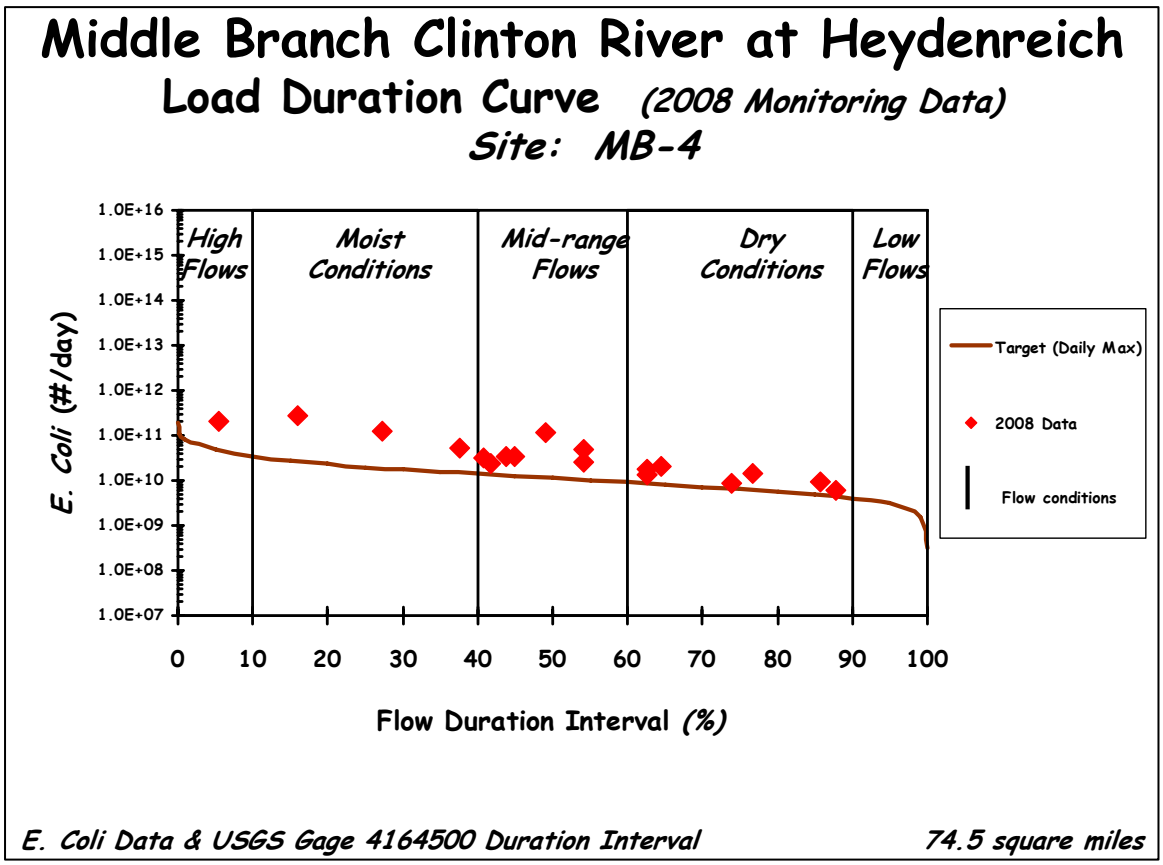
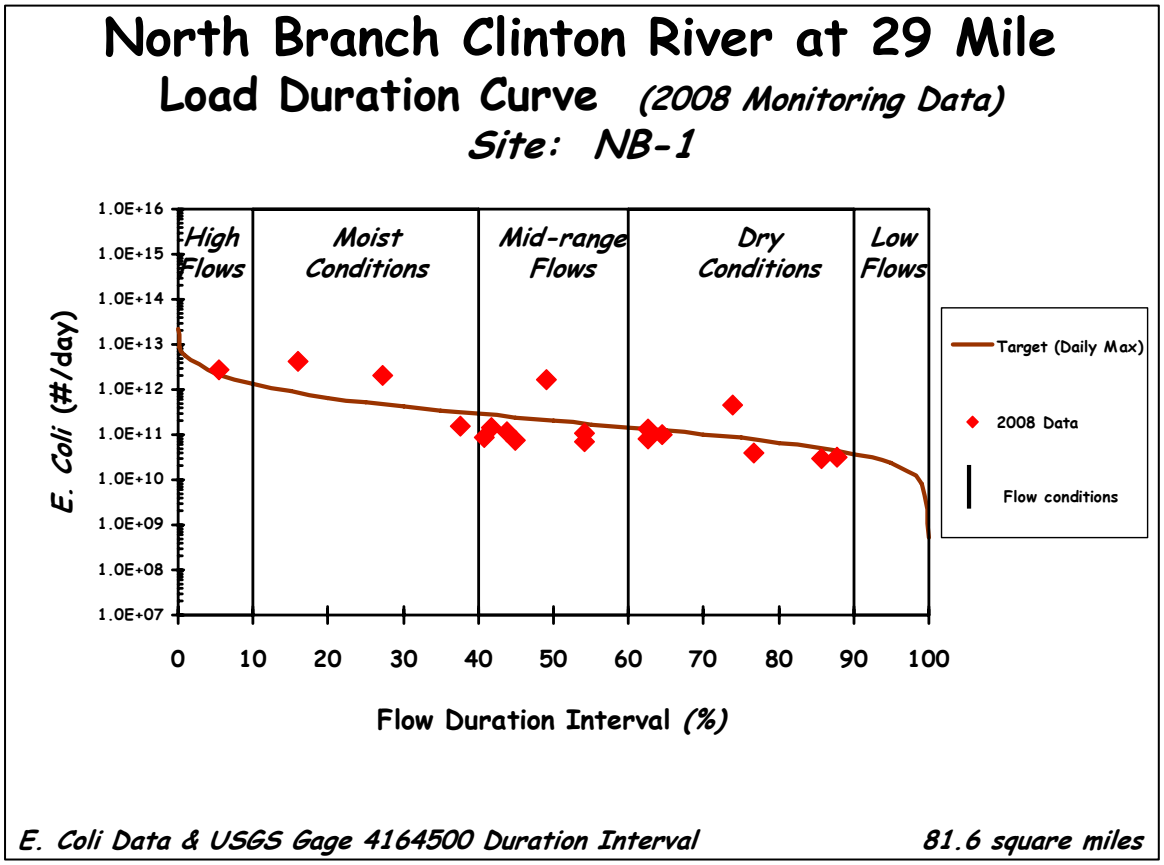
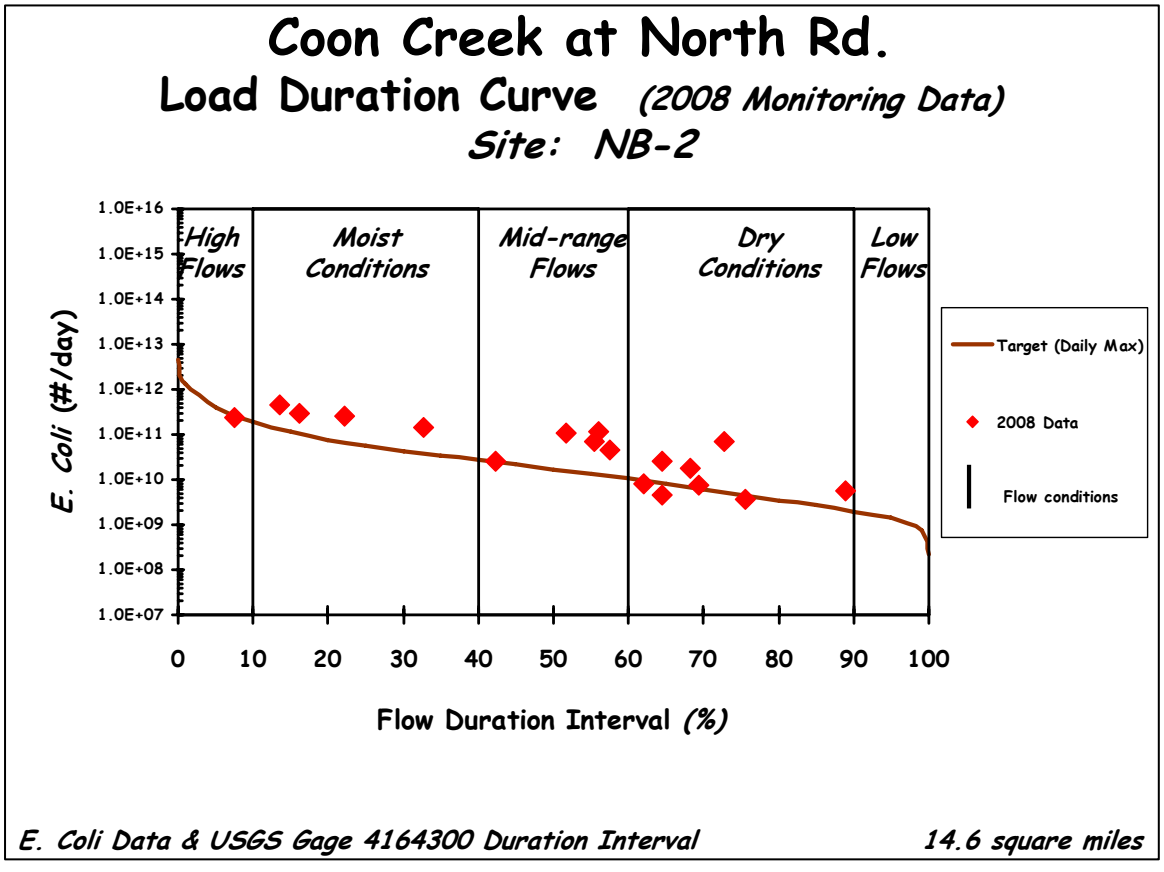




Appendix 5. Load duration curves for the North Branch Clinton River Stations NB1-NB8. The gage used for the correlation and the drainage area size for each drainage area ratio calculation is indicated on the bottom of each chart.





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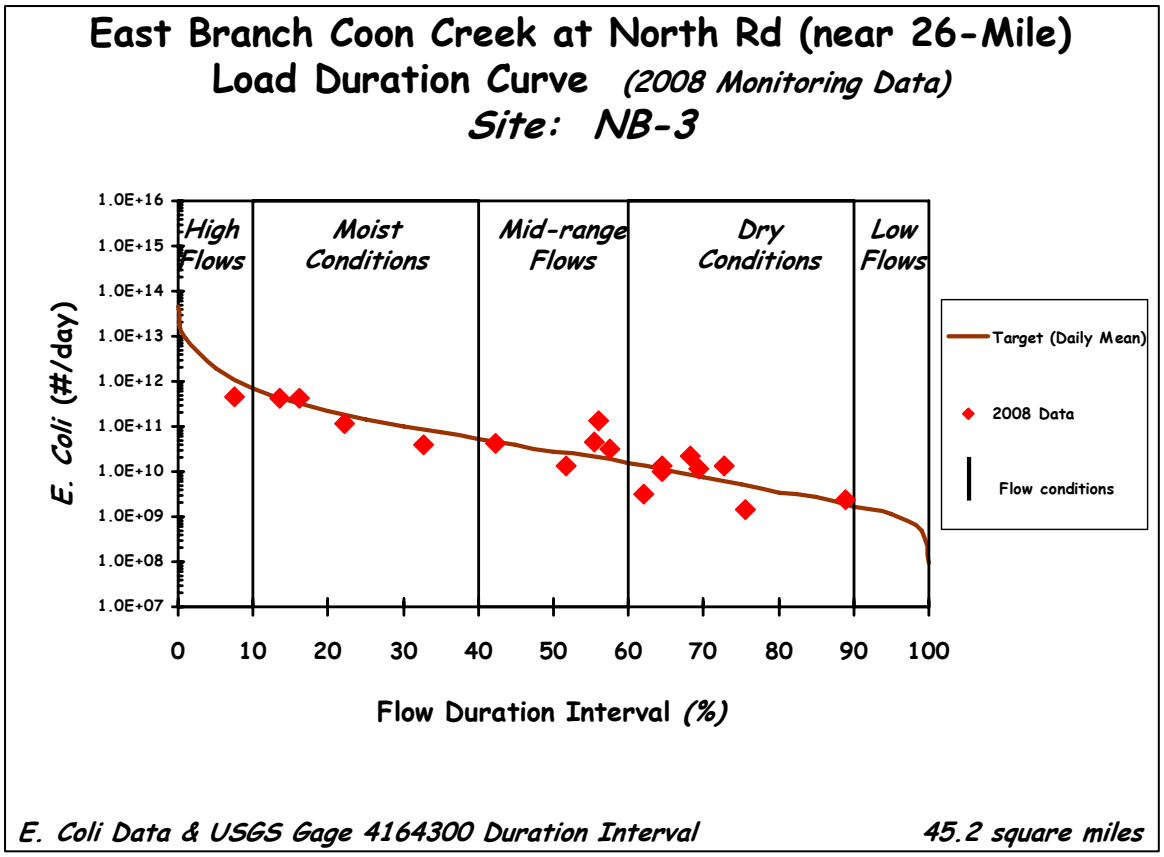

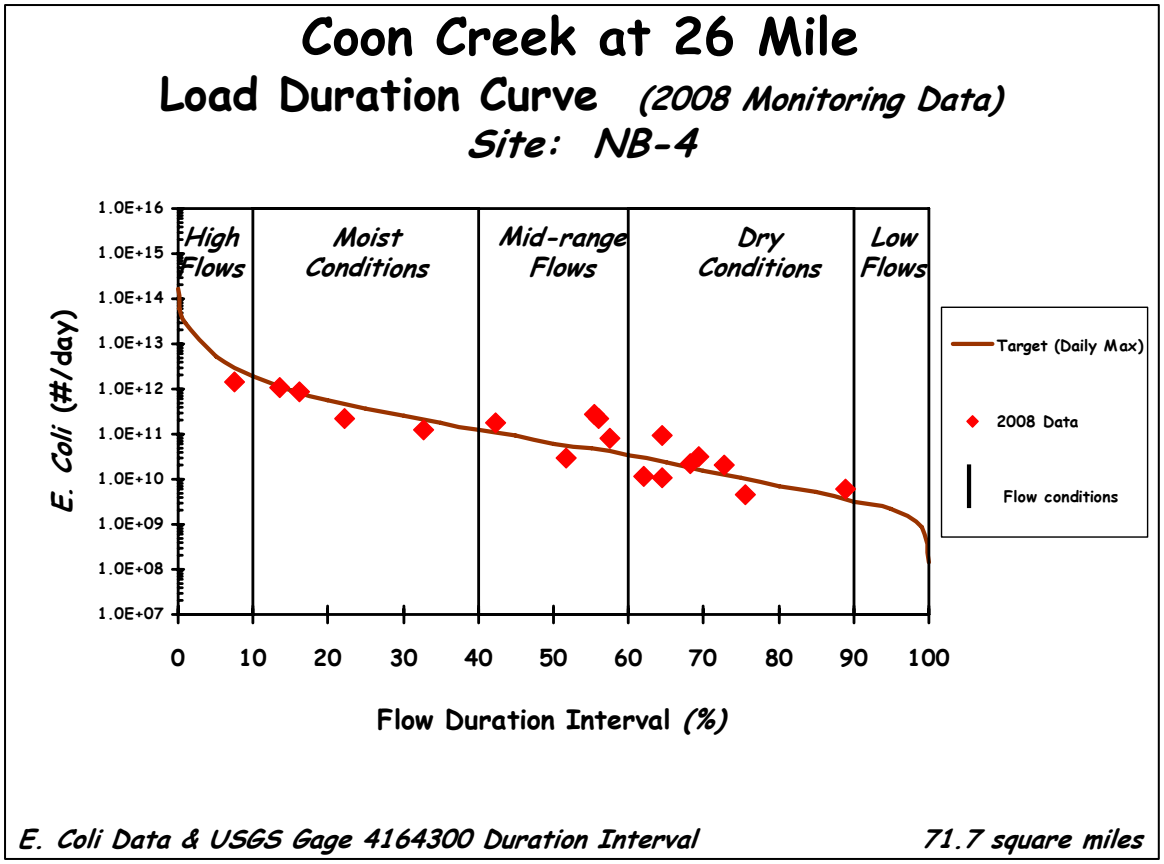

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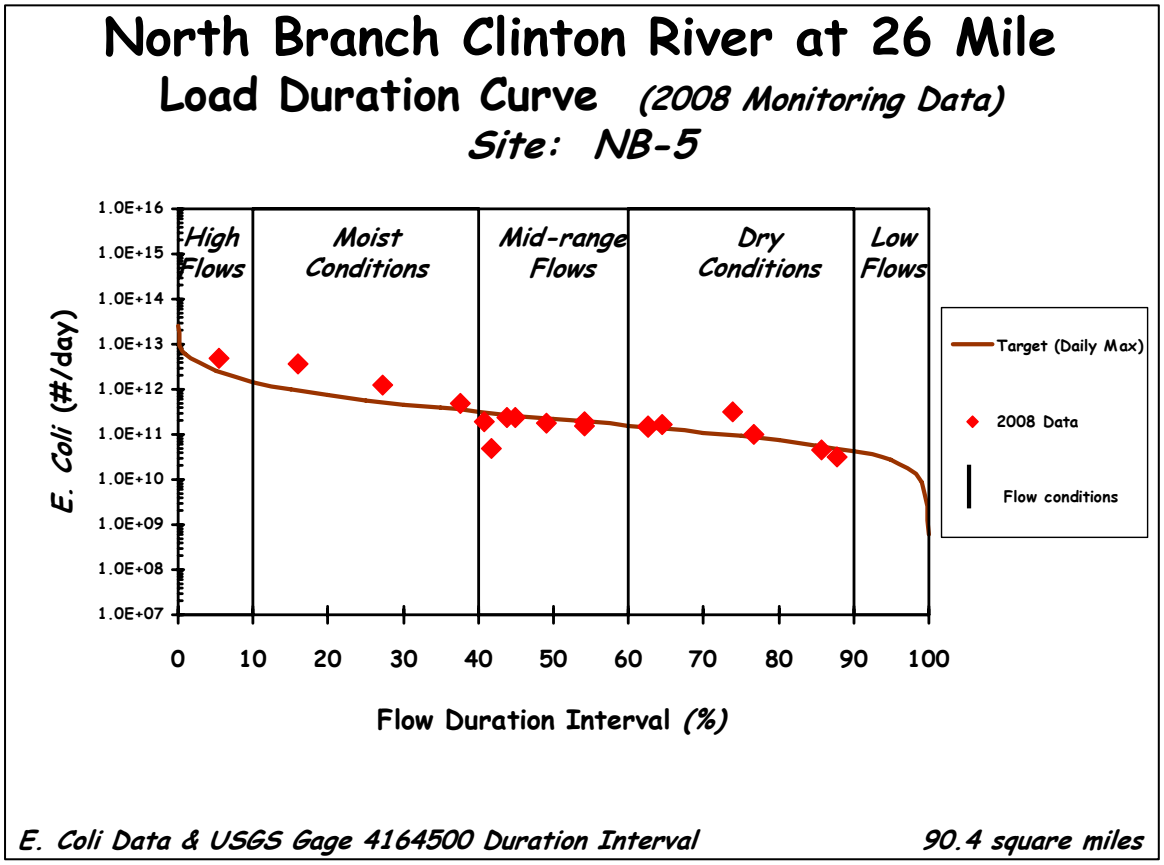

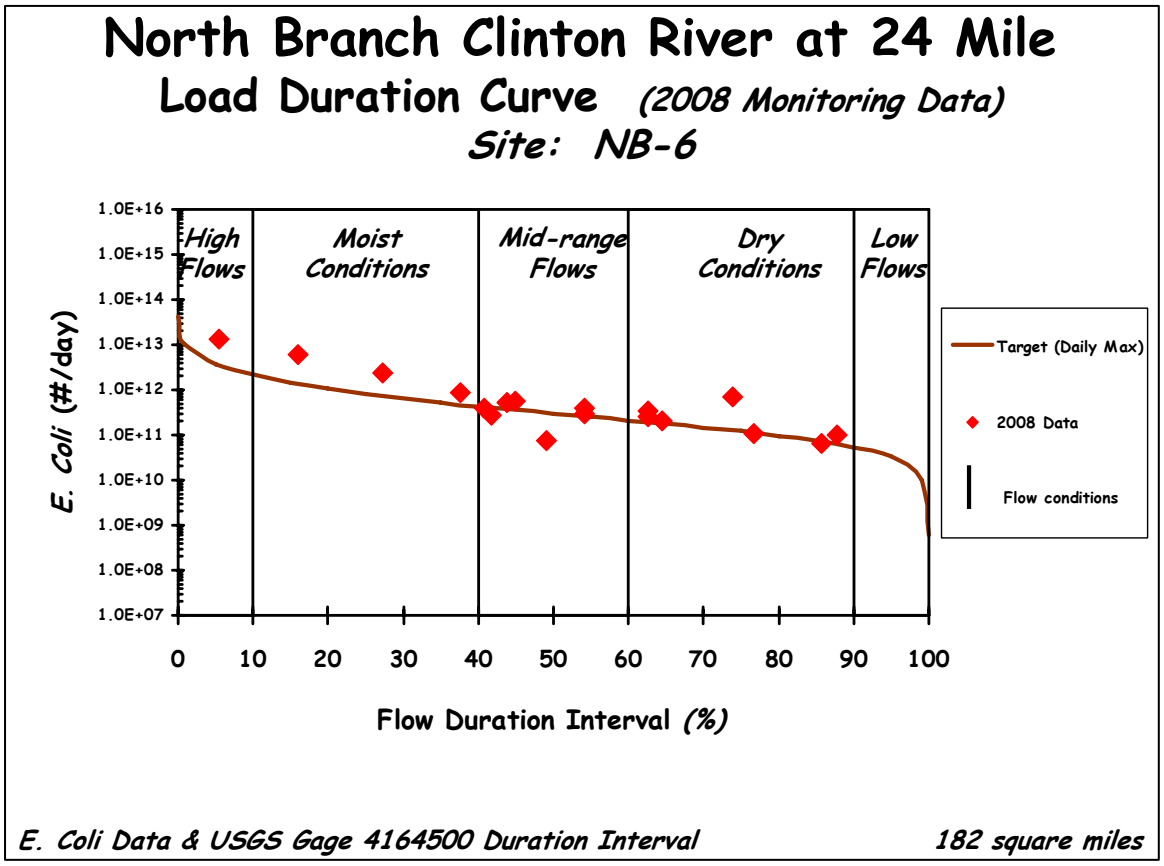

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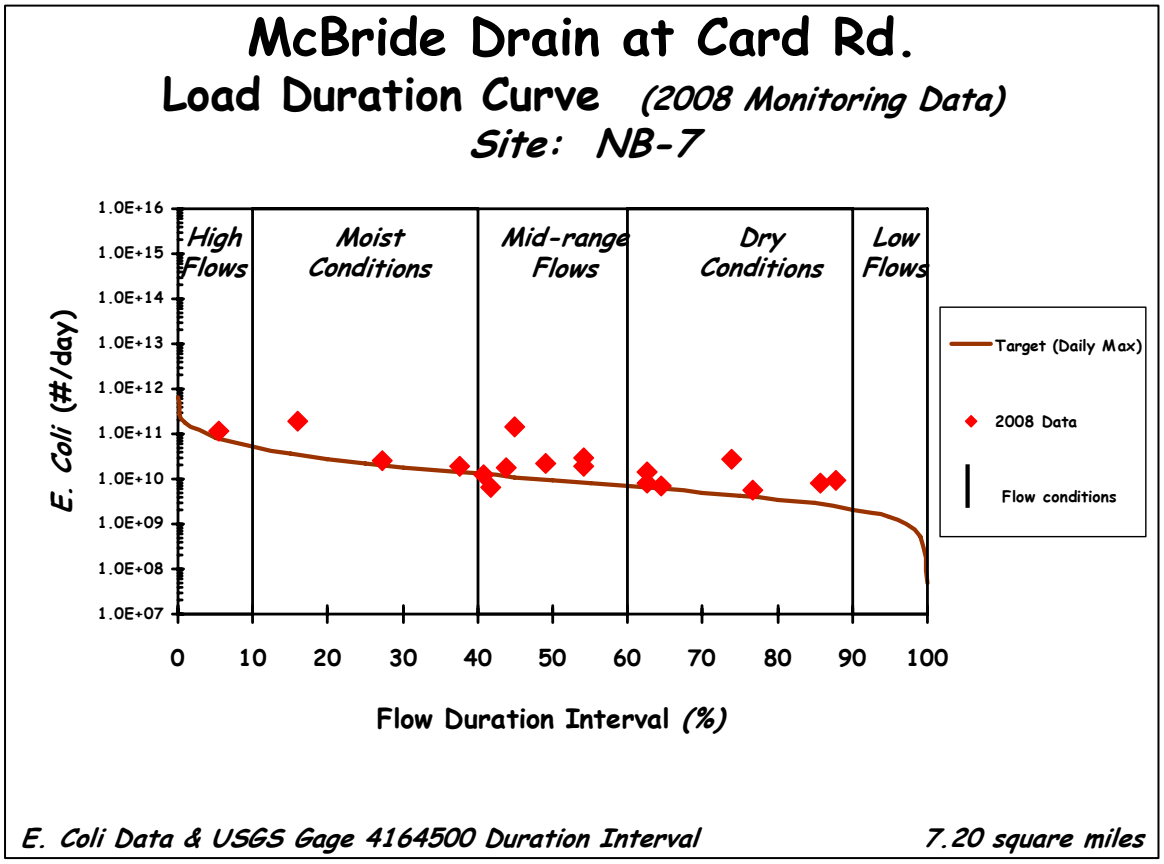
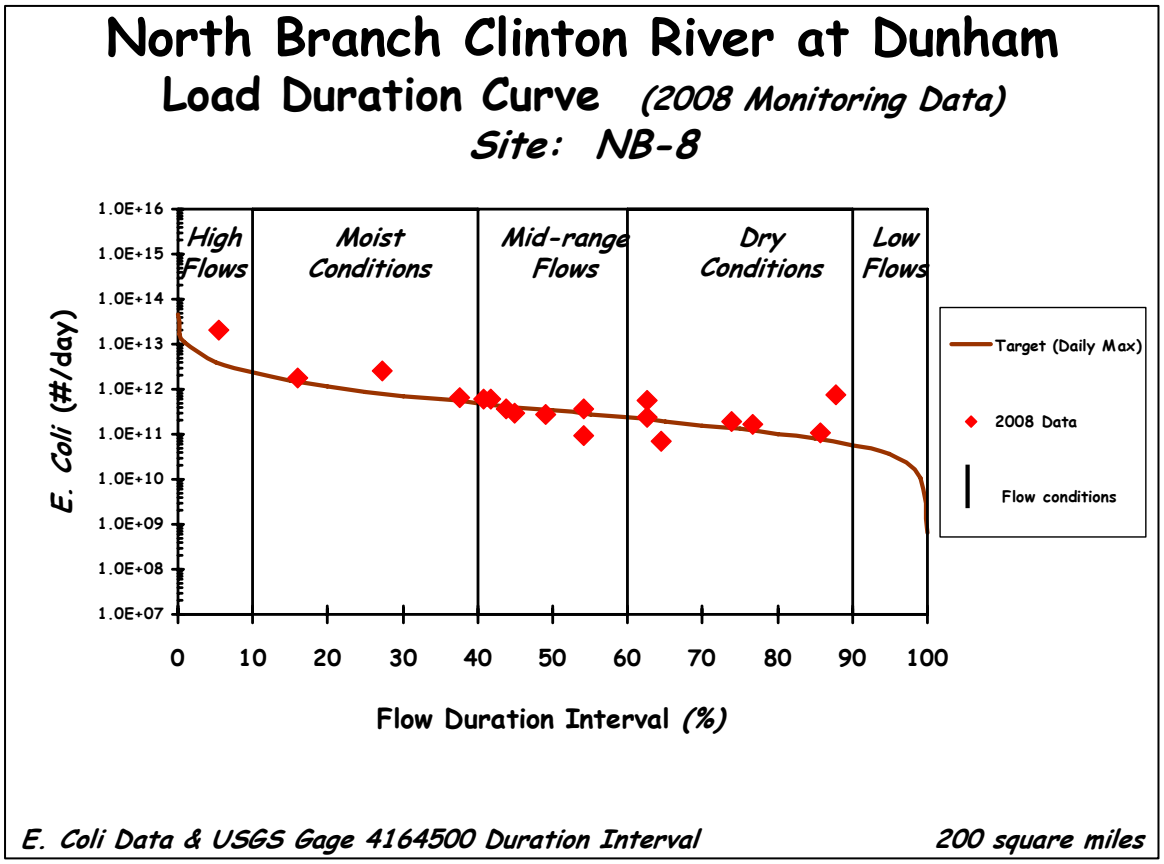
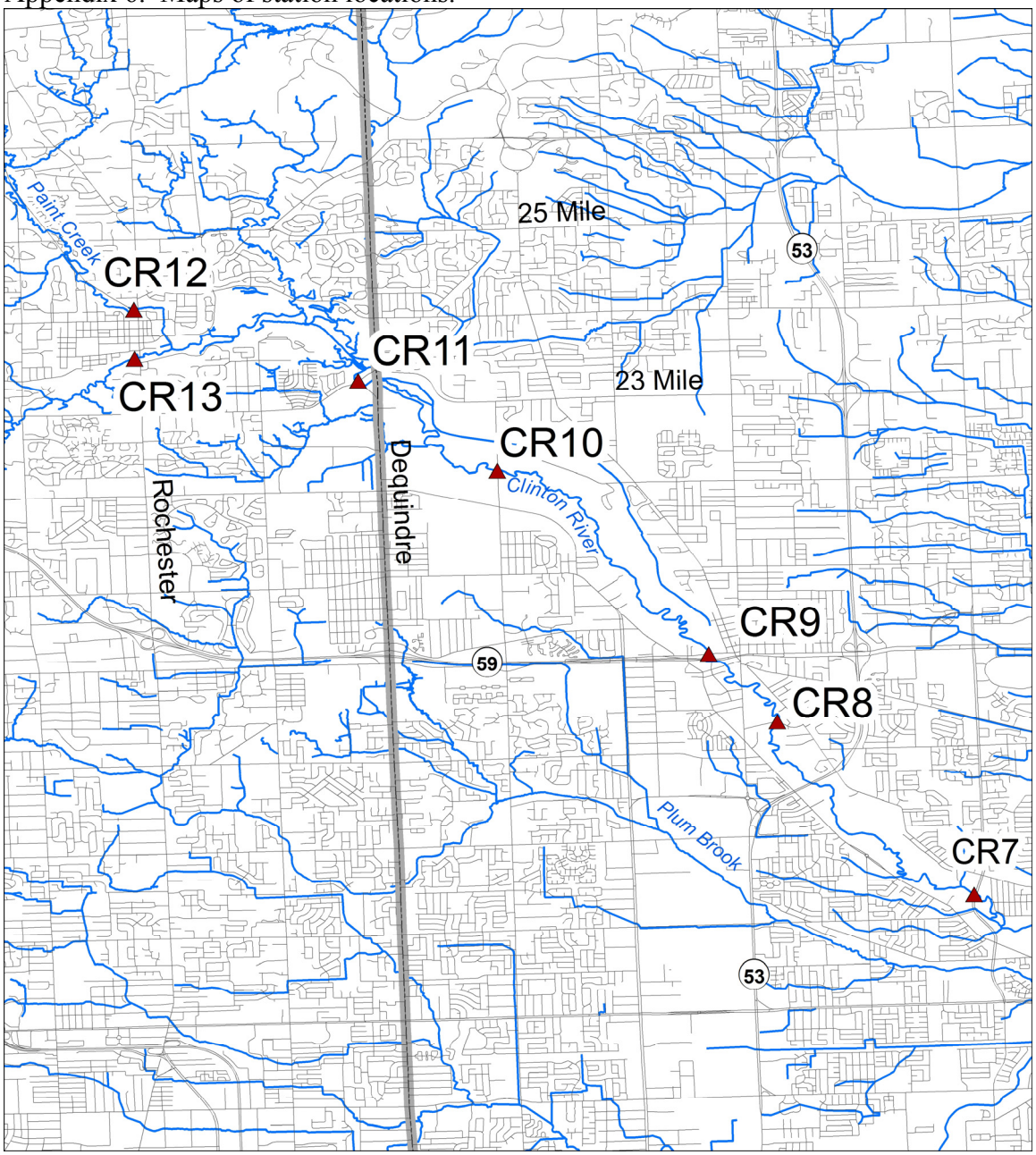




Appendix 6. Maps of station locations.



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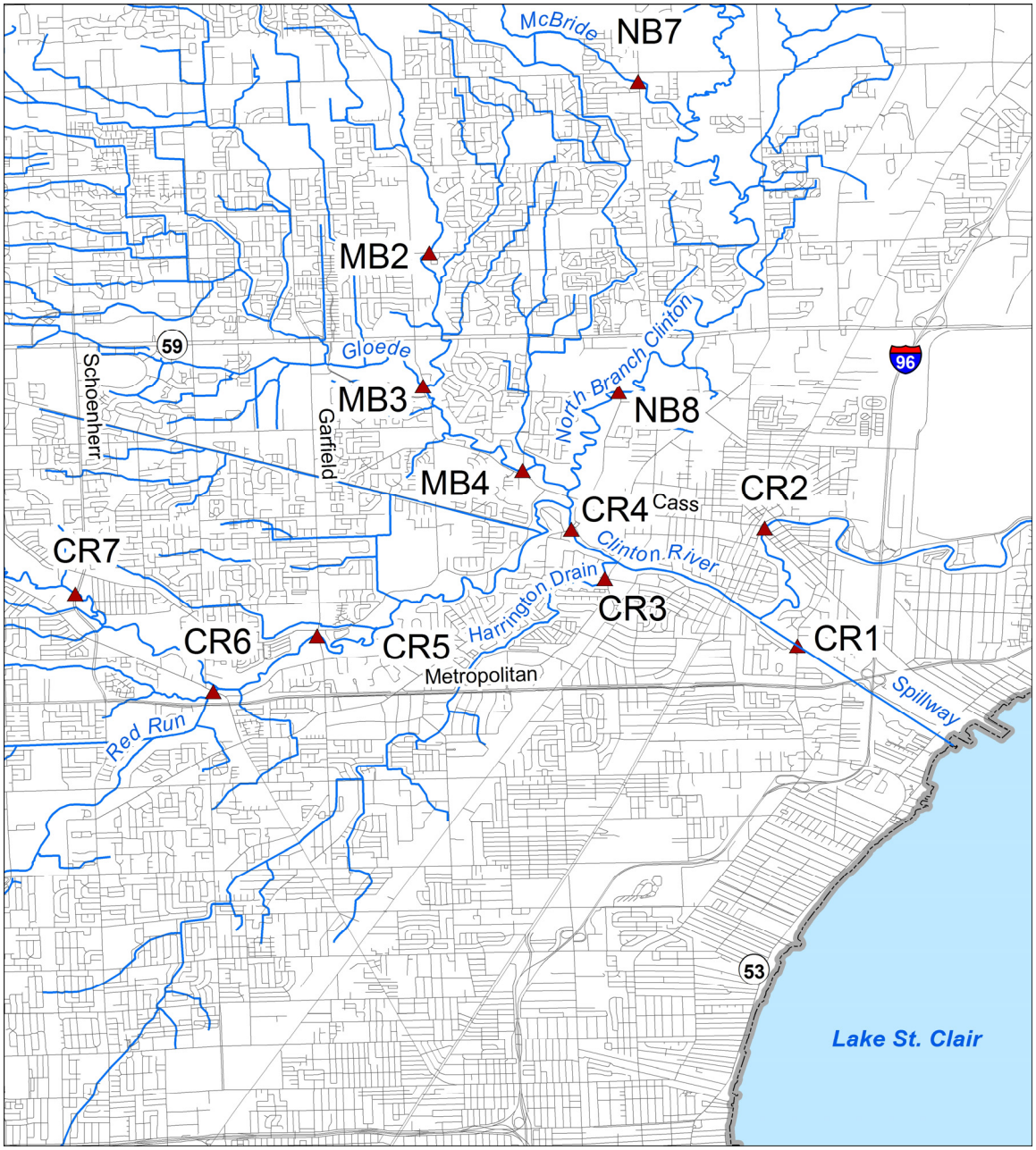

Appendix 6 cont.