

**Michigan Department of Environmental Quality
Water Division
March 2003**

**Total Maximum Daily Load for *Escherichia coli* for Bean Creek
Lenawee and Hillsdale Counties**

INTRODUCTION

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a waterbody 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 Bean Creek, located in Lenawee County, Michigan.

PROBLEM STATEMENT

Bean Creek was first placed on the Section 303(d) list in 1998. This TMDL listing addressed approximately two miles of stream in the vicinity of Hudson. The TMDL reach is on the Section 303(d) list as:

BEAN CREEK

County: LENAWEЕ

HUC: 4100006

WBID#: **060102A**

Size: 2 M

Location: Vicinity of Hudson

Problem: **Untreated sewage discharge, pathogens (Rule 100).**

TMDL YEAR(s): 2003

RF3RchID: 4100006 7

Bean Creek (Figure 1) was placed on the Section 303(d) list (Creal and Wuycheck, 2002) due to impairment of recreational uses as indicated by the presence of elevated levels of *E. coli*. Recent monitoring data (Table 1) collected by the Michigan Department of Environmental Quality (MDEQ) for the 2002 monitoring season documented exceedances of the WQS at all stations sampled. Thirty-day geometric mean *E. coli* concentrations in Bean Creek ranged from 119 *E. coli* per 100 milliliters (ml) in June at Beecher Road to 2,686 *E. coli* per 100 ml in July at US-127 (south of Union Road, BC-4A) (Figure 2). Three rain events coincided with the highest *E. coli* concentrations observed during the 2002 sampling -- July 9, July 22, and July 29. Each station sampled within 24 hours of the event had daily geometric mean concentrations greater than 1,000 *E. coli* per 100 ml. In addition, Bean Creek at US-127 (south of Union Road, BC-4A) had a daily geometric mean *E. coli* concentration on July 9, 2002, of 9,052 *E. coli* per 100 ml and a concentration of 25,788 *E. coli* per 100 ml as a daily mean on July 23, 2002 (Table 1).

The official Section 303(d) listing for Bean Creek was 2.0 miles in the vicinity of Hudson. Based on a review of the listing and the 2002 monitoring data, the listed TMDL reach would more appropriately be described as Bean Creek, approximately 8 miles from Beecher Road downstream to US-127, south of Lowe Road. Bean Creek has moderate flows at this location (Table 2).

NUMERIC TARGET

The impaired designated use addressed by this TMDL is total body contact recreation. Rule 100 of the Michigan WQS requires that this waterbody be protected for total body contact recreation from May 1 to October 31. The target levels for this designated use are the ambient *E. coli* standards established in Rule 62 of the WQS as follows:

R 323.1062 Microorganisms.

Rule 62. (1) All waters of the state protected for total body contact recreation shall not contain more than 130 *Escherichia coli* (*E. coli*) per 100 milliliters, as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during 5 or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of 3 or more samples taken at representative locations within a defined sampling area. At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 milliliters. Compliance shall be based on the geometric mean of 3 or more samples taken during the same sampling event at representative locations within a defined sampling area.

In addition, 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 milliliters, based on the geometric mean of all of 5 or more samples taken over a 30-day period, nor more than 400 fecal coliform bacteria per 100 milliliters, based on the geometric mean of all of 3 or more samples taken during any period of discharge not to exceed 7 days. Other indicators of adequate disinfection may be utilized where approved by the department.

Sanitary wastewater discharges are considered in compliance with the WQS of 130 *E. coli* per 100 ml if their National Pollutant Discharge Elimination System (NPDES) permit limit of 200 fecal coliforms per 100 ml as a monthly average is met. This is assumed because *E. coli* are a subset of fecal coliform (American Public Health Association, 1995). When the wastewater of concern is sewage, fecal coliform is substantially higher than *E. coli* (Whitman, 2001). When the point source discharge is meeting its limit of 200 fecal coliform per 100 ml, it can reasonably be assumed that there are less than 130 *E. coli* per 100 ml in the effluent.

For this TMDL, the WQS of 130 per 100 ml as a 30-day geometric mean is the target level for the TMDL reach from May 1 to October 31. As previously stated, the 2002 monitoring data indicated exceedances of WQS. Stations with the highest concentrations are located downstream of Hudson, particularly at Nelson Road and US-127 (south of Union Road).

SOURCE ASSESSMENT

The official listing for Bean Creek was 2.0 miles in the vicinity of Hudson. Based on data collected in 2002 and a review of the listing, the reach has been modified as Bean Creek, approximately 8 miles from Beecher Road downstream to US-127, south of Lowe Road (Figure 1). The municipalities in the modified TMDL reach for Bean Creek include the city of Hudson, as well as Wheatland, Pittsford, and Hudson Townships (Figure 3). Table 3 shows the distribution of land for each municipality.

The primary pathogen sources for this waterbody are typical of semi-urban and agricultural land uses. Illicit connections, storm water runoff, and agricultural inputs are all possible sources of

E. coli to Bean Creek. Elevated *E. coli* concentrations within the city limits of Hudson coincide with the rain events previously mentioned and may be due to both storm water runoff and inputs upstream of Hudson. Currently, there is one permitted point source discharge in the TMDL reach, the Hudson Wastewater Treatment Plant (WWTP) (MI0021377). The WWTP is working on an excess inflow and infiltration reduction program for their collection system. The current collection system has exceeded the maximum design flow of 0.41 million gallons per day during a wet weather event one time in the last ten years. In addition, there is one construction permit in the Bean Creek TMDL Watershed. This permit was issued to the Michigan Department of Transportation (MIR105926) for road construction on M-34 in the village of Hudson. The permit will terminate in 2003 when the road repairs are finished.

Elevated *E. coli* concentrations were also found upstream of the city of Hudson. As with the majority of the watershed, the primary land use is agriculture. The watershed has been extensively tiled for maximum drainage making it possible for *E. coli* to discharge to Bean Creek or tributaries through field tiles. Other agricultural practices include spraying or injecting animal waste on the land making field run-off another possible contributor of *E. coli* to Bean Creek. In an effort to address these concerns, the MDEQ has issued a general NPDES permit for Concentrated Animal Feeding Operations (CAFOs). Farms meeting the definition of a CAFO are covered by this permit, which requires discharges to surface waters to meet WQS. In addition, the permittees must prepare a Comprehensive Nutrient Management Plan (CNMP). CNMPs identify actions that will be implemented to meet clearly defined nutrient management goals and ensure pollution prevention at CAFOs. Complete coverage of the state will occur over five years. In the TMDL area, there is one animal farm large enough to be classified as a CAFO, Bleich Farms, located upstream of the city of Hudson, on a tributary of Bean Creek.

LINKAGE ANALYSIS

The link between the *E. coli* concentrations in Bean Creek and the potential sources is the basis for the development of the TMDL. The linkage is defined as the cause and effect relationship between the selected indicators and the sources. This provides the basis for estimating the total assimilative capacity of the stream and any needed load reductions. For this TMDL, a significant amount of the pathogen load likely enters Bean Creek by both wet and dry weather sources, such as storm water, agricultural run-off, and illicit connections.

The guiding water quality management principle used to develop the TMDL was that compliance with the numeric pathogen target in Bean Creek depends on the control of *E. coli* from storm water, illicit connections, and agriculture influences. If the *E. coli* inputs can be controlled, then total body contact recreation in Bean Creek will be protected.

TMDL DEVELOPMENT

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving WQS. As indicated in the Numeric Target section, the target for this pathogen TMDL is the WQS of 130 *E. coli* per 100 ml. Concurrent with the selection of a numeric concentration endpoint, TMDL development also defines the environmental conditions that will be used when defining allowable levels. Many TMDLs are designed around the concept of a "critical condition." The "critical condition" is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other conditions. For example, the critical conditions for the control of point sources in Michigan are given in R 323.1082 and R 323.1090. In general, the lowest monthly 95% exceedance flow for streams is used as a design condition for point source discharges. However, for pathogens in point source discharges of treated or untreated human sewage, levels are restricted to a monthly average limit of 200 Fecal coliform per 100 ml regardless of stream flow. Therefore, the design

stream flow is not a critical condition for determining the allowable loading of pathogen for WWTPs. In addition, other sources to Bean Creek arise from a mixture of wet and dry weather-driven nonpoint sources, and there is no single critical condition that is protective for all other conditions. For these sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed.

For most pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For *E. coli*, however, mass is not an appropriate measure, and the USEPA allows pathogen TMDLs to be expressed in terms of organism counts (or resulting concentration) (USEPA, 2001). Therefore, this pathogen TMDL is concentration-based consistent with R 323.1062, and the TMDL is equal to the target concentration of 130 *E. coli* per 100 ml in all portions of the TMDL reach for each month of the recreational season (May through October).

ALLOCATIONS

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

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for nonpoint sources, and the MOS. As previously indicated, this pathogen TMDL will not be expressed on a mass loading basis and is concentration-based consistent with USEPA regulations in 40 CFR, Section 130.2(i).

WLAs

There is one permitted point source discharge of treated human sewage to the listed reach of Bean Creek, the city of Hudson WWTP (MI0021377). As previously stated, when the WWTP is meeting their fecal coliform permit limit, it is assumed the WQS will be met in the discharge. Therefore, the WLA will be equal to 130 *E. coli* per 100 ml.

LAs

Because this TMDL is concentration-based, the LA is equal to 130 *E. coli* per 100 ml. The determination of individual LAs will be based on the assumption of equal bacteria loads per unit area for all lands in the watershed. 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 various units of local government in the watershed. This gives a clear indication of the relative amount of effort that will be required by each entity to restore and maintain the total body contact designated use in Bean Creek.

The government entities with the largest percent land area in the Bean Creek TMDL Watershed are Pittsford Township (56%) and Hudson Township (21%) making up 77% of the watershed. The remaining percent of the watershed is made up of Wheatland Township (19%) and the city of Hudson (4%).

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. The MOS can be either implicit (i.e., incorporated into the TMDL analysis 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.

SEASONALITY

Seasonality in the TMDL is addressed by expressing the TMDL in terms of a total body contact recreation season that is defined as May 1 through October 31 by R 323.1100 of the WQS. There is no total body contact during the remainder of the year primarily due to cold weather. In addition, because this is a concentration-based TMDL, WQS will be met regardless of flow conditions in the applicable season.

MONITORING

In 2002, pathogens were monitored at a total of five stations from May through September. Future monitoring will take place during the rotating five-year basin monitoring. When these results indicate that the waterbody 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 is being met.

In addition, there are two groups independently collecting data in this watershed. The first group is called Community Action. Community Action was awarded a two-year Clean Michigan Initiative Grant (project number 480642-01) to monitor several waterbodies in the Hillsdale County and Lenawee County areas. The second group is called Environmentally Concerned Citizens of South Central Michigan (ECCSCM). ECCSCM independently monitors sites for *E. coli* and dissolved oxygen in numerous waterbodies in Hillsdale and Lenawee Counties, including tributaries of Bean Creek.

REASONABLE ASSURANCE ACTIVITIES

The Hudson WWTP is responsible for meeting their NPDES permit limits for fecal coliform. Compliance is based on review of Discharge Monitoring Report data by the MDEQ. Presently, the WWTP is disinfecting their effluent and meeting their permit limits for fecal coliform. The WWTP is also working on reducing the effects of excess inflow and infiltration to their collection system. The goal of the plan is to decrease the amount of excess water to the system, ultimately eliminating overflows of sewage to Bean Creek. An annual report is submitted to the MDEQ for review, which requires sufficient progress on the correction.

In addition, if found applicable, the city of Hudson may be required to obtain a Phase II storm water permit. This would be applicable if the MDEQ determines that storm water controls are needed for this discharge to address the pollutant of concern (*E. coli*) to meet WQS. This permit requires activities that reduce *E. coli* inputs through the public education, storm water management plan, and illicit connection identification and elimination requirements.

To address agricultural inputs of *E. coli* to Bean Creek, the MDEQ has issued a permit aimed at reducing the impacts of agricultural run-off from CAFOs on surface waterbodies. Farms meeting the CAFO definition will be covered by this permit, which requires discharges to surface waters to meet WQS. In addition, the permit will require designated farming operations to prepare a CNMP, identifying actions that will be implemented to meet clearly defined nutrient

management goals and ensure pollution prevention at CAFOs. The CNMPs also establish a format for recording those actions. The critical aspect of CNMPs is the combination of manure management activities with conservation practices. The CNMP looks at the whole farm giving the producer a comprehensive review of the entire operation. A CNMP includes: the livestock type, herd size, and general construction of the facility and the manure storage system; number of acres available for land applications; and future goals. The permit also requires that the permittee shall have the CAFO under the supervision and control of a person or persons who have been certified by the MDEQ as properly qualified to operate the CAFO in a manner that achieves compliance with permit requirements. The MDEQ is currently developing a program to train and certify CAFO operators.

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REFERENCES

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- Whitman, R. Personal Communication. United States Geological Survey, October 2001.
- USEPA. 2001. Protocol for Developing Pathogen TMDLs. United States Environmental Protection Agency, 841-R-00-002.

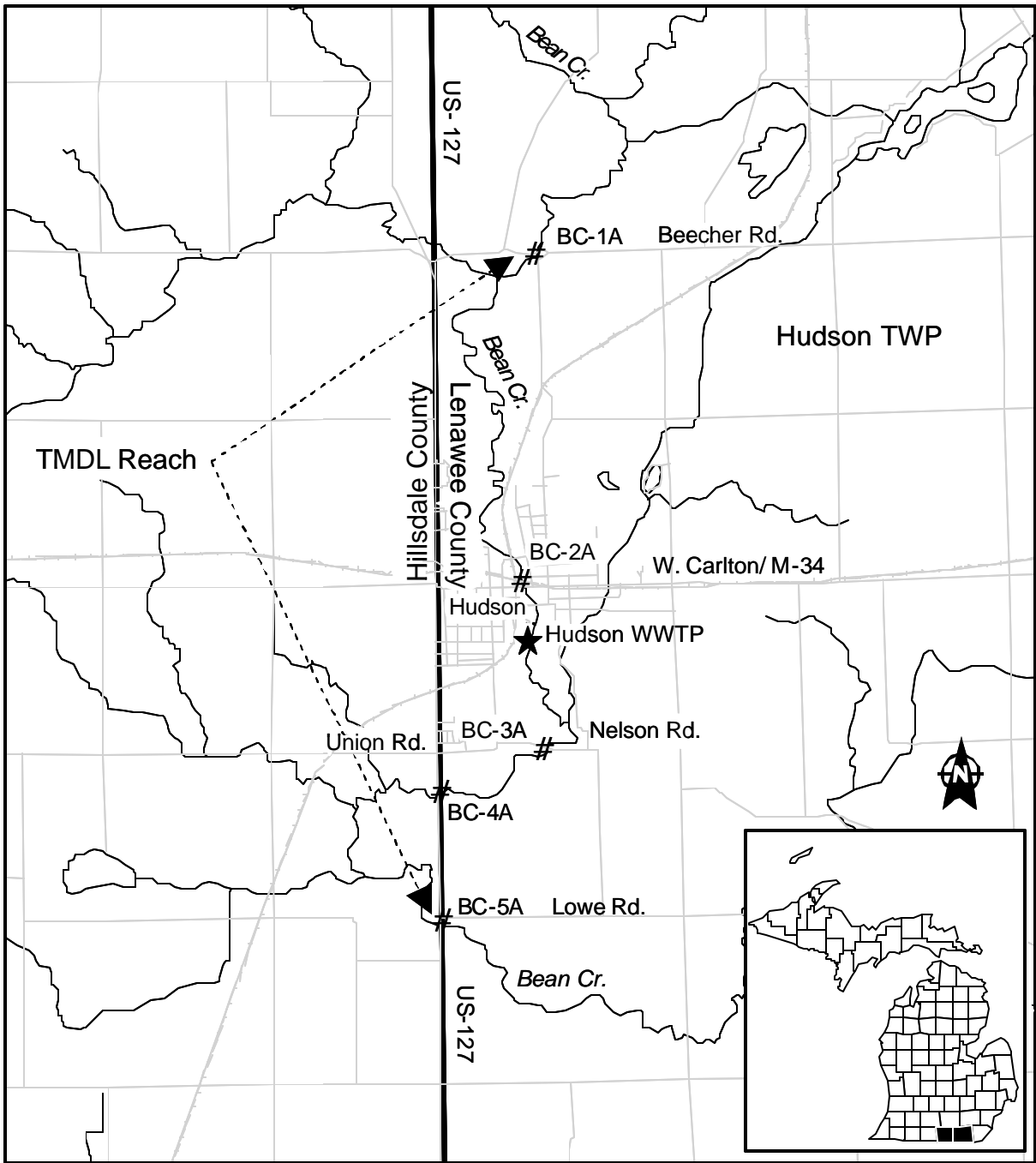


Figure 1. Bean Creek *E. coli* sampling locations, vicinity of Hudson, Michigan, 2002.

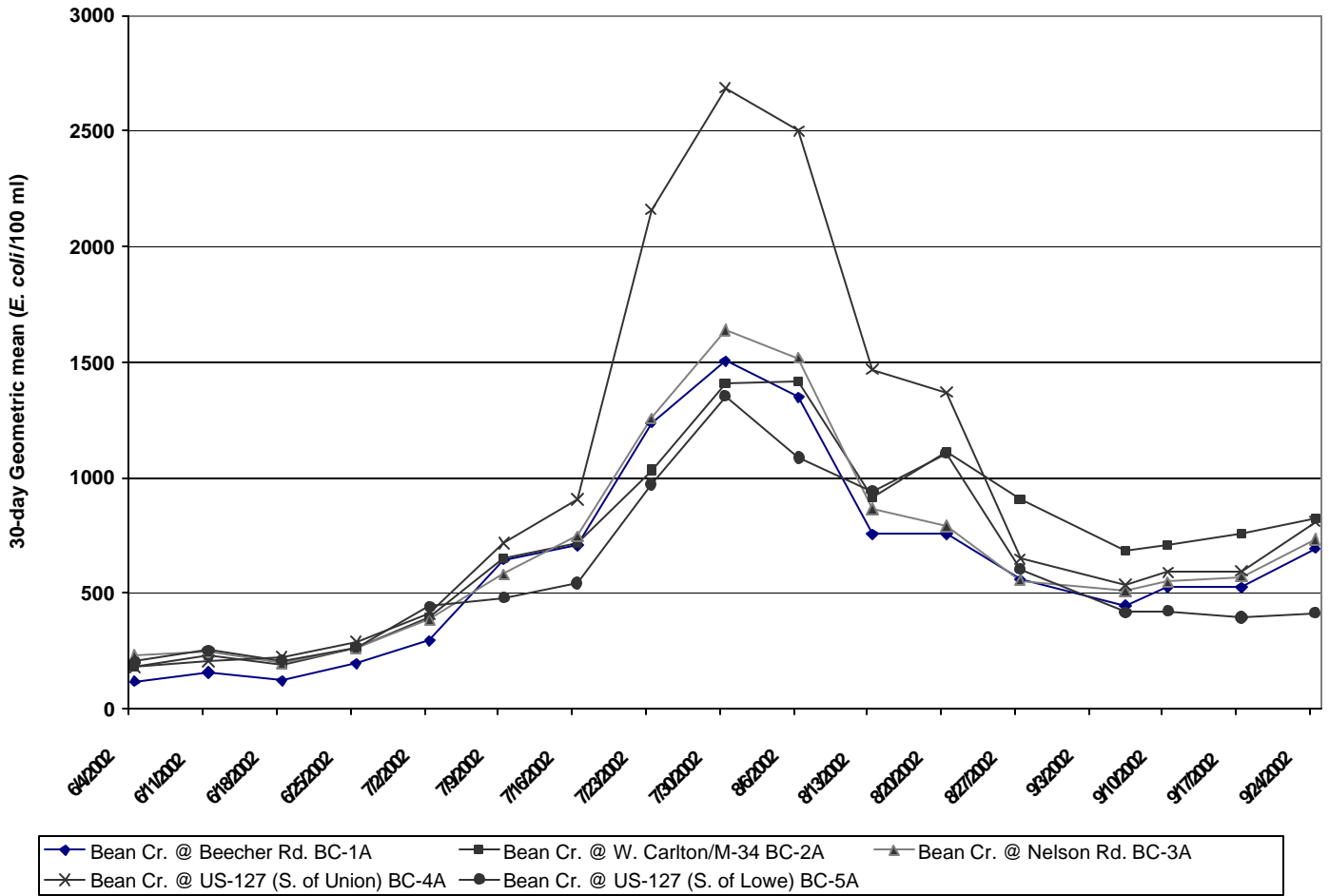


Figure 2. Thirty-day Geometric mean for *E. coli* in Bean Creek, vicinity of Hudson, Michigan, 2002.

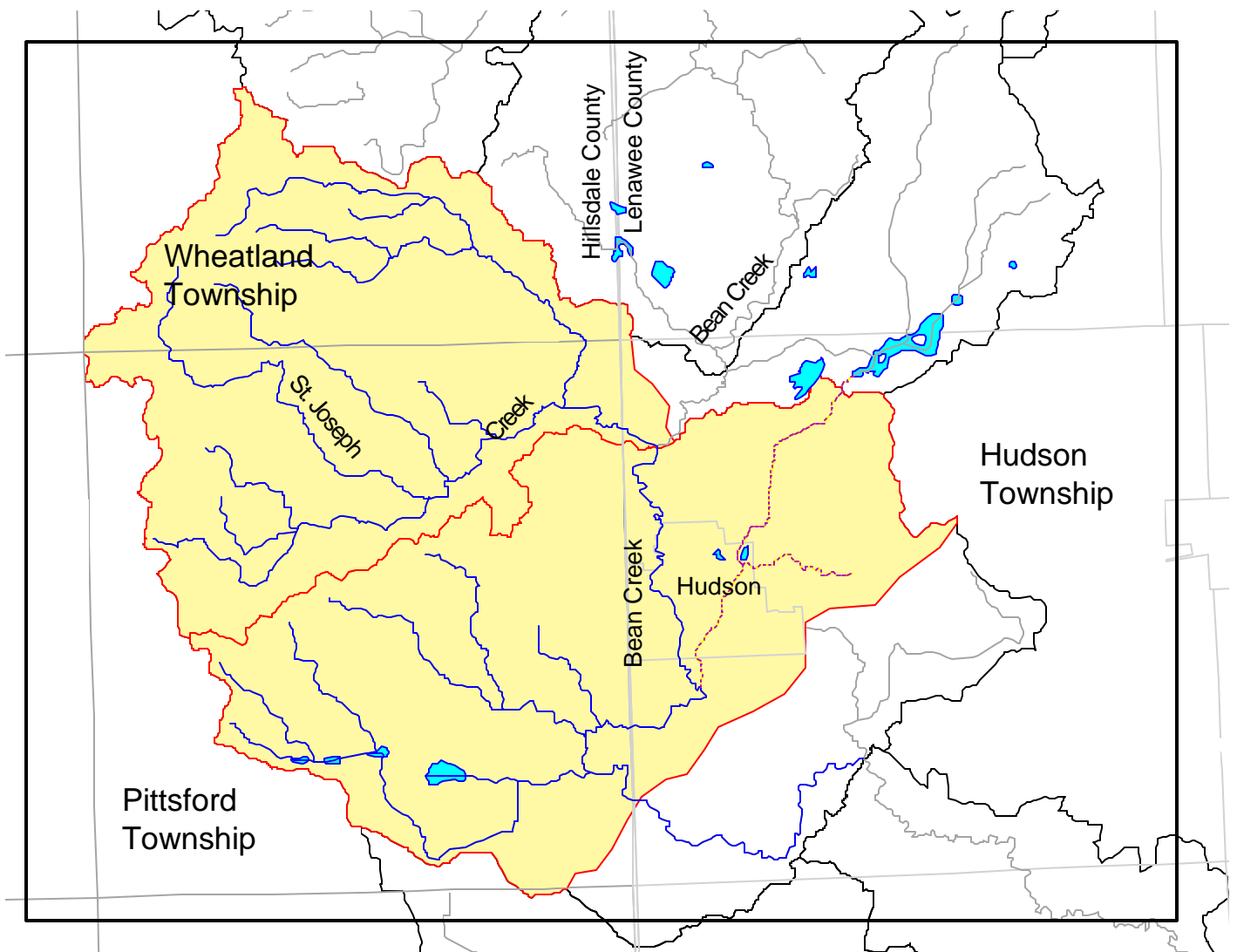


Figure 3. The shaded area indicates the municipalities in the Bean Creek *E. coli* TMDL Watershed.

Table 1. MDEQ 2002 *E. coli* monitoring data for Bean Creek (*E. coli*/100 ml). Shaded areas indicate exceedances of the Water Quality Standard.

DATE	Bean Cr. @ Beecher Rd. BC-1 A			Bean Cr. @ W. Carleton/M-34 BC-2 A			Bean Cr. @ Nelson Rd. BC-3 A			Weather data
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
5/7/2002	74	63	---	55	67	---	95	105	---	foggy, 65°
	57			58			110			
	58			96			110			
5/14/2002	940	902	---	780	889	---	850	839	---	sunny, 65°
	930			980			780			
	840			920			890			
5/21/2002	30	46	---	60	93	---	150	131	---	sunny, 45°
	80			90			150			
	40			150			100			
5/28/2002	50	71	---	90	72	---	190	101	---	partly cloudy, 65°
	80			60			90			
	90			70			60			
6/4/2002	590	131	119	500	520	184	610	569	231	overcast, 55°
	380			470			530			
	10			600			570			
6/11/2002	290	259	158	210	233	236	140	150	248	sunny, 75°
	240			240			150			
	250			250			160			
6/18/2002	300	244	122	250	298	189	230	265	197	clear, 75°
	220			330			290			
	220			320			280			
6/25/2002	520	503	197	520	490	264	900	552	263	hazy, 85°
	470			420			360			
	520			540			520			

Table 1 continued (*E. coli*/100 ml).

DATE	Bean Cr. @ Beecher Rd. BC-1 A			Bean Cr. @ W. Carleton/M-34 BC-2 A			Bean Cr. @ Nelson Rd. BC-3 A			Weather data
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
7/2/2002	400	531	294	510	549	396	690	706	388	clear, 85°
	560			590			750			
	670			550			680			
7/9/2002	6800	6709	647	5000	6227	650	2000	4392	584	rain, 75°
	6000			6900			7700			
	7400			7000			5500			
7/16/2002	300	413	710	330	382	718	540	513	747	clear, 80°
	460			360			520			
	510			470			480			
7/23/2002	4800	3919	1237	1900	1844	1034	3300	3576	1257	partly cloudy, 75°
	3800			1500			4200			
	3300			2200			3300			
7/30/2002	1200	1334	1504	2600	2280	1406	2100	2086	1640	clear, 85°
	1800			1900			1800			
	1100			2400			2400			
8/6/2002	290	306	1347	590	576	1419	570	482	1519	clear, 65°
	330			610			480			
	300			530			410			
8/13/2002	300	372	756	850	710	919	250	266	867	partly sunny, 75°
	400			610			290			
	430			690			260			
8/20/2002	430	413	756	780	975	1109	280	325	792	clear, 70°
	390			1400			490			
	420			850			250			

Table 1 continued (*E. coli*/100 ml).

DATE	Bean Cr. @ Beecher Rd. BC-1A			Bean Cr. @ W. Carleton/M-34 BC-2A			Bean Cr. @ Nelson Rd. BC-3A			Weather data
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
8/27/2002	770	854	557	730	672	906	720	613	556	clear, 70°
	810			650			570			
	1000			640			560			
9/6/2002	370	442	447	560	557	683	1100	1382	512	clear, 70°
	520			560			1200			
	450			550			2000			
9/10/2002	1000	713	529	690	694	710	520	689	550	foggy, 65°
	670			570			630			
	540			850			1000			
9/17/2002	260	359	525	1400	991	759	390	320	571	clear, 65°
	380			800			270			
	470			870			310			
9/24/2002	1400	1698	697	1500	1491	826	820	1139	734	clear, 50°
	2500			1700			1200			
	1400			1300			1500			

Table 1 continued (*E. coli*/100 ml).

DATE	Bean Cr. @ US-127 (S. of Union Rd.) BC-4 A			Bean Cr. @ US-127 (S. of Lowe Rd.) BC-5 A			Weather data
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
5/7/2002	110	91	---	66	61	---	foggy, 65°
	78			60			
	87			58			
5/14/2002	930	215	---	940	937	---	sunny, 65°
	1070			1200			
	10			730			
5/21/2002	200	157	---	80	96	---	sunny, 45°
	160			140			
	120			80			
5/28/2002	130	103	---	100	82	---	partly cloudy, 65°
	140			50			
	60			110			
6/4/2002	750	580	179	770	828	206	overcast, 55°
	650		810				
	400		910				
6/11/2002	190	193	208	140	171	254	sunny, 75°
	210		240				
	180		150				
6/18/2002	350	335	227	700	352	209	clear, 75°
	430			270			
	250			230			
6/25/2002	610	523	289	320	346	269	hazy, 85°
	510			380			
	460			340			

Table 1 continued (*E. coli*/100 ml).

	Bean Cr. @ US-127 (S. of Union Rd.) BC-4A			Bean Cr. @ US-127 (S. of Lowe Rd.) BC-5A			
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Weather data
7/2/2002	480	620	414	1700	984	443	clear, 85°
	710			800			
	700			700			
7/9/2002	6100	9052	717	1100	1256	481	rain, 75°
	19000			1200			
	6400			1500			
7/16/2002	720	620	906	280	316	544	clear, 80°
	850			240			
	390			470			
7/23/2002	35000	25788	2160	7200	6446	973	partly cloudy, 75°
	14000			6200			
	35000			6000			
7/30/2002	1500	1558	2686	1800	1793	1352	clear, 85°
	1400			1600			
	1800			2000			
8/6/2002	460	435	2502	310	332	1088	clear, 65°
	380			310			
	470			380			
8/13/2002	680	634	1470	530	617	943	partly sunny, 75°
	550			660			
	680			670			
8/20/2002	470	436	1370	620	707	1108	clear, 70°
	360			570			
	490			1000			

Table 1 continued (*E. coli*/100 ml).

DATE	Bean Cr. @ US-127 (S. of Union Rd.) BC-4 A			Bean Cr. @ US-127 (S. of Lowe Rd.) BC-5 A			Weather data
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
8/27/2002	690	620	650	310	313	605	clear, 70°
	640			380			
	540			260			
9/6/2002	550	602	537	350	282	418	clear, 70°
	610			230			
	650			280			
9/10/2002	1000	700	591	360	350	423	foggy, 65°
	660			330			
	520			360			
9/17/2002	730	664	597	750	446	396	clear, 65°
	690			370			
	580			320			
9/24/2002	1600	2037	812	990	901	416	clear, 50°
	2400			830			
	2200			890			

Table 2. Bean Creek average flows (cfs) at US-127 (S. of Union Rd.), Lenawee County, Michigan.

May	June	July	August	September	October
75	36	20	13	11	15

Table 3. Distribution of land for each municipality in the TMDL reach.

Municipality	Square Miles	Percent
Pittsford Township	26.4	56
Hudson Township	9.8	21
Wheatland Township	9.1	19
City of Hudson	2.1	4
TOTAL	47.4	100