Enclosure 1

Michigan Department of Environmental Quality

Water Division

July 2004

Total Maximum Daily Load for *Escherichia coli* for Small Creek and Hunter's Lake Alcona County

INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) 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 a basis for determining the pollutant reductions necessary from both point and nonpoint sources (NPS) to restore and maintain the quality of the 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 Small Creek and Hunter's Lake, located in Alcona County, Michigan.

PROBLEM STATEMENT

This TMDL listing addresses approximately 0.5 miles of Small Creek and Hunter's Lake in the vicinity of the town of Glennie. The TMDL reach is on the Section 303(d) list as:

SMALL CREEK & HUNTER'S LAKE WBID#: **210806B**
County: ALCONA HUC: 4070007 Size: 0.5 M
Location: Vicinity of Curtis Twp. (Glennie)
Problem: Untreated sewage discharge, pathogens (Rule 100).
TMDL YEAR(s): 2004 RF3RchID: 4070007 10

Small Creek and Hunter's Lake (Figure 1) were placed on the Section 303(d) list due to impairment of recreational uses as indicated by the presence of elevated levels of *E. coli* (Creal and Wuycheck, 2002). Sampling conducted by the Michigan Department of Environmental Quality (MDEQ) in 2002, indicated exceedances of the WQS at only one station, Small Creek, at the inlet to Hunter's Lake (Table 1). Thirty-day geometric mean *E. coli* concentrations at this location were calculated only through mid-August due to dry conditions and ranged from 57 *E. coli* per 100 milliliters (ml) in June to 206 *E. coli* per 100 ml in July (Figure 2). Random daily geometric mean exceedances were observed in May, June, and July – the highest concentration was 581 *E. coli* per 100 ml. With the exception of one isolated event on the east shore, sampling conducted on Hunter's Lake indicated WQS were met the entire sampling season (Table 1, Figure 3).

NUMERIC TARGET

The impaired designated use addressed by this TMDL is total body contact recreation. Rule 100 of the Michigan WQS requires that this water body 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 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.

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 are the target levels for the TMDL reach from May 1 to October 31. The 2002 monitoring data indicated exceedances of WQS at one station, Small Creek, at the inlet to Hunter's Lake.

SOURCE ASSESSMENT

The Small Creek and Hunter's Lake watershed covered by this TMDL is located in Curtis Township, Alcona County. Small Creek has minimal flow in this reach (Table 2). This TMDL listing was primarily due to an illicit connection from the Glennie Elementary School discharging to Small Creek (Lixey, 2003). The connection was confirmed by dye testing and a permit for an on-site sewage system at Glennie Elementary was issued by the district health department on November 6, 1998.

Other possible sources of *E. coli* appear to be from storm water/surface runoff, and to a lesser degree, from agriculture. The village of Glennie is an unincorporated village without a storm sewer or central waste treatment system (i.e., each business or residence has their own on-site sewage treatment). The only infrastructure in the area that conveys storm water is along a major north/south road, M-65, which is owned by the Michigan Department of Transportation. This drainage system has two outlets, one at the south side of the village and one to the northeast of the village behind the Glennie Elementary School (District Health Department #2, 1989). It is possible that the northeast outlet may be contributing *E. coli* to Small Creek. Sampling at the inlet to Hunter's lake revealed elevated *E. coli* concentrations during the first half of the season (i.e., May through mid-August), after which samples were no longer collected due to zero stream flow. Illicit connections are no longer considered potential sources as all local businesses in Glennie and questionable residences were dye tested and those with illicit connections were ordered to install adequate waste treatment, which has been completed according to the district health department (Lixey, 2003). Land use in the watershed is predominately forest (approximately 53%). Agriculture and pasture lands make up approximately 26% (Purdue, 2004). Small Creek flows through a small, light-use pasture located upstream of the inlet sampling location. It's possible this pasture is a localized source of *E. coli* to the Hunter's Lake.

LINKAGE ANALYSIS

Determining the link between the *E. coli* concentrations in Small Creek and the potential sources is necessary to develop the TMDL. This link provides the basis for estimating the total assimilative capacity of the stream and any needed load reductions. For this TMDL, the major loadings of pathogens likely enter Small Creek by wet weather sources, such as unregulated storm water runoff and agricultural runoff.

The guiding water quality management principle used to develop the TMDL was that compliance with the numeric pathogen target in Small Creek depends on the control of *E. coli*

from storm water runoff, and to a lesser extent agricultural inputs via a pasture. If the *E. coli* inputs can be controlled to meet the numeric standards, then total body contact recreation in Small Creek will be protected.

TMDL DEVELOPMENT

The TMDL 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 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. 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.

TMDLs are generally expressed on a mass loading basis (e.g., pounds per day) for most pollutants. However, mass is not an appropriate measure for *E. coli.* 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 as a monthly average and 300 *E. coli* per 100 ml as a daily maximum 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, load allocations (LAs) for NPS, and natural background levels. The TMDL must include a margin of safety (MOS), either implicitly within the WLA and/or LA, or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving water body. This definition is denoted by the equation:

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

WLAs

There are no permitted point source discharges to the listed reach of Small Creek and Hunter's Lake; therefore the WLA is equal to zero.

LAs

The LA incorporates the pathogen sources for this water body, which include storm water/surface runoff and agricultural runoff. This TMDL is concentration-based. Therefore, 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 concentration 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 uses in Small Creek and Hunter's Lake. This TMDL reach lies entirely in Curtis Township.

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 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 is used. The MDEQ has determined that the use of the WQS of 130 *E. coli* per 100 ml is a more conservative approach because pathogen organisms have a limited capability of surviving outside of their hosts and a rate of decay would normally be used. Applying a rate of decay could result in a discharge limit that would be greater than the WQS, thus no rate of decay is applied in order to provide for greater protection of water quality. Applying the WQS to be met under all flow conditions also adds to the assurance of the MOS.

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. WQS will be met regardless of flow conditions in the applicable season because this is a concentration-based TMDL.

MONITORING

Pathogens were monitored at a total of six stations from May through September 2002. One station was located on Small Creek at the Hunter's Lake inlet and the remaining five locations were on Hunter's Lake. Future monitoring will take place during the rotating, five-year basin monitoring. When these results indicate that the water body may be meeting WQS, sampling will be conducted at the appropriate frequency (as defined in the numeric target section) to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml and 300 *E. coli* per 100 ml as a daily maximum are being met.

REASONABLE ASSURANCE ACTIVITIES

Available *E. coli* data indicate WQS are being met in Hunter's Lake, regardless of the exceedances in the lake inlet (i.e., Small Creek). Due to minimal or zero flow in Small Creek during the sampling season, it is recommended that the district health department coordinate with the MDEQ to identify possible wet weather sources of *E. coli* to Small Creek.

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July 30, 2004

REFERENCES

Choi, J. and B. Engel. 2004. Watershed Delineation Program Agricultural & Biological Engineering Department, Purdue University, West Lafayette, IN. Web site: http://pasture.ecn.purdue.edu/~watergen/.

Creal, W. and J. Wuycheck. 2002. Federal CWA Section 303(d) List – Michigan's Submittal for Year 2002. MDEQ, Surface Water Quality Division, Report #MI/DEQ/SWQ-02/013.

Lixey, J. 2003. Correspondence with District Health Department #2, Covering Alcona County.

District Health Department #2. 1989. Glennie Report.

USEPA. 2001. Protocol for Developing Pathogen TMDLs. USEPA, 841-R-00-002.

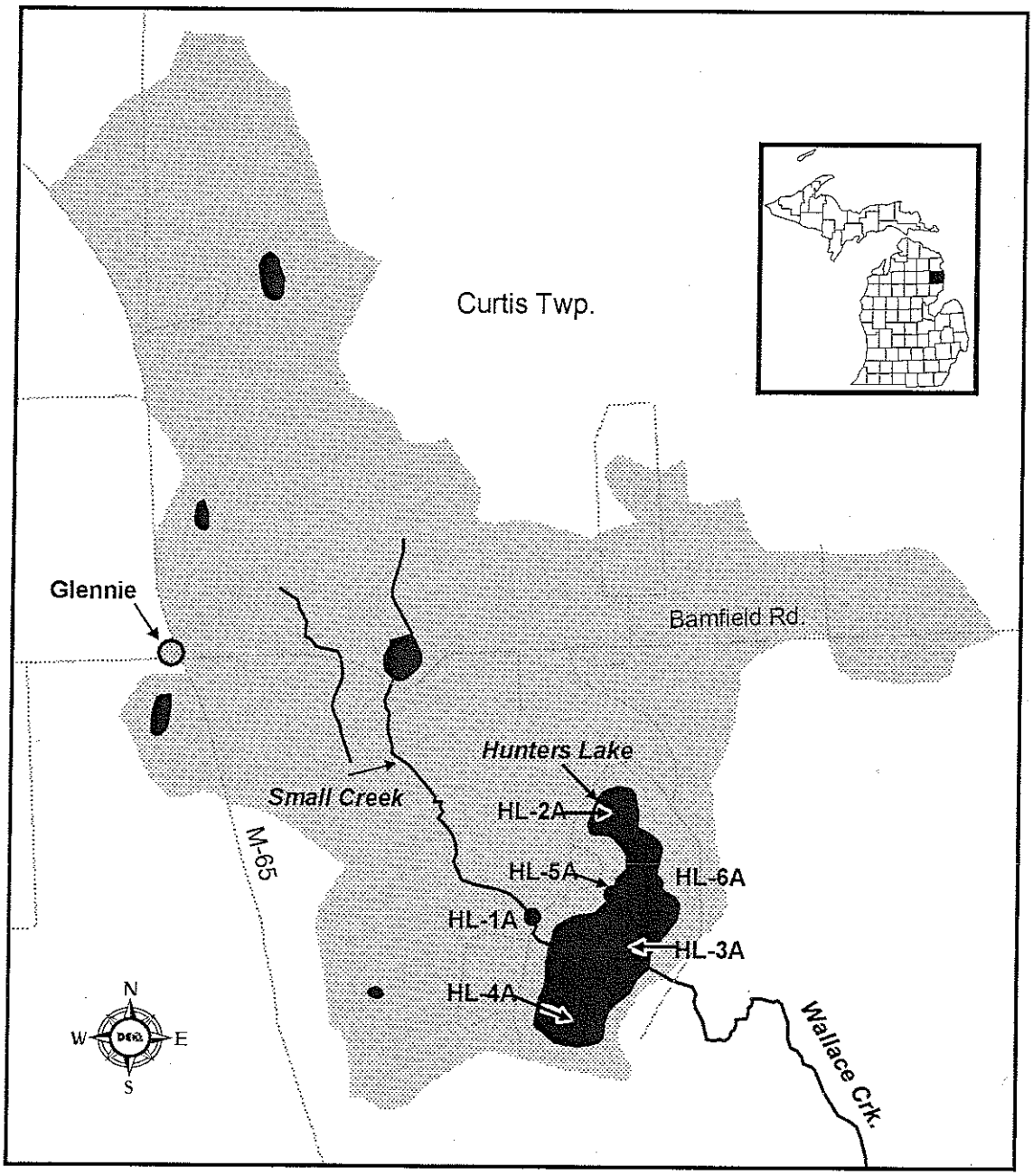

Figure 1. Small Creek and Hunter's Lake *E. coli* sampling locations, vicinity of Glennie, Michigan 2002.

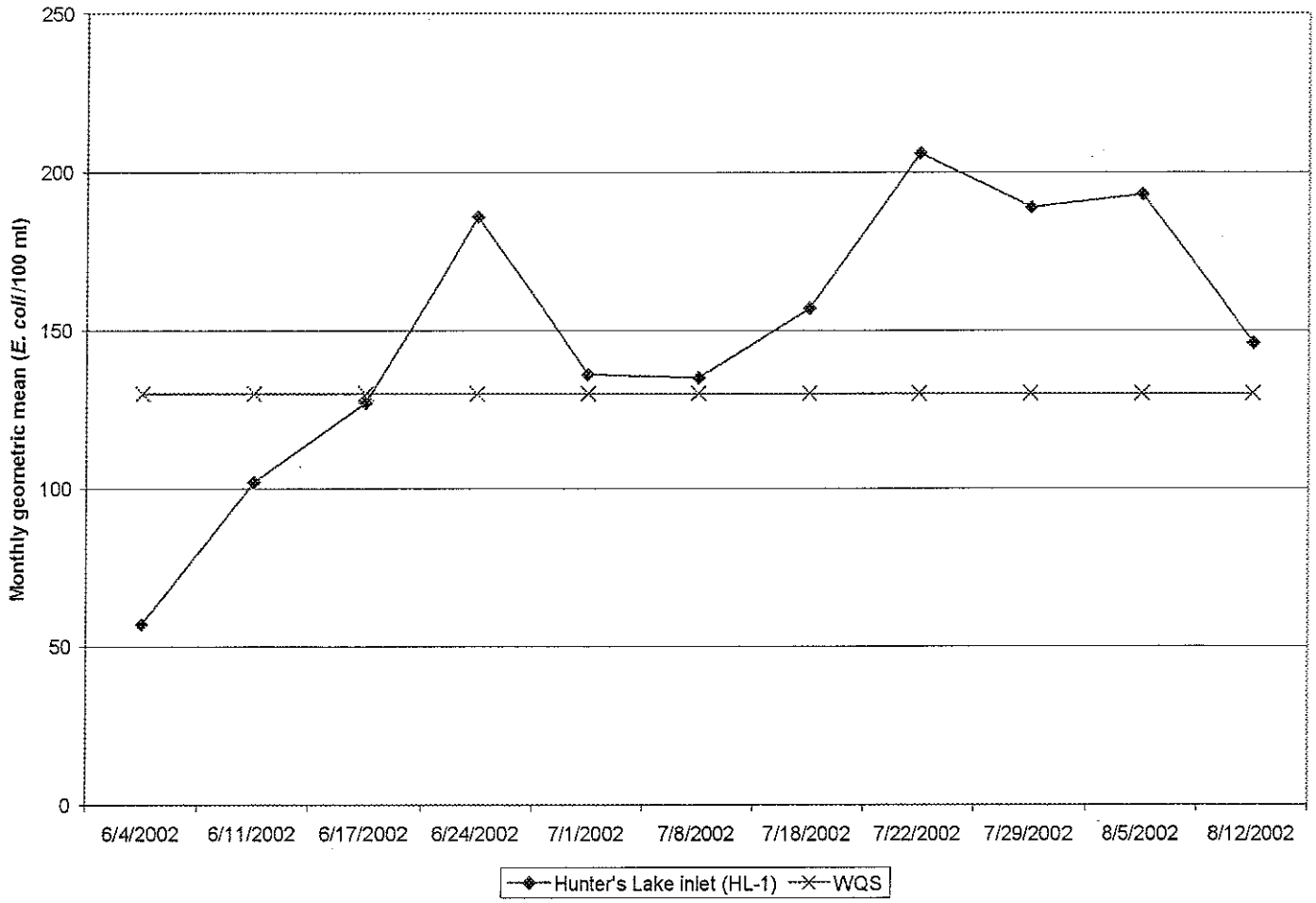

Figure 2. Hunter's Lake inlet *E. coli* monitoring, vicinity of Glennie, Alcona County, Michigan 2002.

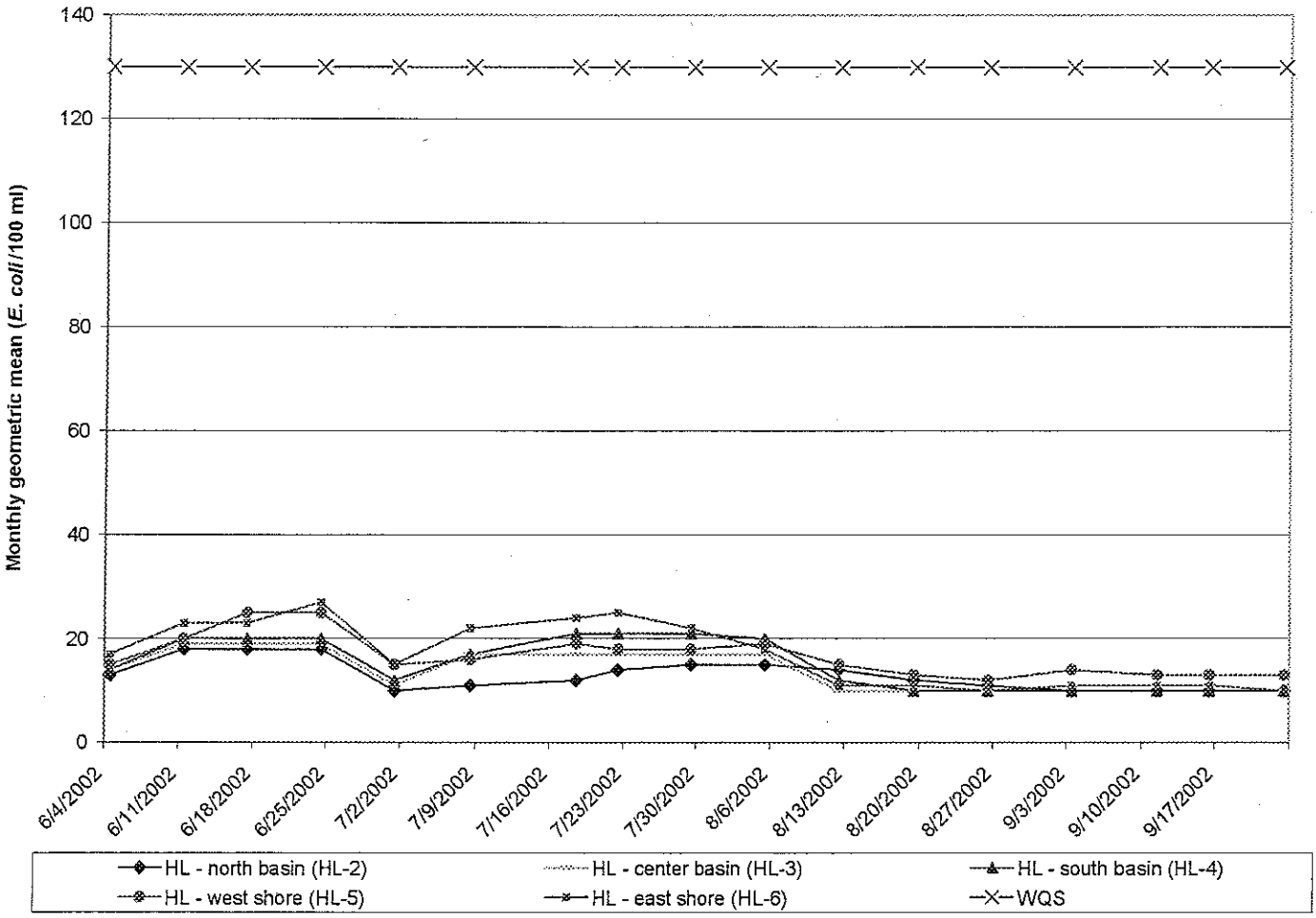

Figure 3. Thirty-day geometric mean for *E. coli* in Hunter's Lake, vicinity of Glennie, Alcona County, Michigan 2002.

Table 1. MDEQ 2002 *E. coli* monitoring data for Small Creek and Hunter's Lake in the vicinity of Glennie (*E. coli*/100 ml). Shaded areas indicate exceedances of the WQS.

	Hunter's Lake inlet at Iroquois Road (HL-1)			Hunter's Lake - north (HL-2)			Hunter's Lake - center (HL-3)			
DATE	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	Weather data
5/6/2002	2	2	---	2	2	---	2	2	---	hazy, 55°
	2			2			2			
	2			2			2			
5/13/2002	47	36	---	10	10	---	10	10	---	cloudy, 50°
	33			10			10			
	30			10			10			
5/20/2002	40	42	---	10	10	---	10	10	---	cloudy, 50°
	60			10			10			
	30			10			10			
5/31/2002	530	561	---	180	206	---	110	164	---	sunny, 65°
	570			230			200			
	650			210			200			
6/4/2002	400	358	57	10	10	13	10	16	14	overcast, 50°
	310			10			40			
	370			10			10			
6/11/2002	50	36	102	10	10	18	10	10	19	cloudy, 65°
	30			10			10			
	30			10			10			
6/17/2002	120	109	127	10	10	18	10	10	19	sunny,60°
	120			10			10			
	90			10			10			
6/24/2002	300	276	186	10	10	18	10	10	19	overcast, 80°
	320			10			10			
	220			10			10			

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

DATE	Hunter's Lake inlet at Iroquois Road (HL-1)			Hunter's Lake - north (HL-2)			Hunter's Lake - center (HL-3)			
	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	Weather data
7/1/2002	110	120	136	10	10	10	10	10	11	clear, 84°
	120			10			10			
	130			10			10			
7/8/2002	310	351	135	10	16	11	140	143	17	clear, 75°
	450			10			130			
	310			40			160			
7/18/2002	80	77	157	10	19	12	10	10	17	clear, 70°
	80			10			10			
	70			70			10			
7/22/2002	400	420	206	20	20	14	10	10	17	clear, 85°
	370			10			10			
	500			40			10			
7/29/2002	200	179	189	10	14	15	10	10	17	foggy, 80°
	110			30			10			
	260			10			10			
8/5/2002	610	131	193	10	10	15	10	10	17	clear, 70°
	370			10			10			
	10			10			10			
8/12/2002	100	87	146	10	10	14	10	10	10	clear, 75°
	130			10			10			
	50			10			10			
8/19/2002	*	---	---	10	10	12	20	13	10	sunny, 60°
	*			10			10			
	*			10			10			

*unable to collect sample due to dry conditions.

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

	Hunter's Lake inlet at Iroquois Road (HL-1)			Hunter's Lake - north (HL-2)			Hunter's Lake - center (HL-3)			
DATE	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	Weather data
8/26/2002	*	---	---	10	10	11	10	10	10	clear, 60°
	*			10			10			
	*			10			10			
9/3/2002	*	---	---	10	10	10	10	13	11	partly cloudy, 70°
	*			10			20			
	*			10			10			
9/11/2002	*	---	---	10	10	10	10	10	11	clear, 60°
	*			10			10			
	*			10			10			
9/16/2002	*	---	---	10	13	10	10	10	11	clear, 50°
	*			20			10			
	*			10			10			
9/23/2002	*	---	---	10	10	10	10	10	10	clear, 50°
	*			10			10			
	*			10			10			

*unable to collect sample due to dry conditions.

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

DATE	Hunter's Lake - south (HL-4)			Hunter's Lake - west shore (HL-5)			Hunter's Lake - east shore (HL-6)			
	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	Weather data
5/6/2002	2 2 2	2	---	2 2 2	2	---	2 2 2	2	---	hazy, 55°
5/13/2002	10 10 10	10	---	10 10 10	10	---	10 10 10	10	---	cloudy, 50°
5/20/2002	10 10 10	10	---	10 10 10	10	---	10 10 10	10	---	cloudy, 50°
5/31/2002	350 150 100	174	---	140 240 230	198	---	560 580 560	567	---	sunny, 65°
6/4/2002	20 30 10	18	14	30 10 20	18	15	20 10 10	13	17	overcast, 50°
6/11/2002	10 10 10	10	20	10 10 10	10	20	10 10 10	10	23	cloudy, 65°
6/17/2002	10 10 10	10	20	10 160 10	25	25	10 10 10	10	23	sunny,60°
6/24/2002	10 10 10	10	20	10 10 10	10	25	40 10 20	20	27	overcast, 80°

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

	Hunter's Lake - south (HL-4)			Hunter's Lake - west shore (HL-5)			Hunter's Lake - east shore (HL-6)			
DATE	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	Weather data
7/1/2002	10	13	12	10	14	15	40	29	15	clear, 84°
	20			30			20			
	10			10			30			
7/8/2002	160	104	17	30	33	16	40	92	22	clear, 75°
	70			60			130			
	100			20			150			
7/18/2002	220	28	21	80	20	19	30	14	24	clear, 70°
	10			10			10			
	10			10			10			
7/22/2002	10	10	21	20	18	18	20	13	25	clear, 85°
	10			10			10			
	10			30			10			
7/29/2002	10	10	21	10	10	18	10	10	22	foggy, 80°
	10			10			10			
	10			10			10			
8/5/2002	10	10	20	10	19	19	10	10	18	clear, 70°
	10			70			10			
	10			10			10			
8/12/2002	10	10	12	10	10	15	10	10	11	clear, 75°
	10			10			10			
	10			10			10			
8/19/2002	10	10	10	10	10	13	10	13	11	sunny, 60°
	10			10			20			
	10			10			10			

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

	Hunter's Lake - south (HL-4)			Hunter's Lake - west shore (HL-5)			Hunter's Lake - east shore (HL-6)			
DATE	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	Weather data
8/26/2002	10	10	10	10	14	12	10	10	10	clear, 60°
	10			10			10			
	10			30			10			
9/3/2002	10	10	10	100	22	14	20	13	11	partly cloudy, 70°
	10			10			10			
	10			10			10			
9/11/2002	10	10	10	10	10	13	10	10	11	clear, 60°
	10			10			10			
	10			10			10			
9/16/2002	10	10	10	10	10	13	10	10	11	clear, 50°
	10			10			10			
	10			10			10			
9/23/2002	10	10	10	10	10	13	10	10	10	clear, 50°
	10			10			10			
	10			10			10			

Table 2. Small Creek average flows (cubic feet per second) at Iroquois Road, Alcona County, Michigan.

May	June	July	August	September	October
0.7	0.6	0.5	0.4	0.4	0.5