Michigan Department of Environmental Quality
Water Bureau
May 2009

Total Maximum Daily Load for *E. coli* for Smiths Creek St. Clair County

INTRODUCTION

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, 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 Smiths Creek, located in St. Clair County, Michigan (Figure 1).

PROBLEM STATEMENT

This TMDL addresses the listing that appears on the 2008 Section 303(d) list (LeSage and Smith, 2008) as:

SMITHS CREEK **AUID**: 040900010303-01
County: ST. CLAIR SIZE: 6.6 M
Location: Smiths Creek confluence with Pine River, u/s to east of Palms Road.
Use impairments: Total and partial body contact recreation.
Cause: *E. coli*
Source: Combined Sewer Overflows
TMDL Year(s): 2009

Smiths Creek was first placed on the Section 303(d) list in 1998 due to impairment of recreational uses by *E. coli* (Creal and Wuycheck, 1998). Combined Sewer Overflows (CSOs) were erroneously listed as the source of *E. coli*. The unincorporated village of Smiths Creek does not have a central sanitary sewer collection system and therefore, no CSOs. However, there is a storm sewer that discharges human sewage to Smiths Creek due to illicit connections of on-site sewage systems. It is believed that the sewage discharge was the basis for the Section 303(d) listing. Monitoring data collected by the Michigan Department of Environmental Quality (MDEQ) in 2007 documented several 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 (Table 1; Figures 2-3).

The TMDL reach is located in the Smiths Creek watershed which flows into the Pine River, and finally the St. Clair River, Hydrologic Unit Code (HUC) 04090001 (Figure 1). The Smiths Creek watershed covers 12,659 acres (about 20 square miles) of St. Clair County. Glacial topology of this region is flat clay lake plain with soils dominated by silt and clay loams dissected by broad glacial drainageways of sandy soil (Albert, 1995). Due to the flat terrain, this area was among

the first in Michigan to be cleared of its beech-maple and elm-ash forests, drained and farmed by European settlers. There are no major urban areas within the Smiths Creek watershed. The Smiths Creek watershed is home to a population of about 2,000 people (United States Census Bureau).

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 milliliters. Compliance shall be based on the geometric mean of 3 or more samples, taken during the same sampling event, at representative locations within a defined sampling area.

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 1000 *E. coli* per 100 ml as a daily maximum year-round to protect the PBC use. The 2007 monitoring data indicated daily maximum and monthly average TBC WQS exceedances at Stations 2-4, and periodic exceedances of the PBC WQS.

DATA DISCUSSION

E. coli data were collected by the MDEQ from four sites in St. Clair County from August 24 through October 26 in 2007 (Figure 1). Precipitation data for the two days prior to each MDEQ sampling event were obtained from a weather station in Emmett, Michigan, approximately nine miles northwest of Smiths Creek (Table 1; Michigan Automated Weather Network, 2009). *E. coli* daily maximum and 30-day geometric mean data for 2007 are shown in Table 1 and Figures 2-3. Station 1 is located upstream of the TMDL reach, while Stations 2-4 are located within the reach. The highest daily maximum *E. coli* concentration of 5,327 *E. coli* per 100 mL was recorded at Station 3 on October 11, 2007. The daily maximum TBC standard (300 *E. coli* per 100 mL) was exceeded at Station 2 on 2 sampling dates, at Station 3 on 8 sampling dates, and at Station 4 on 4 sampling dates, with no exceedances at Station 1. The PBC recreation daily maximum standard (1000 *E. coli* per 100 mL) was exceeded on several occasions at Stations 2-4. Based on the geometric means of all samples at each site, Station 3, in the

immediate vicinity of the village of Smiths Creek, had the highest concentrations of *E. coli* while Station 1, upstream of the listed reach, had the lowest concentrations (Figure 4).

SOURCE ASSESSMENT

Possible sources of *E. coli* include illicit connections to storm sewers and ditches by the village of Smiths Creek, failing septic systems, septage spills, manure spreading, cattle with uncontrolled stream access, pastureland runoff, and wildlife.

Discharges of human sewage to Smiths Creek were first documented in 1977 by Kimball Township (memo from St. Clair County Health Department (SCCHD) to the MDEQ, 1986). In 1986, MDEQ staff visually confirmed raw sewage entering Smiths Creek, and sampling of that discharge by the SCCHD found high levels of fecal coliform (Sayles, 1991). The 2007 sampling data confirms this problem still exists. For instance, data collected at Station 3, in the immediate vicinity of the unincorporated village of Smiths Creek, show a dramatic increase in *E. coli* concentrations from Station 2 (Figure 4). Eight of nine sampling events at Station 3 exceeded the daily maximum TBC WQS, while only two of nine sampling events exceeded the same standard at Station 2. A large portion of this increase can be attributed to illicit connections and failing septic systems originating within the village of Smiths Creek. *E. coli* sampling by the SCCHD and MDEQ has confirmed the existence of multiple illicit connections of on-site septic systems to roadside ditches and storm sewer drains. *E. coli* concentrations >24,192 *E. coli* per 100 mL were found at multiple locations in the storm sewer serving the village of Smiths Creek. Dye testing further showed that this contaminated storm water discharges directly to Smiths Creek via the storm sewer. MDEQ staff have visited the community during heavy rainfall and noted the strong smell of sewage and areas where untreated sewage was visible on residential lawns and in the storm sewer drains. Several of these cases have also been confirmed verbally by local residents. The discharge of untreated human sewage is a major source of *E. coli* to Smiths Creek.

On-site septic systems are currently the only sewage treatment option available to residences in the Smiths Creek watershed. In St. Clair County, it is estimated that there are between 30-40 septic systems per square mile (*E. coli* Work Group, 2008 draft). When septic systems are not functioning properly or are poorly designed or maintained, they are a potential source of *E. coli* contamination to nearby streams. The SCCHD does not maintain point-of-sale septic inspection records. Thus, there is no indication of the on-site septic system failure rate for the Smiths Creek watershed. Based on information obtained from other county health departments statewide, the on-site septic system failure rate across Michigan reportedly averages between 5-10 percent (*E. coli* Work Group, 2008 draft).

There is one National Pollutant Discharge Elimination System (NPDES) permit in the TMDL watershed; a Certificate of Coverage under the general industrial storm water permit (St. Clair Co-Smiths Ck Landfill, MIS410188). The location of the St. Clair Co-Smiths Ck Landfill discharge is shown in Figure 1. On September 4, 2008, approximately 50 gallons of untreated septage was accidentally released into the storm water ponds of the St. Clair Co-Smiths Ck Landfill and was subsequently released to Smiths Creek following heavy rains. Post-spill sampling in the storm water retention pond found *E. coli* levels ranging from 121-1,376 *E. coli* per 100 mL. Background samples were collected at two areas within the landfill for comparison with the contaminated storm water: one in an area with no birds, and another in an area where scavenging birds (seagulls) were observed to be present. The results of this one-time sampling showed that areas with seagulls present had *E. coli* levels >24,192 *E. coli* per 100 mL, while the background sample where there were no birds was <1 *E. coli* per 100 mL. Although based on only a single sample at only two locations, these results indicate that

seagulls attracted to the landfill may be a source of *E. coli* to Smiths Creek via the landfill's storm water retention pond.

There are no permitted Concentrated Animal Feeding Operations in the Smiths Creek watershed; however, application of animal manure and direct cattle access are likely nonpoint sources of *E. coli* to Smiths Creek. Land cover data from 2006 show that the watershed is dominated by cultivated (row) crops (47 percent) (NOAA, 2008). Additional land coverage includes pasture/hay (11 percent), deciduous forest (22 percent), and light to high intensity developed land (<3 percent). Cattle with direct stream access or feedlots with slope directly into the creek were noted as problems in the area upstream of Station 4.

To assist in determining potential sources of *E. coli* to the Smiths Creek, a load duration curve analysis was developed for each sampling station as outlined by Cleland (2002). A load duration curve considers how flow conditions relate to a variety of pollutant sources (point and nonpoint sources). The load duration curves for each station sampled on the Smiths Creek are included in Figures 5-8. The United States Geological Survey (USGS) gauge used to determine the load duration curves is located on the Cass River (HUC 04080205) in Cass City, Michigan (Gauge #4150500). A ratio of the drainage area of the Cass River to the drainage area of the gauged watersheds (defined as the drainage area ratio), was calculated for each of the four sample locations for this TMDL. The curves were generated by applying these drainage area ratios to gauged flows for the period of record.

The load duration curves indicate that no sampling occurred in mid to high flow conditions; therefore, *E. coli* concentrations relative to such events cannot be determined. Exceedances of the TBC daily maximum WQS were observed during low flow events (Figures 5-8). Note that data points above the curve to the right side of the figure indicate *E. coli* WQS exceedances during dry weather conditions (lower flows). Dry weather exceedances indicate that sources of *E. coli* are most likely not related to precipitation events (i.e., runoff). The most likely source of *E. coli* during dry weather is a constant source, such as failing septic systems and illicit connections of sewage sources to surface water bodies throughout the watershed, and specifically the village of Smiths Creek.

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 1000 *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 results 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 1000 *E. coli* per 100 mL as a daily maximum year-round. Expressing the TMDL as a concentration equal to

the WQS ensures that the WQS will be met under all flow and loading conditions; therefore, a critical condition is not applicable for this TMDL.

LC

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

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

The LC represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. Because this TMDL is concentration-based, the total loading for this TMDL is equal to the TBC WQS of 130 *E. coli* per 100 mL as a 30-day geometric mean and 300 *E. coli* per 100 mL as a daily maximum during the recreation season and PBC WQS of 1000 *E. coli* per 100 mL as a daily maximum year-round.

WLAs

The WLA for the St Clair Co-Smiths Ck Landfill (MIS410188) is equal to 130 *E. coli* per 100 mL as a 30-day average and 300 *E. coli* per 100 mL as a daily maximum during the recreational season between May 1 and October 31, and 1000 *E. coli* per 100 mL as a daily maximum the remainder of the year.

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 1000 *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 2). Four municipalities have land area within the Smiths Creek TMDL watershed.

MOS

This section addresses the incorporation of an MOS in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality, including the pollutant decay rate, if applicable. The MOS can be either implicit (i.e., incorporated into the WLA or LA through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS because no rate of decay was used. Pathogen organisms ordinarily have a limited capability of surviving outside of their hosts and a rate of decay could be developed. However, applying a rate of decay could result in an allocation that would be greater than the WQS, thus no rate of decay is applied to provide for greater protection of water quality. The MDEQ has determined that the use of the TBC WQS of 130 *E. coli* per 100 mL as a 30-day geometric mean and 300 *E. coli* per 100 mL as a daily maximum during the recreational season, and the PBC WQS of 1000 *E. coli* per 100 mL as a daily maximum year-round for the WLA and LA is a more conservative approach than developing an explicit MOS. This accounts for the uncertainty in

the relationship between pollutant loading and water quality, based on available data and the assumption to not use a rate of decay. Applying the WQS to be met under all flow conditions also adds to the assurance that an explicit MOS is unnecessary.

SEASONALITY

The WQS for *E. coli* are expressed in terms of seasons, e.g., TBC from May 1 through October 31 and PBC year-round. Allocations and controls developed for the more protective TBC season are also expected to assure attainment of the daily maximum PBC WQS of 1000 *E. coli* per 100 mL, year-round. Because this is a concentration-based TMDL, WQS must be met regardless of flow conditions in the applicable season.

REASONABLE ASSURANCE ACTIVITIES

The SCCHD is voluntarily conducting a county-wide Illicit Discharge Elimination Program, which includes *E. coli* sampling in the Smiths Creek watershed. Aside from detecting the high levels of *E. coli* originating from the village of Smiths Creek, this program has not found any other significant sources of *E. coli* within the TMDL watershed. In addition to this sampling, the St. Clair County Drain Commission inspected all designated drains in the watershed for illicit connections in 2003 and 2004. Illicit connection eliminations on county drains were funded by a Clean Michigan Initiative grant. This effort found and corrected five sources of *E. coli* on Liverance and Alpine Drains (between Stations 3 and 4) and three sources on Spencer Drain (upstream of Station 1) (Fuller, 2008; personal communication). Elimination of any future illicit connections to county drains will greatly reduce *E. coli* levels in the Smiths Creek.

In 2007, the MDEQ issued a Notice of Non-Compliance to Kimball Township for discharging raw sewage originating from the village of Smiths Creek to the TMDL water body. The MDEQ is currently negotiating a remedy with Kimball Township. On-site septic systems are not well suited for the small-sized lots and heavy clay soil type of this community. Discussions between the MDEQ, SCCHD, and Kimball Township are ongoing for a permanent solution for the entire community, including eliminating the future need for on-site septic systems. Eliminating the discharge of untreated sewage from the village of Smiths Creek will greatly reduce *E. coli* levels in Smiths Creek.

The NPDES permit for the St Clair Co-Smiths Ck Landfill contains measures to reduce or eliminate the potential for fecal contamination of Smiths Creek. The general industrial storm water permit for this facility states that if there is a TMDL established by the MDEQ for the receiving water that restricts a material that could impair or degrade water quality, then the required Storm Water Pollution Prevention Plan shall identify the level of control for those materials necessary to comply with the TMDL and an estimate of the current annual load of those materials via storm water discharges to the receiving stream. The St Clair Co-Smiths Ck Landfill has installed a valve on each injection line in order to prevent future accidental releases of septage to Smiths Creek like the spill that occurred in 2008.

Agricultural nonpoint source pollution issues are investigated by the MDEQ and Michigan Department of Agriculture. The elimination or minimization of livestock manure contamination by implementing Best Management Practices would help to reduce *E. coli* levels in Smiths Creek.

MONITORING

Future monitoring will take place as part of the five-year rotating basin monitoring, as resources allow, once actions have occurred to address sources of *E. coli.* When these results indicate that the water body may be meeting WQS, sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml and daily maximum values of 300 *E. coli* per 100 ml and 1000 *E. coli* per 100 ml are being met.

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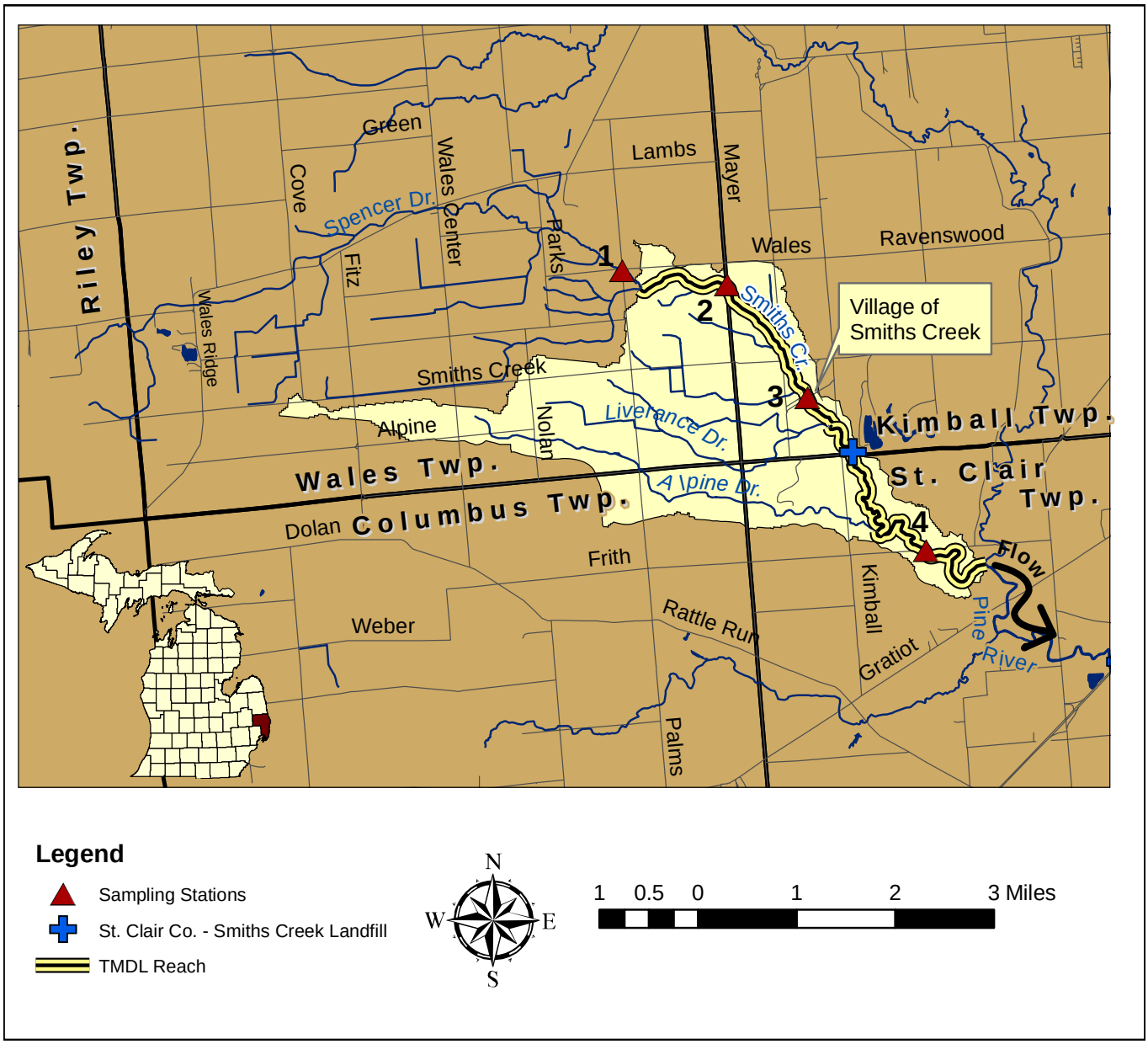

Figure 1. Location of Smiths Creek monitoring sites (1-4), the unincorporated village of Smiths Creek and the St. Clair Co – Smiths Creek Landfill within the TMDL watershed.

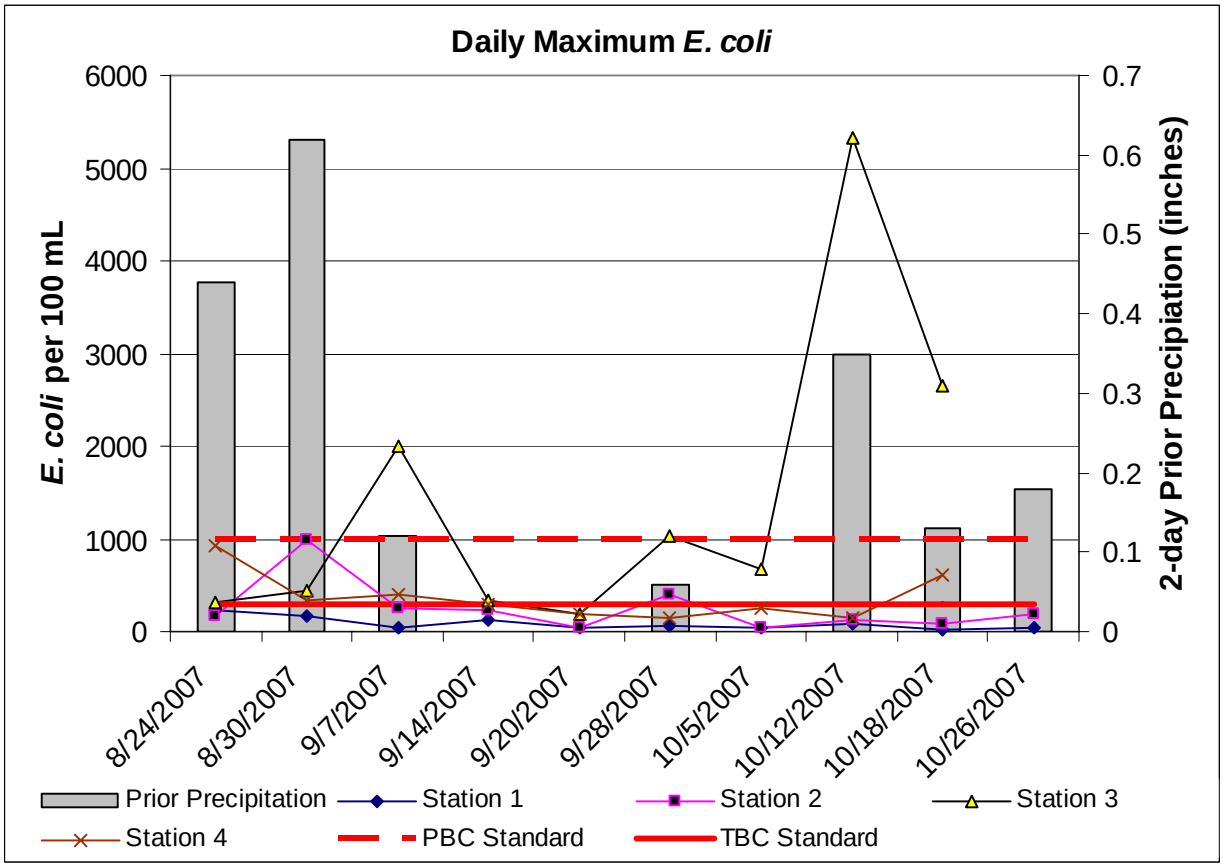

Figure 2. Daily Maximum *E. coli* sampling results from Smiths Creek (Stations 1-4).

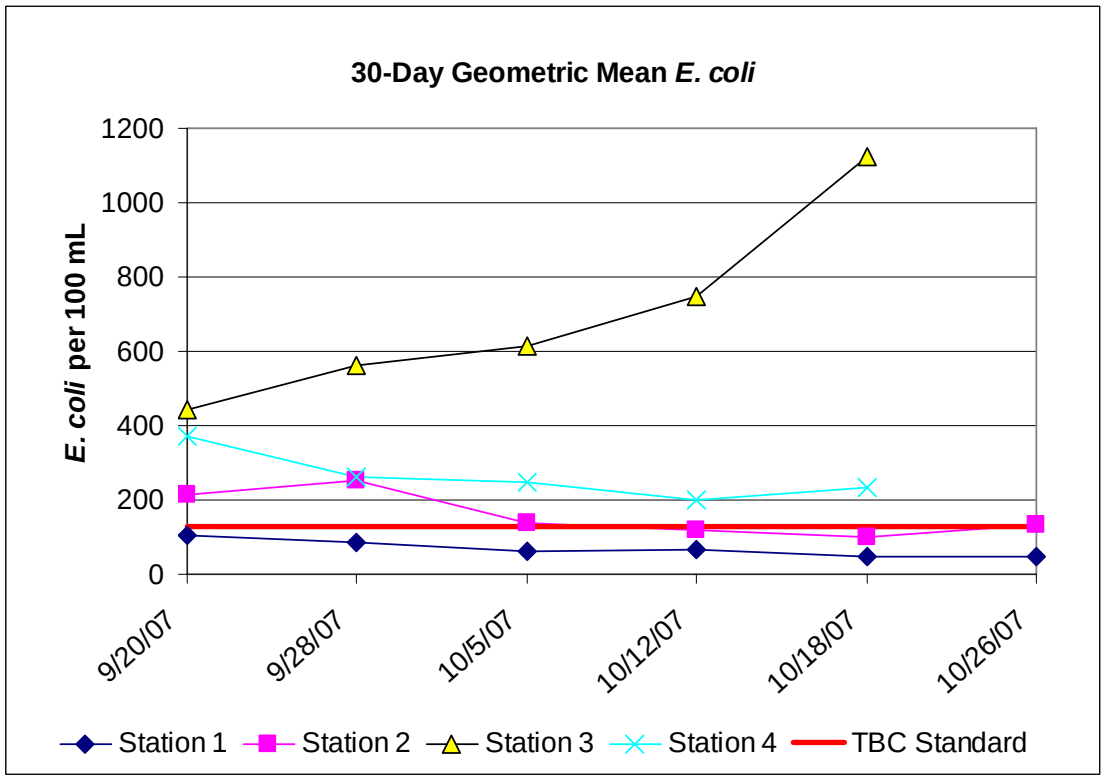

Figure 3. 30-day geometric mean *E. coli* sampling results from Smiths Creek (Stations 1-4).

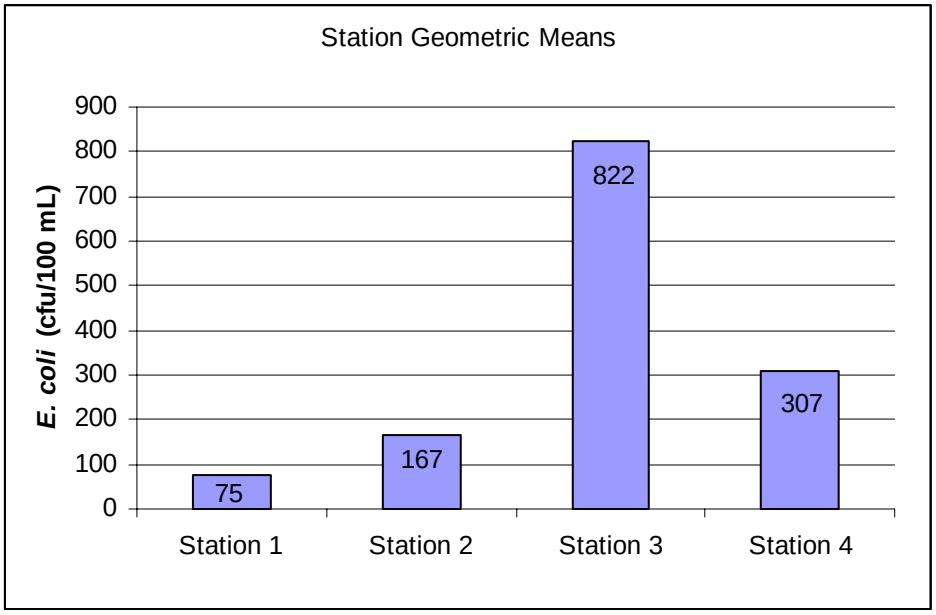

Figure 4. Geometric mean concentrations of all samples for each station.

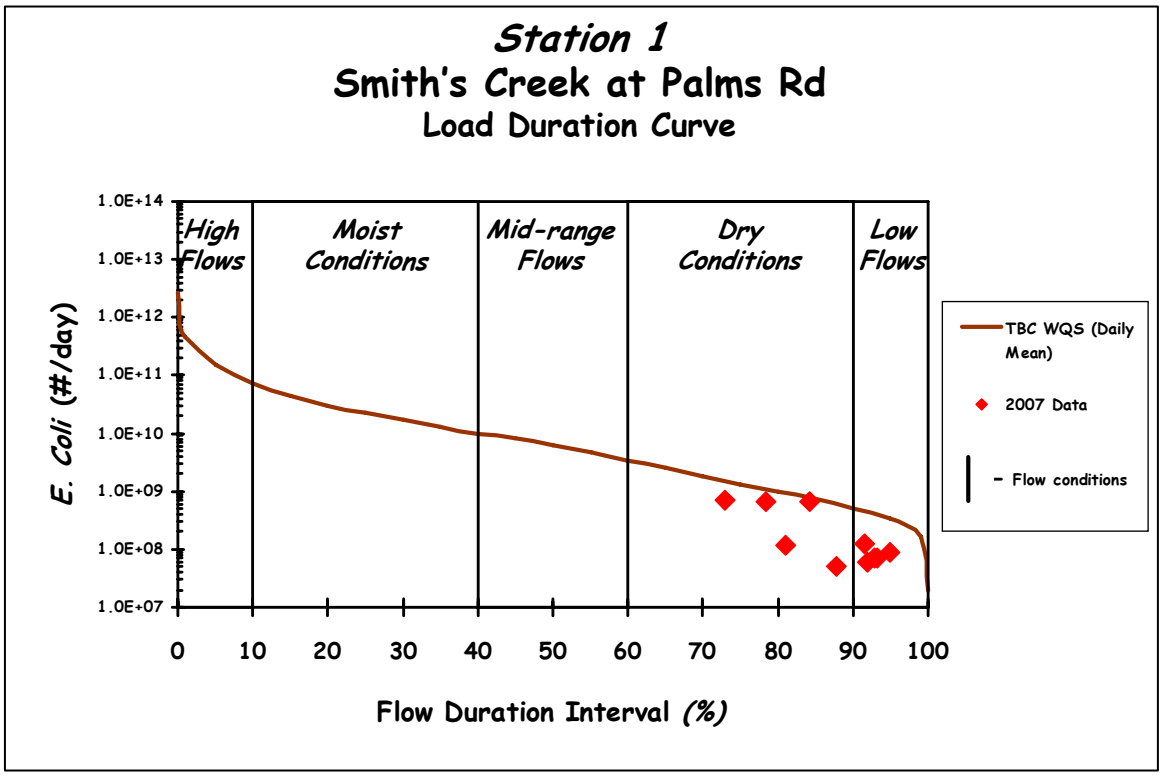

Figure 5. Flow duration curve for Smiths Creek at Palms Road (Station 1). *E. coli* Data and USGS Gage Duration Interval 04150500, 8.5 square miles.

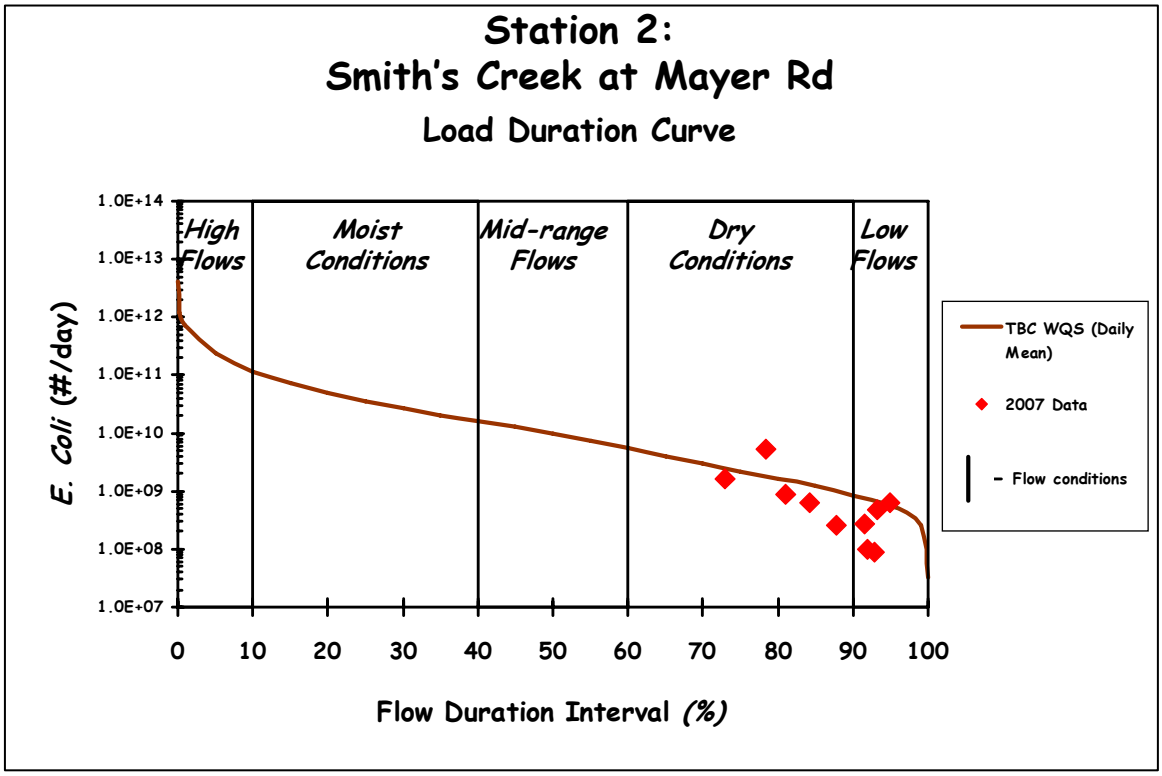

Figure 6. Flow duration curve for Smiths Creek at Mayer Road (Station 2). *E. coli* Data and USGS Gage Duration Interval 04150500, 11.5 square miles.

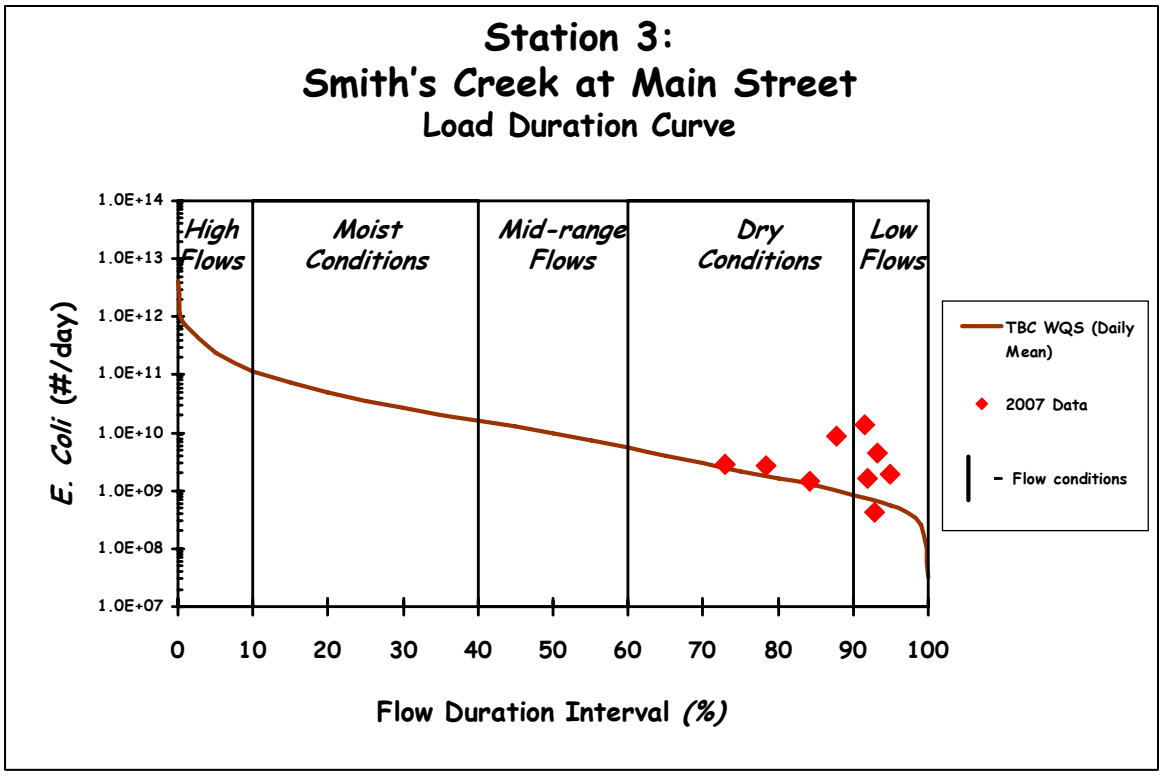

Figure 7. Flow duration curve for Smiths Creek at Main Road (Station 3). *E. coli* Data and USGS Gage Duration Interval 04150500, 13.7 square miles.

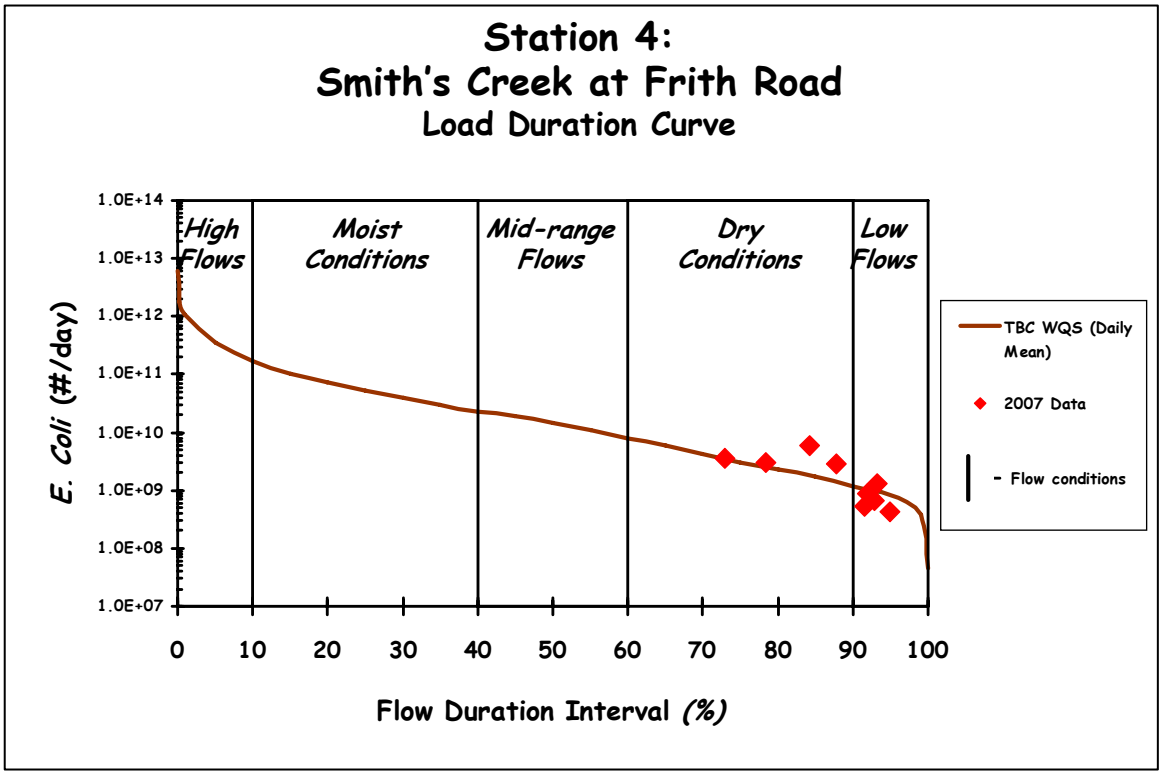

Figure 8. Flow duration curve for Smiths Creek at Frith Road (Station 4). *E. coli* Data and USGS Gage Duration Interval 04150500, 19.8 square miles.

Table 1. Weekly *E. coli* sampling results (counts per 100 mL) from Smiths Creek (Stations 1-4). August 24-October 26, 2007. Exceedances of the TBC WQS are shaded gray and PBC exceedances are outlined in bold.

	Station 1			Station 2			Station 3			Station 4			**Prior 2-Day**
	Palms Road, just south of Ravenswood			Smith's Creek at Mayer Road, south of Ravenswood			Smith's Creek at Main Street, south of railroad			Smith's Creek at Frith Road, east of Richman			**Precipitation**
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	**(inches)**
	120			**160**			**120**			**400**			
8/24/2007	**140**			**80**			**480**			**1,400**			
	800	238		**400**	172		**580**	322		**1,400**	922		**0.44**
	200			**1,000**			**800**			**480**			
8/30/2007	**120**			**800**			**360**			**200**			
	200	169		**1,200**	986		**280**	432		**400**	337		**0.62**
	40			**400**			**2,000**			**400**			
9/7/2007	**60**			**200**			**2,200**			**400**			
	60	52		**200**	252		**1,800**	1993		**400**	400		**0.12**
	160			**160**			**300**			**200**			
9/14/2007	**140**			**400**			**340**			**300**			
	100	131		**180**	226		**400**	344		**400**	288		**0**
	60			**80**			**100**			**260**			
9/20/2007	**20**			**20**			**200**			**300**			
	100	49	106	**60**	46	213	**300**	182	444	**100**	198	372	**0**
	100			**400**			**800**			**220**			
9/28/2007	**200**			**400**			**1,000**			**140**			
	20	74	84	**400**	400	253	**1,400**	1038	562	**120**	155	260	**0.06**
	20			**60**			**320**			**200**			
10/5/2007	**80**			**20**			**1,200**			**200**			
	40	40	63	**100**	49	139	**800**	675	614	**400**	252	245	**0**
	60			**120**			**4,000**			**160**			
10/12/2007	**80**			**120**			**7,000**			**160**			
	100	78	68	**140**	126	121	**5,400**	5327	748	**120**	145	200	**0.35**
	20			**160**			**1,000**			**360**			
10/18/2007	**40**			**120**			**3,200**			**800**			
	20	25	49	**40**	92	101	**5,800**	2648	1124	**760**	603	232	**0.13**
	20			**200**			na			na			
10/26/2007	**40**			**200**			na			na			
	60	36	46	**180**	193	135	na			na			**0.18**

Table 2. Percent of land area in Smiths Creek TMDL watershed located within each municipality.

Township	Percent of TMDL Watershed
Wales	51%
Columbus	9%
St. Clair	20%
Kimball	20%