Total Maximum Daily Load for *E. coli* in C.S. Mott Lake – Bluebell Beach (Impoundment of the Flint River)

Genesee and Lapeer Counties

Michigan Department of Environmental Quality
Water Resources Division
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Table of Contents

List of Tables

List of Figures

List of Appendices

1. 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 C.S. Mott Lake – Bluebell Beach, located in an impoundment of the Flint River in Genesee County, Michigan (Figure M-1).

1.1 PROBLEM STATEMENT

This TMDL addresses the assessment units (AUIDs) and listings that appear on the 2010 Section 303(d) list (LeSage and Smith, 2010 [draft]) as:

C.S. MOTT LAKE BLUEBELL BEACH **AUID**: 040802040409-05
County: Genesee SIZE: 1 M
Location: Impoundment of the Flint River.
Use impairments: Total body contact recreation.
Cause: *E. coli*
Source: Unknown.
TMDL Year(s): 2011

This TMDL also addresses the AUIDs, described in Appendix 1, proposed for inclusion on the Michigan Department of Environmental Quality's (MDEQ's) draft 2012 Section 303(d) list. Monitoring data collected by the MDEQ in 2009 for the tributaries to C.S. Mott Lake 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 1-3; Figures 1-6 and M-1). According to the MDEQ methodology for listing water bodies as impaired in the Integrated Report (LeSage and Smith, 2010 [draft]), all sites are not attaining the TBC and PBC WQS, with the exception of sites FR7 and FR8 on the mainstem Flint River. The AUIDs for C.S. Mott Lake Reservoir and Boat Ramp Beach (040802040409-08 and -06) have been included in this TMDL because *E. coli* data from C.S. Mott Lake – Bluebell Beach (040802040409-05), which is in the same water body, shows impairment and every sampled tributary to the lake was shown to be in nonattainment of the TBC and PBC WQS. The AUID containing site FR7 (040802040409-04), the furthest upstream monitored site on the Flint River mainstem, also contains Parker Scothan Drain (site FR10). The MDEQ proposes to split this AUID in the 2012 Integrated Report to reflect the finding that the Parker Scothan Drain is not attaining, and the Flint River mainstem is attaining, the WQS. This TMDL addresses both the PBC and TBC WQS impairment issues on all AUIDs listed above and in Appendix 1. The AUIDs listed above, and in Appendix 1, will be listed in the 2012 Integrated Report as Category 4a (TMDL completed) for both the PBC and TBC designated uses. The catchments containing these AUIDs are hereafter referred to as the TMDL source area.

1.2 BACKGROUND

C.S. Mott Lake – Bluebell Beach is located on the west bank of C.S. Mott Lake, an impoundment of the Flint River (hydrologic unit code: 04080204) located just north of Flint, Michigan (Figure M-1). The Flint River watershed (about 1,400 square miles in area) drains to the Saginaw River. The Saginaw River empties into Saginaw Bay (Lake Michigan), and is part of the largest watershed in Michigan.

The TMDL source area lies within the Lansing (VI.4.1.) and Lum Interlobate (VI.5.2) subsubsections of the regional Landscape Ecosystem Classification of Michigan (Albert, 1995). Lower sections of the area, including the lower portions of Butternut Creek, the Powers Cullen Drain, and tributaries that lead directly to C.S. Mott Lake, are within the Lansing subsubsection. This portion of the source area is broad till plain with rich loamy soils, which are desirable for agriculture. Topography in the Lansing subsubsection is gently rolling ground moraines, which tend to be moderately well-drained ridges with poorly-drained linear depressions between the moraines. Prior to European colonization, the lowlands were maple swamps or wet meadows. Currently, the majority of the uplands have been converted to crop production, while most of the swamps have been converted to pasture. Upper sections of Butternut Creek, near the villages of Otter Lake, are within the Lum Interlobate subsubsection. This area is characterized by end moraine surrounded by pitted sandy glacial outwash deposits, resulting in numerous kettle lakes and wetland areas. The end moraine soils are most commonly sandy loams on the ridges and therefore tend to be well drained. Drainage capacity of the outwash areas vary from well- to poorly-drained. The uplands in this area were converted to agriculture, while the steepest slopes were left as woodlots. The combination of agriculture and residential development has lead to the eutrophication of lakes and the degradation of wetlands (Albert, 1995). Hydrology has been further altered by historic and current efforts to quickly drain water from agricultural production areas via ditches.

According to 2006-Era Land Cover Data (NOAA, 2008b), the TMDL source area is 46 percent agricultural, 12 percent developed, 29 percent natural (forests and grasslands combined) and 10 percent wetland land, and 3 percent other cover types (Figure M-10).

1.3 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 2009 monitoring data indicated daily maximum TBC WQS exceedances at all sites. The PBC WQS and 30-day geometric mean, were exceeded at least once at all sites, except sites FR7 and FR8 (mainstem of the Flint River).

2. 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. The existence of multiple sources of *E. coli* to a water body result in a variety of critical conditions (e.g., high flow is the critical condition for storm water-related sources and low flow is the critical condition for dry weather sources such as illicit connections); therefore, no single critical condition is applicable for this TMDL. Expressing the TMDL as a concentration equal to the WQS ensures that the WQS will be met under all critical flow and loading conditions.

2.1 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.

2.1.a WLAs

The WLA for the facilities listed in Table 4 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 National Pollutant Discharge Elimination System (NPDES) permits included in the WLA. Certificates of Coverage (COCs) under general NPDES permits include: 7 storm water from industrial activities (MIS510000), 3 watershed-based Municipal Separate Storm Sewer Systems (MS4s) (MIG610000), 2 hydrostatic pressure test water (MIG670000), 1 discharge from a municipal potable water supply (MIG640000), and 1 storm water discharge with required monitoring (MIS520000).

2.1.b 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 (Table 5). Nine minor civil divisions have land area within the C.S. Mott Lake – Bluebell Beach TMDL source area, five of which have a land area greater than 1 percent of the source area. Minor civil divisions with less than 1 percent of the source area are not included in Table 5.

2.1.c MOS

This section addresses the incorporation of an MOS in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality, including the pollutant decay rate if applicable. The MOS can be either implicit (i.e., incorporated into the WLA or LA through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS because no rate of pollutant decay was used. Pathogen organisms ordinarily have a limited capability of surviving outside of their hosts, and therefore, a rate of pollutant decay could be developed. However, applying a rate of pollutant decay could result in an allocation that would be greater than the WQS, thus no rate of decay is applied to provide for a greater protection of water quality. The use of the TBC (130 *E. coli* per 100 mL as a 30-day geometric mean and 300 *E. coli* per 100 mL during the recreational season) and PBC (1,000 *E. coli* per 100 mL as a daily maximum the remainder of the year) WQS as a WLA and LA is a more conservative approach than developing an explicit MOS and accounts for the uncertainty in the relationship between pollutant loading and water quality, based on available data and the assumption to not use a rate of pollutant decay. Applying the WQS to be met under all flow conditions also adds to the assurance that an explicit MOS is unnecessary.

3. DATA DISCUSSION

Weekly *E. coli* data to support this TMDL were collected for 16 weeks; from May 20 to September 2, 2009. Generally, the MDEQ weekly samples were taken on Wednesdays, between 9:30 and 11:30 am. At sites FR1-FR11, single samples were collected from the left bank, center, and right bank portions of the streams. At C.S. Mott Lake – Bluebell Beach, single samples were collected weekly at five sites (ML1-ML5) along the beach where the water was approximately 3 feet deep. With the exception of the beach sites, samples were not collected from a site if the water was not flowing at the time of sampling. All samples, duplicates, and blanks were collected and analyzed according to an approved Quality Assurance Project Plan (Great Lakes Environmental Research Center and Limnotech, Inc. 2009). At sites FR1-FR11, the geometric mean of the three samples was calculated to compare with the daily maximum TBC WQS and the PBC WQS. At the beach, the samples from all five sites (ML1-ML5) were used to calculate the daily geometric mean.

The number of WQS exceedances at each sampling site and site geometric means are summarized in Table 1. *E. coli* daily geometric means and 30-day geometric means are shown in relation to precipitation events in Tables 2-3 and Figures 1-6. Site FR10, on the Parker Scothan Drain, had the greatest number of daily maximum TBC WQS exceedances of all sites, with 16 exceedances, followed by site FR2 (No Name Creek 4) with 15 exceedances, and sites FR6 (Butternut Creek) and FR9 (Powers Cullen Drain) each with 14 exceedances. The daily maximum TBC WQS was exceeded on 3 occasions at C.S. Mott Lake – Bluebell Beach site (ML1-ML5) during the sampling season. Sites FR7 (Flint River at Irish Road) and FR8 (Flint River at Genesee Road) had the fewest daily maximum TBC WQS exceedances.

Site FR2, on No Name Creek 4, had the greatest number of PBC WQS exceedances (12) of all sites in the entire TMDL source area. Bluebell Beach exceeded the PBC WQS during a large rain event on June 17, 2009, and then again on August 12, 2009, during dry weather. The majority of the sites had only periodic exceedances of the PBC WQS throughout the sampling period (Table 1).

The 30-day geometric mean TBC WQS was exceeded 100 percent of the time during the sampling period at sites FR2, FR4, FR5, FR6, FR9, and FR10 (Table 2 and Figures 4-6). Site FR1 exceeded the 30-day geometric mean TBC WQS 91 percent of the time during the sampling period. The 30-day geometric mean TBC WQS was exceeded 17 percent of the time during the sampling period at the C.S. Mott Lake – Bluebell Beach (ML1-ML5), but was not exceeded at sites FR7 and FR8 on the main stem Flint River.

Site geometric means were calculated by incorporating all the weekly data for each site into a geometric mean calculation (Table 1). Site geometric means are intended to facilitate comparison among sites and to help in the determination of priority areas, but are not to be compared with the numeric WQS. The site with the highest site geometric mean (2,793 *E. coli* per 100 mL) was FR2, located on No Name Creek 4, which discharges immediately upstream of Bluebell Beach (Figure M-1). It is notable that both sites located on the Flint River main stem (FR7 and FR8) had the lowest site geometric means, the fewest exceedances of the daily maximum TBC, and no exceedances of the 30-day geometric mean TBC or PBC WQS. Of the Flint River tributary sites (FR1-FR6 and FR9-FR11), site FR3 on No Name Creek 3 had the lowest site geometric mean and the fewest daily maximum TBC and PBC WQS exceedances.

Precipitation data for the 24-hours prior to each MDEQ sampling event were obtained from a weather site at the Flint Bishop International Airport, located in Flint, Michigan (NOAA, 2008a) (Tables 2-3 and Figures 1-3). The MDEQ weekly sampling did not target wet weather deliberately, but did correspond with three measureable rain events; May 27, 2009 (0.20 inches), June 16-17, 2009 (3.15 inches), and August 26, 2009 (0.60 inches). Each of these rain events coincided with increased concentrations of *E. coli* in samples, and likely caused wet weather exceedances of the WQS at some of the sites. The highest daily geometric mean detected in this study was 60,760 *E. coli* per 100 mL, at FR10 (Parker Scothan Drain), following the rain event of 3.15 inches on June 16-17, 2009. The precipitation event on June 16-17, 2009, produced a heavy rainfall rate beginning around 7:16 a.m. and continuing throughout sample collection, which ended at 11:35 a.m., June 17, 2009. All sites, except FR7 and FR8 on the Flint River mainstem, exceeded the PBC WQS on June 17, 2009. Given that sample collection was occurring during this runoff event, it is conceivable that any elevated *E. coli* associated with the storm flow pulse had not yet reached the two Flint River main stem sites at the time of sampling. The May 27, 2009 rain event was light, occurred approximately 6 hours prior to MDEQ sampling and did not likely produce significant amount of runoff. Site FR10 (Parker Scothan Drain) exceeded the PBC WQS on this date, but it is not clear if the rainfall from the preceding 24 hours may have caused this exceedance. The August 26, 2009 rain event produced a steady to light rain, beginning at about 6:30 a.m. on the morning of sampling. Five sites exceeded the PBC WQS after the August 26, 2009 rain event. In addition to these rain events occurring in the 24 hours preceding sampling, there were a large number of sites that exceeded the daily maximum TBC (8 sites) and PBC (5 sites) WQS on the June 10, 2009 sampling date. Precipitation records were not available from the Flint Airport on that date; however, data from Lapeer, Michigan weather site (Enviro-Weather, 2009), approximately 11 miles east of the Flint Airport, shows that two rain events occurred on June 8, 2009. The first event (0.53 inches) occurred 47 hours prior to the start of sampling, and the second (0.42 inches) occurred approximately 34 hours prior to the start of sampling.

The Genesee County Health Department (GCHD) also monitors C.S. Mott Lake – Bluebell Beach on a weekly basis, but generally sampled two days prior to the MDEQ weekly sampling. This difference in sample timing as well as differences in sampling methodology makes the GCHD and MDEQ data sets separate and distinct. There were no beach closures based on the groundwater, NPDES permitted discharges, as well as unregulated urban and rural storm water data collected by the GCHD in 2009 (TBC WQS was not exceeded).

4. SOURCE ASSESSMENT

Potential sources to the TMDL area include illicit connections, failing on-site sewage disposal systems (OSDS), agricultural operations, wildlife and pet waste, dumping of trash, contaminated runoff and storm sewers. The source assessment for the C.S. Mott Lake – Bluebell Beach TMDL includes a load duration curve analysis for each sampled site on a flowing water body (FR1-FR11), an inventory of NPDES permitted discharges, and a nonpoint source assessment, which included spatial and stressor analysis.

For the purposes of locating target areas for implementation activities and to facilitate discussion, the TMDL source area has been subdivided at two levels: individual catchments (1-43); and catchment groupings (A-M) (Figure M-2). The catchments were defined by using the catchment layer of the National Hydrography Dataset (USDA-NRCS, USGS, and USEPA, 2009), with some modifications made when the catchments were too small to be practical. The 43 catchments were then merged into 13 groupings (A-M) based on larger subwatersheds.

4.1 Load Duration Curve Analysis

To assist in determining potential sources to TMDL water bodies, the MDEQ conducted a load duration curve analysis for sites FR1-FR11 (Cleland, 2002). A load duration curve considers how stream flow conditions relate to a variety of pollutant sources (point and nonpoint sources). The load duration curves for each site show the flow conditions that occurred during sampling and can be used to make rough determinations as to what flow conditions result in exceedances of the WQS. The load duration curves for each site sampled in the C.S. Mott Lake – Bluebell Beach TMDL area are included in Appendix 2. United States Geologic Survey (USGS) gauge No. 4147500 (located on the Flint River, near Otisville, Michigan) was used to develop the load duration curves for this TMDL. A ratio of the drainage area of the site locations to the drainage area of the gauged watershed (defined as the drainage area ratio) was calculated for each of the 11 sites for this TMDL. The curves were generated by applying these drainage area ratios to gauged flows for the period of record of the gauge (57 years). The flow information used in load duration curve development was determined on each sampling date at sites FR1-FR11 by collecting water level elevation data. Water level elevation is a relative measure of water depth in the channel, determined by measuring the distance from a fixed point (such as a culvert edge) to the water's surface using a weighted tape. MDEQ hydrology staff also visited sites to collect reference flows for correlating the water level elevation data with actual gauged flows (USGS, 2007).

Exceedances of the *E. coli* WQS 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 OSDS are too close to surface waters or in areas where livestock or animal waste is allowed to accumulate in close proximity to surface waters. According to the load duration curves, low flow conditions were not well represented during the 2009 sampling period.
Load duration curves indicate that exceedances were common at sites FR2, FR4-FR6, and FR9-FR10 across all conditions sampled (high flows to dry conditions); therefore, indicating that dry and wet weather sources are present. In particular, the load duration curves analyses at these sites indicate that illicit connections or failing OSDS (or some other constant source of *E. coli*) are present in catchment groupings D, F, I, J, and L, and individual catchment 33 (within grouping C), upstream of the sampled sites. Load Duration Curves from the remaining sites (FR1, FR3, FR7, FR8, and FR11) indicate that exceedances occur most often associated with wet weather (high flows), indicating that *E. coli* concentrations within individual catchments 31, 37, and 38, and the mainstem Flint River (FR7 and FR8), are mainly affected by wet weather sources.

4.2 NPDES Discharges

There are 18 NPDES permitted facilities discharging within the TMDL source area (Table 4 and Figure M-3). Treated sanitary discharges (Otisville, Orchard Cove, and Otter Lake Wastewater Treatment Plants [WWTPs]) are not expected to contribute to exceedances of the WQS because they are subject to strict permit limitations and disinfection. There are no combined sewer overflow facilities or outfalls, or chronic sanitary sewer overflow issues within the TMDL source area. Illicit connections to the storm sewers regulated under MS4 permits (Genesee County, Genesee Township, Mount Morris Township, and Michigan Department of

Transportation [MDOT]) are a potential source of *E. coli* to the source area. MS4 outfall and storm drain spatial data were provided by Genesee County and are incorporated into Figure M-3 for informational purposes (data accessed in March and May 2011). State roads covered under the MDOT MS4 permit, which may discharge to the TMDL source area include Vienna Road, State Road, Dort Highway, and I-475 (Figure M-1). The discharge of storm water that contains *E. coli* in quantities that exceed the WQS is prohibited by the Industrial Storm Water General permits (MIS510000 and MIS520000); however, all regulated storm water can be contaminated by a flush of waste from pets, feral animals, wildlife attracted by human habitation (such as raccoons), and improperly disposed of garbage (such as diapers or cat litter). Because landfills may attract undesirable wildlife such as raccoons and seagulls, the Richfield Landfill (MIS510282), which discharges storm water to the Parker Scothan Drain (individual catchment 14, grouping J), may be a potentially significant source of *E. coli* to the TMDL area. The highest wet weather *E. coli* concentration recorded in the 2009 *E. coli* sampling was downstream of the Richfield Landfill, at sampling site FR10, on the Parker Scothan Drain, and may indicate contamination issues at this facility. It is not expected that hydrostatic pressure test water and municipal potable water supply discharges listed in Table 4 would be a source of *E. coli* due to the nature of the discharges and because the discharge of this contaminant is prohibited by the permit.

4.3 Nonpoint Sources

Nonpoint sources of *E. coli* contamination include any source that is not regulated by an NPDES permit, including failing OSDS, unregulated storm water, livestock, manure applications to agricultural fields, and pet and wildlife waste.

Unregulated storm water includes storm runoff from rural areas from all land cover types, including agriculture and natural land covers, as well as storm water from storm sewers located in Otisville, Otter Lake, and other residential developments (subdivisions). Unregulated storm water can be contaminated by the same potential sources as regulated storm water (see Section 4.2). As the amount of developed land in a watershed increases, the amount of impervious surfaces also increases. Impervious surfaces, such as roads and rooftops, do not allow stormwater to infiltrate the ground, and thus increases runoff. The risk of surface water contamination increases as the amount of runoff increases, because the capture of pollutants by infiltration is lessened or eliminated prior to the discharge of the runoff into a surface water. Higher concentrations of pathogens are associated with increased relative cover of developed and urbanized land cover (Schoonover and Lockaby, 2006). The pets, livestock, or wildlife that may be contaminating surface water vary by the state of urban or rural development present. Generally, a significant contributor to urban storm water contamination is pet waste. According to the American Veterinary Medical Association (2007) an average of 37.2 percent of households own dogs, and households with dogs have an average of 1.7 dogs. Given these statistics, and the occupied housing unit data from the 2010 U.S. Census, the dog population in the source area is an estimated 4,880 (Table 8). An estimate of cat ownership was not conducted for this TMDL, due to the limitations on cat ownership statistics available. Cats, unlike dogs, can defecate in litter boxes indoors, in which case their feces may be disposed of in a landfill, making the numbers of cat ownership more unreliable in association with *E. coli* contamination. However, feral and outdoor cats and dogs are a potential source to this TMDL water body and should be considered in any effort to reduce contamination by encouraging people to clean up after their pets.

There are several areas with a high density of human population in the TMDL source area (see Figure M-8) including: housing developments located in Section 2 (catchments 18 and 23) and Section 14 (catchment 32) of Genesee Township, and Section 27 of Richfield Township (catchment 35). Sections 32 and 37 of Richfield Township (catchments 35 and 39) contain a substantial amount of developed land, which is adjacent to tributaries of the Powers Cullen Drain (grouping L). All of the above mentioned housing developments are served by sanitary sewers, but runoff and storm sewer issues remain a potential threat to water quality. Nonpoint sources from these high population density areas in Richfield Township (catchments 35 and 39) are likely sources for the wet weather exceedances noted in the Powers Cullen Drain (site FR9). Given the high density of human population in this area, illicit connections (either to storm sewers or direct to water bodies) and failing OSDS in unsewered areas are potential sources for the dry weather exceedances to the Powers Cullen Drain.

In rural areas, livestock are a more likely source of contamination to stormwater. Agriculture, including hay/pasture, can cause bacterial contamination in streams and accounts for approximately 46 percent of the land use in the entire TMDL source area and as much as 87 percent of the land area in individual catchments (Table 8, Figure M-10). Runoff and discharges from artificial drainage, such as tiles, from pastureland and the land application of manure to cultivated land are sources of *E. coli* to surface waters (Abu-Ashour and Lee, 2000). Many factors affect the amount of *E. coli* transported from fields when manure is land applied or deposited by grazing animals; 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).

Manure applications on no-till, tile drained fields may pose an especially high risk of surface water contamination by *E. coli*, given that fissures in the natural soil structure can provide a relatively unimpeded pathway for contaminated water to reach tiles, then surface water, without the benefits of filtration through soil or riparian buffer strips (Shipitalo and Gibbs, 2000 and Cook and Baker, 2001). Throughout the entire Midwest, approximately 20 percent of all agricultural lands are tile drained (Zucker and Brown, 1998). Subsurface drainage tiles reduce the amount of surface runoff up to 45 percent (Busman and Sands, 2002), but reroute precipitation through the soil vadose zone (3- to 5-feet depth) and into a permeable tile, which then routes directly to surface water bypassing buffer strips. In fields where water infiltration rates are slow due to already saturated conditions or poorly drained soil types, runoff can be enhanced, causing sheet-flow of contaminated storm water if manure has been applied. The end result in a field with poorly drained soil types, either tiled or not tiled, is an increased risk of contaminated storm water to a surface water body if manure is applied prior to rainfall.

The MDEQ has identified several Animal Feeding Operations (AFOs) that appear to be medium (12 to 50 livestock animals) to large (50+ livestock animals) in size, and therefore, are potential nonpoint sources of *E. coli* to the TMDL source area. Of these, Niec Farm and Southview Farm deserve particular attention due to their proximity adjacent to water bodies. Niec Farm (ID=4; Table 6 and Figure M-9), located on Wilson Road near the Belsay intersection (Catchment 9) was close in proximity to a tributary to Butternut Creek, and the pasture was sloped toward the creek, making this cattle operation a likely source of *E. coli* by direct runoff. Large cattle operations will generally spread manure in the early spring and late fall on fields available to them for land application as near as possible to their operations. Manure spreading resulting from Niec Farm, and several other large cattle/dairy operations in and near the source area, are a likely source of *E. coli*. Southview Farm (ID=17; Table 6 and Figure M-9), a horse farm located on East Mt. Morris Road near the intersection of Barkley Road (Catchment 21), is situated with pastures sloping to a tributary upstream of site FR5 and is a likely source of *E. coli* during wet weather events. Manure stockpile practices of the Southview Farm are not known, but given that this horse operation is located near Kurtz Drain (upstream of site FR5), it is likely contributing to wet weather exceedances noted at site FR5 (Load Duration Curve for site FR5, Appendix 2). Based on the land cover analysis (Table 7 and 8) and locations of identified livestock farms, manure from livestock or manure kept near streams or land applied is a likely a significant source to sites FR5, FR6, and FR10.

OSDS are used to provide treatment of sanitary waste when a building is not connected to sanitary sewers. OSDS treat sewage by settling out solids, which are pumped and disposed of at licensed facilities, allowing liquid waste to percolate downward in the septic field. This downward percolation provides both filtration and time for natural processes to treat the waste. When the septic field does not allow downward percolation because soil or water-table characteristics inhibit movement, OSDS do not provide proper treatment and pose a contamination risk to either groundwater, surface water, or both. Failing OSDS and illicit connections to water bodies are considered a potential source in all catchments and sampled sites. The *E. coli* data from site FR2 on No Name Creek 4 was consistently exceeding the daily maximum TBC and PBC WQS in all weather conditions, suggesting illicit connections as a source (see Load Duration Curve for site FR2, Appendix 2). Further investigation found several illicit connections from residences upstream of site FR2 (see Reasonable Assurance Section 5.2, regarding illicit connections in Catchment 33 – No Name Creek 4).

4.4 Spatial Analysis

A spatial analysis of each individual catchment was conducted in order to characterize the potential sources that may contribute to *E. coli* WQS exceedances. The land cover, soil characteristics, and human habitation patterns in each catchment all may indicate potential sources and conditions unique to each catchment and can be used to aid source assessment.

Coastal Change Analysis Program 2006-Era Land Cover Data (NOAA, 2008b) characterizes an area by land cover type (i.e., cultivated land, hay/pasture, developed land). Each land cover type has potential sources of *E. coli* particular to that land cover type (i.e., cultivated land may have livestock manure applied to it, but developed land likely does not). The 2006-Era Land Cover Data dataset is a raster dataset made up of a 30-square meter (1/4-acre) grid with an 85 percent accuracy rate. A 15 percent error is expected with an 85 percent accuracy rate. In areas where development of agricultural lands has occurred between 2006 and the present (2011), land cover data may be out of date. However, this is the most up-to-date land cover data available. The 2006-Era Land Cover Data was edited within the catchment grouping L (Powers Cullen Drain), to match digital ortho photoquads dated 2005, to reflect recent urban development in that area. Results of the land cover analysis can be found in Table 7 at the catchment grouping level, and Table 8 at the individual catchment level.

The Soil Survey Geographic (SSURGO) Database was used to obtain the drainage characteristics of soils in the TMDL source area (USDA-NRCS, 2011). Soil drainage characteristics can have a significant effect on the quantity of runoff and infiltration, both of which can effect *E. coli* contamination of surface waters. Within the SSURGO dataset, mapped soil units are further broken down into more specific soil components, which are based on multiple additional soil characteristics (such as drainage capacity). As a result, some map units have many different soil characteristics that have been aggregated by soil survey staff to facilitate mapping. The resulting table, Mapunit Aggregated Attribute, was used for the spatial analysis, which is the basis for the stressor analysis.

High human population and high density housing either near a water body or connected to a surface water body by storm sewers, poses a significant *E. coli* contamination risk. The increased risk of contamination originates from storm water contamination issues (discussed above), illicit connections to storm sewers or water bodies, and failing OSDS. Occupied housing units and population data from the 2010 Census at the census block level were used to calculate the number of occupied housing units, population numbers, and density (Table 8).

4.5 Stressor Analysis

In order for stakeholders to prioritize actions within the TMDL source area, and to further define nonpoint sources of *E. coli*, a stressor analysis was completed using the results of spatial analyses. Stressors are defined as a set of physical conditions, which would increase the likelihood of *E. coli* contamination to surface waters. For ease of discussion, the 10 stressors selected for this analysis were divided into urban and rural categories.

The urban stressors for each individual catchment include the following stressors:

- Road density.
- Percent cover of developed land served by sanitary sewers.
- Occupied housing units.
- Human population density.
- Total human population.

The rural stressors for each individual catchment include the following stressors:

- Number of AFOs.
- Percent cover of agricultural land.
- Percent cover of agricultural land with poor drainage.
- Percent cover of developed land with no sanitary sewers.
- Percent cover of soils with poor OSDS absorption characteristics.

For each stressor, the catchment data (e.g., human population or percent land cover) was ranked and divided into the first through fourth quartiles (the first quartile contains the catchments with the bottom 25 percent of the data, the second quartile contains the catchments in the 25th through 50th percentile, etc.). The quartile to which each catchment belongs (first through fourth) was translated into the stressor score (1 through 4), with 4 being the highest environmental stress score for each stressor variable. For each catchment, the stressor scores were then summed to calculate an urban stressor score (5 through 20), a rural stressor score (5 through 20), and the overall stressor score, combining all urban and rural stressors (10 through 40). The methods for calculating the stressors, and the results, are described in detail in Sections 4.5.a through 4.5.f. The results of stressor scoring are shown in Figure M-13 and Table 8, and discussed in Section 6.

4.5.a Urban Stressors: Road Density

Road density was used as an indicator of the area of impervious surface and urban development for the stressor analysis. Impervious surface area is not equivalent or directly related to developed land cover. Therefore, both road density and developed land cover were used separately in the stressor analysis. Road density was calculated by determining the length of roads, and dividing that length by the area of each individual catchment. Road density was highest in the highly urbanized catchments (32, 34, 38, and 26 [Table 8]).

4.5.b Urban Stressors: Percent Cover of Developed Land Served by Sanitary Sewers

According to 2006-Era Land Cover Data (NOAA, 2008b) 12 percent of the TMDL source area is high, medium, or low density or open developed land. This is a relatively small proportion of the source area, but in terms of *E. coli* contamination from OSDS, pets, and wildlife, it is an important segment. In terms of developed land cover relative to the total catchment area, catchments 32, 34, 36, and 38 (within groupings A, B, C, and M) were each more than 50 percent developed land (Table 8). These highly developed catchments have sanitary sewers available in most areas, but not all residences may be properly connected to them.

The majority (69 percent) of developed land area in the TMDL source area is served by sanitary sewers maintained by the city of Flint, villages of Otisville and Otter Lake, or Genesee County. Areas served by sanitary sewers were determined using the gravity and forced main spatial data provided by Genesee County, Michigan (accessed March 2011). In addition, it was determined that the city of Flint and the villages of Otisville and Otter Lake were served by sanitary sewers based on NPDES permit information and discussions with MDEQ staff. Within areas that are largely served by sanitary sewers, illicit connections and failing OSDS remain a potential source of *E. coli* contamination to surface waters.

4.5.c Urban Stressors: Occupied Housing Units, Human Population Density, and Total Human Population

Human population within the source area in 2010 was estimated to be approximately 20,326 people, which was about 2,000 less than the year 2000 Census estimate (Figures M-5 and M-6 and Table 8) (U.S. Census Bureau, 2000a; 2000b, 2010a; and 2010b). Catchment 32 (grouping M) had the highest human population and highest human density (people per acre) of any catchment in the source area. In terms of occupied housing unit density (units per acre), catchment 32 has the highest density followed by catchments 34, 26, and 38; all of which are located near the city of Flint (Figure M-7).

4.5.d Rural Stressors: Number of AFOs

The number of AFOs in each catchment was used as an indicator of rural stress. AFOs can be potential sources of *E. coli* by contaminating surface runoff at the AFO site, as well as over a wider area if the manure is land applied or stockpiled off-site. There are no permitted Concentrated Animal Feeding Operations (CAFOs) in or near the TMDL source area. There are, however, animal operations, which do not require NPDES permits under the CAFO definition. For the purposes of this TMDL, all livestock within the source area are considered potential sources of *E. coli*, although larger operations and operations directly adjacent to water bodies are more likely to create contamination issues (these AFOs are discussed in Section 4.3). A complete list of livestock operations, ranging in size from a single animal up to larger dairy and meat operations, are included in Table 6 and Figure M-9. Individual AFOs and active pasture lands are labeled with identification (ID) numbers to facilitate discussion. Thirty-eight farms were identified by examining 2008 aerial imagery followed by ground-truthing reconnaissance. Table 6 also indicates whether the site is confirmed as a potential livestock source (animals were seen) or if the potential source is suspected (farm appeared to be outfitted for livestock, but the existence of animals could not be confirmed visually from the road). Smaller farms, such as hobby horse farms and small family farms (<12 animals), can also contaminate surface water if the pastures slope into adjacent water bodies, animals have direct access, or if manure is stockpiled upslope of a water body. Hobby horse farms were found in 10 of the 43 catchments, and tended to be localized in the upper Butternut Creek subwatershed (catchment group I). Livestock in the watershed appear to be mainly cattle and horses, although catchment 19 contained a sheep farm (Id = 20) and a game bird farm (Id = 21). No AFOs or pastures were noted with animals having direct access to water bodies, but this does not eliminate animal access issues as a potential source of *E. coli* contamination. Individual catchments (6, 14, 23, and 42) had the highest number of AFOs within the TMDL source area.

4.5.e. Rural Stressors: Percent Cover of Agricultural Land and Agricultural Land with Poor Drainage

The western catchments (6, 12, 15-18, and 43) of grouping I (Butternut Creek) had the highest percent of land cover in agriculture and were in the upper quartile of all 43 catchments for percent land cover occupied by agriculture (hay/pasture and cultivated land combined) (Figure M-9). Catchments 39, 40, and 41, located in the upper reaches of grouping L (Powers Cullen Drain), were also in the upper quartile for percent land cover occupied by agriculture. Catchment groupings I (Butternut Creek), J (Parker Scothan Drain), and L (Powers Cullen Drain) each were more than 50 percent hay/pasture and cultivated land (Table 7). However, the Powers Cullen Drain was not found to contain any livestock farms of significant size, with only a few small horse farms in the lower watershed. Additionally, it was noted that land cover in the Powers Cullen Drain was more developed than the 2006-Era Land Cover Data suggested, so manure land application is not considered a major source of contamination in this area, but remains a potential problem. Land application of manure is likely to be a significant source in lower portions of Butternut Creek and in the Powers Cullen Drain, based upon land cover data and the number of livestock operations found there.

The capacity of soils to support agriculture with or without artificial drainage was estimated using the component table of the Farmland Classification System SSURGO dataset: (1) Prime Farmland; and (2) Prime Farmland if Drained (USDA-NRCS, 2011). The Prime Farmland classification (1) is designated after consideration of the water table and flooding frequency and without regard to current land use. Soils categorized as Prime Farmland if Drained (2), could potentially produce crops at a ‘prime farmland’ level if artificial drainage or flood control was installed. The resulting datasets were layered with the 2006-Era Land Cover Data (NOAA, 2008b) to produce coverage of soil characteristics by land cover type. Farmland areas (cultivated land and hay/pasture) in the source area where artificial drainage is needed to maximize farmland potential are shown in Figure M-12. The catchments with the highest proportion of agricultural land having these poor drainage characteristics are located in the highly agricultural western portions of Butternut Creek (Catchments 13, 15, 17, and 18) and in the upper portions of the Powers Cullen Drain (Catchments 39 and 40). These areas may pose a particular surface water contamination risk if manure is applied prior to a heavy rainfall.

4.5.f. Rural Stressors: Percent Cover of Developed Land with No Sanitary Sewers and Soils with Poor OSDS Absorption Characteristics

Developed areas served by sanitary sewers were determined using the gravity and forced main spatial data provided by Genesee County, Michigan. In addition, it was determined that the city of Flint and villages of Otisville and Otter Lake were served by sanitary sewers based on NPDES permit information and discussions with MDEQ staff. Developed land cover, which is not served by sanitary sewers (about 4 percent of the entire source area) is shown in Figure M-4, and is largely rural housing relying on OSDS for sewage treatment. Individual catchments with the highest percent of unsewered, developed land, relative to the entire catchment area, are 13, 17, 23, and 36. The unsewered developed land in Catchment 36 is mainly parkland for Genesee County, while it is residential or commercial in Catchments 12, 17, and 23.

The capacity of the soil to provide the necessary drainage to accommodate a properly functioning OSDS was derived from the ‘septic tank absorption field’ of the Mapunit Aggregated Attribute (USDA-NRCS, 2011). About 61 percent of the TMDL source area is made up of soils that limit the ability of OSDS drainage fields to infiltrate properly. Catchments with a high proportion of the land area covered by soils that limit OSDS functionality can be seen in Figure

M-11, and tend to be concentrated in the western portion of Butternut Creek (Catchment grouping I) and the uppermost portion of the Powers Cullen Drain (Catchment grouping J). OSDS located on these soils with poor, or slow, infiltration rates may lead to a higher rate of surface and seasonal failures.

5. REASONABLE ASSURANCE ACTIVITIES

5.1 NPDES

The Otter Lake, Otisville, and Orchard Cove Mobile Home Park WWTPs (identified in Table 4) are required to meet their NPDES permit limits. Michigan regulates discharges containing treated or untreated human waste (i.e., sanitary wastewater) using fecal coliform as the indicator. Sanitary wastewater discharges are required to meet the effluent limitation of 200 fecal coliform per 100 mL as a monthly average and 400 fecal coliform per 100 mL as a maximum. Michigan's WQS for *E. coli* are based upon criteria in the USEPA's 1986 criteria document (USEPA, 1986). Specifically, the USEPA criterion of 126 *E. coli* per 100 mL is the basis for Michigan's TBC WQS of 130 *E. coli* per 100 mL. This criterion is intended to provide a level of protection of producing no more than 8 illnesses per 1,000 swimmers and approximates the degree of protection provided by the fecal coliform indicator of 200 fecal coliform per 100 mL bacteria standard recommended by the USEPA prior to the adoption of the 1986 criteria. The sanitary discharges are expected to be in compliance with the ambient PBC and TBC *E. coli* 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. According to MDEQ discharge monitoring reports, all three WWTPs are currently in compliance with the NPDES permit limits for fecal coliform.

The COCs for the general industrial storm water permit (MIS510000 and MIS520000) listed in Table 4, specify that if a TMDL is established by the Department 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 provide an estimate of the current annual load of those materials via storm water discharges to the receiving stream. In addition, storm water permit authorization requires facilities to obtain a certified operator who will have supervision and control over the control structures at the facility, eliminate any unauthorized non-storm water discharges, and develop and implement the Storm Water Pollution Prevention Plan for the facility.

The TMDL source area receives storm water discharges from Genesee County, Genesee Township, and Mount Morris Township – Genesee MS4s (Table 4). These regulated MS4s are required to obtain permit coverage under Michigan's NPDES MS4 Jurisdictional-Based or Watershed-Based Storm Water General Permits. Currently, Genesee County, Genesee Township, and Mount Morris Township have coverage under the Watershed-Based Storm Water General Permit (MIG610000). Genesee County also nests the Genesee School District and Kearsley Community Schools under their permit, which has regulated storm water discharges within the TMDL source area. Under the Watershed-Based 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 Watershed Management Plan and a Storm Water Pollution Prevention Plan, which includes 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 projects, a Construction Storm Water Runoff Control Program, and a Pollution Prevention/Good Housekeeping Program for municipal operations. In addition, the MDOT Statewide Individual

Storm Water NPDES Permit (MI0057364) covers storm water discharges from state roads, including Vienna Road, State Road, Dort Highway, and I-475 (Figure M-1). 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.

The IDEP requirements of the MS4 permits have great potential to reduce *E. coli* levels in the C. S. Mott Lake – Bluebell Beach TMDL source area. The IDEP requires 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 MDEQ). 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 most recently submitted Phase II Annual Report for Genesee County municipalities covers the period from November 1, 2007 to October 31, 2008. In 2006, IDEP activities were conducted in the upper Flint River watershed, which includes the TMDL source area (Genesee County Phase II Municipalities, 2008). Approximately 93 miles of drains and rivers were explored on foot or by boat, including Butternut Creek and some of its tributaries; Kurtz Drain, Carpenter Drain, Powers Cullen Drain, and portions of the Parker Scothan Drain (all of which were sampled in support of this TMDL). One illicit connection on Center Road was found to be discharging to Kurtz Drain (Catchment 21) and was corrected during the reporting period. The 2006 IDEP activities along No Name Creek 4 located three potential illicit connections on Coldwater Road; two were confirmed and one was suspected. On June 10, 2009, the MDEQ notified the GCHD of consistently elevated levels of *E. coli* found at site FR2 on No Name Creek 4, which discharges to C.S. Mott Lake immediately upstream of Bluebell Beach. The GCHD immediately launched an investigation including dye testing, which resulted in the identification of three residences with illicit sanitary connections to the water body, one of which had previously been identified by the IDEP in 2006. Two of the residences (now vacant) were temporarily condemned and repair permits have been issued and are expected to be completed in 2011 (personal communication with Brian McKenzie, GCHD). The third residence was an adult foster care facility and repairs were completed on that home on August 10, 2009. The elimination of these sources on Coldwater Road should improve conditions both in No Name Creek 4 and at C.S. Mott Lake - Bluebell Beach.

5.2 Nonpoint Sources

Failing or poorly designed OSDS are likely a significant source of *E. coli* to C.S. Mott Lake, particularly in unsewered areas (Figure M-4). Neither Genesee nor Lapeer Counties operates a Point-of-Sale OSDS inspection program, which would ensure that OSDS are functioning properly each time property is bought or sold. OSDS repair permits and permits for new construction of OSDS are issued by the GCHD and Lapeer County Health Department. Of the 19 OSDS repair/replacement permits issued by the GCHD in 2009 and 2010, 4 were located in Forest Township, 3 in Genesee Township, 5 in Richfield Township and 7 in Thetford Township (personal communication with Tammy Trzcinski-Green, GCHD, March 8, 2011). Genesee County has put in place the Sewer Use Ordinance, which requires that if a property boundary is within 300 feet of a sanitary sewer, the building on that property must be connected to the sewer line rather than rely on an OSDS for sanitary sewage treatment. Lapeer County issued 2 OSDS repair permits in 2009 and 12 in 2010 in Marathon Township (personal communication with Mitch Caskey, Lapeer County Health Department, April 29, 2011). Lapeer County also has an ordinance requiring that a building producing sanitary waste be connected to sanitary sewer system if accessible, but does not define ‘accessible’.

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 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 C.S. Mott Lake source area will significantly improve water quality by removing a public health threat.

Enteric bacteria in agricultural soil where manure has been applied usually declines 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). Even given the potential longevity of enteric bacteria after manure application, studies show that if 4 to 8 days pass between manure application and heavy rainfall, contamination can be reduced (Crane et al., 1978 and Saini et al., 2003). Vegetated riparian buffer strips wide enough to trap sediment have been shown to reduce the enteric bacteria in runoff (Coyne et al., 1998 and Lim et al., 1998).

Nonpoint source pollution from unpermitted agricultural operations is generally not regulated by the MDEQ, but is mitigated through voluntary programs such as Clean Michigan Initiative and federal Clean Water Act Section 319 funded grants for watershed management plan development and implementation. Unregulated AFOs may be required to apply for an NPDES permit in accordance with the circumstances set forth within R 323.2196 of the Part 21 administrative rules. This authority allows the MDEQ to impose pollution controls and conduct inspections, thereby reducing pollutant contamination (i.e., *E. coli*) from agricultural operations that have been determined to be significant contributors of pollutants. Both Niec Farm and Southview Farm (noted in the Source Assessment Section for their size and proximity to water bodies) have been referred to Michigan Department of Agriculture staff for further investigation.

No Clean Michigan Initiative and federal Clean Water Act Section 319 funded grants have been awarded within the TMDL source area. Once approved, this TMDL will elevate the priority of this source area for potential future funding under these programs.

6. IMPLEMENTATION RECOMMENDATIONS

Implementation of NPDES permit-related point source discharges, including MS4 permitted storm water, is regulated as determined by the language contained within each permit and must be consistent with this TMDL. The implementation of nonpoint source activities to reach the goal of attaining the WQS is voluntary. Funding is available on a competitive basis through Clean Michigan Initiative and federal Clean Water Act Section 319 funded grants for TMDL implementation and watershed planning and management activities. Priority catchments were identified using the stressor analysis (Table 8 and Figure M-13). Higher stressor scores indicate a higher priority in terms of the implementation of voluntary nonpoint source activities and can also be used by NPDES MS4 permittees for prioritization. The top five priority catchments to address urban contamination issues are: 22, 26, 32, 34, and 38. Priority catchments to address rural contamination issues are: 13, 15, 17, 18, and 21. Catchments that scored above

30 (on a scale of 10 to 40) in their overall/combined stressor scores are: 18, 21, 39, and 41. We recommend the following voluntary activities to make progress in meeting the goal of this TMDL:

Recommended Voluntary Urban Activities:

- Outreach to educate residents on backyard conservation, which include proper pet waste management, rain gardens, rain barrels, improving storm water infiltration and storage, and discouragement of congregating wildlife.
- Outreach to educate residents on the signs that their residence may have improper connections to a sanitary or storm sewer or a surface water body.
- Adoption of pet waste ordinances.

Recommended Voluntary Rural Activities:

- Focused effort by health department and other agencies to locate and address failing OSDS. This effort could include the adoption of a time-of-sale OSDS inspection program.
- Riparian vegetated buffer strips in agricultural areas that are not artificially drained (tiled).
- Water table management (controlled drainage) where manure is applied to artificially drained land.
- Livestock exclusion from riparian areas and providing vegetated buffers between pasture and water.
- Outreach to agricultural community to encourage best management practices on manure storage, composting, and application and the development of nutrient management plans.

7. FUTURE MONITORING

Future monitoring by the MDEQ 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*, as described in this document. When the results of these actions indicate that the water body may have improved to meet 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. Requests for future *E. coli* monitoring within this TMDL area may be submitted for consideration via the form found on the MDEQ Web site at http://www.michigan.gov/deq/ then search for “monitoring request form.” Any future data collected by the MDEQ will be accessible to the public via the Beach Guard database, at http://www.egle.state.mi.us/beach/. The GCHD will continue to monitor the C.S. Mott Lake – Bluebell Beach on a weekly basis as funding allows.

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8. REFERENCES

Abu-Ashour, J. and H. Lee. 2000. Transport of Bacteria on Sloping Soil Surfaces by Runoff. Environmental Toxicology. Vol. 15: 149-153.

Albert, Dennis A. 1995. Regional Landscape Ecosystems of Michigan, Minnesota, and Wisconsin: A Working Map and Classification. Gen. Tech. Rep. NC-178. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.treesearch.fs.fed.us/pubs/10242 (Version 03JUN1998).

American Veterinary Medical Association. 2007. "U.S. Pet Ownership and Demographics Sourcebook, 2007 Edition," 1, 29 at Table 1-13.

Busman, L. and G. Sands, 2002. Agricultural Drainage; Issues and Answers. University of Minnesota Extension. Publication MI-07740.

Cleland, B. 2002. TMDL Development from the "Bottom Up" – Part II. Using Duration Curves to Connect the Pieces. America's Clean Water Foundation.

Cook, M.J., and J.L. Baker. 2001. Bacteria and Nutrient Transport to Tile Lines Shortly after Application of Large Volumes of Liquid Swine Manure. Transactions of the ASAE. Vol. 44(3): 495-503.

Coyne, M.S., R.A. Gilfillen, A. Villalba, Z. Zhang, R. Rhodes, L. Dunn, and R.L. Blevins. 1998. Fecal Bacteria Trapping by Grass Filter Strips during Simulated Rain. Journal of Soil and Water Conservation. Vol. 53(2); 140-145.

Crane, S.R., M.R. Overcash, and P.W. Westerman. 1978. Swine Manure Microbial Die-Off and Runoff Transport under Controlled Boundary Conditions. Unpublished Paper, 15 pp.

Enviro-Weather. 2009. Enviro-Weather (formerly Michigan Automated Weather Network). Michigan State University. http://www.agweather.geo.msu.edu/mawn/.

Genesee County Phase II Municipalities. 2008. 2008 Annual Report. Submitted by Genesee County Drain Commissioner's Office, Genesee County, Michigan.

Great Lakes Environmental Research Center and Limnotech, Inc. 2009. Quality Assurance Project Plan: *E. coli* Monitoring for TMDL Development.

Jamieson, R.C., R.J. Gordon, K.E. Sharples, G.W. Stratton, and A. Madani. 2002. Movement and Persistence of Fecal Bacteria in Agricultural Soils and Subsurface Drainage Water: A Review. Canadian Biosystems Engineering, Volume 44.

Jiang, X., J. Morgan, and M.P. Doyle. 2002. Fate of Escherichia coli O157:H7 in Manure-Amended Soil. Applied and Environmental Microbiology 68(5):2605-2609.

LeSage, S. and J. Smith. 2010. Draft Water Quality and Pollution Control in Michigan: 2010 Sections 303(d), 305(b), and 314 Integrated Report. MDEQ Report No. MI/DEQ/WB-10/001. April 2010.

Lim, T.T., Dr. R. Edwards, S.R. Workman, B.T. Larson, and L. Dunn. 1998. Vegetated Filter Strip Removal of Cattle Manure Constituents in Runoff. Transactions of the ASAE. Vol. 4(5): 1375-1381.

NOAA. 2008a. National Environmental Satellite, Data, and Information Service (NESDIS). National Climatic Data Center: https://www.nesdis.noaa.gov/. National Oceanic and Atmospheric Administration.

NOAA. 2008b. NOAA Coastal Change Analysis Program (C-CAP) Zone 51 (lower) 2006-Era Land Cover. Charleston, SC. National Oceanic and Atmospheric Administration. Accessed 2011.

Oliver, D.M., L. Heathwaite, P.M. Haygarth, and C.D. Clegg. 2005. Transfer of *Escherichia coli* to Water from Drained and Undrained Grassland after Grazing. Journal of Environmental Quality 34: 918-925.

Saini, R., L.J. Halverson, and J.C. Lorimor. 2003. Rainfall Timing and Frequency Influence on Leaching of *Escherichia coli* RS2G through Soil following Manure Application. Journal of Environmental Quality. Vol. 32:1865-1872.

Schoonover, J. E., and B. G. Lockaby. 2006. Land Cover Impacts on Stream Nutrients and Fecal Coliform in the Lower Piedmont of West Georgia. Journal of Hydrology 331:371-382.

Shipitalo, M.J. and F. Gibbs. 2000. Potential of Earthworm Burrows to Transmit Injected Animal Wastes to Tile Drains. Soil Science Society of America Journal. Vol. 64:2103-2109.

Stoddard, C.S., M.S. Coyne, and J.H. Grove. 1998. Fecal Bacteria Survival and Infiltration through a Shallow Agricultural Soil: Timing and Tillage Effects. Journal of Environmental Quality. Vol. 27(6):1516-1523.

Unc, A. and M.J. Goss. 2004. Transport of Bacteria from Manure and Protection of Water Resources. Applied Soil Ecology 25: 1-18.

U.S. Census Bureau. 2000a. 2010 Redistricting Data, Race, Hispanic or Latino, Age, and Housing Occupancy: 2000, MI. Accessed March 23, 2011, from http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

U.S. Census Bureau. 2000b. Michigan TIGER/Line Shapefiles. 2000 Census Block Polygons for Lapeer, Genesee, and Tuscola Counties.

U.S. Census Bureau. 2010a. 2010 Redistricting Data, Race, Hispanic or Latino, Age, and Housing Occupancy: 2010, MI. Accessed March 23, 2011, from http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml.

U.S. Census Bureau. 2010b. Michigan TIGER/Line Shapefiles. 2010 Census Block Polygons for Lapeer, Genesee, and Tuscola Counties.

USDA- NRCS. 2011. Soil Survey Staff. Soil Survey Geographic (SSURGO) Database for Genesee, Tuscola and Lapeer Counties, Michigan. Available online at https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/. Accessed January 26, 2011.

USDA-NRCS, USGS, and the USEPA. 2009. The National Hydrography Dataset, Watershed Boundary Dataset. Watershed Boundary Dataset for HUC#04080204, Michigan. Available URL: http://datagateway.nrcs.usda.gov. Accessed 2009.

USEPA. 1986. Ambient Water Quality Criteria for Bacteria-1986. Report #EPA440/5-84-002.

USGS. 2007. Measurement and Computation of Streamflow. Volume 1. Measurement of Stage and Discharge and Volume 2. Computation of Discharge. U.S. Geological Survey, Water Supply Paper 2175.

Zucker, L.A. and L.C. Brown (eds.). 1998. Agricultural Drainage: Water Quality Impacts and Subsurface Drainage Studies in the Midwest. Ohio State Univ. Extension Bulletin 871.

Table 1. Summary of sampling site locations, site geometric means, and TBC and PBC WQS exceedances for entire 16-week sampling period in 2009. Note that site geometric means are the geometric means of all sample results for each site, and are calculated to facilitate comparisons among sites and are *not* intended to be compared to the WQS to determine exceedances.

Location	Site Description	Latitude	Longitude	Site Geomeans	TBC exceedances	PBC exceedances
FR1	Cornwell Drain @ Bray Rd.	43.086345	-83.656401	199	6	2
FR2	No Name Creek 4 @ Bray Rd.	43.093493	-83.656596	2793	15	12
FR3	No Name Creek 3 @ Bray Rd.	43.100269	-83.656808	86	2	1
FR4	No Name Creek 2 @ Stanley Rd.	43.10561	-83.652138	641	13	4
FR5	Kurtz Drain @ Gregor Rd.	43.112332	-83.625985	595	13	3
FR6	Butternut Creek @ Mt. Morris Rd.	43.121005	-83.59582	583	14	3
FR7	Flint River @ Irish Rd.	43.102624	-83.558079	64	1	0
FR8	Flint River @ Genesee Rd.	43.108121	-83.617363	40	1	0
FR9	Powers Cullen Drain @ Coldwater Rd.	43.091964	-83.558092	786	14	4
FR10	Parker Scothan Drain @ Irish Rd.	43.116165	-83.558495	955	16	4
FR11	Carpenter Drain @ Center Rd.	43.08544	-83.636667	208	4	1
ML1-ML5	Bluebell Beach - all sites	see below	see below	101	3	2
ML-1	Bluebell Beach - north end	43.086293	-83.650855	*	*	*
ML-2	Bluebell Beach	43.08706	-83.650384	*	*	*
ML-3	Bluebell Beach	43.087768	-83.65001	*	*	*
ML-4	Bluebell Beach	43.08855	-83.64955	*	*	*
ML-5	Bluebell Beach - south end	43.089157	-83.649223	*	*	*

* - values not calculated for individual beach sites

Table 2. *E. coli* data collected weekly from May 20 through September 2, 2009. “Daily geomeans” are the geometric means of all sample results for a site and given sampling date. Daily geomeans are compared to the daily maximum TBC WQS and the PBC WQS to determine attainment. Gray shading indicates that the daily maximum TBC or 30-day geometric mean WQS was exceeded. A gray shading with a bold outline indicates that both the daily maximum TBC and PBC WQS were exceeded.

Date	Location	FR1 Cornwell Drain @ Bray Rd.			FR2 No Name Creek 4 @ Bray Rd.			FR3 No Name Creek 3 @ Bray Rd.			FR4 No Name Creek 2 @ Stanley Rd.			FR5 Kurtz Drain @ Gregor Rd.			FR6 Butternut Creek @ Mt. Morris Rd.			Precipitation in prior 24 hours
		Sample Results	Daily Geomean	30-day Geomean	Sample Results	Daily Geomean	30-day Geomean	Sample Results	Daily Geomean	30-day Geomean	Sample Results	Daily Geomean	30-day Geomean	Sample Results	Daily Geomean	30-day Geomean	Sample Results	Daily Geomean	30-day Geomean	
	L	40			3,500			450			60			190			170			
5/20/2009	C	10			4,900			460			30			180			270			
	R	100	34		4,400	4,226		420	443		70	50		100	151		280	234		0.00
	L	300			3,400			280			140			410			270			
5/27/2009	C	140			2,700			320			90			380			630			
	R	120	171		3,700	3,239		290	296		90	104		400	396		470	431		0.20
	L	<10			1,300			80			70			280			180			
6/3/2009	C	40			1,700			40			40			510			210			
	R	100	63		1,600	1,523		60	58		80	61		340	365		170	186		0.00
	L	800			2,200			200			830			1,300			2,400			
6/10/2009	C	1,300			1,600			100			970			1,300			3,000			
	R	1,500	1,160		900	1,469		110	130		900	898		2,200	1,549		3,500	2,932		0.00
	L	4,200			41,000			6,900			36,000			12,000			6,700			
6/17/2009	C	3,000			34,000			6,200			54,000			11,000			6,200			
	R	3,600	3,566	274	43,000	39,136	4,128	7,400	6,815	368	38,000	41,959	413	7,100	9,786	801	6,300	6,396	811	3.15
	L	430			20,000			60			2,200			800			400			
6/24/2009	C	410			16,000			60			2,100			830			560			
	R	690	495	467	21,000	18,871	5,568	60	60	246	2,900	2,375	893	860	830	1,127	770	557	965	0.00
	L	480			750			30			790			610			430			
7/1/2009	C	490			690			30			840			730			530			
	R	440	469	571	730	723	4,125	50	36	161	760	796	1,340	590	640	1,241	440	465	980	0.00
	L	90			2,600			50			610			680			350			
7/8/2009	C	110			2,500			30			690			680			490			
	R	100	100	626	2,500	2,533	4,567	30	36	146	710	669	2,166	670	677	1,404	320	380	1,130	0.00
	L	350			5,800			30			1,800			900			350			
7/15/2009	C	350			4,700			30			1,200			1,400			410			
	R	370	357	494	4,600	5,005	5,836	10	21	101	1,700	1,543	2,413	1,100	1,115	1,314	390	383	752	trace
	L	200			7,100			60			900			1,000			570			
7/22/2009	C	160			5,500			20			600			420			500			
	R	170	176	271	5,700	6,060	4,019	70	44	37	1,200	865	1,110	340	523	732	510	526	456	trace
	L	180			9,300			<10			460			300			470			
7/29/2009	C	240			9,700			20			460			260			400			
	R	220	212	228	9,700	9,565	3,508	<10	20	30	530	482	807	360	304	598	240	356	417	0.00
	L	160			4,300			<10			440			600			590			
8/5/2009	C	120			3,800			70			460			710			610			
	R	180	151	182	3,300	3,778	4,883	30	46	31	320	402	704	690	665	603	680	626	443	0.00
	L	700			520			90			250			480			570			
8/12/2009	C	290			560			80			440			400			580			
	R	160	319	230	1,000	663	3,735	90	87	37	290	317	606	520	464	559	640	596	484	0.00
	L	40			520			40			340			210			510			
8/19/2009	C	30			610			30			360			230			470			
	R	40	36	146	620	582	2,428	30	33	41	390	363	454	190	209	400	490	490	509	0.00
	L	120			5,900			60			3,700			900			1,900			
8/26/2009	C	110			4,900			50			4,200			910			1,100			
	R	170	131	137	5,700	5,482	2,380	60	56	43	4,700	4,180	622	790	865	443	900	1,234	604	0.60
	L	50			190			<10			410			190			370			
9/2/2009	C	50			140			10			460			280			360			
	R	20	37	97	110	143	1,027	<10	10	37	430	433	609	180	212	412	250	322	592	0.00

Table 2. cont.

		FR7			FR8			FR9			FR10			FR11		
	Location	Flint River @ Irish Rd.			Flint River @ Genesee Rd.			Powers Cullen Drain @ Coldwater Rd.			Parker Scothan Drain @ Irish Rd.			Carpenter Drain @ Center Rd.		
Date		Sample Results	Daily Max.	30-day Geomean	Sample Results	Daily Max.	30-day Geomean	Sample Results	Daily Max.	30-day Geomean	Sample Results	Daily Max.	30-day Geomean	Sample Results	Daily Max.	30-day Geomean
	L	30			20			130			350			280		
5/20/2009	C	20			20			190			360			370		
	R	10	18		10	16		110	140		370	360		310	318	
	L	50			40			100			2,000			830		
5/27/2009	C	10			10			110			2,600			790		
	R	40	27		20	20		210	132		2,400	2,320		750	789	
	L	50			20			450			320			50		
6/3/2009	C	50			50			580			520			130		
	R	60	53		40	34		570	530		400	405		90	84	
	L	20			830			1,100			2,000			150		
6/10/2009	C	30			600			950			2,300			150		
	R	70	35		620	676		910	983		1,600	1,945		180	159	
	L	180			30			27,000			54,000			3,700		
6/17/2009	C	310			80			23,000			67,000			3,300		
	R	410	284	48	30	42	50	29,000	26,212	759	62,000	60,760	2,091	10,000	4,961	441
	L	30			30			690			820			200		
6/24/2009	C	60			30			450			930			110		
	R	10	26	52	80	42	60	420	507	983	740	826	2,469	140	145	377
	L	30			50			450			530			290		
7/1/2009	C	<10			40			560			670			330		
	R	320	98	67	60	49	72	520	508	1,286	570	587	1,876	220	276	305
	L	30			60			340			730			290		
7/8/2009	C	50			60			450			600			170		
	R	20	31	60	60	60	81	350	377	1,201	560	626	2,046	170	203	365
	L	70			50			670			790			200		
7/15/2009	C	120			30			910			710			100		
	R	60	80	71	10	25	42	1,000	848	1,166	890	793	1,710	120	134	352
	L	80			30			1,900			680			40		
7/22/2009	C	50			60			1,500			680			70		
	R	140	82	55	30	38	41	1,800	1,725	677	690	683	697	50	52	142
	L	30			10			980			600			140		
7/29/2009	C	80			50			990			510			110		
	R	80	58	65	40	27	38	910	959	769	550	552	643	110	119	136
	L	40			10			790			550			140		
8/5/2009	C	90			10			720			620			210		
	R	30	48	56	10	10	27	670	725	826	540	569	639	180	174	124
	L	340			340			1,900			720			80		
8/12/2009	C	330			260			2,100			680			90		
	R	350	340	91	280	291	37	1,500	1,816	1,131	490	621	638	130	98	107
	L	90			20			370			260			170		
8/19/2009	C	30			10			400			330			180		
	R	40	48	82	20	16	34	360	376	961	350	311	529	120	154	110
	L	250			50			2,400			2,600			440		
8/26/2009	C	180			30			2,500			2,700			450		
	R	160	193	97	80	49	36	1,800	2,210	1,010	3,600	2,935	708	720	522	175
	L	170			10			720			630			150		
9/2/2009	C	80			50			510			460			50		
	R	50	88	106	10	17	33	490	565	908	230	405	666	60	77	160

Table 3. *E. coli* results from C.S. Mott Lake - Bluebell Beach collected weekly from May 20 through September 2, 2009. “Daily geomeans” are the geometric means of all sample results for a site and given sampling date. Daily geomeans are compared to the daily maximum TBC WQS and the PBC WQS to determine attainment. Gray shading indicates that the daily maximum TBC or 30-day geometric mean WQS was exceeded. A gray shading with a bold outline indicates that both the daily maximum TBC and PBC WQS were exceeded.

Date	Location	ML1 through 5 Mott Lake - Bluebell Beach Sample Results	Daily Geomean	30-day Geomean	Precipitation in prior 24 hours
5/20/2009	**1**	**30**			
	2	**30**			
	3	**30**			
	4	**20**			
	5	**2,600**	**68**		**0.00**
5/27/2009	**1**	**30**			
	2	**10**			
	3	**10**			
	4	**10**			
	5	**<10**	**13**		**0.20**
6/3/2009	**1**	**60**			
	2	**<10**			
	3	**<10**			
	4	**10**			
	5	**20**	**23**		**0.00**
6/10/2009	**1**	**30**			
	2	**<10**			
	3	**<10**			
	4	**30**			
	5	**80**	**42**		**0.00**
6/17/2009	**1**	**17,000**			
	2	**4,100**			
	3	**4,100**			
	4	**4,500**			
	5	**1,000**	**4186**	**81**	**3.15**
6/24/2009	**1**	**<10**			
	2	**30**			
	3	**20**			
	4	**50**			
	5	**980**	**74**	**83**	**0.00**
7/1/2009	**1**	**<10**			
	2	**<10**			
	3	**10**			
	4	**<10**			
	5	**<10**	**10**	**78**	**0.00**
7/8/2009	**1**	**110**			
	2	**80**			
	3	**250**			
	4	**830**			
	5	**<10**	**207**	**122**	**0.00**
7/15/2009	**1**	**10**			
	2	**10**			
	3	**30**			
	4	**10**			
	5	**190**	**22**	**159**	**trace**
7/22/2009	**1**	**100**			
	2	**30**			
	3	**50**			
	4	**60**			
	5	**10**	**39**	**53**	**trace**
7/29/2009	**1**	**50**			
	2	**230**			
	3	**460**			
	4	**160**			
	5	**500**	**211**	**45**	**0.00**
8/5/2009	**1**	**30**			
	2	**30**			
	3	**30**			
	4	**30**			
	5	**230**	**45**	**207**	**0.00**
8/12/2009	**1**	**1,800**			
	2	**2,400**			
	3	**600**			
	4	**1,800**			
	5	**310**	**1077**	**98**	**0.00**
8/19/2009	**1**	**20**			
	2	**60**			
	3	**<10**			
	4	**30**			
	5	**70**	**40**	**110**	**0.00**
8/26/2009	**1**	**8,200**			
	2	**180**			
	3	**270**			
	4	**180**			
	5	**50**	**324**	**168**	**0.60**
9/2/2009	**1**	**70**			
	2	**190**			
	3	**50**			
	4	**140**			
	5	**20**	**71**	**135**	**0.00**

Table 4. NPDES permitted facilities discharging to the source watershed of the TMDL.

Facility Name	Permit No.	Receiving water	Latitude	Longitude
Individual Permits				
Otisville WWTP	MI0028720	Coe Dr.	43.1775	-83.54194
MDOT Statewide MS4	MI0057364	Butternut Cr, Parker Scothan Dr, Powers Cullen Dr, Cornwell Dr, No Name Cr 2-4, and Kurtz Dr	various	various
Orchard Cove Mobile Home Park	MI0054755	unnamed tributary of Coe Dr.	43.16361	-83.53583
Otter Lake WWTP	MI0056979	Butternut Cr.	43.208333	-83.466666
Municipal Separate Storm Sewers, General Permit: MIG610000				
Genesee Co MS4	MIG610072	various	See Figure M-3	
Genesee Twp MS4-Genesee	MIG610073	various	na	na
Mount Morris MS4-Genesee	MIG610081	various	na	na
Hydrostatic Pressure Test Water, General Permit: MIG6790000				
Marathon Petro Co-Flint	MIG670001	Cornwell Dr.	43.177777	-83.910277
Buckeye Terminals-Flint	MIG670290	Cornwell Dr.	43.09	-83.65
Storm Water from Industrial Activities, General Permit: MIS510000				
GCRC-Otisville Maint Garage	MIS510239	Sand Lake	43.171400	-83.517500
Superior Materials Plt 20	MIS510263	unnamed tributary of Mott Lake	43.085000	-83.673300
Richfield Landfill Inc	MIS510282	Parker Scothan Dr.	43.127550	-83.496750
Bristol Steel & Conveyor	MIS510483	Powers Cullen Dr.	43.072700	-83.515730
Lamrock & Company	MIS510658	Butternut Cr.	43.186390	-83.520280
CPCO-Thetford Generating	MIS510734	Geiger Dr.	43.155277	-83.631666
Marathon Petro Co-Mt Morris	MIS510743	Mott Lake	43.092220	-83.675000
Storm Water Discharges With Required Monitoring, General Permit: MIS520000				
Buckeye Terminals-Flint	MIS520015	Cornwell Dr.	43.086666	-83.674166
Discharge from Municipal Potable Water Supply, General Permit: MIS640000				
Otisville WTP	MIG640235	unnamed tributary of Coe Dr.	43.16306	-83.55139

Table 5. The land area (in acres) of each civil division that falls within the TMDL source area, and the percent of TMDL source area for which each division is responsible. Civil divisions that compose less than 1 percent of the TMDL source area are not listed. An astrix denotes municipalities that have MS4 NPDES permits.

Civil Division	Area Within TMDL source Watershed (acres)	Percent of TMDL Source Area in Civil Division
Marathon Twp	762	1.6%
Forest Twp	16233	34.0%
Thetford Twp	8008	16.8%
Richfield Twp	9921	20.8%
Genesee Twp*	12477	26.1%
Total	47791	

Table 6. List of locations and descriptions of AFOs and active pasture in the source area as determined by remote sensing and visual observations (ground truthing). The size of the operation (small = 1 to 12, medium = 13 to 50, and large = 50+ animals) is intended to be only an estimate and is based solely on visual observations of animals and the size of pasture areas.

Id	Type	Livestock Type	Confidence	Size of Activity	X Coordinate (1984 Michigan Georef)	Y Coordinate (1984 Michigan Georef)	Catchment	Catchment Grouping
1	pasture	cattle	confirmed	medium	-83.47900	43.19475	2	I
2	pasture	horse	confirmed	small	-83.65238	43.16354	17	I
3	feedlot	cattle	confirmed	medium	-83.61417	43.16585	13	I
4	feedlot	cattle	confirmed	large	-83.60278	43.16639	9	I
5	feedlot	cattle	confirmed	large	-83.50268	43.16639	14	J
6	pasture	horse	confirmed	small	-83.59023	43.14996	43	I
7	pasture	unknown	suspected	unknown	-83.61302	43.15246	15	I
8	pasture	cattle	confirmed	small	-83.63284	43.15137	17	I
9	pasture	cattle	confirmed	large	-83.63916	43.14358	18	I
10	pasture	cattle	confirmed	small	-83.60553	43.13491	15	I
11	pasture	horse	confirmed	small	-83.60436	43.13493	23	I
12	pasture	cattle	confirmed	medium	-83.56540	43.13725	23	I
13	pasture	cattle	suspected	unknown	-83.55059	43.13735	14	J
14	pasture	horse	suspected	small	-83.53033	43.13563	14	J
15	feedlot	cattle	confirmed	medium	-83.52643	43.12107	na	na
16	feedlot	cattle	confirmed	unknown	-83.56968	43.12006	20	H
17	pasture	horse	confirmed	medium	-83.63803	43.12073	21	F
18	pasture	horse	confirmed	small	-83.64760	43.10447	27	D
19	pasture	unknown	suspected	unknown	-83.67037	43.09109	33	C
20	feedlot	cattle	suspected	unknown	-83.57955	43.18927	6	I
21	pasture	unknown	confirmed	unknown	-83.51211	43.16590	10	I
22	pasture	horse	confirmed	small	-83.50037	43.18196	5	I
23	pasture	horse	confirmed	small	-83.50013	43.18827	5	I
24	pasture	horse	confirmed	small	-83.48045	43.20487	42	I
25	pasture	horse	confirmed	small	-83.46300	43.20897	42	I
26	pasture	horse	confirmed	small	-83.47601	43.22311	42	I
27	pasture	horse	confirmed	small	-83.48076	43.22241	42	I
28	pasture	horse	confirmed	medium	-83.57838	43.18010	6	I
29	pasture	horse	confirmed	medium	-83.59276	43.17999	12	I
30	pasture	horse	confirmed	small	-83.58073	43.19286	6	I
31	pasture	horse	confirmed	small	-83.58943	43.15083	43	I
32	pasture	horse	confirmed	small	-83.57143	43.16553	16	I
33	pasture	sheep	confirmed	unknown	-83.55878	43.15717	19	I
34	feedlot	poultry	confirmed	unknown	-83.53190	43.15141	19	I
35	pasture	horse	confirmed	small	-83.59639	43.13620	23	I
36	pasture	unknown	suspected	unknown	-83.63594	43.13556	21	F
37	pasture	horse	confirmed	small	-83.57440	43.09184	29	L
38	pasture	horse	confirmed	small	-83.56502	43.09190	29	L

Table 7. 2006-Era Land Cover (NOAA, 2008b) for each catchment grouping (A through M), as the number of acres and percent of each grouping, and entire C.S. Mott Lake - Bluebell Beach Source Area.

Grouping	Developed Land - ALL (gridcodes 2-5)		Pasture/Hay (gridcode 7)		Cultivated Land (gridcode 6)		Natural areas (sum of gridcodes 8-11)		Wetland (sum of gridcodes 12-18)		Total Area
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres
A	425	65%	7	1%	65	10%	139	21%	15	2%	657
B	632	51%	209	17%	77	6%	604	49%	28	2%	1230
C	550	36%	97	6%	351	23%	411	27%	75	5%	1507
D	208	24%	59	7%	194	22%	354	41%	49	6%	864
E	240	11%	118	6%	253	12%	723	34%	121	6%	2125
F	533	28%	303	16%	610	32%	384	20%	83	4%	1934
G	236	23%	132	13%	130	12%	365	35%	50	5%	1047
H	101	5%	441	23%	224	12%	763	39%	257	13%	1946
I	1315	5%	5879	24%	6963	28%	7162	29%	3105	13%	24767
J	199	5%	1078	25%	1304	30%	1176	27%	475	11%	4298
K	49	6%	51	6%	114	14%	379	46%	217	27%	817
L	833	14%	1454	24%	1964	32%	1356	22%	339	6%	6158
M	240	53%	46	10%	14	3%	105	23%	36	8%	451
Entire TMDL Source Area	5561	12%	9873	21%	12262	26%	13921	29%	4850	10%	47801

Table 8. 2006-Era Land Cover (NOAA, 2008b) soil characteristics (USDA-NRCS, 2011), population, housing, and pet information derived from the 2010 U.S. Census (U.S. Census Bureau, 2010a and 2010b) for each catchment (1 through 43), as the number of acres, percent of each catchment, and stressor score (where applicable).

Catchment ID	Total Area	Grouping	Unsewered Developed Land -			Sewered Developed Land			Road Density		Number of Animal Feeding Operations		Soils with Very Limited OSDS Percolation			Cultivated Land and Hay/Pasture with poor drainage (artificial draining recommended)			Agricultural land (gridcodes 6 and 7)		
	Acres		Acres	Percent	Stressor Score	Acres	Percent	Stressor Score	Meters of Road per Acre	Stressor Score	Number	Stressor Score	Acres	Percent	Stressor Score	Acres	Percent	Stressor Score	Acres	Percent	Stressor Score
1	591	I	12	2%	2	30	5%	3	9.7	4	0	1	390	66%	3	2	0%	1	66	11%	1
2	626	I	6	1%	1	0	0%	1	6.0	2	1	3	227	36%	1	84	13%	2	343	55%	3
3	317	I	6	2%	2	0	0%	1	2.9	1	0	1	266	84%	4	1	0%	1	61	19%	1
4	589	I	21	4%	3	0	0%	1	4.8	1	0	1	427	72%	3	107	18%	2	320	54%	3
5	1125	I	15	1%	1	0	0%	1	7.2	3	2	4	361	32%	1	134	12%	2	477	42%	2
6	1841	I	50	3%	2	0	0%	1	4.4	1	3	4	1061	58%	2	589	32%	3	1376	75%	4
7	553	I	32	6%	4	0	0%	1	7.0	3	0	1	246	44%	1	3	1%	1	104	19%	1
8	339	I	7	2%	2	0	0%	1	7.7	3	0	1	177	52%	2	5	1%	1	84	25%	1
9	743	I	46	6%	4	0	0%	1	4.0	1	1	3	658	89%	4	120	16%	2	333	45%	3
10	2235	I	80	4%	3	118	0%	1	9.5	4	1	3	881	39%	1	164	7%	1	945	42%	2
11	575	I	14	2%	2	0	0%	1	4.2	1	0	1	249	43%	1	82	14%	2	305	53%	3
12	821	I	30	4%	3	0	0%	1	5.2	2	1	3	593	72%	3	207	25%	3	714	87%	4
13	611	I	48	8%	4	0	0%	1	4.2	1	1	3	550	90%	4	291	48%	4	365	60%	3
14	4298	J	199	5%	4	0	0%	1	5.3	2	3	4	1818	42%	1	669	16%	2	2381	55%	3
15	1940	I	105	5%	4	2	0%	2	5.9	2	2	4	1721	89%	4	1023	53%	4	1380	71%	4
16	1506	I	50	3%	3	0	0%	1	4.4	1	1	3	863	57%	2	401	27%	3	956	63%	4
17	843	I	70	8%	4	0	0%	1	5.8	2	2	4	738	88%	4	460	55%	4	670	79%	4
18	1353	I	41	3%	3	41	3%	3	6.4	3	1	3	1165	86%	4	820	61%	4	1080	80%	4
19	1150	I	44	4%	4	0	0%	1	4.9	2	2	4	573	50%	2	405	35%	4	610	53%	3
20	456	H	14	3%	3	0	0%	1	5.8	2	1	3	183	40%	1	74	16%	2	277	61%	4
21	1035	F	38	4%	3	224	22%	4	6.1	2	2	4	848	82%	4	415	40%	4	598	58%	3
22	1047	G	21	2%	2	215	21%	4	11.1	4	0	1	590	56%	2	113	11%	2	262	25%	2
23	2254	I	190	8%	4	68	3%	3	6.2	2	3	4	1383	61%	2	570	25%	3	1001	44%	2
24	817	K	49	6%	4	0	0%	1	3.2	1	0	1	398	49%	2	19	2%	1	166	20%	1
25	362	F	3	1%	1	34	10%	3	11.1	4	0	1	234	65%	3	81	22%	3	149	41%	2
26	537	F	3	1%	1	230	43%	4	17.4	4	0	1	419	78%	3	140	26%	3	166	31%	2
27	864	D	26	3%	2	182	21%	4	5.2	2	1	3	639	74%	3	224	26%	3	253	29%	2
28	1473	E	99	7%	4	141	10%	3	7.7	3	0	1	599	41%	1	153	10%	1	224	15%	1
29	3253	L	55	2%	1	428	13%	3	5.7	2	2	4	2194	67%	3	1161	36%	4	1593	49%	3
30	1490	H	57	4%	3	30	2%	2	4.0	1	0	1	642	43%	1	79	5%	1	388	26%	2
31	538	C	18	3%	3	127	24%	4	7.5	3	0	1	499	93%	4	148	28%	3	196	36%	2
32	451	M	8	2%	1	232	51%	4	31.2	4	0	1	245	54%	2	40	9%	1	60	13%	1
33	865	C	6	1%	1	347	40%	4	11.3	4	1	3	619	72%	3	176	20%	2	227	26%	2
34	652	E	1	0%	1	328	50%	4	15.4	4	0	1	390	60%	2	105	16%	2	147	22%	1
35	1029	L	10	1%	1	120	12%	3	8.6	3	0	1	650	63%	2	234	23%	3	544	53%	3
36	104	C	22	21%	4	30	28%	4	2.6	1	0	1	35	34%	1	23	22%	3	24	23%	1
37	1230	B	23	2%	2	280	23%	4	7.6	3	0	1	674	55%	2	142	12%	2	286	23%	1
38	657	A	7	1%	1	418	64%	4	28.0	4	0	1	102	16%	1	65	10%	1	72	11%	1
39	1196	L	42	4%	3	100	8%	3	9.4	3	0	1	1071	90%	4	586	49%	4	856	72%	4
40	182	L	5	3%	2	20	11%	3	12.1	4	0	1	153	84%	4	100	55%	4	112	61%	4
41	498	L	6	1%	1	48	10%	3	10.0	4	0	1	424	85%	4	176	35%	4	313	63%	4
42	4010	I	99	2%	2	70	2%	2	6.9	3	4	4	2708	68%	3	124	3%	1	1045	26%	2
43	745	I	20	3%	2	0	0%	2	3.7	1	2	4	575	77%	3	237	32%	3	606	81%	4
Total for Source Area	47,801	-	1,698	4%	-	3,863	8%	-	-	-	-	-	29,238	61%	-	10,752	22%	-	22,135	46%	-

Table 8. Cont.

Catchment ID	Human Population (2010)		Human Population Density (2010)		Occupied Housing Units (2010)			Developed Land Sum (gridcodes 2-5)		Natural areas (sum of gridcodes 8-11)		Wetland (sum of gridcodes 12-18)		Human Population (2000)	Population Change (2000-2010)	Estimated number of pet Dogs	Urban Stressor Score	Rural Stressor Score	Overall Stressor Score	Stressor Score Rank
	Persons	Stressor Score	Persons per acre	Stressor Score	Units	Density (units/acre)	Stressor Score	Acres	Percent	Acres	Percent	Acres	Percent	Persons	Persons	Dogs				
1	183	2	0.3	3	71	0.1	3	42	7%	279	47%	133	23%	228	-45	45	15	8	23	10
2	92	1	0.1	1	35	0.1	1	6	1%	178	28%	93	15%	91	1	22	6	10	16	17
3	56	1	0.2	2	23	0.1	2	6	2%	167	53%	80	25%	60	-4	15	7	9	16	17
4	63	1	0.1	1	26	0.0	1	21	4%	136	23%	109	19%	55	8	16	5	12	17	16
5	184	2	0.2	1	71	0.1	1	15	1%	401	36%	216	19%	196	-12	45	8	10	18	15
6	177	2	0.1	1	74	0.0	1	50	3%	172	9%	235	13%	164	14	47	6	15	21	12
7	62	1	0.1	1	27	0.0	1	32	6%	339	61%	74	13%	82	-19	17	8	8	16	18
8	46	1	0.1	1	19	0.1	1	7	2%	147	43%	96	28%	47	0	12	7	7	14	19
9	145	2	0.2	2	60	0.1	2	46	6%	281	38%	80	11%	165	-20	38	8	16	24	9
10	1198	4	0.5	3	471	0.2	3	198	9%	680	30%	382	17%	1189	9	298	15	10	25	8
11	126	1	0.2	2	42	0.1	2	14	2%	151	26%	101	18%	130	-4	27	7	9	16	17
12	133	1	0.2	1	46	0.1	1	30	4%	39	5%	38	5%	94	39	29	6	16	22	11
13	83	1	0.1	1	34	0.1	1	48	8%	183	30%	15	2%	90	-7	21	5	18	23	10
14	964	4	0.2	2	390	0.1	2	199	5%	1176	27%	475	11%	1041	-76	246	11	14	25	8
15	338	3	0.2	2	130	0.1	1	107	6%	374	19%	70	4%	382	-44	82	10	20	30	3
16	264	2	0.2	2	104	0.1	2	50	3%	388	26%	105	7%	274	-9	66	8	15	23	10
17	148	2	0.2	1	53	0.1	1	70	8%	81	10%	15	2%	144	3	33	7	20	27	6
18	390	3	0.3	3	145	0.1	2	82	6%	164	12%	20	1%	447	-57	92	14	18	32	2
19	241	2	0.2	2	89	0.1	2	44	4%	303	26%	180	16%	238	3	56	9	17	26	7
20	96	1	0.2	2	35	0.1	2	14	3%	158	35%	5	1%	88	8	22	8	13	21	13
21	460	3	0.4	3	190	0.2	3	262	25%	140	14%	29	3%	326	134	120	15	18	33	1
22	830	4	0.8	4	358	0.3	4	236	23%	365	35%	50	5%	944	-114	227	20	9	29	4
23	757	3	0.3	3	292	0.1	3	258	11%	683	30%	220	10%	1086	-329	184	14	15	29	4
24	170	2	0.2	2	68	0.1	2	49	6%	379	46%	217	27%	196	-26	43	8	9	17	16
25	433	3	1.2	4	165	0.5	4	37	10%	124	34%	37	10%	465	-32	104	18	10	28	5
26	554	3	1.0	4	282	0.5	4	233	43%	120	22%	17	3%	850	-296	178	19	10	29	4
27	350	3	0.4	4	141	0.2	3	208	24%	354	41%	49	6%	697	-347	89	16	13	29	4
28	918	4	0.6	4	345	0.2	3	240	16%	574	39%	99	7%	1163	-245	218	17	8	25	8
29	1660	4	0.5	3	612	0.2	3	483	15%	932	29%	234	7%	1442	218	387	15	15	30	3
30	492	3	0.3	3	175	0.1	3	87	6%	605	41%	252	17%	536	-44	111	12	8	20	14
31	150	2	0.3	2	59	0.1	3	145	27%	164	30%	31	6%	157	-6	38	14	13	27	6
32	1749	4	3.9	4	576	1.3	4	240	53%	105	23%	36	8%	1843	-93	364	20	6	26	7
33	292	2	0.3	3	126	0.1	3	353	41%	243	28%	38	4%	394	-102	80	16	11	27	6
34	1050	4	1.6	4	364	0.6	4	329	51%	149	23%	22	3%	1177	-127	230	20	7	27	6
35	1032	4	1.0	4	324	0.3	4	130	13%	171	17%	31	3%	1251	-219	205	18	10	28	5
36	0	1	0.0	1	0	0.0	1	52	50%	4	4%	6	6%	0	0	0	8	10	18	15
37	1217	4	1.0	4	455	0.4	4	303	25%	604	49%	28	2%	1237	-20	288	19	8	27	6
38	843	4	1.3	4	339	0.5	4	425	65%	139	21%	15	2%	1156	-313	214	20	5	25	8
39	953	4	0.8	3	375	0.3	4	142	12%	140	12%	35	3%	685	268	237	17	16	33	1
40	115	1	0.6	3	47	0.3	4	25	14%	18	10%	4	2%	111	5	30	15	15	30	3
41	386	3	0.8	4	145	0.3	4	54	11%	95	19%	35	7%	475	-89	92	18	14	32	2
42	772	3	0.2	2	293	0.1	2	169	4%	1932	48%	808	20%	805	-32	185	12	12	24	9
43	150	2	0.2	1	57	0.1	2	20	3%	84	11%	35	5%	127	24	36	8	16	24	9

Figure 1. Daily geometric means for MDEQ sites (small tributaries) and dates sampled in 2009, and precipitation (in inches) for the 24-hour period prior to sampling.

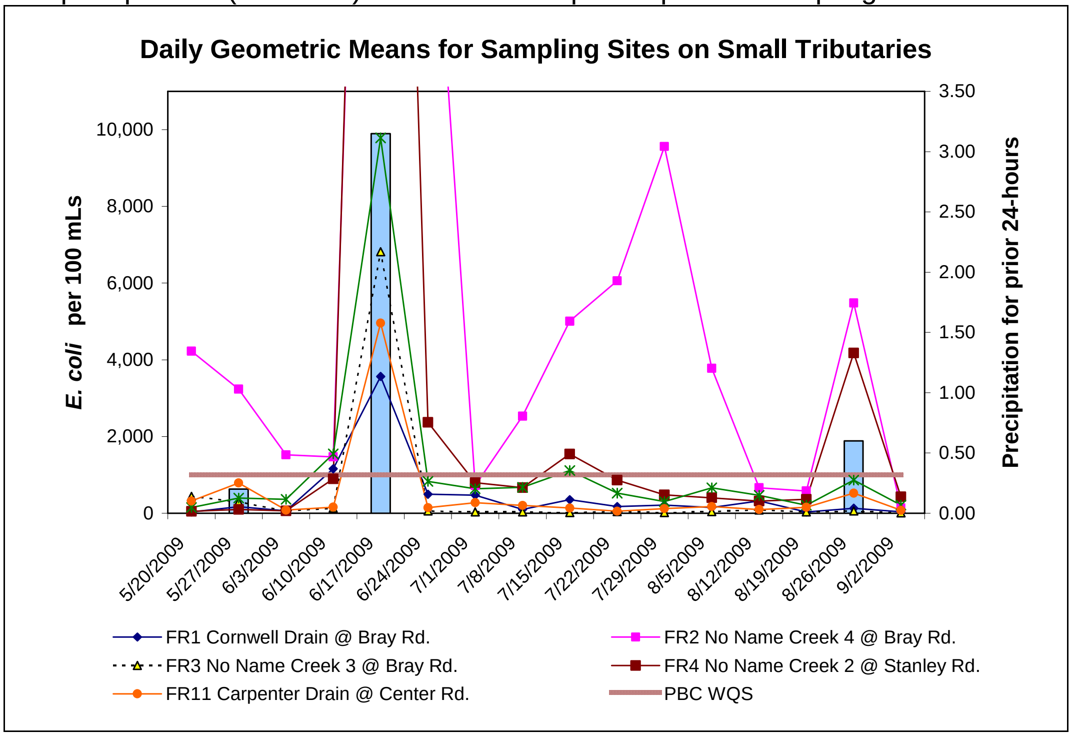


Figure 2. Daily geometric means for MDEQ sites (large tributaries) and dates sampled in 2009, and precipitation (in inches) for the 24-hour period prior to sampling.

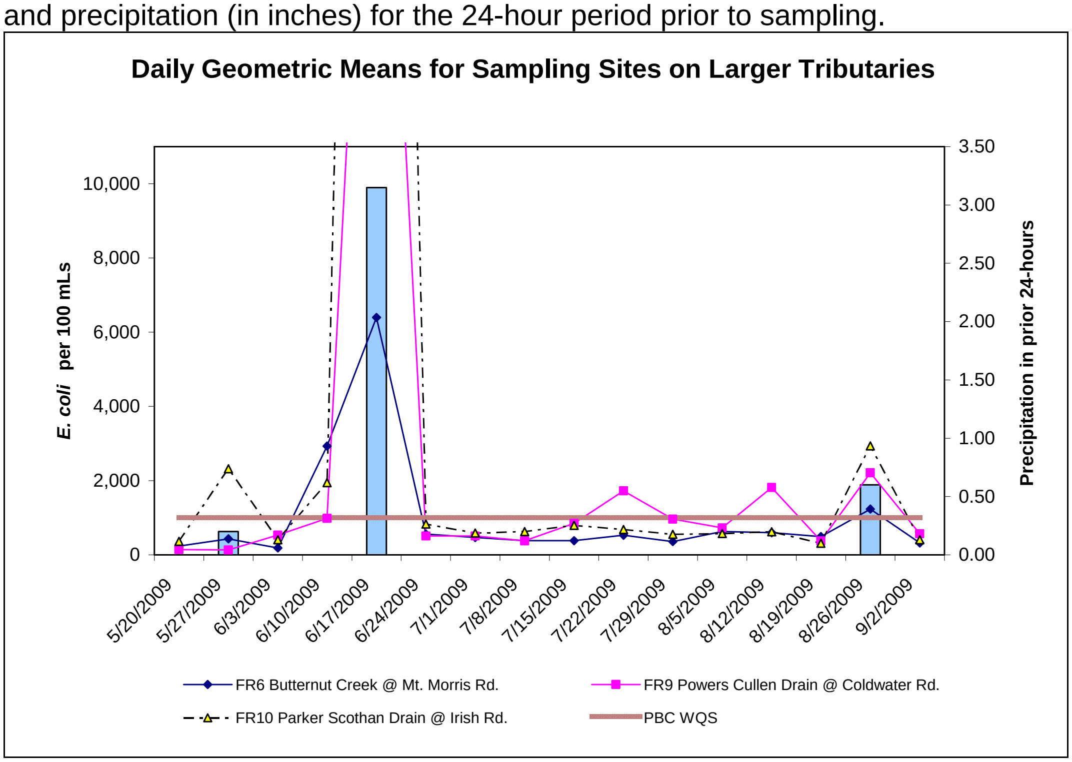


Figure 3. Daily geometric means for MDEQ sites (Flint River and Mott Lake) and dates sampled in 2009, and precipitation (in inches) for the 24-hour period prior to sampling.

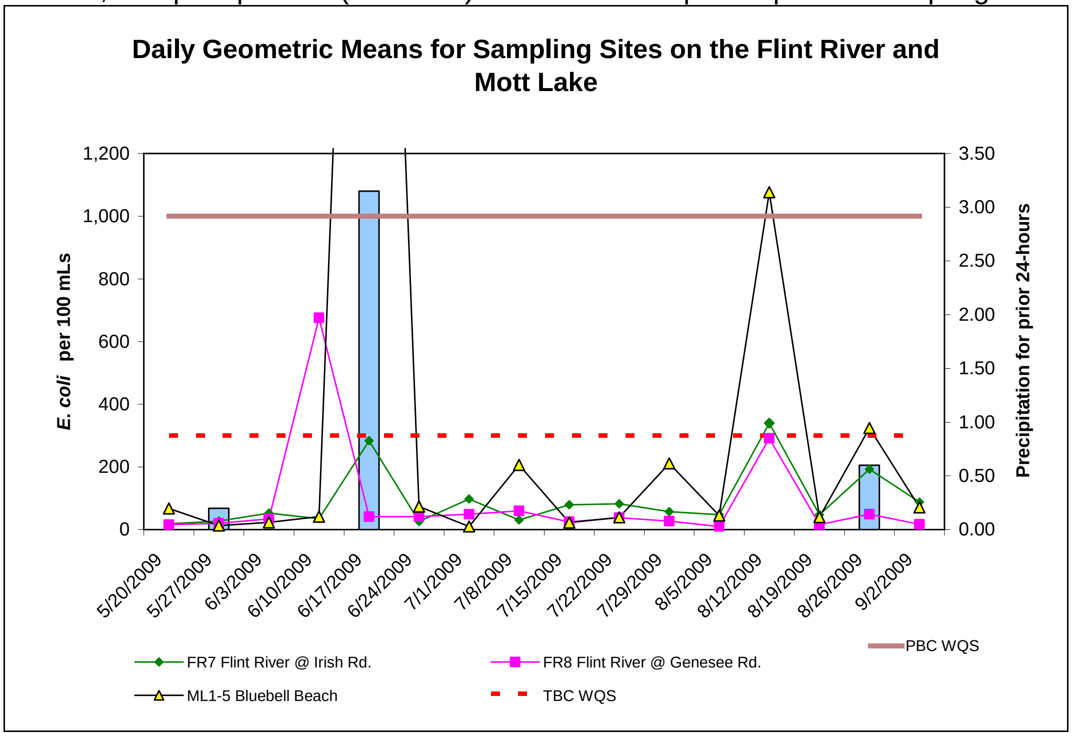


Figure 4. Thirty-day geometric means for MDEQ sites (small tributaries) and dates sampled in 2009, and precipitation (in inches) for the 24-hour period prior to sampling.

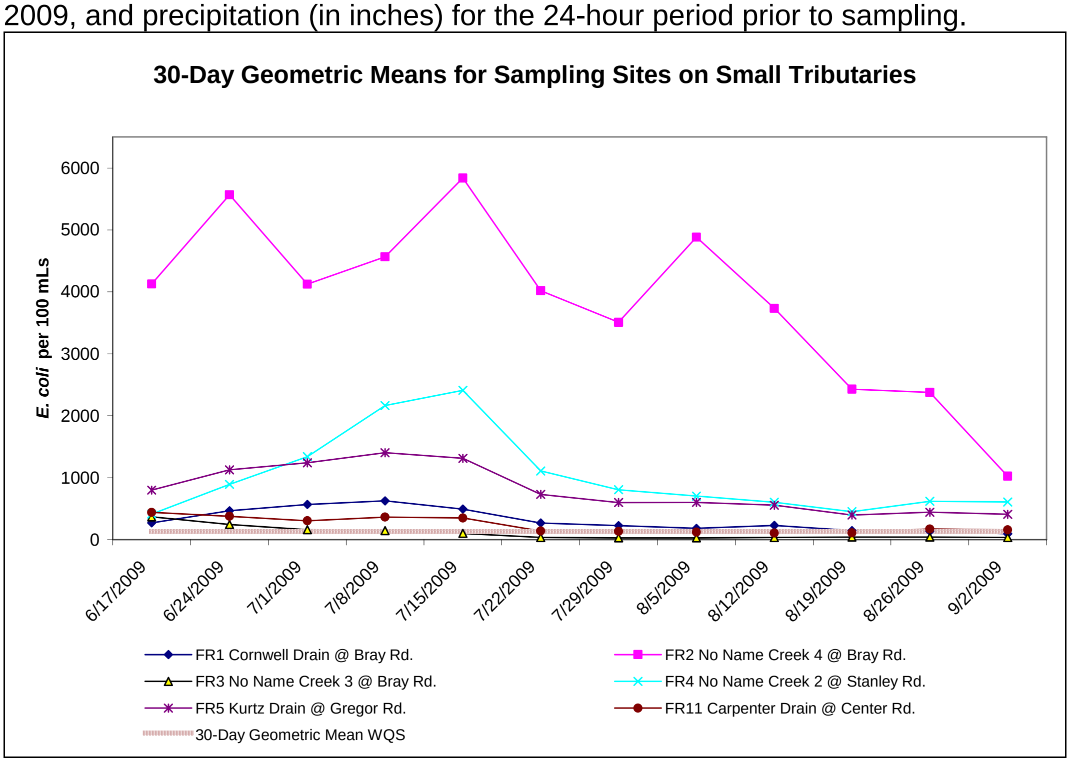


Figure 5. Thirty-day geometric means for MDEQ sites (large tributaries) and dates sampled in 2009, and precipitation (in inches) for the 24-hour period prior to sampling.

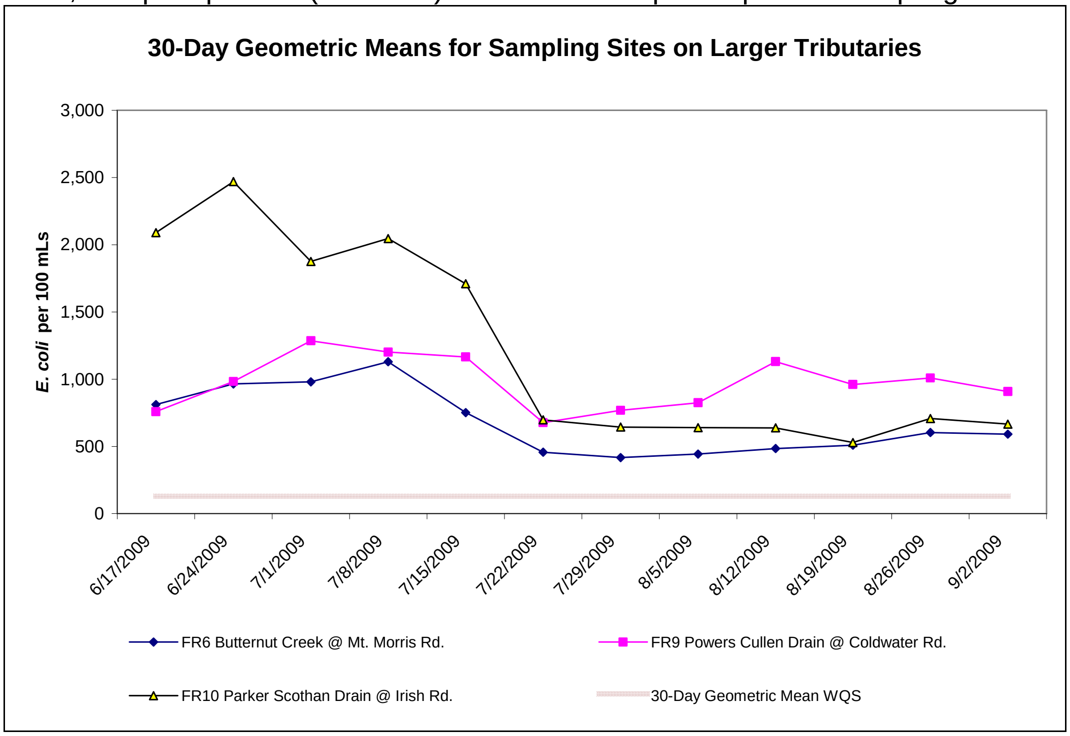
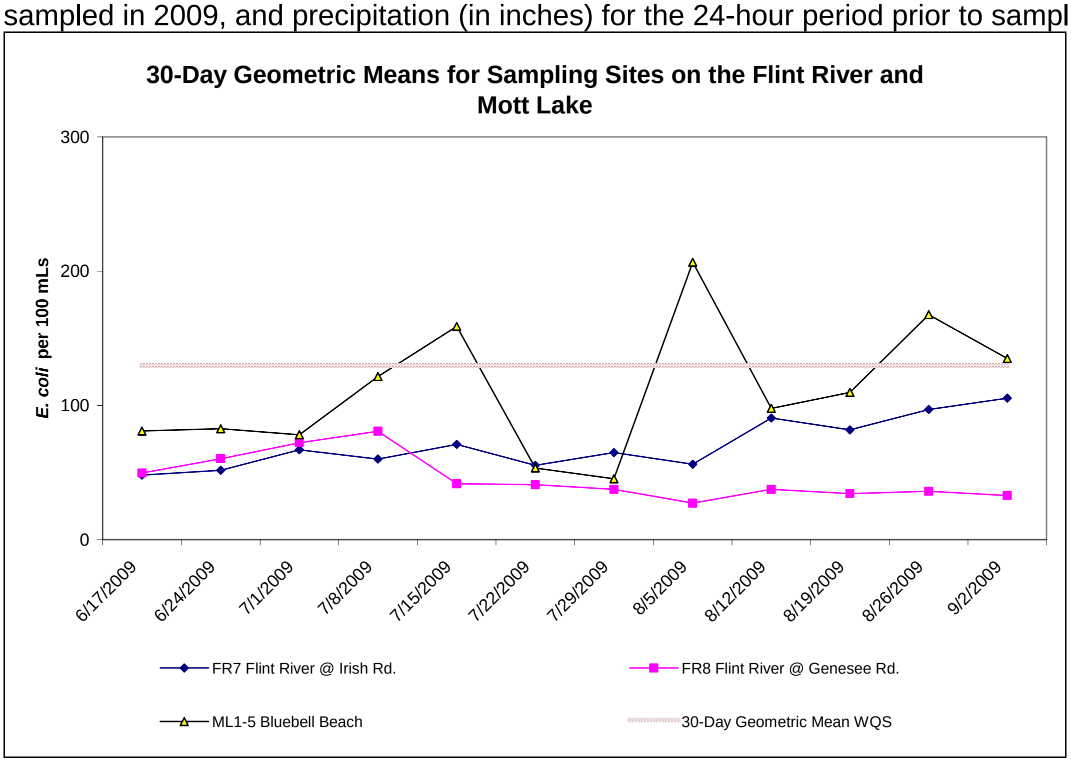


Figure 6. Thirty-day geometric means for MDEQ sites (Flint River and Mott Lake) and dates sampled in 2009, and precipitation (in inches) for the 24-hour period prior to sampling.



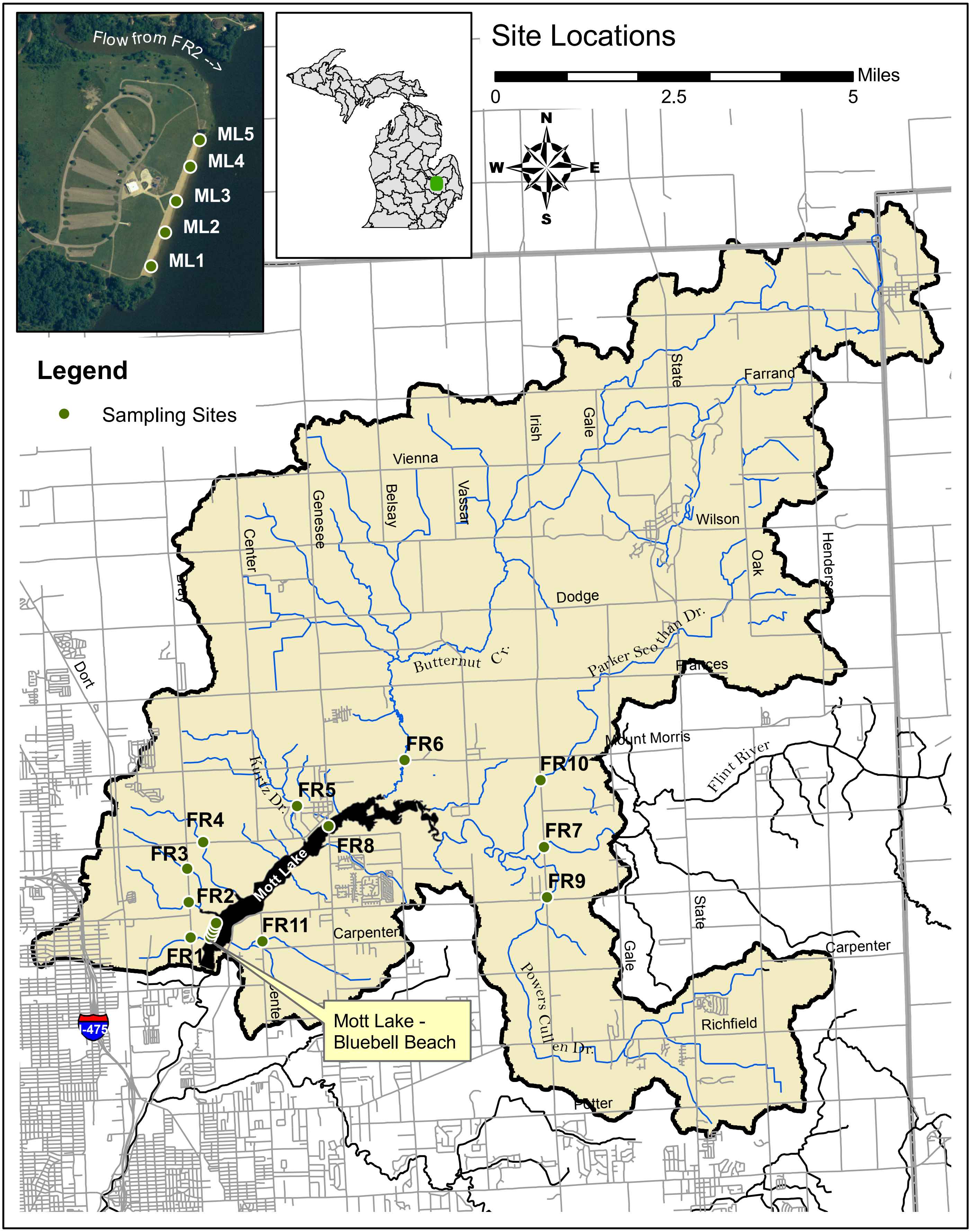


Figure M-1. Map of the C.S. Mott Lake - Bluebell Beach TMDL source watershed area, sampling sites and beach location (inset).

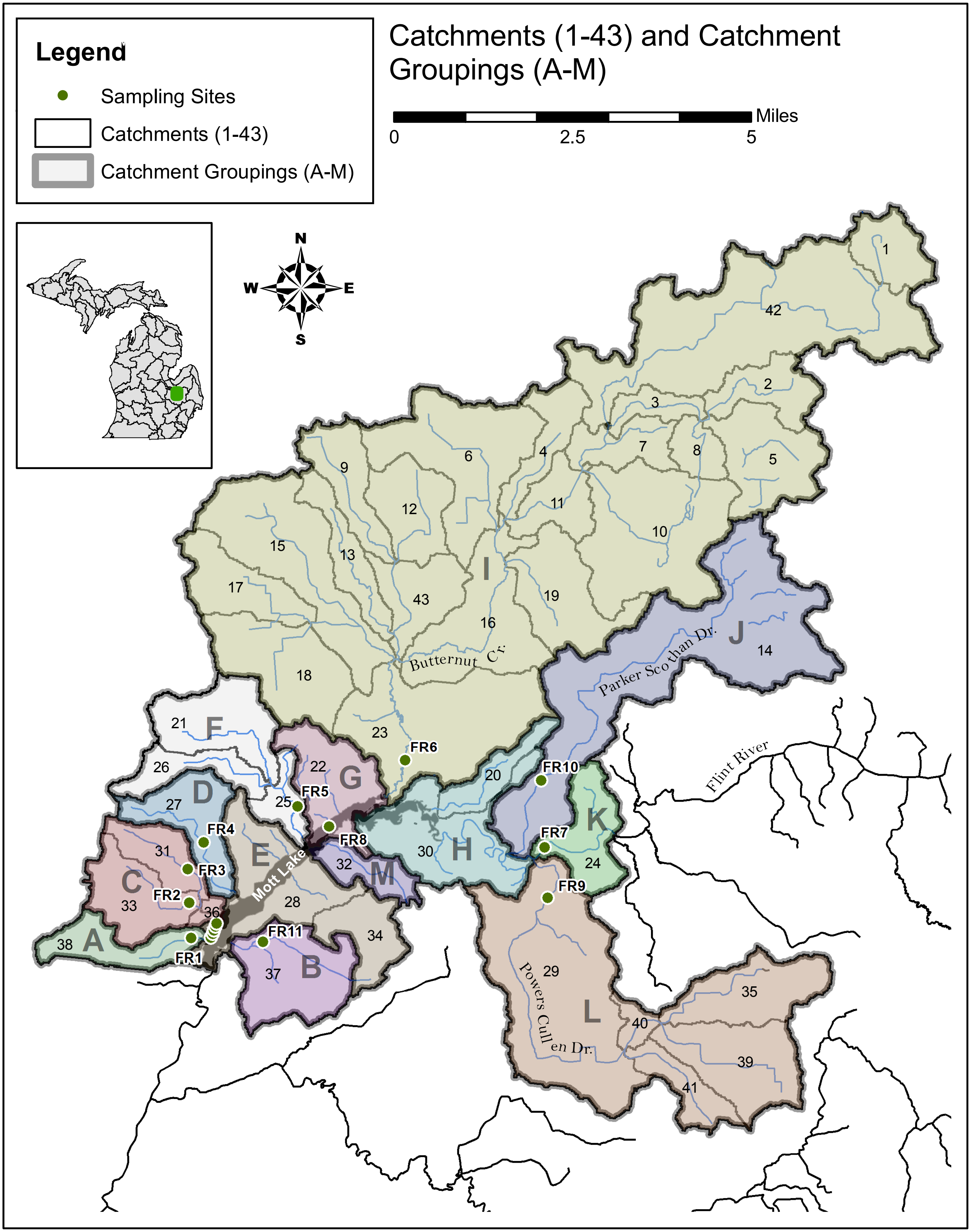


Figure M-2. Locations of catchments (1-43), catchment groupings (A-M) and sampling sites within the source area.

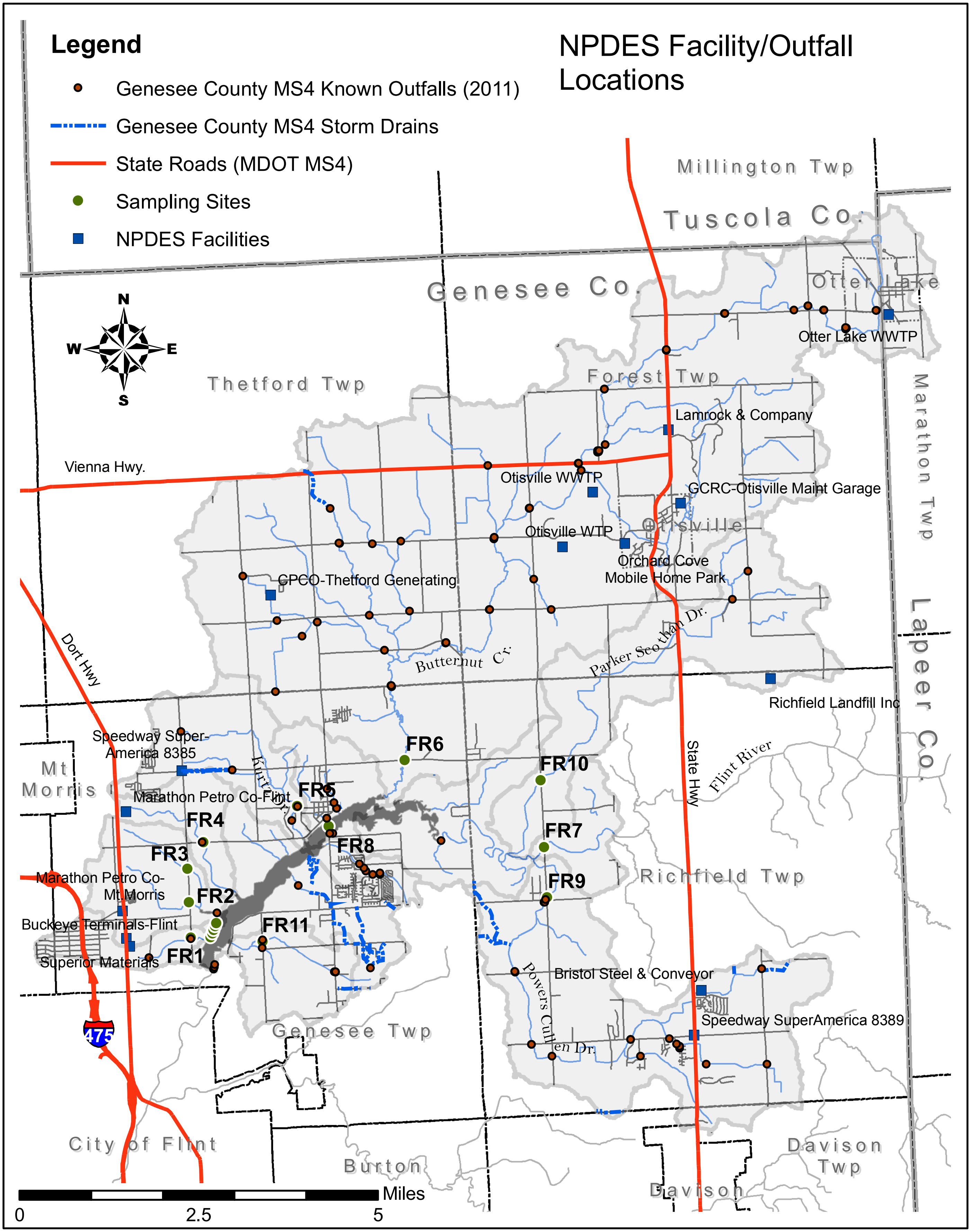


Figure M-3: Map of NPDES permitted facilities with discharges in the TMDL source area, sampling sites, state roads (MDOT MS4), Genesee County MS4 storm drains and outfalls, civil divisions and the villages of Otisville and Otter Lake.

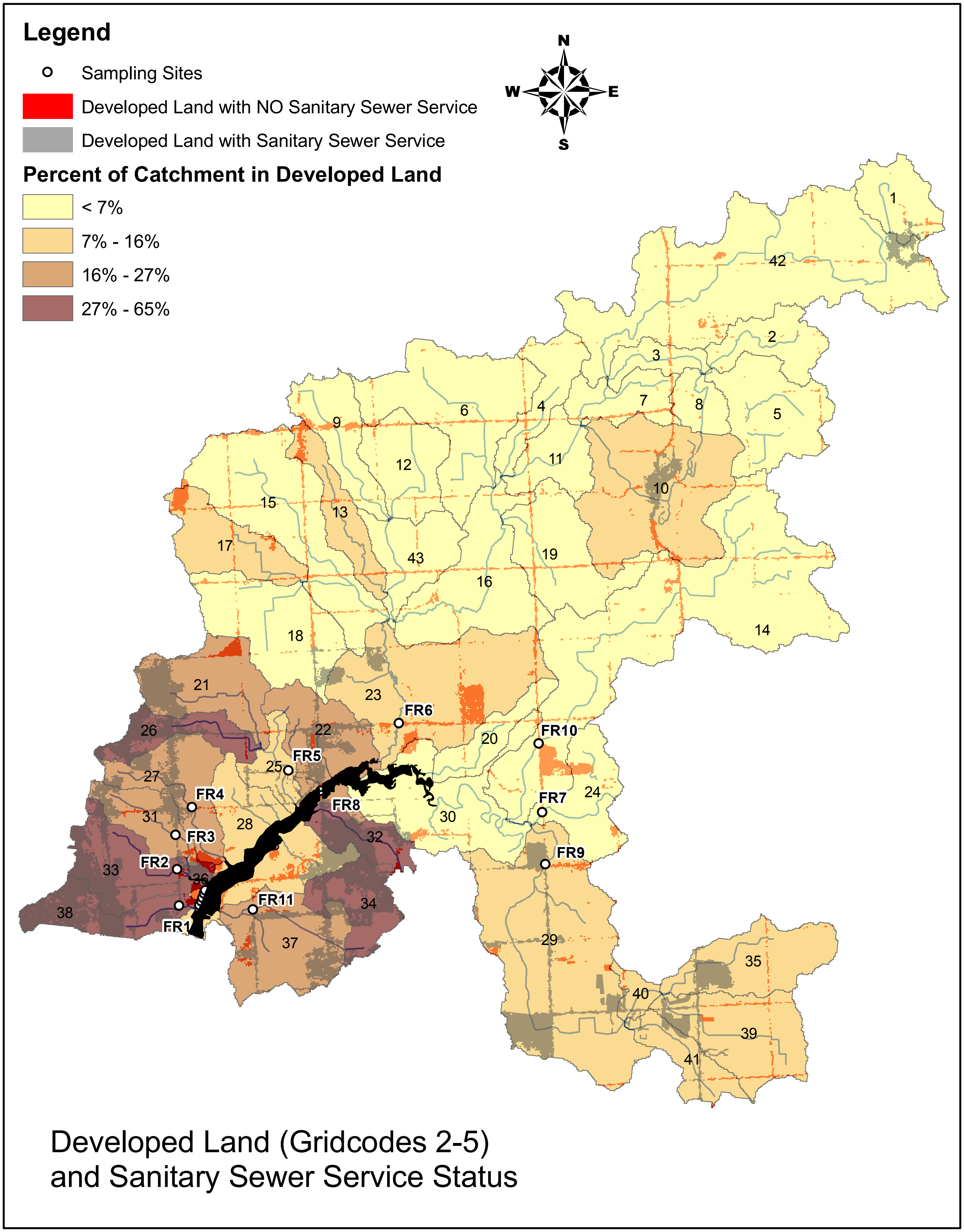


Figure M-4. Developed land is classified according to sanitary sewer service availability. Areas with no sanitary sewer available rely on on-site sewage disposal systems (OSDS) for sanitary waste treatment. Catchments are color coded to indicate the percent of land cover that is developed (high, medium, low and open space).

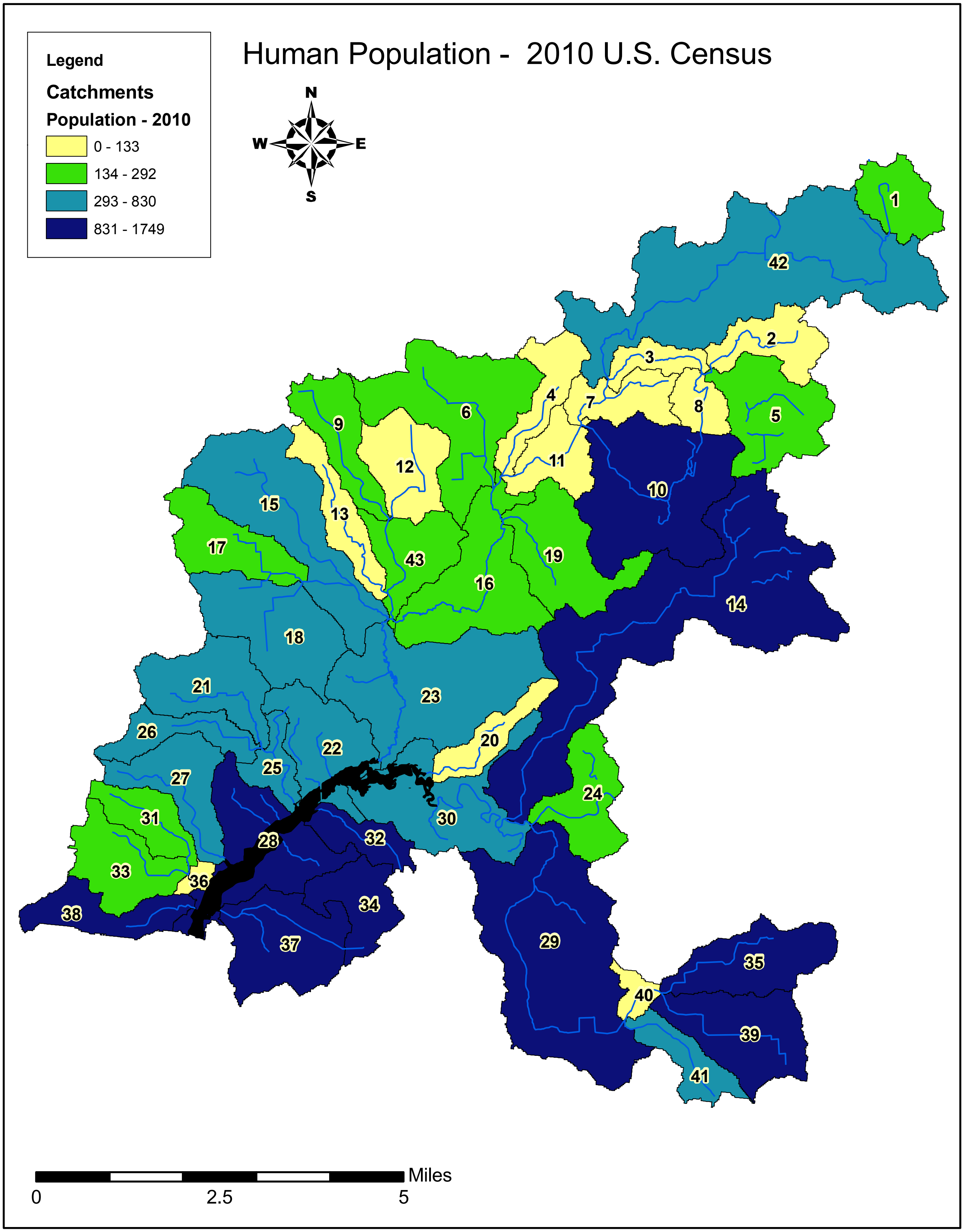


Figure M-5. Approximate human population of each catchment according the the 2010 Census (US Census Bureau, 2010a and 2010b).

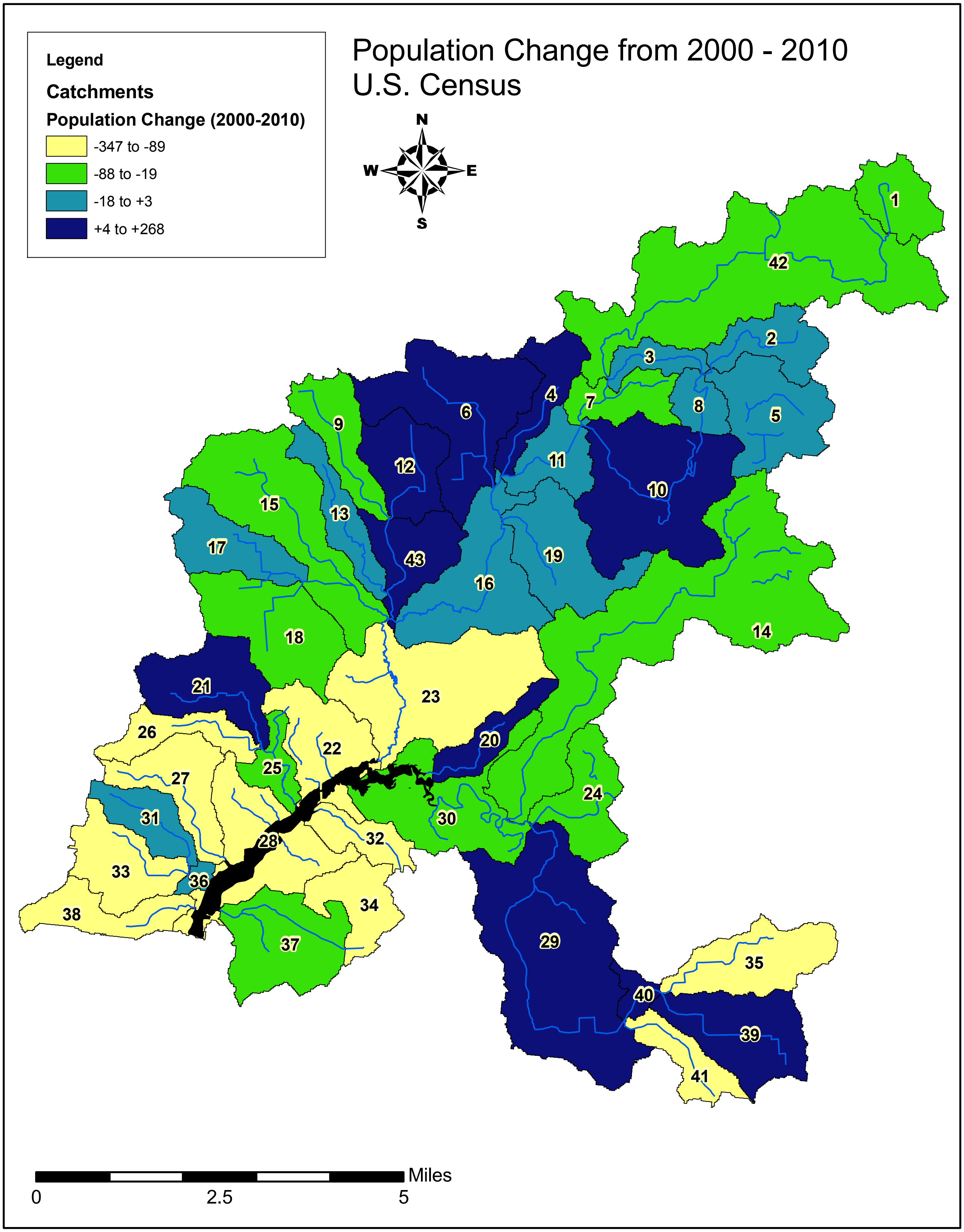


Figure M-6. Change in human population between the 2000 and 2010 U.S. Census (2000a, 200b, 2010a and 2010b). An overall population decrease of approximately 2,000 people occurred during this time-frame in the TMDL source area.

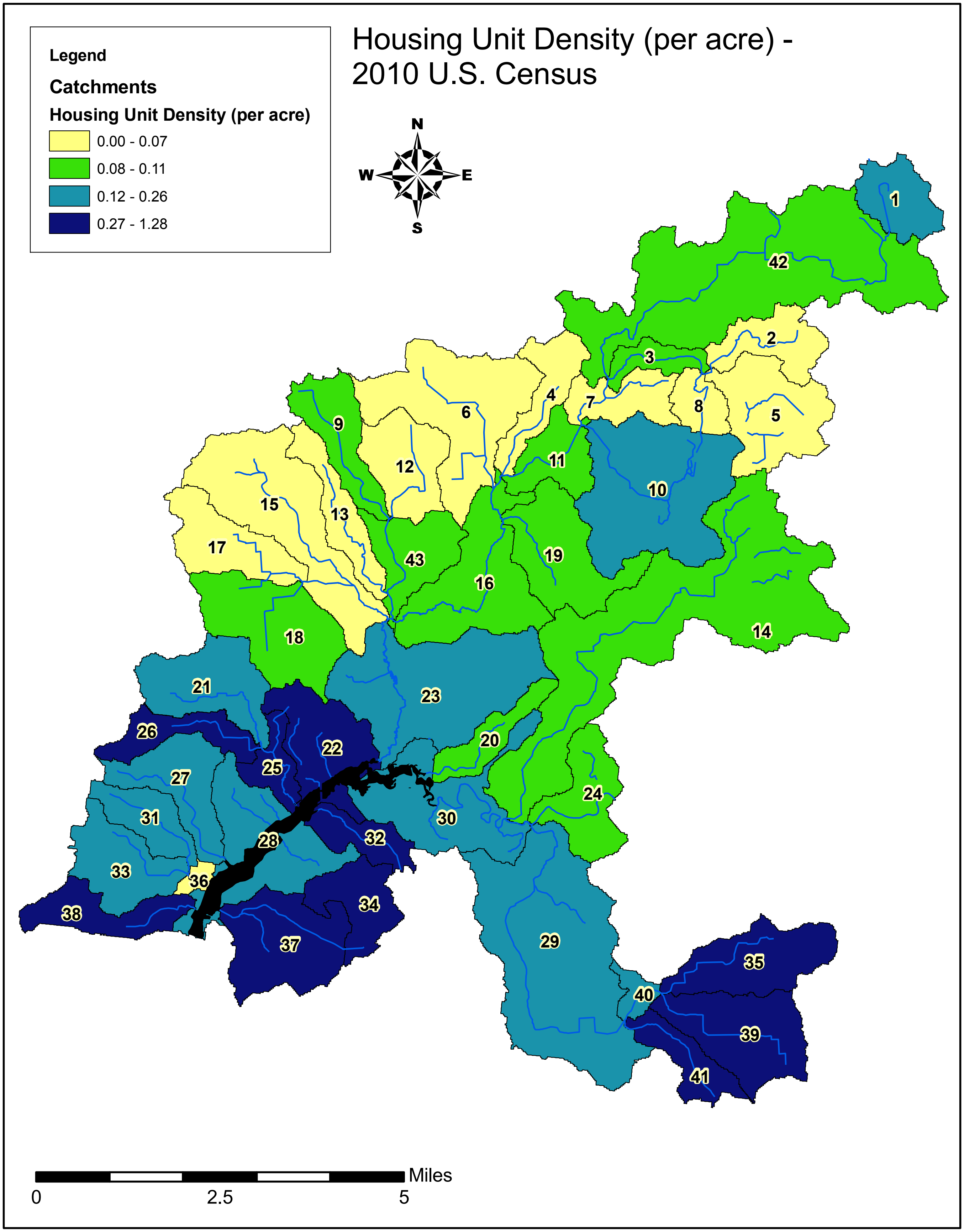


Figure M-7. Density of occupied housing units (units per acre) in the TMDL source area (US Census Bureau, 2010a and 2010b).

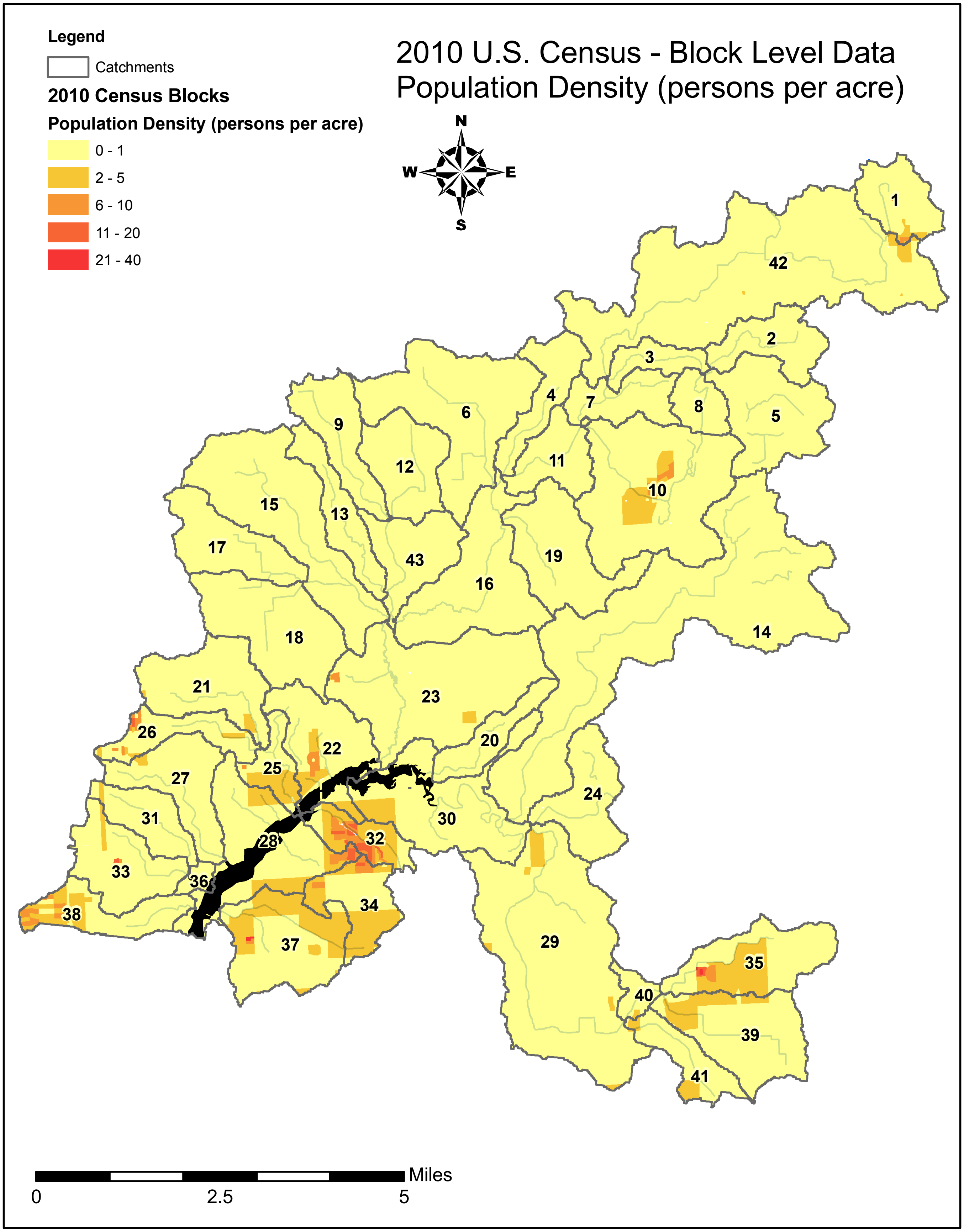


Figure M-8. Population density (people per acre) for each 2010 Census block (US Census Bureau 2010a and 2010b).

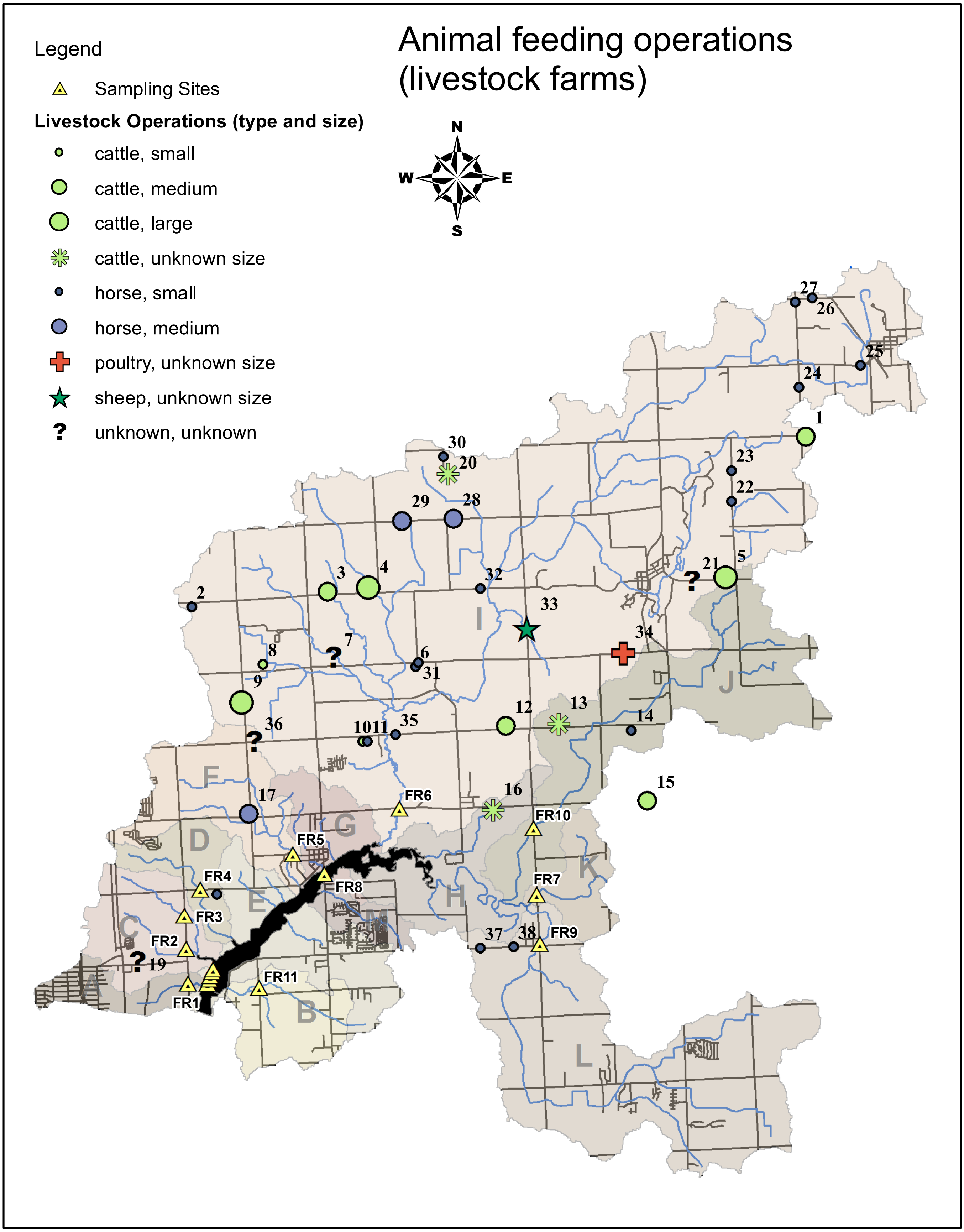


Figure M-9. Animal feeding operations by type of livestock and estimated operation size, based on visual observations.

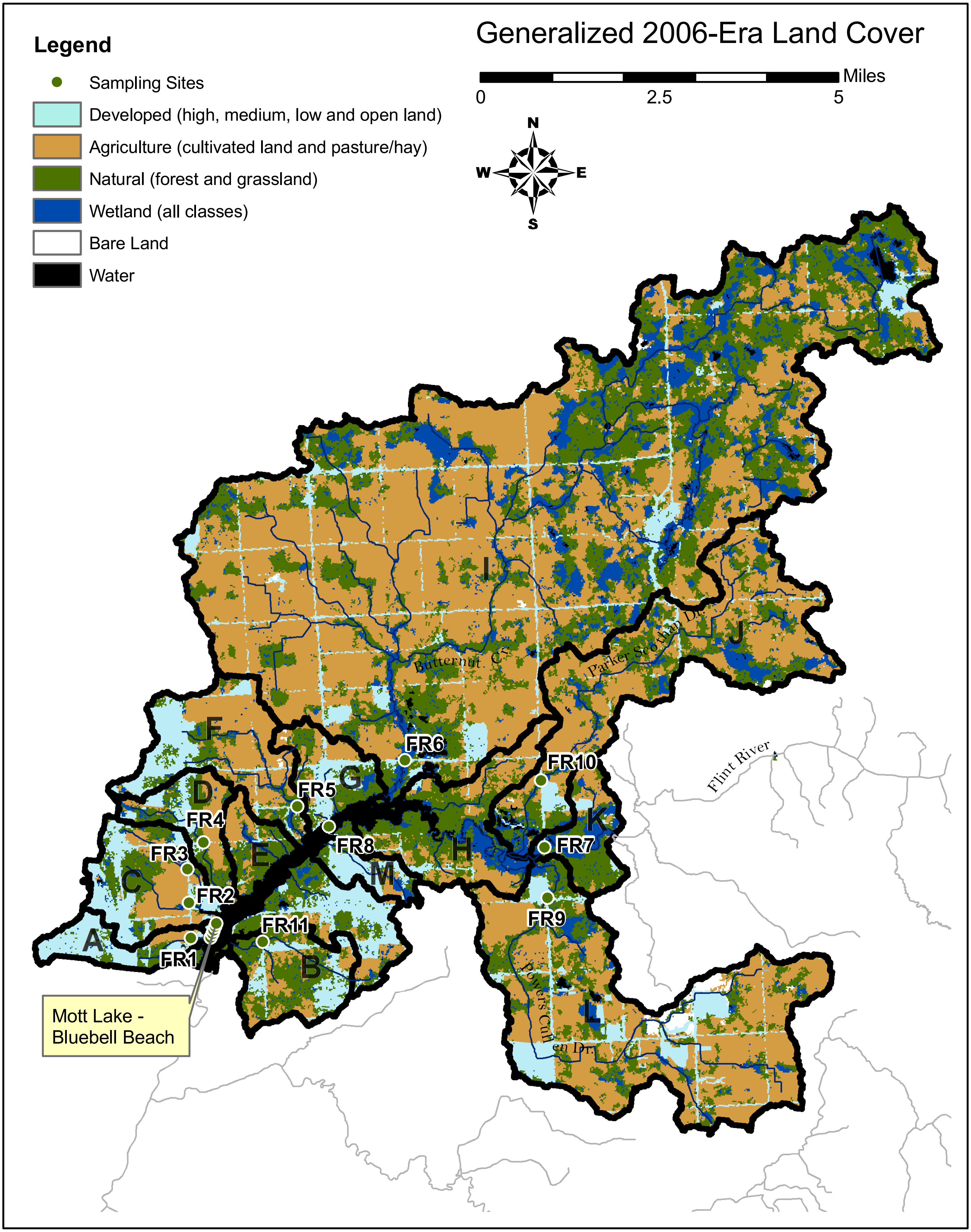


Figure M-10. Generalized 2006-Era Land Cover Data (NOAA, 2008b) by catchment grouping.

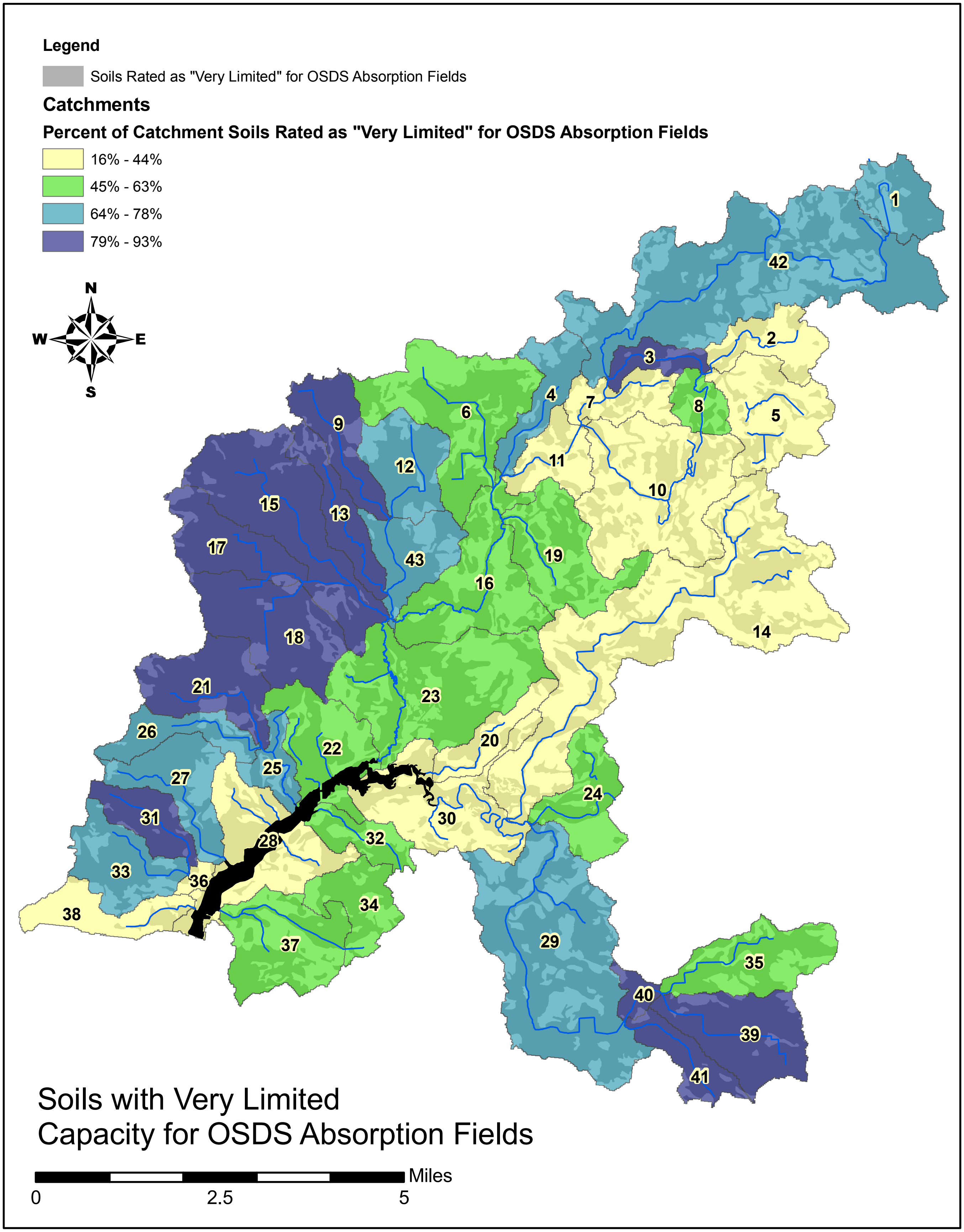


Figure M-11. Percentage of soils with very limited capacity for OSDS absorption fields (poor drainage) in each catchment. The location of a housing unit with an OSDS on these poorly drained soils may indicate an increased risk for certain types of OSDS failures.

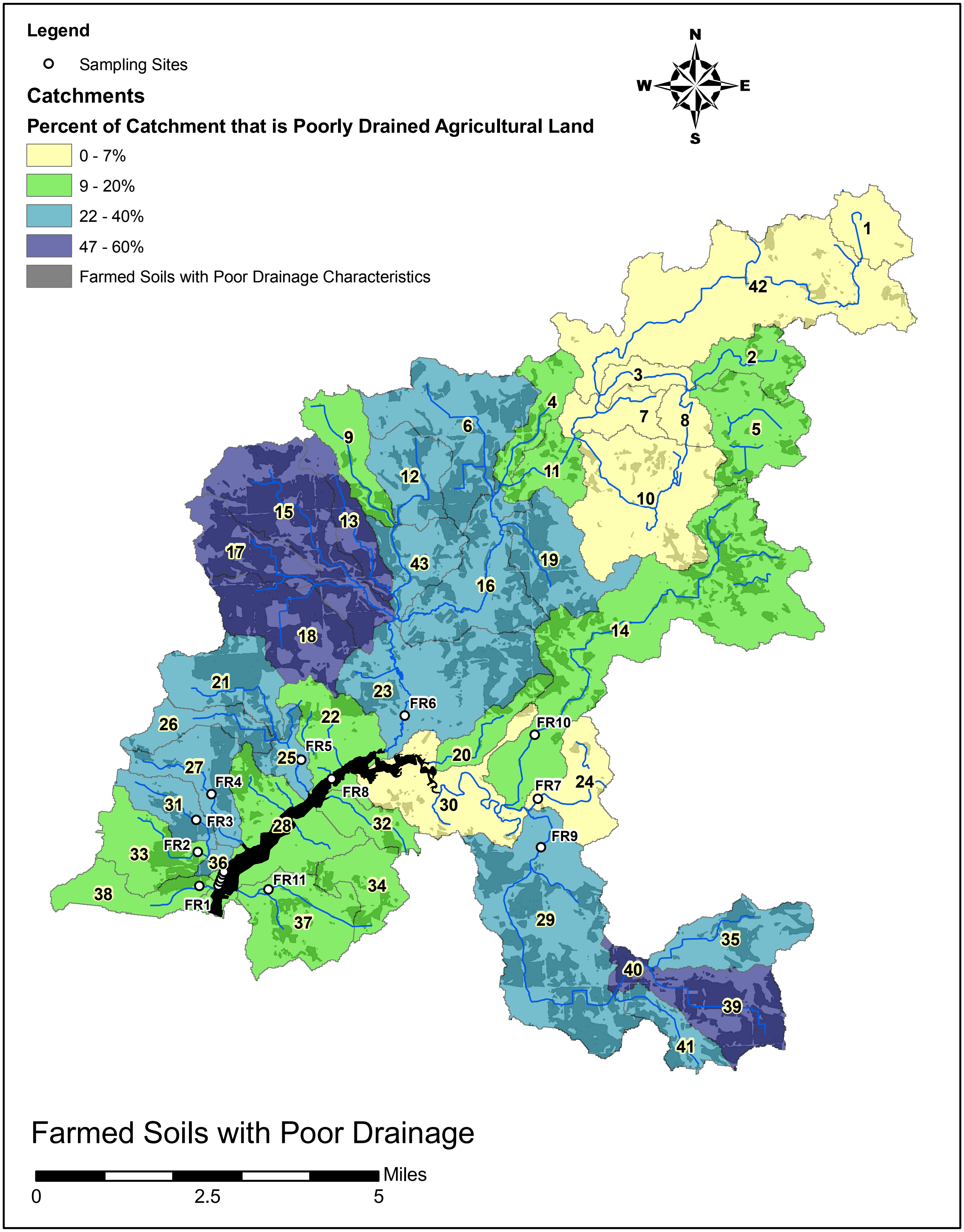
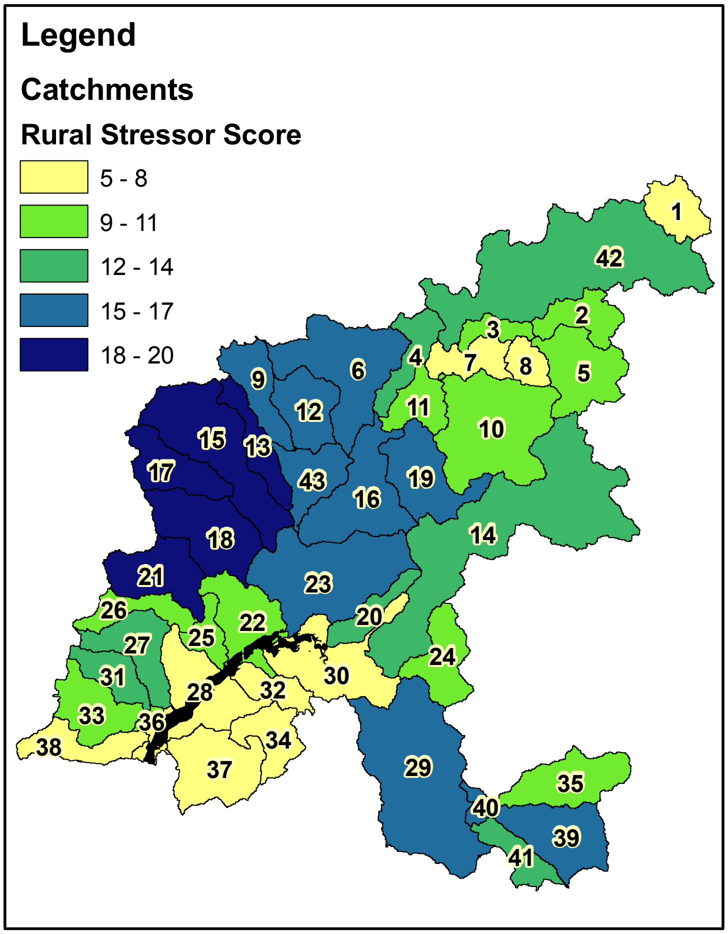
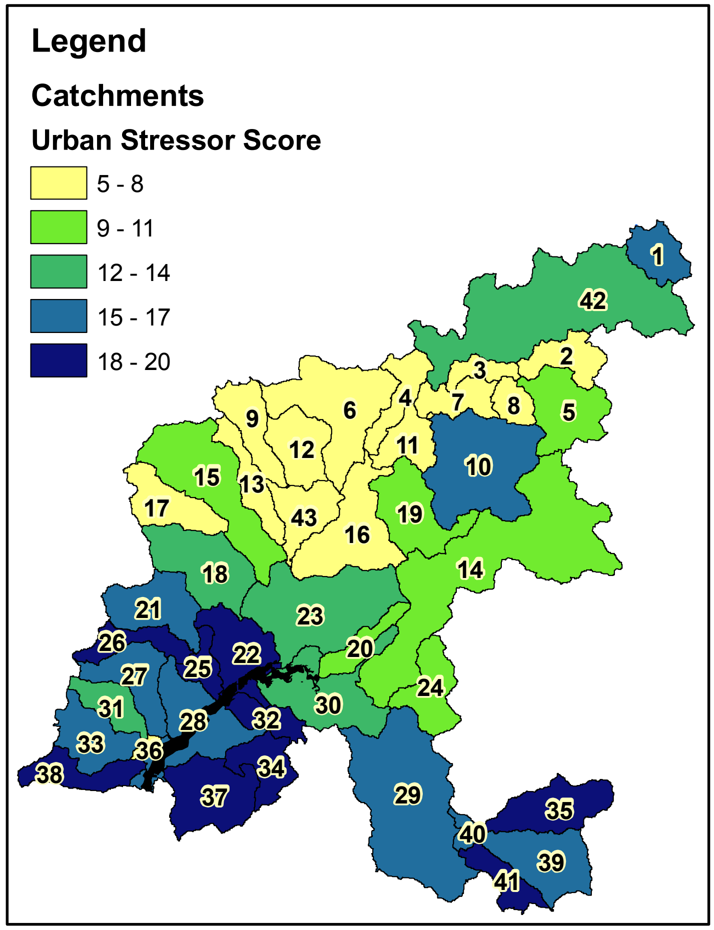
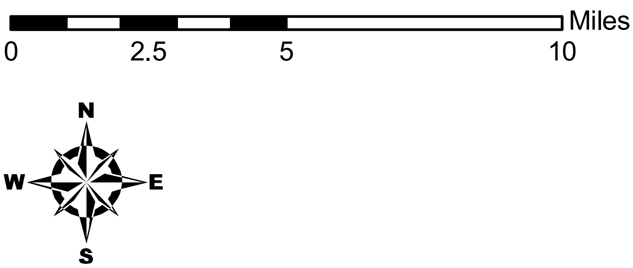


Figure M-12. The percent of each catchment which is farmed on poorly drained soils is represented in this map. For the purposes of crop production, poorly drained soils are defined as requiring artificial drainage to obtain prime farmland condition. Agricultural land cover classes (NOAA, 2008b) overlapping with poorly drained soils are indicated by shading.





Rural, Urban and Overall Stressor Scores for Catchments



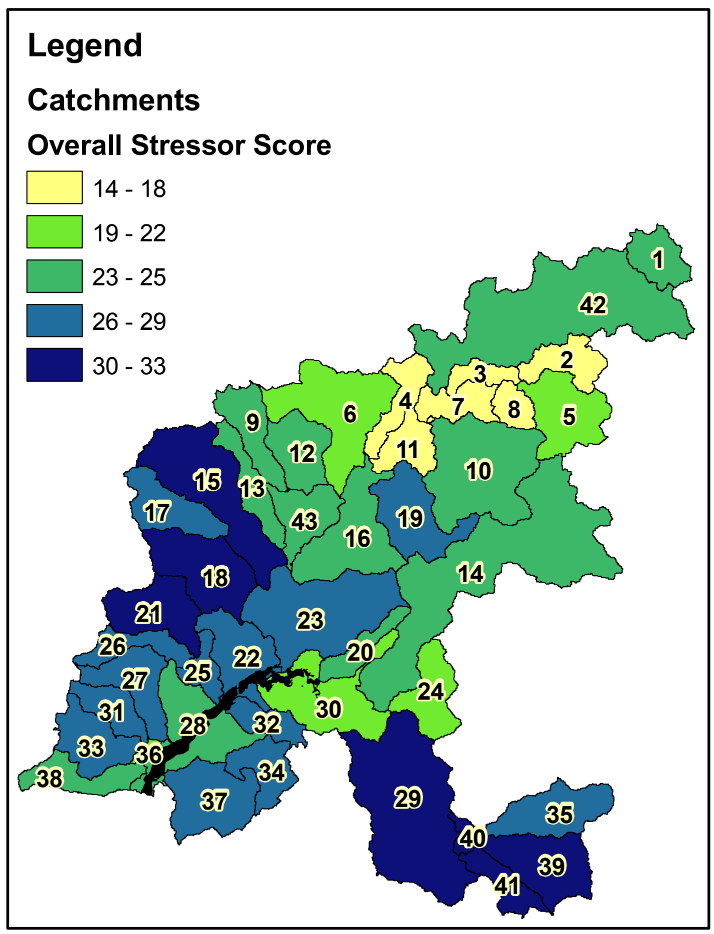


Figure M-13. Rural, urban and overall stressor scores for each catchment were calculated as described in the Methods section, and in Table 8. A higher stressor score (dark blue) indicates that a catchment has a number of risk factors which make the area a likely contributor to E. coli contamination, and would therefore be a priority for potential future implementation activities.

Appendix 1. Complete list of AUIDs proposed to be listed as Category 4a (not attaining the TBC and PBC designated uses due to *E. coli,* TMDL completed) in the 2012 Sections 303(d), 305(b), and 314 Integrated Report.

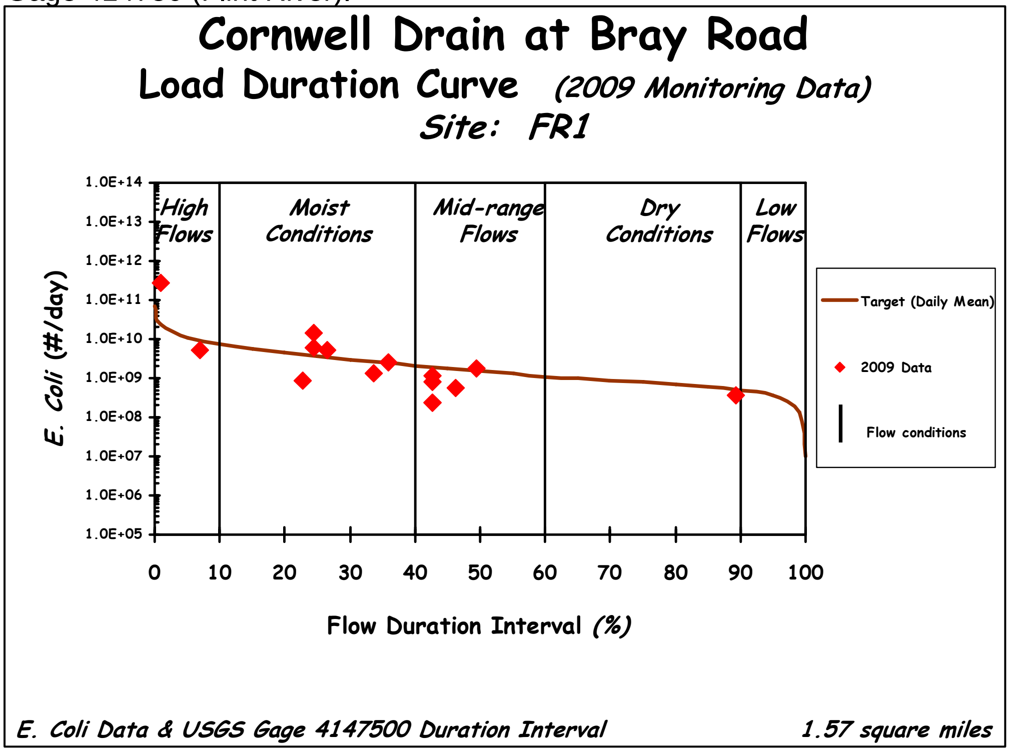
Stream Assessment Units		Sampling Site	2010 Listing Category		
AUID	WATER NAME	representing AUID	PBC WQS	TBC WQS	Length (miles)
040802040407-01	Butternut Creek	FR6	3n	3n	46.5
040802040409-02	Direct drainage to Mott Lake	FR1-5 and 11	3n	3n	21.1
040802040409-03	Powers Cullen Drain	FR9	3n	3n	13.4
040802040409-04	Parker Scothan Drain	FR10	3n	3n	15.2

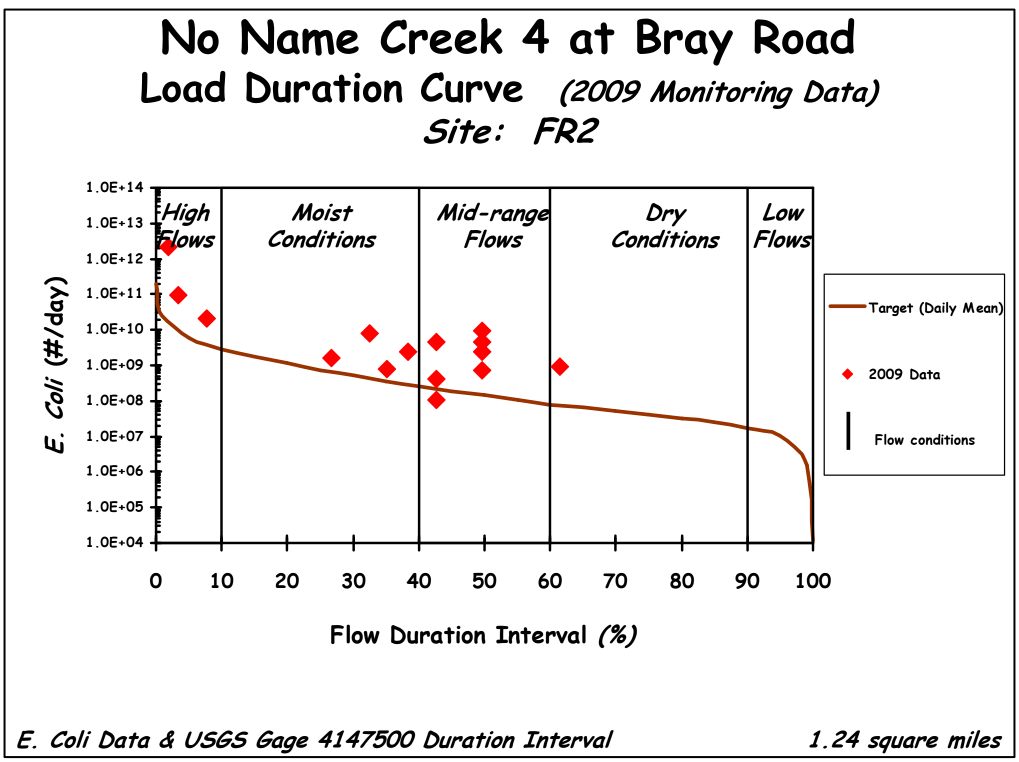
Point Assessment Units		Sampling Site	2010 Listing Category			
AUID	WATER NAME	representing AUID	PBC WQS	TBC WQS	LATITUDE	LONGITUDE
040802040409-05	C.S. MOTT LAKE BLUEBELL BEACH	ML1-5	2	5	43.0872	-83.6502
040802040409-06	C.S. MOTT LAKE BLUEGILL BOAT RAMP BEACH	ML1-5, FR7	2	3i	43.0967	-83.6303

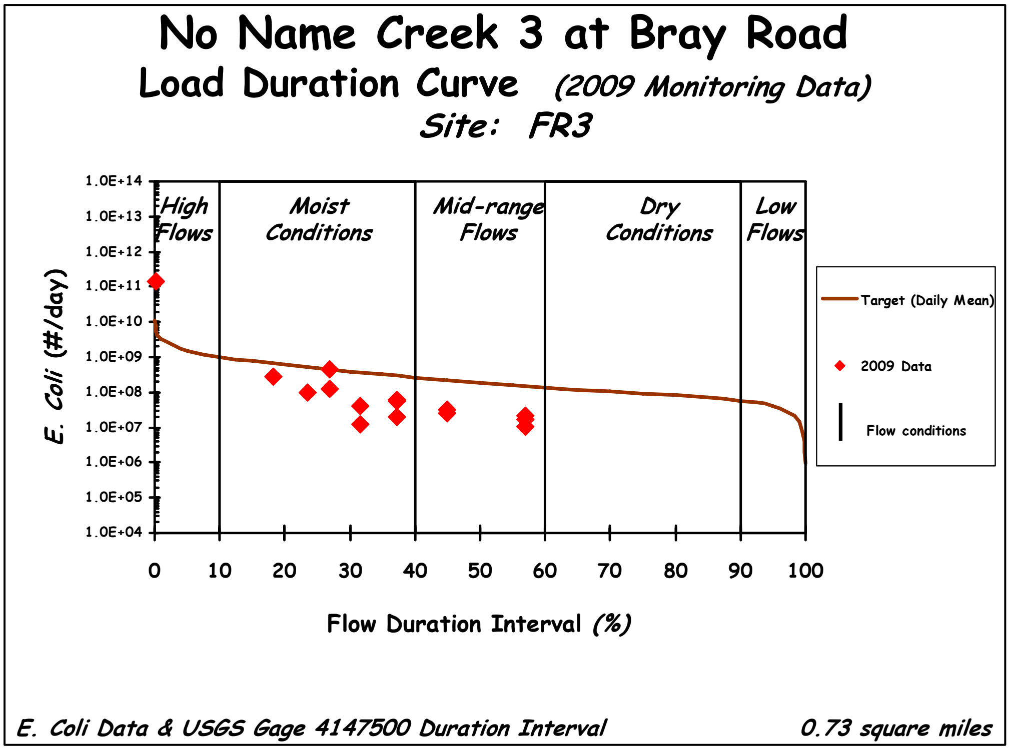
Lake Assessment Units		Sampling Site	2010 Listing	
AUID	WATER NAME	representing AUID	PBC WQS	TBC WQS
040802040409-08	C. S. MOTT LAKE (RESERVOIR)	ML1-5, FR7	3n	3n

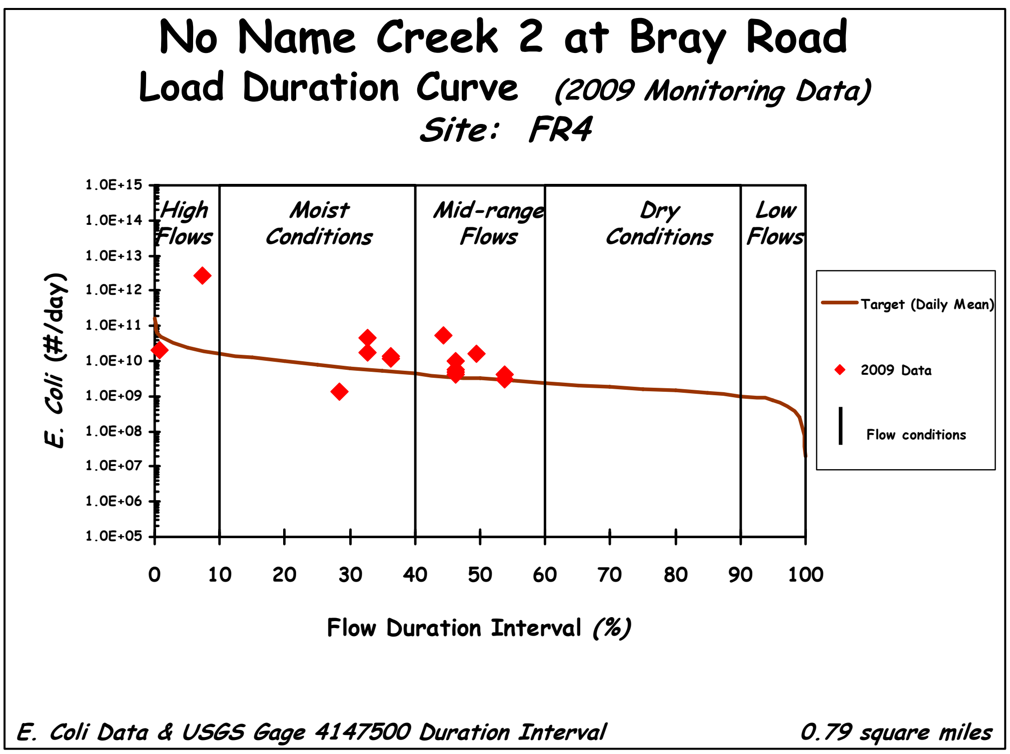
2 - Category 2 - Attaining use
3n - Category 3 - Use not assessed
3i - Category 3 - insufficient information
5 - Category 5 - Not attaining use, TMDL required

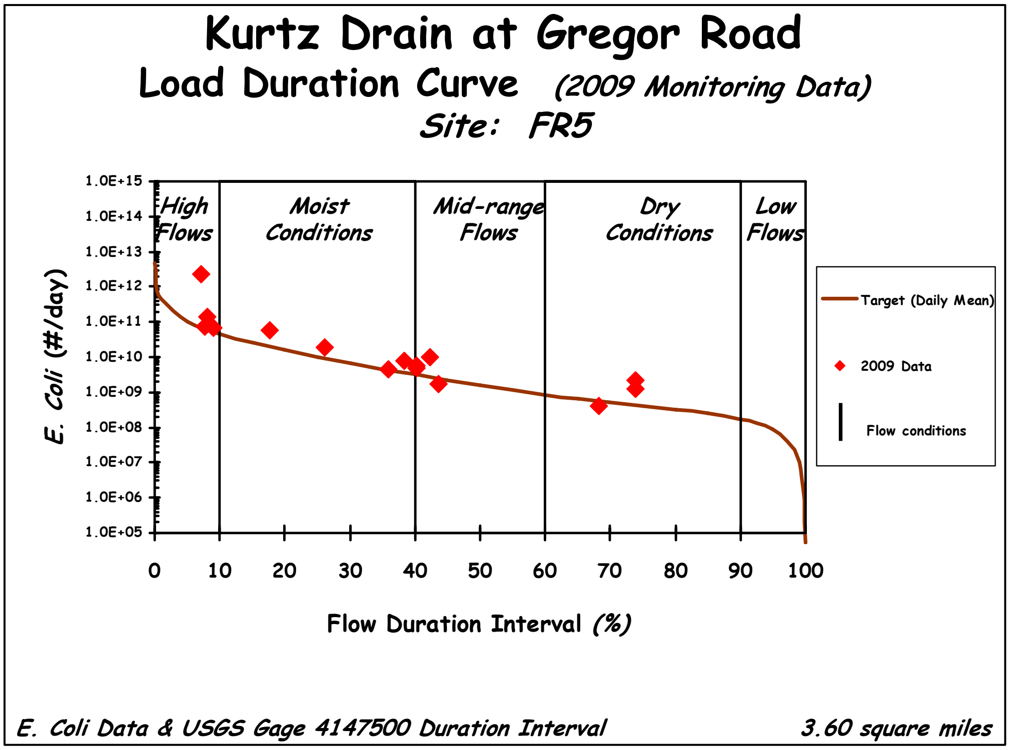
Appendix 2. Load duration curves for each site (FR1 through FR11) developed from 2009 MDEQ *E. coli* monitoring data, and relative water level elevations correlated with USGS Gage 414750 (Flint River).



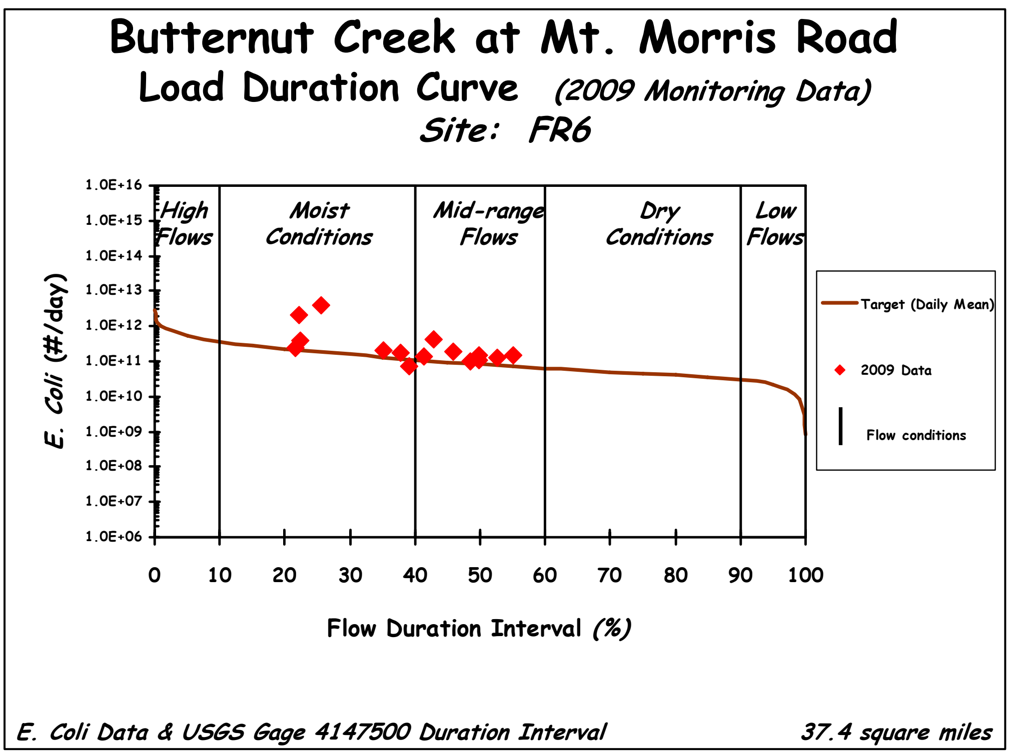



No Name Creek 3 at Bray Road
Load Duration Curve (2009 Monitoring Data)
Site: FR3
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
Target (Daily Mean)
2009 Data
Flow conditions
E. Coli (#/day)
Flow Duration Interval (%)
E. Coli Data & USGS Gage 4147500 Duration Interval
0.73 square miles

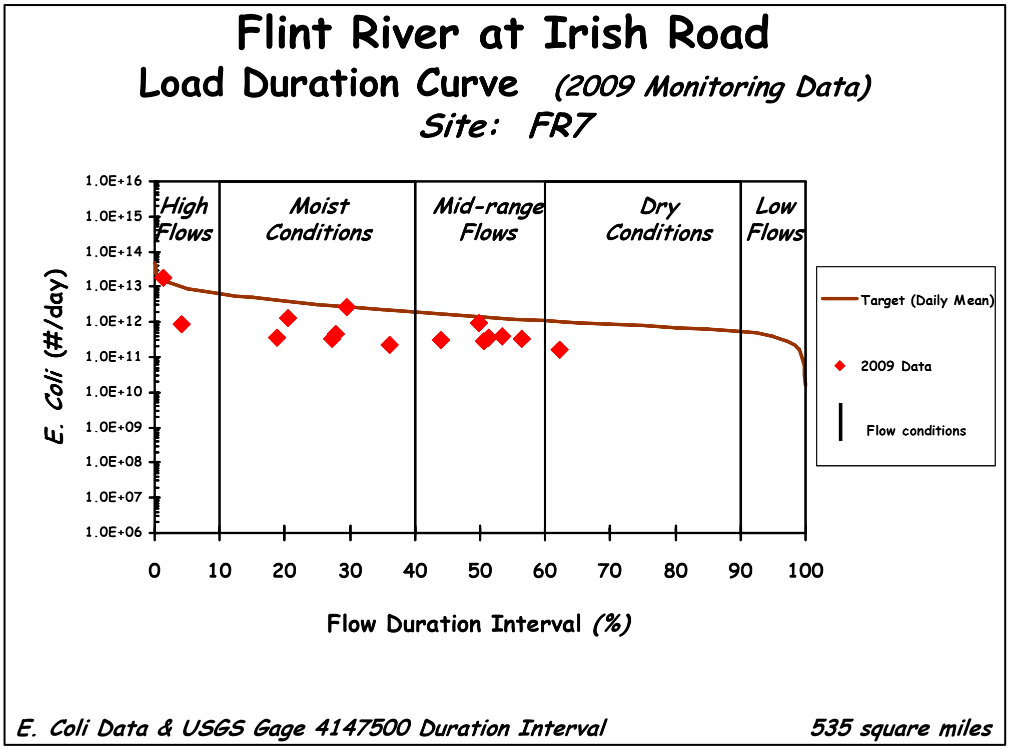

No Name Creek 2 at Bray Road
Load Duration Curve (2009 Monitoring Data)
Site: FR4
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
Target (Daily Mean)
2009 Data
Flow conditions
E. Coli (#/day)
Flow Duration Interval (%)
E. Coli Data & USGS Gage 4147500 Duration Interval
0.79 square miles

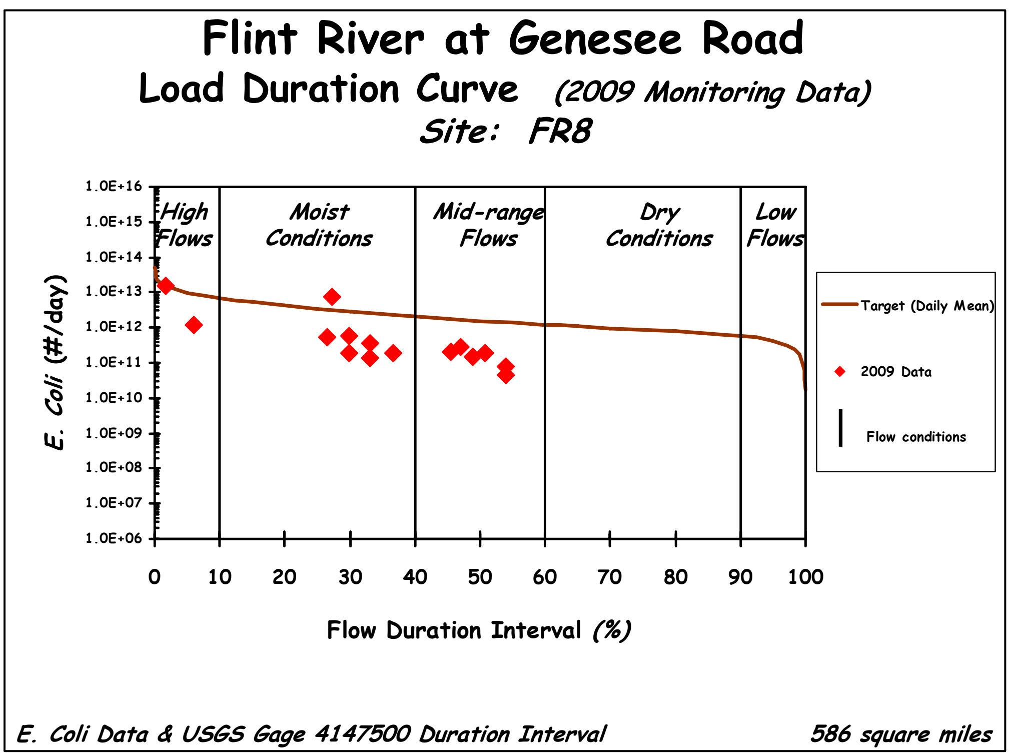


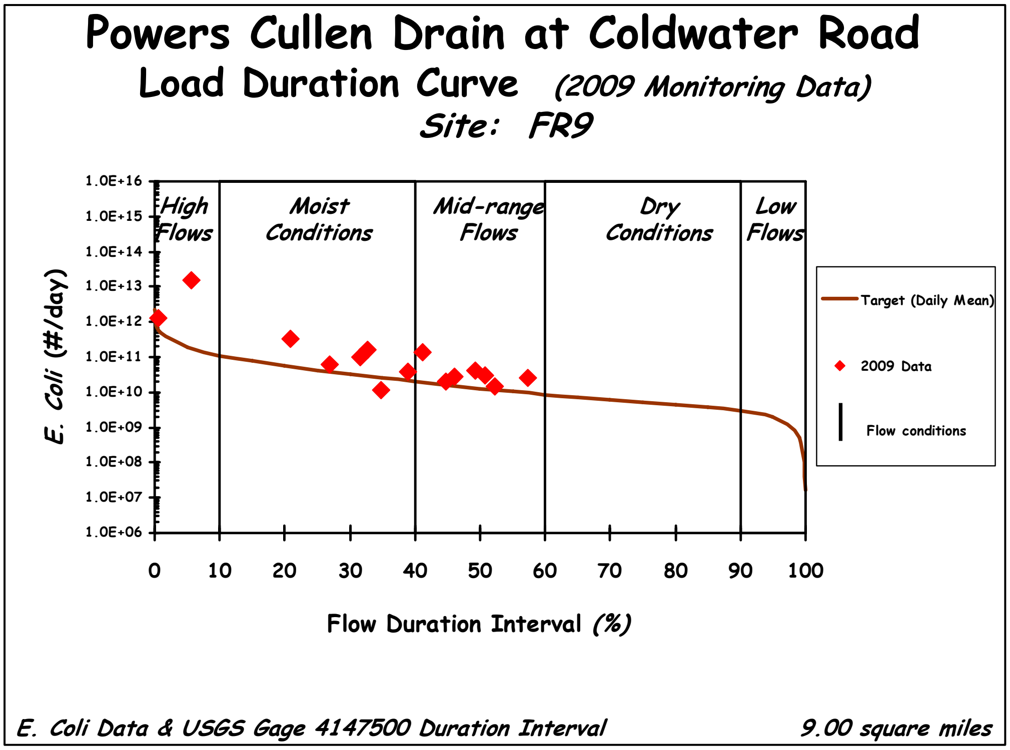
Kurtz Drain at Gregor Road
Load Duration Curve (2009 Monitoring Data)
Site: FR5
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
1.0E+15
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
1.0E+05
0 10 20 30 40 50 60 70 80 90 100
E. Coli (#/day)
Flow Duration Interval (%)
Target (Daily Mean)
2009 Data
Flow conditions
E. Coli Data & USGS Gage 4147500 Duration Interval
3.60 square miles

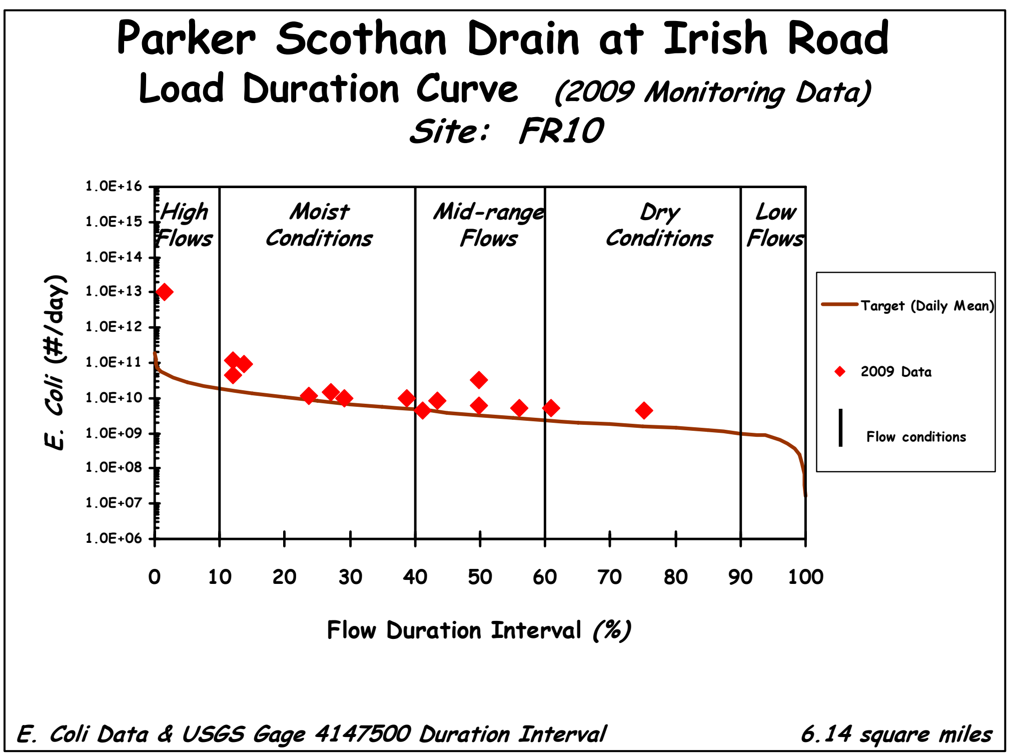


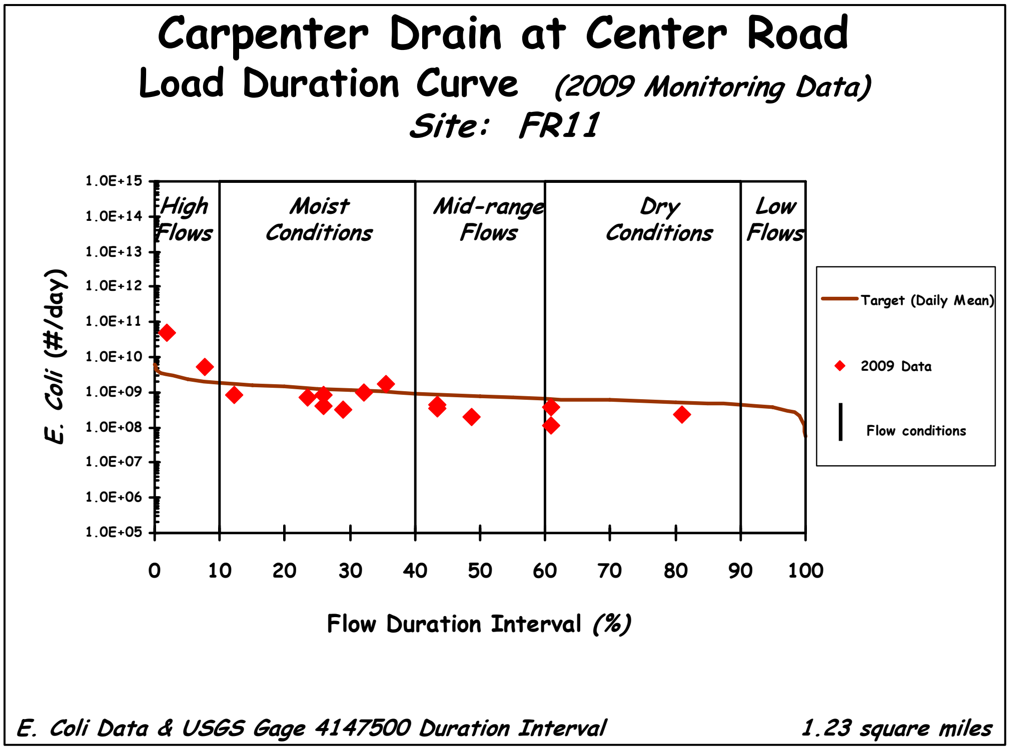
Butternut Creek at Mt. Morris Road
Load Duration Curve (2009 Monitoring Data)
Site: FR6
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
1.0E+16
1.0E+15
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0 10 20 30 40 50 60 70 80 90 100
E. Coli (#/day)
Flow Duration Interval (%)
Target (Daily Mean)
2009 Data
Flow conditions
E. Coli Data & USGS Gage 4147500 Duration Interval
37.4 square miles


Flint River at Irish Road
Load Duration Curve (2009 Monitoring Data)
Site: FR7
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
1.0E+16
1.0E+15
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
E. Coli (#/day)
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Target (Daily Mean)
2009 Data
Flow conditions
E. Coli Data & USGS Gage 4147500 Duration Interval
535 square miles


Flint River at Genesee Road
Load Duration Curve (2009 Monitoring Data)
Site: FR8
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
1.0E+16
1.0E+15
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
E. Coli (#/day)
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Target (Daily Mean)
2009 Data
Flow conditions
E. Coli Data & USGS Gage 4147500 Duration Interval
586 square miles


Powers Cullen Drain at Coldwater Road
Load Duration Curve (2009 Monitoring Data)
Site: FR9
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
E. Coli (#/day)
1.0E+16
1.0E+15
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Target (Daily Mean)
2009 Data
Flow conditions
E. Coli Data & USGS Gage 4147500 Duration Interval
9.00 square miles


Parker Scothan Drain at Irish Road
Load Duration Curve (2009 Monitoring Data)
Site: FR10
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
E. Coli (#/day)
1.0E+16
1.0E+15
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Target (Daily Mean)
2009 Data
Flow conditions
E. Coli Data & USGS Gage 4147500 Duration Interval
6.14 square miles


Carpenter Drain at Center Road
Load Duration Curve (2009 Monitoring Data)
Site: FR11
1.0E+15
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
1.0E+06
1.0E+05
E. Coli (#/day)
High Flows
Moist Conditions
Mid-range Flows
Dry Conditions
Low Flows
Target (Daily Mean)
2009 Data
Flow conditions
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
E. Coli Data & USGS Gage 4147500 Duration Interval
1.23 square miles