Bacteria Reduction Implementation Plan for the Honey Creek Watershed

2014 —2024

For the purpose of achieving the Total Maximum Daily Load (TMDL) and removing the bacteria impairment of Honey Creek

Version 3.0
May 2014

Developed by the Huron River Watershed Council.

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1. Introduction and Background

The following plan is designed to be a Total Maximum Daily Load (TMDL) Implementation Plan that also meets the nine elements required for Watershed Management Plan approval by the Michigan Department of Environmental Quality (MDEQ). TMDLs in general and the one established for Honey Creek are discussed in section 2.

The Huron River and Middle Huron

Features

The Huron River (HR) is a Michigan gem. The Michigan Natural Rivers Act of 1970 designated a 27-mile stretch, from Kent Lake Dam, near Brighton, to Barton Pond, north of Ann Arbor, as a "country-scenic river," Southeast Michigan's only such designation. Flowing 136 miles, it originates in Indian Springs Metropark near Waterford, flows south of Brighton, through Ann Arbor and Ypsilanti to Lake Erie, south of Detroit. En route, it provides drinking water for 150,000 residents throughout its 900 square mile watershed. It does not flow free, however. It is dammed 98 times, 17 of which are on the main stem.

The Middle Huron (MH), a segment designated as downstream of the confluence with Mill Creek in Dexter through Ford and Bellville Lakes, east of Ypsilanti, comprises 40 of the 136 miles (plus another 593 miles of contributing streams), forming a 217 square mile watershed. All or portions of 13 local communities are situated in the Middle Huron Watershed, of which the largest portions are within the cities of Ann Arbor and Ypsilanti, and the townships of Scio, Ann Arbor, Superior, Pittsfield, Ypsilanti and Van Buren. Other communities with smaller areas in the watershed include the townships of Webster, Northfield, Salem, and Lodi, as well as the Village of Dexter and the City of Belleville. Because the MH's gradient (5 ft. /mi.) is steeper than the Upper Huron or other Michigan watersheds, and because of intensive urban development, fewer lakes and wetlands remain in the MH.

Land Use and Development

The MH watershed's land cover is dominated by urban and sub-urban residential, commercial and industrial uses, with low-density residential areas, grasslands/old agricultural fields, forested lands, and wetlands scattered primarily in the northern and western fringes of the watershed. Permanent mixed density residential land use is the single largest use of the watershed (29.5%), followed closely by forest (27.1%), and rural (20.9%). In recent decades, the MH watershed has experienced amplified development pressures from a growing economy and urban sprawl. Its population will continue to grow through 2030, with 30% growth rates projected in Scio, Superior and Ypsilanti Townships (SEMCOG, 2000).

If current development practices are employed to accommodate the projected increase in population and associated infrastructure, then SEMCOG estimates 40% of the remaining open spaces will be developed within the HR watershed by 2020. Much of this projected conversion of undeveloped land will occur in the MH, with potential increases for negative environmental impacts, including water quality impacts from erosion, sedimentation, and increased inputs of stormwater pollutants. Potential impacts on water quantity also increase as wetlands, woodlands, floodplains and other natural features that regulate water quantity are altered or replaced with impervious surfaces. Land development results in significant changes to the hydrology of the watershed: it increases daily fluctuations in streamflow and diminishes groundwater recharge. All tributaries to the Huron River suffer from comprehensive

channelization, lack of cover, and large flow fluctuations as a result of efforts to accelerate drainage through these streams.

Management
Regulatory and enforcement responsibility for water quantity and quality regulation often lies with the United States Environmental Protection Agency (US EPA) and the Michigan Department of Environmental Quality (MDEQ). Major activities regulated by the state, through the MDEQ, are the alteration/loss of wetlands, pollutant discharges, control of stormwater, and dredging/filling of surface waters. Because the western end of the MH is designated as a Scenic River, special development restrictions apply along the river and tributaries. While state and county governments take an active role in many relevant watershed or water quality regulations and policies, local governments assume significant leadership in land and water management by passing and enforcing safeguards. These local ordinances can be more protective than state laws, though state regulations set minimum protections that cannot be violated. Local governments oversee enforcement of their policies.

The Middle Huron Watershed Management Plan

Background
The MH WMP was originally drafted in 1994 by a Policy Advisory Committee, consisting of members representing each of the communities in the project area. They have continued to meet on a regular basis, and the meetings are currently coordinated by the Middle Huron Partnership Initiative – a voluntary partnership of municipalities and agencies in the Middle Huron River watershed focused on reducing phosphorus loading. The plan was updated in 2000, and a major redraft was completed in 2008 by HRWC under the coordination of the Washtenaw County Drain Commissioner (WCDC).

Intent
Though originally designed to reduce Phosphorus levels in Ford and Belleville Lakes at the direction of the MDEQ, it was also intended to proactively address other water quality issues throughout the watershed. However, the MH WMP serves as an umbrella plan, under which subwatershed plans are developed to address specific water quality issues unique to the sub-watersheds. Presently, sub-watershed and lake plans exist for several bodies throughout the MH watershed. Subwatershed plans are intended to address the challenges posed to the HR and are to be rooted in the HR WMP.

Creek groups have contributed a unique community-involvement component to the development of the original WMP and updates. Several creek groups have formed since the development of the original WMP, and several of these have developed the subwatershed plans or other sets of recommendations. Staff from the HRWC and the WCDC have met and will continue to meet with creek groups throughout the process of developing and implementing watershed plans.

Goals
The Advisory Committee prioritized goals in the WMP. Those that are most pertinent to Honey Creek include the following: reduce nonpoint source loading, increase public awareness and involvement, gain broad implementation of subwatershed plans, and continue monitoring and data collection for water quality, water quantity and biological indicators.

Action plan

The action plan of the WMP was determined by the plan's authors (HRWC) and the Advisory Committee, based on the prioritized goals, environmental effectiveness, and likelihood of implementation. Because it is meant to be an umbrella plan for subwatershed plans, it presents the broad range of practices and general information about their application. The recommended actions most pertinent to Honey Creek fall under the following categories: ordinances and policies (e.g., ordinances for stormwater management), practices (e.g., street cleaning programs), public information and education (e.g., a public hotline for elicit discharge), illicit discharge elimination, and structural improvements (e.g., installing inlet filters). Several pathogen-reduction strategies, focusing on *E. coli* sources, were presented to diminish illicit discharges, domestic and feral animal sources, and wildlife animal sources, including strategies of land use planning and treatment.

Implementation.
Multi-layered advisory committees have been established to advocate and facilitate the plan. In addition, local subwatershed groups have participated, and program specific community involvement activities have taken place (e.g., Community Partners for Clean Streams, and Adopt-a-Stream). Evaluation methods for measuring success were put in place and monitoring responsibilities established. Specifically, *E. coli* levels have been analyzed one to two times per month, plus during rain events, by the HRWC and Ann Arbor Water Treatment Plant (AA WTP).

Watershed Characterization

Flowing through what is now Scio and Lodi Townships as well as the western edge of the City of Ann Arbor, Honey Creek was home to numerous beehives in trees along the creek. Historically, the Honey Creek watershed was an area of agriculture and gravel pit mining. Over time, areas of residential and commercial centers have developed along major road arteries. However, agriculture (including many horse pastures) is still a prominent feature in the creekshed.

Landscape and Natural Features
Honey Creek joins the western end of the MH at the upper end of Barton Pond, between Dexter and Ann Arbor (see Figure 1). The watershed encompasses 23 square miles and comprises most of the area of Scio Township, plus small portions of Lima, and Lodi Townships, and the City of Ann Arbor.

Topology
Glacial typology of the region is flat clay lake plain with soils dominated by silt and clay loams dissected by broad glacial drainageways of sandy soil. The landform is relatively flat across the upper watershed with particularly large, flat (formerly wetland) areas in the southwestern section of the watershed. The downstream sections of the watershed are more steep. The creek's average slope is 30 feet per mile, which is steep for the Huron River watershed as a whole. There is a rapid drop in elevation from Miller Road to the Huron River, resulting in a series of mini-rapids in this section of the creek. An undisturbed stream with this high slope will typically have well established riffle-pool sequences and excellent diversity in fish habitat and water flow. However, channelization and urbanization have reduced this habitat diversity.

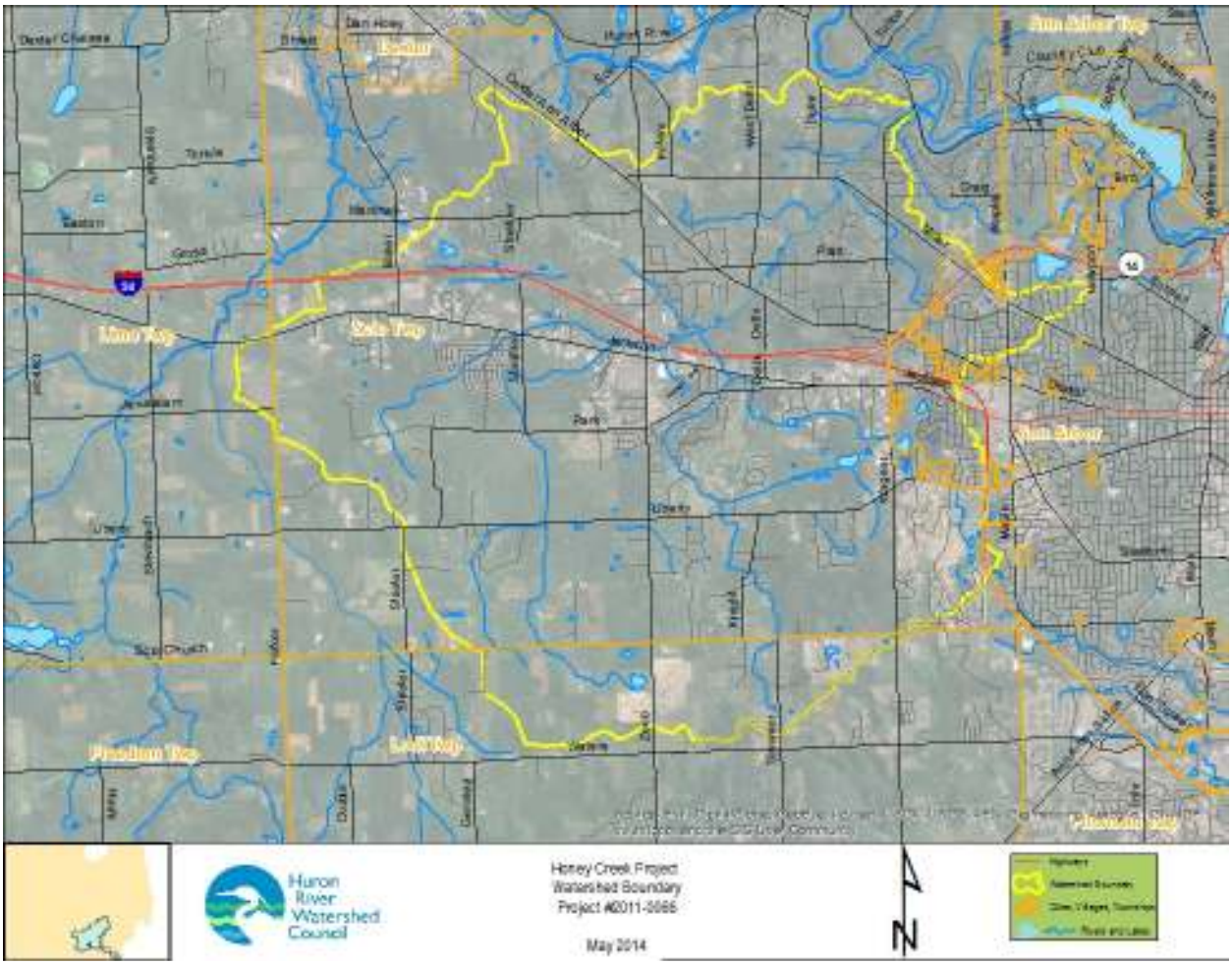


Figure 1. The Honey Creek watershed boundary and location.

Geology and Soils

Glacial outwash plains and medium textured end moraines characterize the watershed. Glacial outwash plains were created by melting glaciers whose runoff sorted soils into layers of similarly sized particles. These well-sorted soils include sand and gravel that allow rapid infiltration of surface water to groundwater aquifers and stream systems. End moraines are areas where glacial processes deposited huge quantities of rock and soil material of various sizes in one place. The mixture of varying sized soil particles increases the soils' ability to hold moisture and nutrients, which is conducive to agriculture. Medium textured end moraines generally have low permeability.

The soils in the Honey Creek watershed are largely end moraines of medium-textured till or sand and gravel glacial outwash. Sand and gravel line the riparian zone of the river and creek. Figure 2 shows the soils according to their hydrological classification, ranging from rapid to slow infiltration. The general trend of soil infiltration in the Honey Creek watershed is moderately rapid infiltration across most of the watershed, with slow infiltration areas toward the western end – an area dominated by current and former wetlands.

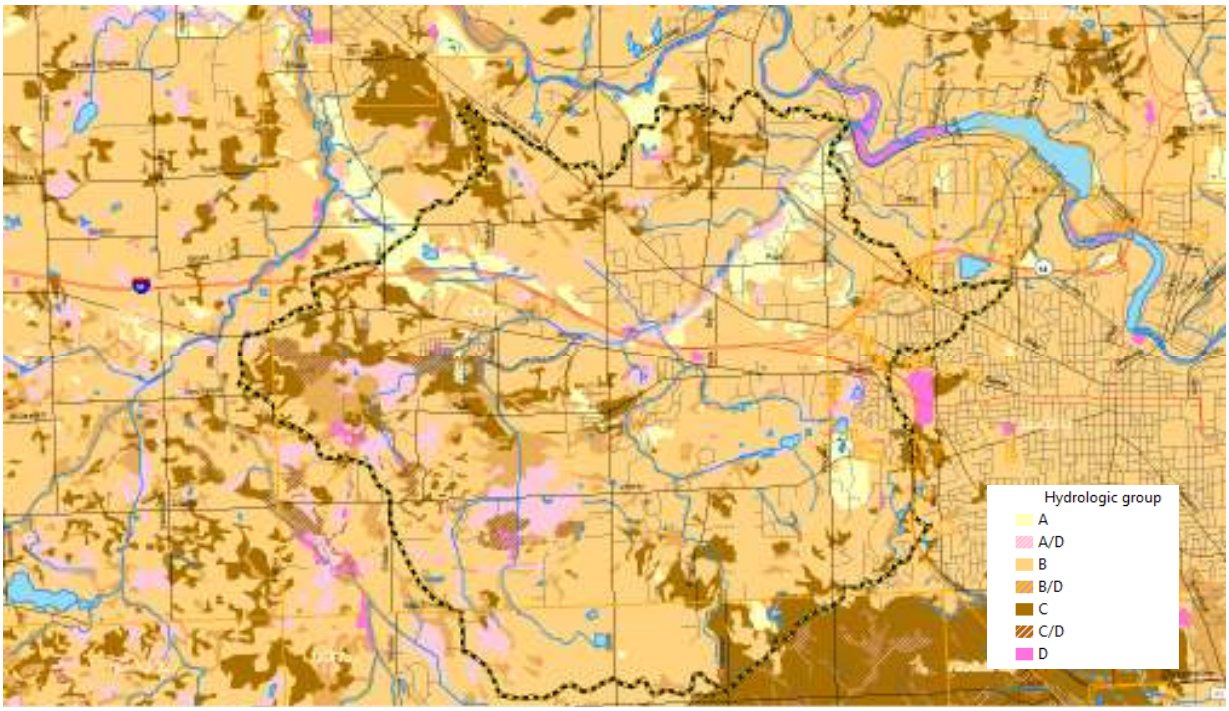


Figure 2. Hydrologic soil groups in the Honey Creek watershed. The scale generally runs from the group with the highest infiltration capacity (A) to the lowest (D).

Natural features

There are 4 lakes (open water > 5 acres) in the Honey Creek watershed. There are 3 ponds (open water < 5 acres). Honey Creek is composed of 26 miles of branching stream channels, and it drains 23 square miles of land. There are no known dams on Honey Creek. The water flows freely from the upper tributaries down to the mouth of the river.

The creekshed's forests, wetlands, and grasslands soak up rainwater and runoff, filter pollutants from runoff, and provide wildlife habitat and beautiful places for all to enjoy. Only 17% of the creekshed has intact natural areas (see Figure 3), and only a small fraction of these areas are protected from development (about 2% of the watershed, notably Saginaw Forest and Dolph Park). However, a number of the natural areas are large in area with significant core area established. Without its intact natural areas, the creekshed faces an uncertain future.

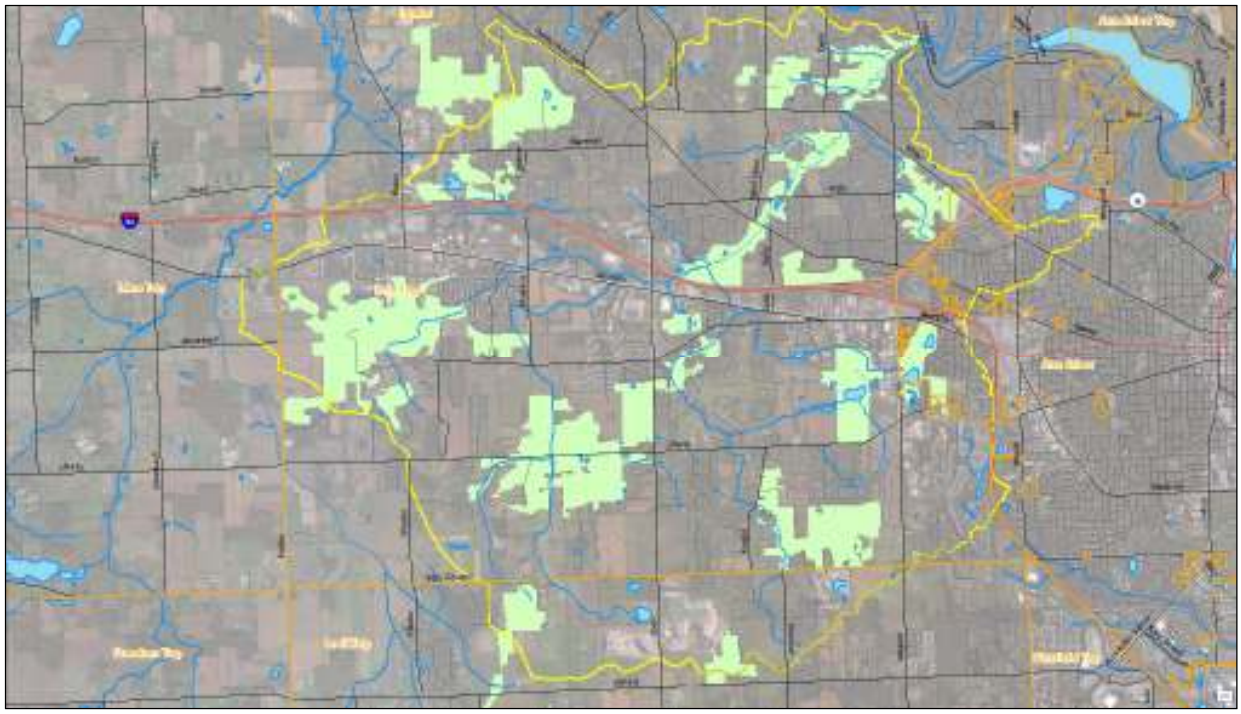


Figure 3. Intact natural areas (HRWC Bioreserve sites) in the Honey Creek watershed.

Wetlands

Wetlands provide many important functions in a watershed from providing flood storage, critical habitat for numerous plant and animal species (many of which are threatened or endangered), and carbon sequestration, to serving in water quality treatment, flow mitigation and bacteria removal capacities. As of 2005, the Honey Creek watershed contained only 1,459 acres of wetlands (1% of the watershed). This compares to pre-settlement wetland coverage of 3,109 acres (2% of the watershed) – a 53% loss (see Figure 4). Looked at from a functional perspective, the greatest loss in the watershed was fish habitat, with 80% of wetland area providing this function lost. Importantly, 57% of the wetlands providing sediment and pathogen retention have been lost. For a detailed evaluation, see MDEQ's *Functional Wetland Assessment* in Appendix A.

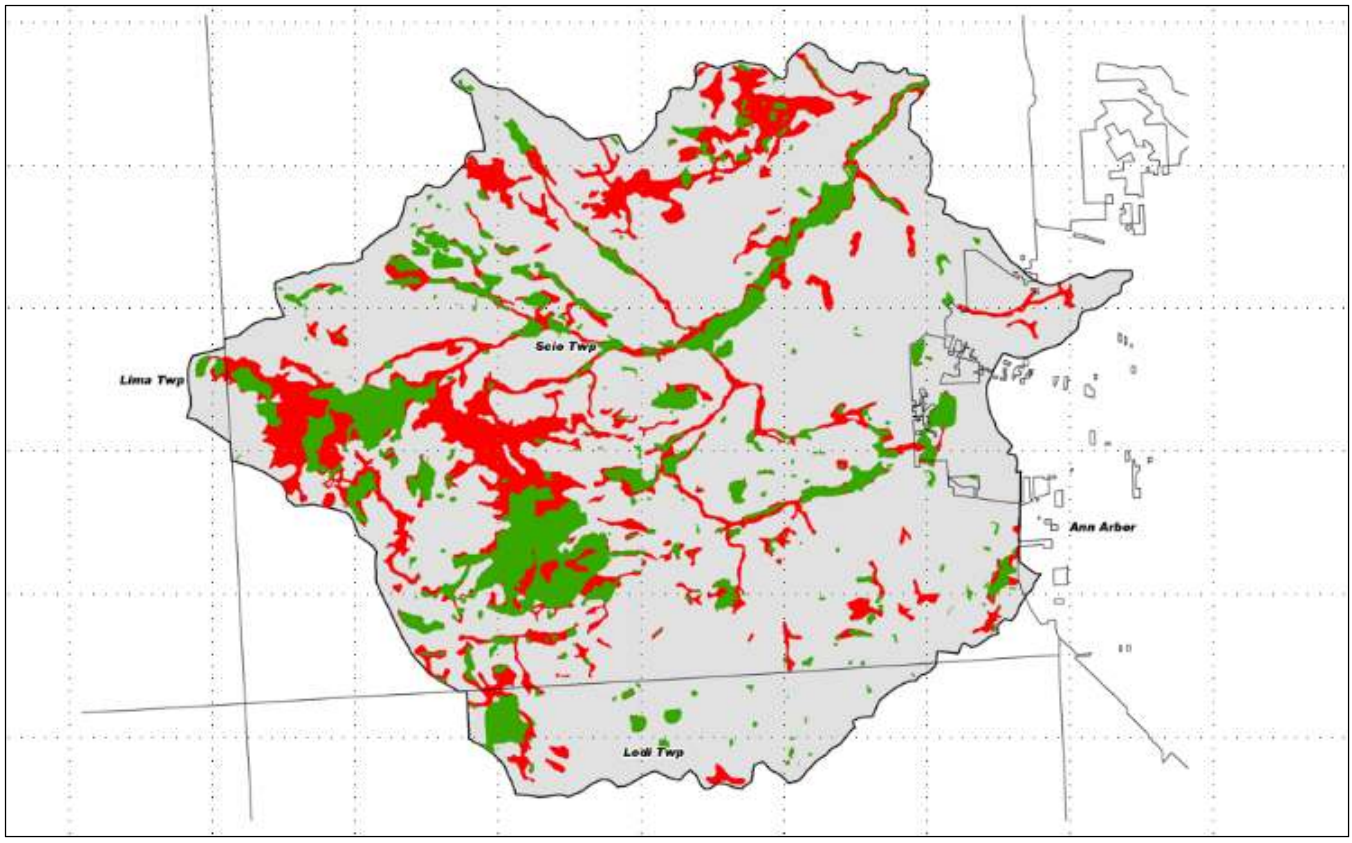


Figure 4. Approximate wetland loss in the Honey Creek watershed from pre-European settlement to 2005. Pre-settlement wetlands lost are shown in red and 2005 wetlands shown in green. Source: MDEQ, 2012.

Government and Land Use

Political Structure

The majority (85%) of the Honey Creek watershed is located in Scio Township. The remainder is found in the Lima Township (1%) to the west, Lodi Township (9%) to the south and the City of Ann Arbor (5%) to the east. All of the watershed is in Washtenaw County.

Each local government in the watershed has a zoning code and holds regularly scheduled meetings where rulings are made on policy additions and changes, budgets, land use issues, and other important local business. Working with the guidance of statewide procedures, townships and other local governments have power to formulate land use and development policy, among other important activities. The City of Ann Arbor has jurisdiction over and management responsibility for sewers and stormwater infrastructure, such as gutters, catch basins, pipes and outlets. Drains, including roadside ditches, pipes, bridges, and culverts under state highways and county roads that are not designated county drains are maintained by the county Road Commissions.

Political jurisdictions regarding the Huron River and its tributaries, riparian zones, and land are controlled by federal and state laws, county and local ordinances, and town by-laws. Regulatory and enforcement responsibility for water quantity and quality regulation often lies with the United States Environmental Protection Agency (U.S. EPA) and MDEQ. Major activities regulated by the state, through the MDEQ, are the alteration/loss of wetlands, pollutant discharges (NPDES permits), control of stormwater, and dredging/filling of surface waters.

County government assumes responsibility for carrying out certain state policies. In most cases, county governments enforce the state erosion control policy, under the Michigan Soil Erosion and Sedimentation Control Act 347 of 1972 and Part 91 of Act 504 of 2000, although local governments may also administer this program, and county road commissions typically self-regulate their erosion control. At the time of this publication the City of Ann Arbor was the only local government in the Middle Huron Watershed known to administer its own soil erosion and sediment control program.

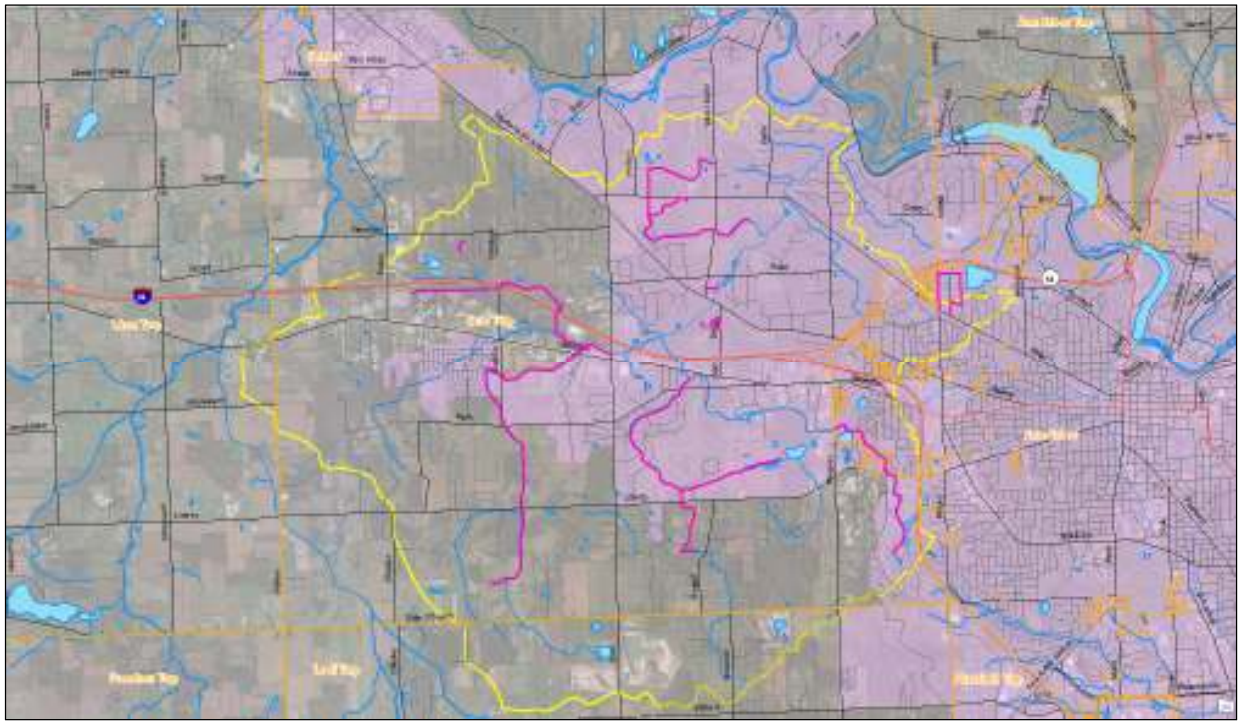


Figure 5. Designated county drains managed by the Washtenaw County Water Resources Commissioner in Honey Creek watershed are highlighted along with the urbanized area.

Designated county drains in the watershed may be open ditches, streams or underground pipes, retention ponds or swales that convey stormwater. The Water Resources Commissioner Office of Washtenaw County is responsible for operation and maintenance of these storm water management systems ("county drains"). These systems are designed to provide storm water management, drainage, flood prevention, and stream protection for urban and agricultural lands. The Drain Code gives the Water Resources Commissioner authority for construction or maintenance of drains, creeks, rivers and watercourses and their branches for flood control and water management. Figure 5 shows the designated county drains in Honey Creek along with the urbanized area. Federal and state stormwater regulations apply to the drains within the urbanized area only.

While state and county governments take an active role in many relevant watershed or water quality regulations and policies, local governments assume much leadership in land and water management by passing and enforcing safeguards. These local ordinances can be more protective than state laws, though state regulations set minimum protections that cannot be violated. Working under numerous established procedures, local governments may enact ordinances to control stormwater runoff and soil erosion and sedimentation; protect sensitive habitats such as woodlands, wetlands and riparian zones; and establish watershed-friendly development standards and lawn care and landscaping practices, among other options. Local governments oversee enforcement of their policies.

Land Use and Development

The watershed contains a spectrum of land uses ranging from agricultural operations and small-scale animal farms near the headwaters to the urbanized City of Ann Arbor downstream. Land uses in the watershed are as follows based on consolidated Southeast Michigan Council of Governments' (SEMCOG) aerial photographic data (2000): residential, 27%; forest, 9%; Agriculture, 31%; commercial/industrial, 9%; water/wetland 8%; open/public recreation, 17% (see Figure 6).

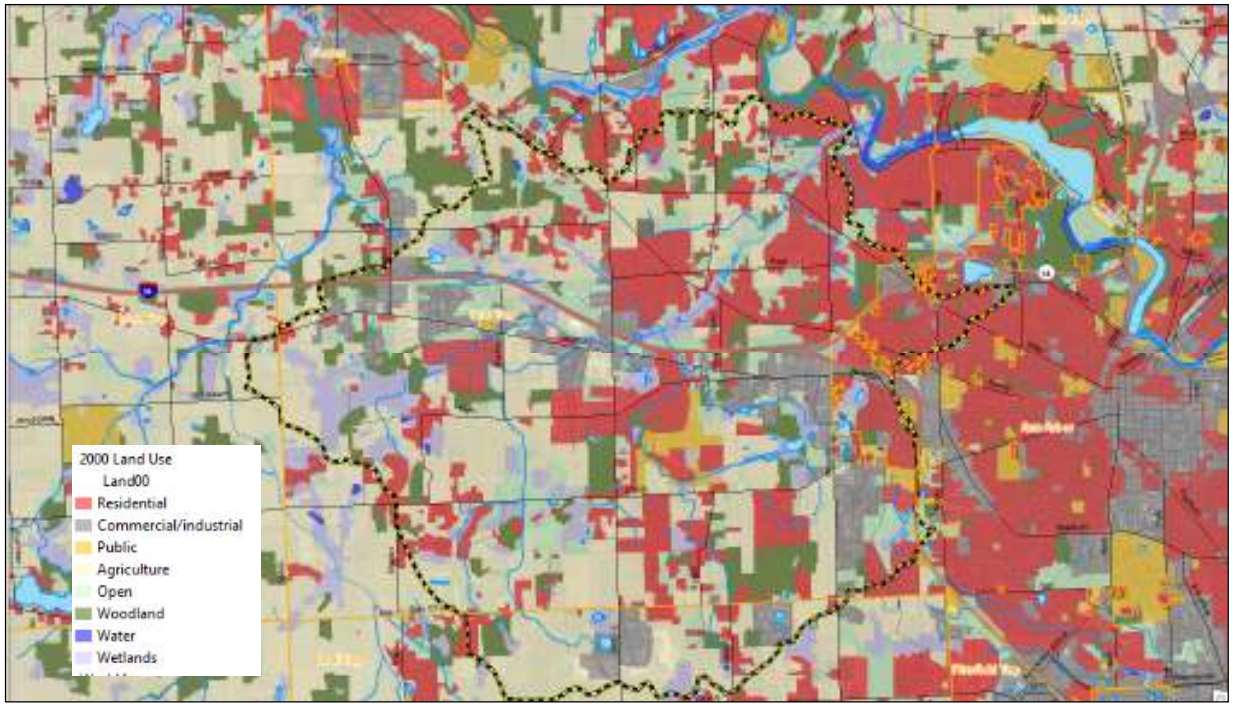


Figure 6. Land use in the Honey Creek watershed as of 2000. Source: SEMCOG aerial photo interpretation.

Bordering the built-out City of Ann Arbor, population is expanding into the Honey Creek watershed. Population growth in Scio Township between U.S. census years 2000 (year of the last land use estimation) and 2010 was 22.7%. This compares with a 6.8% growth rate across Washtenaw County. According to SEMCOG estimates through December 2013, the population in Scio Township grew another 3.3% from 2010, for a total growth of 26% since 2000.

The result of this growth has been an increase in development and the addition of area that is impervious to water infiltration into the soil. The total impervious area estimated from a 2010 SEMCOG land cover analysis was 16% (see Figure 7). Generally, research indicates that once the impervious cover in a watershed exceeds 10%, surface waters begin to show signs of impairment. Imperious cover over 25% generally results in significant impairment, and watersheds with over 50% impervious cover required extensive and expensive management actions to maintain even modest water and habitat quality. Riparian buffer zones may mitigate the impact of impervious development. However, Honey Creekshed in general lacks quality buffer zones compared to other creeksheds on the MH, compounding the problem of pollution due to runoff. Honey Creek could be a target for better riparian buffer protection and restoration. As a result, ecological conditions have been rated as poor.

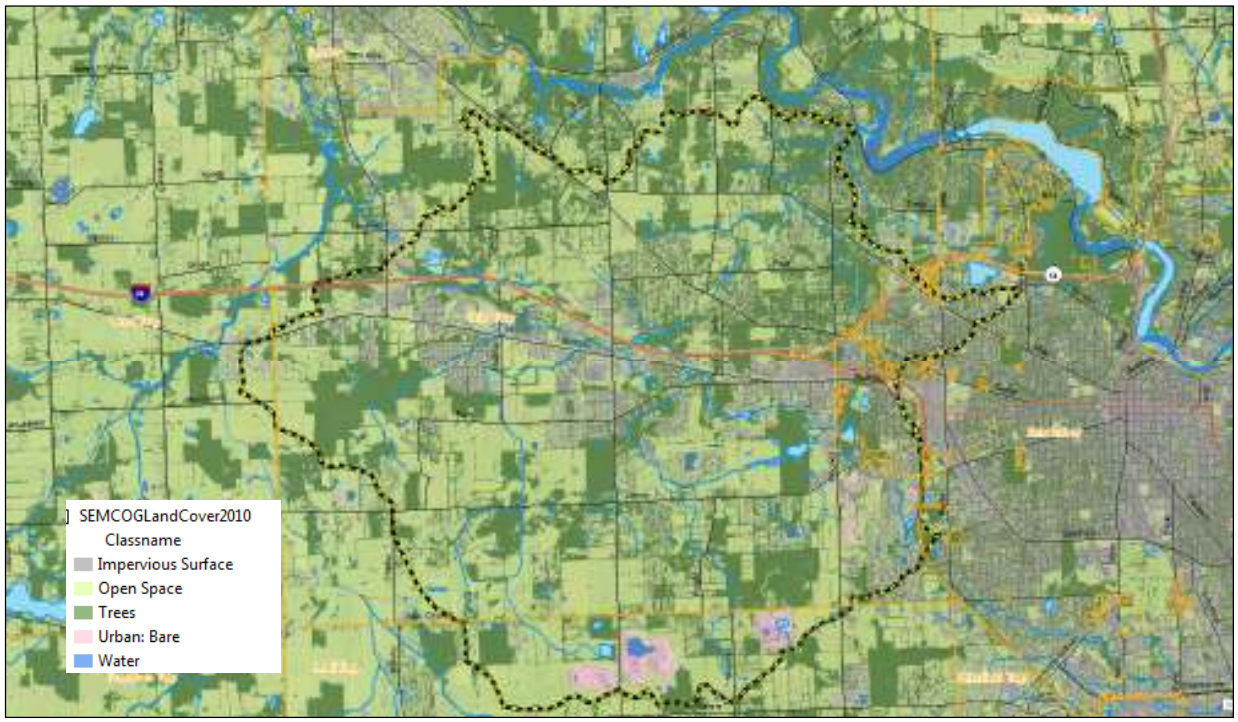


Figure 7. Land cover in the Honey Creek watershed, as classified from aerial photos in 2010 under SEMCOG contract.

Point Sources

There are ten active point source facilities in the watershed that hold National Pollution Discharge Elimination System (NPDES) permits issued by the State of Michigan as of the date of plan development (see Figure 8). Some facilities hold more than one permit. The number of permitted point sources is not static due to expiring old permits and activation of new permits. All active permits are for industrial facilities. As such, there are no permitted waste water treatment facilities discharging to Honey Creek.

One large-volume discharger of note is Pall Life Sciences, Inc. Their permit allows the facility to discharge up to 1.7 million gallons of effluent per day. The facility discharges groundwater that has been treated to remove 1,4-dioxane, which has contaminated groundwater in a plume under Honey Creek and extends east beyond the watershed boundaries. The plume is monitored by the company and MDEQ and is continuing to migrate. While this contamination represents a threat to Honey Creek surface water quality, a separate process exists, with MDEQ and citizen oversight, to monitor and address the threat, and thus will not be further addressed in this plan.

The remaining permitees are considered minor point source dischargers and are privately owned.

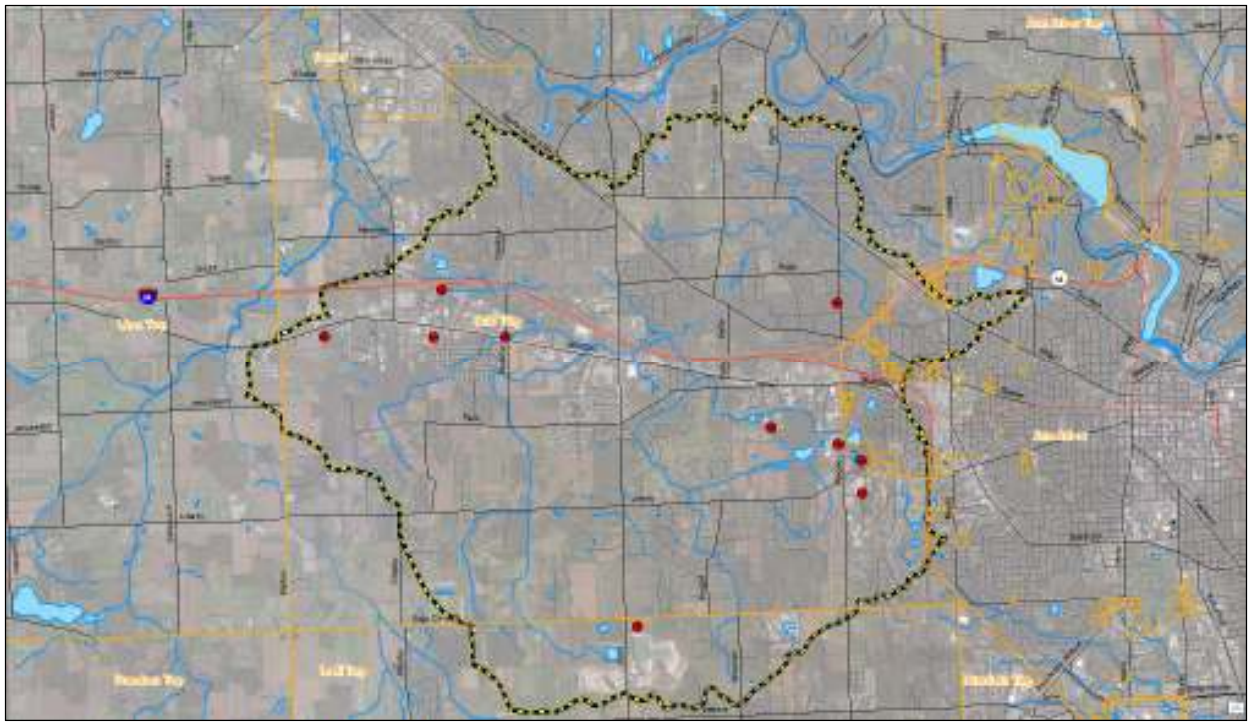


Figure 8. Facilities holding permits from MDEQ to discharge pollutants to Honey Creek under the National Pollutant Discharge Elimination System. Source: MDEQ, 2014.

Sanitary Sewers and Septic Systems

The commercial and residentially developed corridor along Jackson Road and I-94, as well as areas east of Wagner Road were built with hook-ups to the public sewer system operated by the City of Ann Arbor (see Figure 9). All waste water is exported out of the Honey Creek watershed, and treated effluent is discharged to the Huron River downstream. Waste water from the remainder of the watershed is treated by private septic systems. Using household data from SEMCOG, there are an estimated 6,700 private septic systems in Scio Township.

Improperly functioning sewer systems and privately owned septic systems can have a profound impact on the water quality. By carrying nutrients (phosphorus and nitrogen), bacteria, pharmaceutical agents, and other pollutants to waterbodies with little or no treatment, impaired systems can result in unhealthful conditions to humans (i.e., bacterial contamination) and to aquatic organisms (i.e., low dissolved oxygen from plant growth).

If either system is designed, constructed, or maintained improperly, it can be a significant source of water pollution and a threat to public health. The health department of Washtenaw County regulates the design, installation, and repair of privately owned septic systems. Washtenaw County is also unique in requiring regular maintenance and inspection at the time of property sale to assure proper functioning of these systems. Through implementation of the time-of-sale program, Washtenaw County has determined that 20% of privately owned septic systems in the county are failing and require repair. A more recent effort was made to identify failing systems using aerial imagery, but few systems were successfully identified.

Sanitary sewer systems can suffer from improper installation and maintenance. For instance, in many older developments sanitary sewer pipes can be inadvertently connected to stormwater drainage

systems, causing what is termed an “illicit discharge.” These discharges can have an even greater impact on water quality than impaired septic systems, depending on the type, volume, and frequency of the activity. Both county and local units of government covered by Phase II stormwater permits are required to identify and eliminate illicit discharges in their communities through an Illicit Discharge Elimination Program (IDEP).

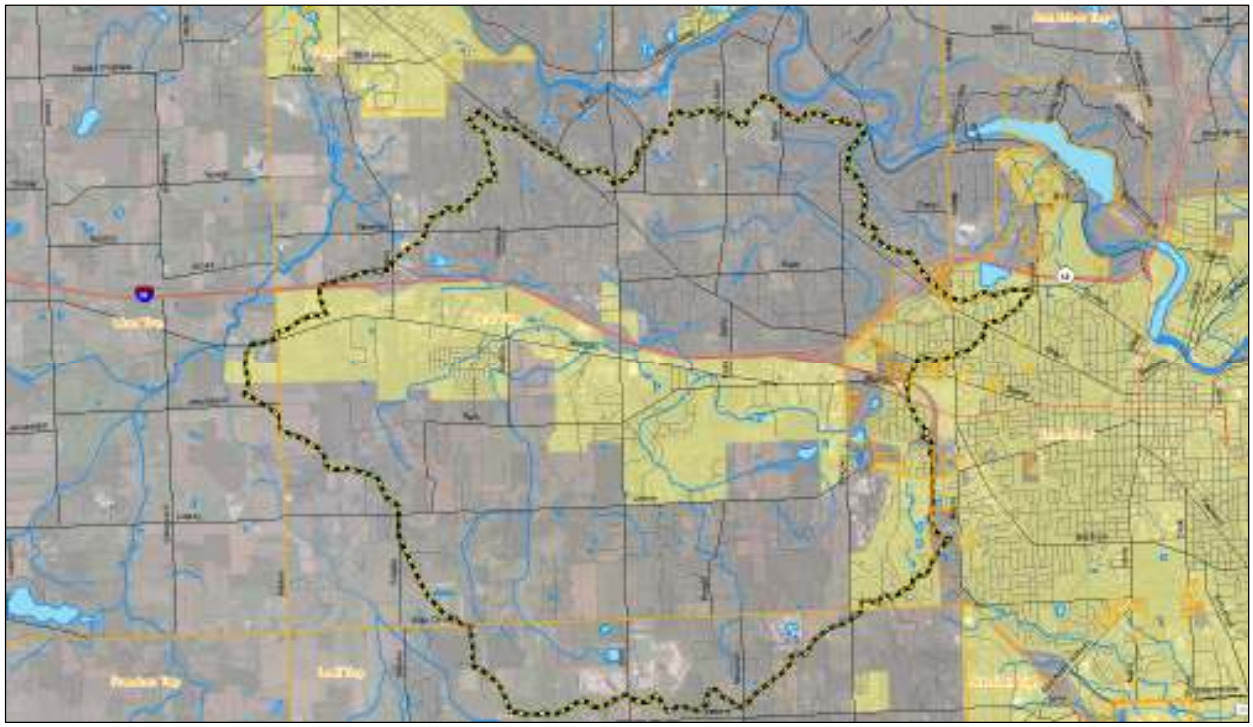


Figure 9. Areas within Honey Creek watershed that are serviced by a sanitary sewer system. All treated waste water is discharged outside the watershed. Remaining areas are on private septic systems.

Water Quality Indicators

Chemistry and Bacteria

HRWC’s Water Quality Monitoring Program has collected water quality data for Honey Creek at Wagner Road annually from May to September since 2003. April measurements were added starting in 2010. Measurements include total phosphorus load, total suspended solids, conductivity, pH, and dissolved oxygen. *E. coli* surveys were added in 2006. *E. coli* results are discussed in Chapter 2.

Mean Total Phosphorus concentrations in Honey Creek remain above the 0.05 mg/l target (see Figure 10). However, the mean concentration has declined significantly over time. Through 2006, the mean TP concentration in Honey Creek was 0.083 mg/l. From 2008-13, the mean concentration dropped to 0.058 mg/l. Phosphorus is considered for the entire Middle Huron River watershed in a separate plan for that larger watershed.

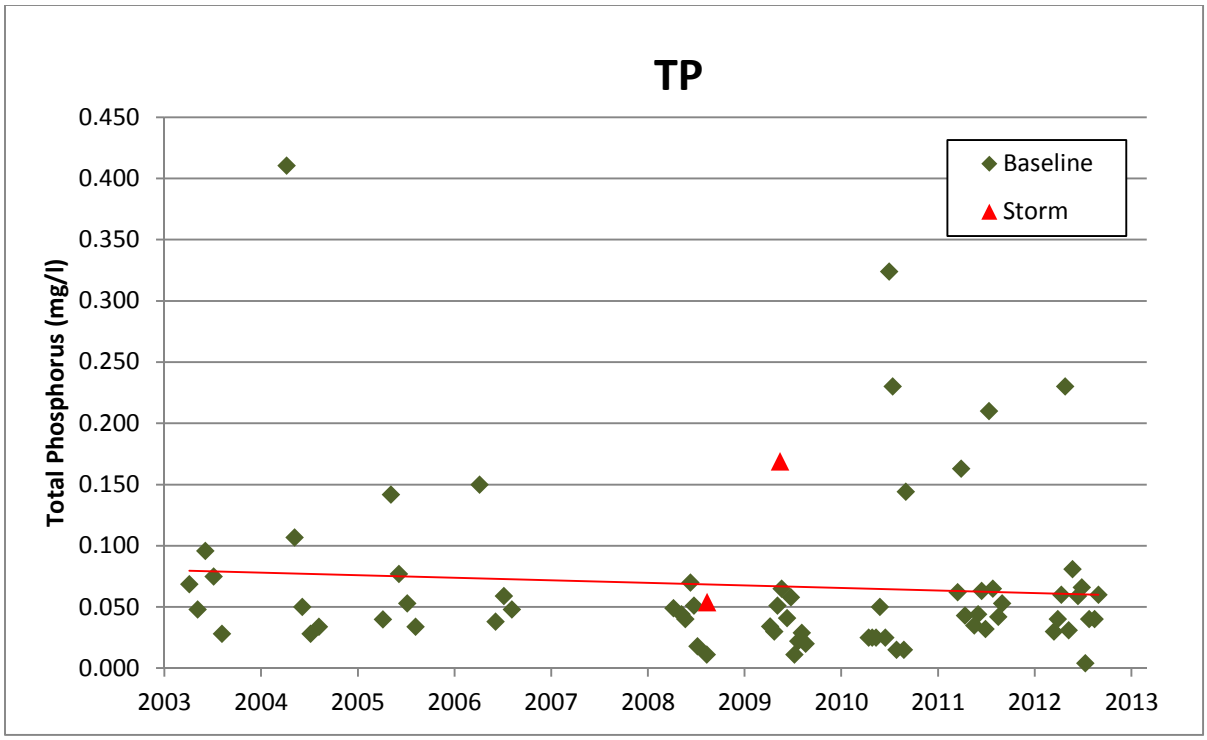


Figure 10. Total phosphorus concentrations sampled from Honey Creek at Wagner Road along with a liner trend line. Event mean concentrations from storm events are also depicted.

Total suspended solids, a measure of the sediments in the water column, are typically quite low in Honey Creek. Creek samples remain below 20 mg/l during dry conditions and most smaller storms. Only during or following the largest rain events does the concentration exceed 80 mg/l. The mean concentration in 2013 was 3.82 mg/l. The maximum concentration across the entire 2003-13 sampling period was 147 mg/l.

The ion balance in Honey Creek, as measured by pH, remains fairly stable sample to sample. All but one sample was within the Michigan standard range between 6.5 and 9. The one sample that registered 6.2 appears to have been a one-time anomaly, as all other measurements were well over 7.

The flowing water at the downstream Honey Creek site is well mixed and always maintains healthy dissolved oxygen concentration. The level has never been measured below 5 mg/l, and the lowest measure was 6.8 mg/l. The average dissolved oxygen concentration over the monitoring record is 9.4 mg/l.

HRWC also measures conductivity – a measure of a material's ability to conduct charge and a broad measure of pollution content. HRWC uses a stream water conductivity threshold of 800 µS as an indicator of possible water pollution, above which studies have shown water quality degradation may be occurring. At the Wagner Road site, the mean conductivity over 11 years of monitoring was 988 µS. The mean for 2013 was somewhat lower at 847 µS. Honey Creek is also monitored at Jackson Road, Pratt Road, and Wagner Road by the Adopt-A-Stream program 1-3 times per year. At Jackson Road, the average conductivity level is 788 µS. The average conductivity at Pratt Road is 1085 µS. The Wagner Road site (identical location as the Water Quality Monitoring Program site) has a conductivity average of 1135 µS. These conductivity levels all suggest possible impairment.

The MDEQ conducted a biological survey of the Huron River and its tributaries from July to September of 1997, 2002, and 2007. Water quality parameters such as conductivity, Kjeldahl nitrogen, total phosphorus, and total suspended solids were measured in 2002 for Honey Creek at Huron River Drive. These measurements fell within the range of reference sites for the region. [i, ii]

Groundwater in parts of Washtenaw County, including areas in the City of Ann Arbor and Ann Arbor and Scio Townships, is contaminated with the industrial solvent 1,4-dioxane. Most of this contamination is within the Honey Creekshed. Gelman Sciences, now Pall Life Sciences (PLS), used 1,4-dioxane in their manufacturing process through the mid-1980s, and the chemical seeped into and contaminated the groundwater.[iii] Monitoring and clean-up activities are on-going through coordination between MDEQ, the City of Ann Arbor and PLS.

Hydrology

Honey Creek, at the Wagner Road location, exhibits characteristics of a stream impacted by hydrologic alteration. HRWC regularly measures the flow rate at the site when sampling April through September. HRWC also installed a flow sensor at the site to continuously measure flow over four periods: May-November 2008, May-October 2009, May-October 2012, and May-November 2013. Over these four seasons, Honey Creek registered a flashiness index of 0.30. That index is a measure of the magnitude and frequency which the stream rises and falls. An index of that level places Honey Creek in the third quartile (above average) of measured streams of similar size in Michigan.[1] During these four seasons, the highest peak flow recorded was 408 cfs during a 2.6-inch, 24-hour storm. Honey Creek never runs dry, with the minimum flow dropping to 2.1 cfs.

Figure 11 illustrates a typical hydrograph for Honey Creek. During a modest 1.3" 24-hour storm, the stream flow rose relatively quickly to a peak of 44 cfs. The stream flow returned to baseflow over a period of about 24 hours. This storm event response pattern is more natural than many of the more urbanized streams in the watershed, but less natural than other less-impacted streams of comparable size in the Huron River watershed and elsewhere across Michigan.

[1] Referenced against data published in *Application of the Richards-Baker Flashiness Index to Gaged Michigan Rivers and Streams.* MDEQ, 2007.

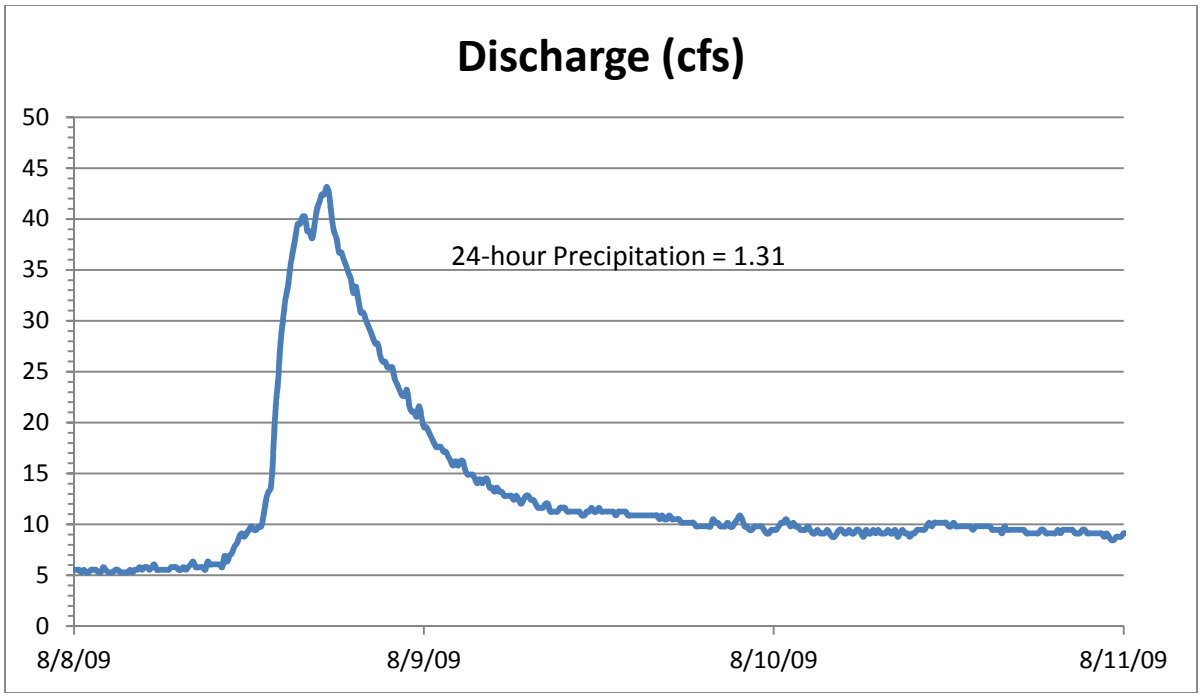


Figure 11. Discharge (stream flow) from Honey Creek around a modest storm in August 2009.

Aquatic Biology

The Huron River Watershed Council (HRWC) Adopt-a-Stream program has taken biological samples from 2001-2013 at three sites along Honey Creek. Ecological conditions, as determined by a combination of biological and physical data, have varied from ratings of poor, fair, and good at these sites. Aquatic invertebrate communities and insect diversity have remained stable, while insect diversity has increased steadily in some locations.

Overall, Honey Creek has a lower insect diversity than many other creeks located within the Huron River watershed, but is better than most of the urban creeks (like Malletts or Millers). Sensitive insects including winter stoneflies are present, but never abundant. At the mouth of Honey Creek, the insect community is slightly below average, and further upstream the population is far below average, but not yet poor. The insect population is restricted by the high amount of fine sediment in the creek. Table 1 provides a site-based summary of aquatic insect data.

Table 1. Ecological Conditions and Aquatic Insect Families at HRWC Adopt-A-Stream Program Monitoring Sites in the Honey Creekshed

Study Site	Ecological Conditions*	Population Diversity	Avg. Insect Families	Avg. EPT Families	Avg. Sensitive Families	Winter Stonefly
Jackson Rd	Fair	Stable	12	4	0	Rarely
Pratt Rd	Poor	Stable	11	3	0	None in past 5 years
Wagner Rd	Fair	Stable	11	4	2	2 families present

** categories: excellent, good, fair, and poor.*

In 1997 and 2002, MDEQ surveyed Honey Creek at Huron River Drive (close to the Wagner Road site) for macroinvertebrates. The invertebrate community rating in 1997 was rated "poor" and in 2002 was found to be "acceptable." The total rating in 2002 was -3, with 21 taxa found, including 5 EPT taxa (all caddisflies; 14%).

As to stream habitat, at the mouth of Honey Creek, the stream habitat is of good quality; large rocks, riffles, and pools are plentiful as it nears the Huron River. However, the middle to upper parts of the creek have unstable and eroding stream banks and the stream bed is full of sand and muck. The study site on Pratt Road has the worst substrate of all sites HRWC monitors—100% of the streambed is covered by fine sediment.

The MDEQ collected qualitative habitat data including substrate and instream cover, channel morphology, and riparian and bank structure for Honey Creek at Huron River Drive during their 2002 survey. Habitat condition was rated as slightly impaired due to low availability of epifaunal substrate, bank instability, and high stream flashiness. [iv]

Based on Michigan Department of Natural Resources fish surveys and an Institute of Fisheries Research model, Honey Creek is home to a variety of small fish typically found in small, cool creeks. Bluntnose minnows, johnny darters, central stonerollers, blacknose dace, and green sunfish have all been found in Honey Creek. None of these fish are particularly sensitive to pollution or altered hydrology.

Designated and Desired Uses

Following requirements in the federal Clean Water Act, the State of Michigan established designated uses for all state waterways, as listed below. The designated uses that apply to the Honey Creek watershed are in boldface:

- **Agriculture**
- **Industrial water supply**
- Public water supply at the point of intake (no public supply in Honey Creek)
- Navigation
- **Warmwater fishery**
- **Other indigenous aquatic life and wildlife**
- **Partial body contact recreation**
- **Total body contact recreation between May 1 and October 31**
- Coldwater fishery (natural temperatures are too high)

Due to human impacts and the impairments they cause throughout the Honey Creek Watershed, not all of the designated uses are fulfilled. Based on the watershed assessment in this section (and bacteria assessment discussed in section 2) designated uses currently being met are agricultural and industrial water supply, warmwater fishery, and other indigenous aquatic life and wildlife. **Designated uses not being met in the Honey Creek watershed are partial body contact and total body contact recreation due to bacterial contamination (assessed in section 2).**

Agriculture and Industrial Water Supply

Agricultural and industrial water uses are assumed to be supported unless specific information is discovered suggesting otherwise. No such information was discovered.

Warmwater Fishery

The primary tool for assessing warmwater fishery use is the presence of a diverse fishery appropriate for the watershed type and size. According to MDNR surveys, a stable, diverse (though not sensitive) fish population exists in Honey Creek. Secondary assessment measures include water chemistry, habitat and flow characteristics that allow for a healthy fish population. No parameters exceed thresholds to prohibit fish growth or reproduction.

Other Indigenous Aquatic Life and Wildlife

The primary measure for this use is the presence of a diverse aquatic macroinvertebrate population. Assessment of three locations by HRWC indicate two of the three locations with a "fair" population rating, but one with a "poor" rating. MDEQ assessment in 2002 found a Honey Creek mactroinvertebrate population to be "acceptable." Habitat assessments in Honey Creek at the mouth have been rated as good to slightly impaired. Upstream habitat (at Platt Road) is listed as poor. Stream flow is more flashy than other gaged Michigan streams of its size, but not to the point of impairment. Overall, this designated use would not be considered impaired, but should be considered threatened. This use should continue to be monitored as it appears on the threshold of being impaired. Management activities that have a secondary benefit of improving stream flow or sediment reduction should be considered.

In addition to state-designated uses, the residents of the watershed wish to use its surface waters in ways that are not yet achievable. The following desired uses have been identified by the communities in the watershed over the course of the development and updating of the MH Watershed Management Plan: coordinated development between environmental and economic considerations; protected and enhanced hydrologic functions; protected open space, recreation and urban amenities.

2. Problem Definition

Honey Creek, a feeding tributary to the Huron River in Washtenaw County, Michigan, is listed as an impaired waterbody on Michigan's Section 303(d) list (Impaired Waterbodies List) due to impairment of recreational uses by the presence of elevated levels of pathogens. The listed segment addresses approximately 26 miles of branching stream channels, and 23 square miles of land drainage – the entire Honey Creek watershed. Based on previous sampling by MDEQ, the entire watershed, including all stream reaches, is impaired for excessive bacteria. Water sampling in this area has shown that Michigan Water Quality Standards (WQS) for partial body contact (PBC) and total body contact (TBC) are not consistently being met in this waterbody or its tributaries. Based on analysis of a more complete study of the watershed (see Appendix C), areas of impairment were limited to "critical areas" identified in Section 3.

Impairments to the Middle Huron

The major impairments to the MH, in order of priority, are high nutrient loading, altered hydrology, sedimentation and soil erosion, and pathogen overloading. Pathogen overloading is the most relevant to this plan for Honey Creek and its effect on the MH. In 2006, HRWC added *E. coli* counts to the measurement parameters under the Water Quality Monitoring Program. All but one site exceeded the single event standard, which indicates that *E. coli* bacteria contamination is a significant concern in the MH watershed. Major sources of pathogens, especially *E. coli*, in the Middle Huron include wildlife living in or near storm drains and outlets, pet and wildlife waste washed into streams from upland areas, agricultural sources including livestock operations, failing septic systems, land application of untreated waste from these septic systems, and illicit discharges of sanitary waste into storm drains.

The overarching challenges to mitigating these impairments are land use change (e.g., suburbanization), loss of natural features (e.g., riparian buffer zones), need for public awareness and action, need for administrative support and institutional and financial arrangements, and monitoring programs and data. These challenges have been and are being addressed through the MH Watershed Management Plan (WMP).

What is a TMDL?

When a water body is not attaining Water Quality Standards (WQS) for designated uses, it is put on the EPA's 303(d) List, according to the Clean Water Act, and is required to have a Total Maximum Daily Load (TMDL), allowing the MDEQ to establish controls to reduce pollution and restore the quality of the resource. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. It is a document which presents available information to determine potential sources of contaminants.

As of the 2010 303(d) List of Nonattaining Waterbodies, Honey Creek (HC) remains listed for water quality impairments for TBC and PBC. The HC TMDL, which specifically targets *E. coli* contamination, was completed by the MDEQ in April 2009 (see Appendix B).

Bacteria

Excess pathogens in water resources can become a public health concern and cause the public to lose recreational opportunities such as wading and canoeing. *Coliform* is a group of bacteria that includes a

smaller group known as *fecal coliforms*, which are found in the digestive tract of warm-blooded animals. Their presence in freshwater ecosystems indicates that pollution by sewage or wastewater may have occurred and that other harmful microorganisms may be present. A species of *fecal coliform* known as *Escherichia coli*, or *E. coli*, is analyzed to test for contamination. It is used as an indicator organism to predict the presence of multiple harmful microorganisms. *E. coli* and associated microorganisms, when taken into the body, can cause severe sickness: bacterial infections (cholera, salmonellosis), viral infections (hepatitis, gastroenteritis), or protozoa infections (cryptosporidiosis, giardiasis). Once these pathogens are in a stream or lake, they can infect humans through ingestion, skin contact or contaminated fish.

Sources

E. coli can originate from single discharge points or more broadly across multiple points of similar types. Point-source discharge can emerge as treated (e.g., from wastewater treatment plants) or untreated (e.g., from raw or partially treated sewage overflows during storms). Untreated occurrences can result from Combined Sewer Overflows (CSO), of which there are none in the Huron River watershed, and Sanitary Sewer Overflows (SSO), which are illegal "spills." This broadly sourced pollution can be the result of failing septic systems, overland run-off, agricultural inputs (e.g., maneuver spreading or unrestricted livestock access to streams), illicit connections (septic systems draining into stormwater drains or streams), pets, or wildlife.

Regulations

Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 451) limits the concentration of microorganisms in surface waters of the state and surface water discharges. Waters of the state that are protected for Total Body Contact (TBC) recreation must meet limits of 130 *E. coli* colony forming units (cfu) per 100 (ml) water as a 30-day geometric mean of five sampling events (3 samples per event) and 300 *E. coli* per 100 (ml) water for any single sampling event during the May 1 through October 31 period. The TBC standard protects the public during summer months, assuming that people will swim with head submerged. The limit for waters of the state that are protected for Partial Body Contact (PBC) recreation is a geometric mean of 1000 *E. coli* per 100 ml water for any single sampling event at any time of the year. The PBC standard protects the public year-round, assuming that people will not swim in the winter season, but still may come into contact with the water.

Why a TMDL for Honey Creek?

Standards for TBC and PBC of *E. coli* are being exceeded in Honey Creek, especially during times of heavy precipitation. The TMDL is based on data from four stations, monitored weekly from August through October 2007, an unusually dry year. The 30-day geometric mean hovers between 400 and 1,500 cfu *above* TBC standards, especially at Station 1.[v] In part, these impairments result from the lack of substantial riparian buffer zones and the rapidly growing human population in the creekshed, leading to a greater percentage of impervious surfaces. In part, they are due to point and non-point sources.

Bacteroidetes analysis determines presence or absence of bacteria specific to human feces. In a single sample taken from the worst site (Staebler Rd.) on 12 October 2007, no human marker was detected, but this does not rule out the potential for human sources.

The Nature of Escherichia coli[2]

Bacteria are among the simplest, smallest, and most abundant organisms on earth. Bacteria are "procaryotic" organisms—a term which indicates a cellular structure lacking an organized nucleus and nuclear membrane. Instead of containing genetic information stored on several chromosomes, bacteria contain a single strand of DNA. These organisms reproduce by binary fission, which occurs when a single cell divides to form two new cells called daughter cells. Each daughter cell contains an exact copy of the genetic information contained in the parent cell. The process continues with each daughter cell giving rise to a generation of two new cells. The generation time is the time required for a given population to double in size. This time can be as short as 20 minutes for some bacteria species (e.g., *Escherichia coli*).

While the vast majority of bacteria are not harmful, certain types of bacteria cause disease in humans and animals. Examples of waterborne diseases caused by bacteria are: cholera, dysentery, shigellosis and typhoid fever. During the London cholera epidemics of 1853-1854, Dr. John Snow observed that nearly everyone who became ill obtained their drinking water from a specific well into which a cesspool was leaking. Those who became ill either drank water from the well or came into contact with fecally contaminated material while tending those already sick. Concerns about bacterial contamination of surface waters led to the development of analytical methods to measure the presence of waterborne bacteria. Since 1880, coliform bacteria have been used to assess the quality of water and the likelihood of pathogens being present. Although several of the coliform bacteria are not usually pathogenic themselves, they serve as an indicator of potential bacterial pathogen contamination. It is generally much simpler, quicker, and safer to analyze for these organisms than for the individual pathogens that may be present. Fecal coliforms are the coliform bacteria that originate specifically from the intestinal tract of warm-blooded animals (e.g., humans, beavers, raccoons, etc.). They are cultured in a special growth medium and incubated at 44.5^{o} C.

The first U.S. standards for drinking water, established by the Public Health Service in 1914, were based on coliform evaluations. It was reasoned that the greatest source of human pathogens in water was from human waste. Each day, the average human excretes billions of coliform bacteria. These bacteria are present whether people are ill or healthy. Monitoring for coliform bacteria was designed to prevent outbreaks of enteric diseases, rather than to detect the presence of specific pathogens. Today, coliform bacteria concentrations are determined using methods specified by the Environmental Protection Agency (EPA) and *Standard Methods for the Examination of Water and Wastewater* (AWWA, APHA, and WEF, 20th ed., 1998).

Sources of Bacteria[3]

Human sources of bacteria can enter water via either point or nonpoint sources of contamination. Point sources are those that are readily identifiable and typically discharge water through a system of pipes. Communities with sewer systems may not have enough capacity to treat the extremely large volume of water sometimes experienced after heavy rainfalls. At such times, treatment facilities may need to bypass some of the wastewater. During bypass or other overflow events, bacteria-laden water is discharged directly into the surface water as either sanitary sewer overflow (SSO) or as combined sewer overflow (CSO). Power outages and flooding can also contribute to the discharge of untreated wastewater.

[2] Text adapted from MDEQ, Surface Water Quality, NPDES Permits website. February 2003.
[3] Text adapted from MDEQ, Surface Water Quality, NPDES Permits website. February 2003

Improperly functioning sewer systems and privately owned septic systems can have a profound impact on water quality. By carrying nutrients (phosphorus and nitrogen), bacteria, pharmaceutical agents, and other pollutants to waterbodies with little or no treatment, impaired systems can result in unhealthful conditions to humans and to aquatic organisms.
The Washtenaw County Health Department regulates the design, installation, and repair of privately owned septic systems. The County currently requires regular maintenance and inspection to assure proper functioning of these systems, which occurs at the time the property is sold, and has determined that nearly 20% of privately owned septic systems in the county are failing and require repair (a typical percentage for the area), nearly 50% have reached their service life expectancy, and more than 5% have an illicit discharge (i.e., a connection to a storm drain instead of a septic drain). Illicit discharges can have an even greater impact on water quality than impaired septic systems. Both county and local units of government covered by Phase II stormwater permits are required to identify and eliminate illicit discharges in their communities through an Illicit Discharge Elimination Program (IDEP).

Illicit connections to storm sewers are a source of bacteria in surface waters, even during dry periods. A connection to a storm sewer is "illicit" when the wastewater requires treatment prior to discharge and should be routed to the sanitary sewer. Only storm water and certain permitted discharges (e.g. clear, non-contact cooling water) should be discharged to a storm sewer.

Nonpoint sources are those that originate over a more widespread area and can be more difficult to trace back to a definite starting point. Failed on-site wastewater disposal systems (septic systems) in residential or rural areas can contribute large numbers of coliforms and other bacteria to surface water and groundwater.

Animal sources of bacteria are often from nonpoint sources of contamination. Concentrated animal feeding operations, however, may become point source dischargers. Agricultural sources of bacteria include livestock excrement from barnyards, pastures, rangelands, feedlots, and uncontrolled manure storage areas. Land application of manure and sewage sludge can also result in water contamination, which is why states require permits, waste utilization plans, or other forms of regulatory compliance.

Storm water runoff from residential, rural, and urban areas can transport waste material from domestic pets and wildlife into surface waters. Landscaping practices may create ideal habitat for geese and other migratory waterfowl, concentrating populations during the nesting season or creating year-round flocks, and creating hazardous quantities of fecal litter, leaving E. coli and other disease-causing organisms ready to be washed into ponds and waterways.

Bacteria from both human and animal sources can cause disease in humans. Bacteria-laden water can either leach into groundwater and seep, via subsurface flow, into surface waters or rise to the surface and be transported by overland flow. Bacteria in overland flow can be transported freely or within organic particles. Overland flow is the most direct route for bacteria transport to surface waters. Underground transport is less direct, because the movement of water and bacteria is impeded by soil porosity and permeability constraints.

Potential sources of bacteria in Honey Creek as indicated by the TMDL include the following:

- Failing septic systems (according to the Washtenaw County Environmental Health Department inspection records, 8% of septic systems in the TMDL watershed are inadequate, and 4% had above ground sewage present);

- Illicit connections to stormwater drains;
- Sanitary Sewer Overflows (SSO) (there were two reported isolated events);
- Permitted point source discharges (there exists one NPDES permitted sanitary wastewater discharge, but it is not yet constructed, and permits require disinfection and contain appropriate limits to meet WQSs);
- Pets (Scio Farms MHC, located upstream from Station 1, is home to 650+ dogs in a quarter square mile community, with dog walk areas directly on the creek and around stormwater retention ponds);
- Wildlife (e.g., geese, raccoons, etc.); and
- Agriculture, which could cause both wet and dry weather contamination (e.g., manure spreading, animals with unrestricted access to streams, and pasture runoff—30% of the creekshed is in agricultural use, some as pasture).

TMDL Mandate and Applicable Regulations

Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (U.S. EPA) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). The impaired designated use for Honey Creek 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 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.

The MDEQ finalized the Honey Creek *E. coli* TMDL in April 2009. The TMDL was developed based in part on MDEQ analysis of water sampling data collected in 2007.

Water Quality Target

All surface tributaries (not enclosed) are required to comply with the WQS of 130 *E. coli* per 100 ml as a 30-day geometric mean. Because enclosed tributaries are not considered waters of the state, the daily maximum WQS of 300 *E. coli* per 100 ml will apply as a monthly average to the few enclosed sections of Honey Creek. By maintaining the concentration of 300 *E. coli* per 100 ml in the enclosed tributaries, any area of WQS exceedance in Honey Creek will be minimized. If the pathogen inputs can be controlled so that surface tributaries meet a 30-day geometric mean of 130 *E. coli* per 100 ml, the enclosed tributaries meet a monthly average of 300 *E. coli* per 100 ml and background levels do not significantly increase, then total body contact recreation in this reach of the Huron River will be protected.

Sampling Effort and Data Summary

Sampling results include initial efforts by MDEQ for TMDL development, ongoing monitoring by HRWC, and a sampling study used for plan development. For this study, in 2012 and 2013, HRWC sampled 21 locations throughout Honey Creek over three 5-week periods in three different seasons. Sampling was conducted to identify sources based on two factors: geographic distribution and host sources.

Geographic Distribution

MDEQ Sampling. Honey Creek was placed on the Section 303(d) list in 2000, due to impairment of recreational uses by the presence of elevated levels of pathogens. The original listing was based on sampling conducted by Washtenaw County Environmental Health Department (WCEHD) and MDEQ. (MDEQ, 2009) MDEQ followed up with sampling to develop the TMDL (see Appendix B) in August through October, 2007. The sampling results showed broad exceedences of both total and partial body contact standards at four points along Honey Creek (see Figure 12 for sampling stations).

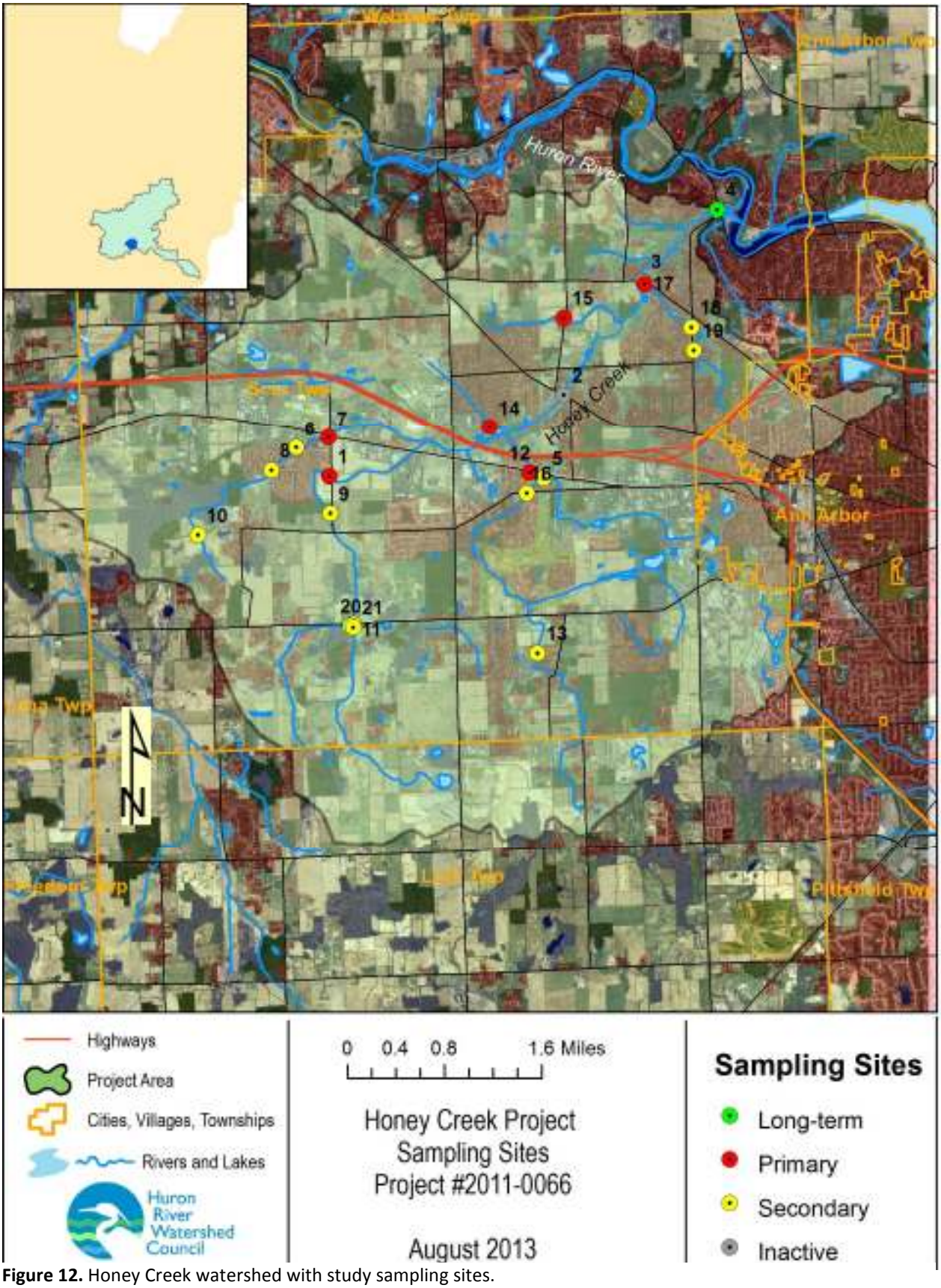


Figure 12. Honey Creek watershed with study sampling sites.

Figure 13 below illustrates the results at all four sampling locations along with precipitation from 48 hours prior to sampling. *E. coli* concentrations exceeded standards at all four sampling locations. Bacteria colony counts were generally higher following rain storms. Bacteria concentrations were also generally highest at the most upstream location and progressively less at each downstream location. The TMDL identified this as a "decreasing trend of *E. Coli* concentrations from upstream to downstream." This suggested a potential source or sources close to the upstream location (HC01)[4].

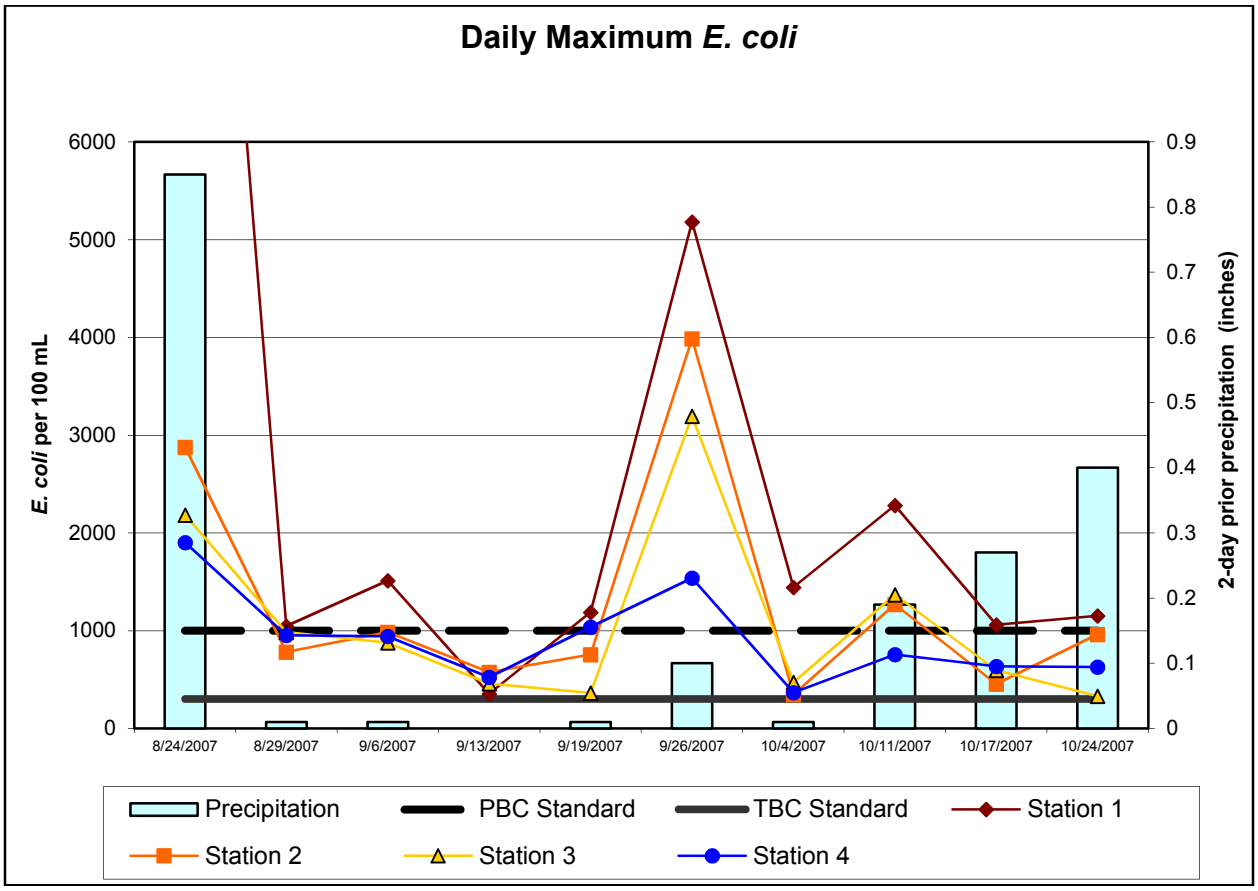


Figure 13. Results from sampling events in 2007 at four stations along Honey Creek. Results represent *E. coli* cfu/100 ml and 2 days of pre-event precipitation.

HRWC Sampling

HRWC has been sampling Honey Creek (at the station identified as HC04 in Figure 12) as part of the Middle Huron Monitoring Program since 2003. In 2006, the program added *E. coli* as a parameter. Since that time, through 2012, the median *E. coli* concentration was 120 cfu/100 ml, though the geomean was 211 cfu. This figure is above the 30-day TBC standard. Complete results of this monitoring are included in Appendices B and C.

In an effort to confirm this geographic pattern of bacterial contamination, HRWC located sampling stations at all major branches and tributaries to Honey Creek. Sampling was conducted over three five-week periods starting in June and October in 2012 and July in 2013. This represented sampling across

[4] Here and throughout the discussion of results, stream sections are referenced to sampling points identified by number code. The numbers correlate to station numbers in Figure 12. When referring to stream sections and watershed areas, the designation refers to the area upstream of the station, unless otherwise indicated.

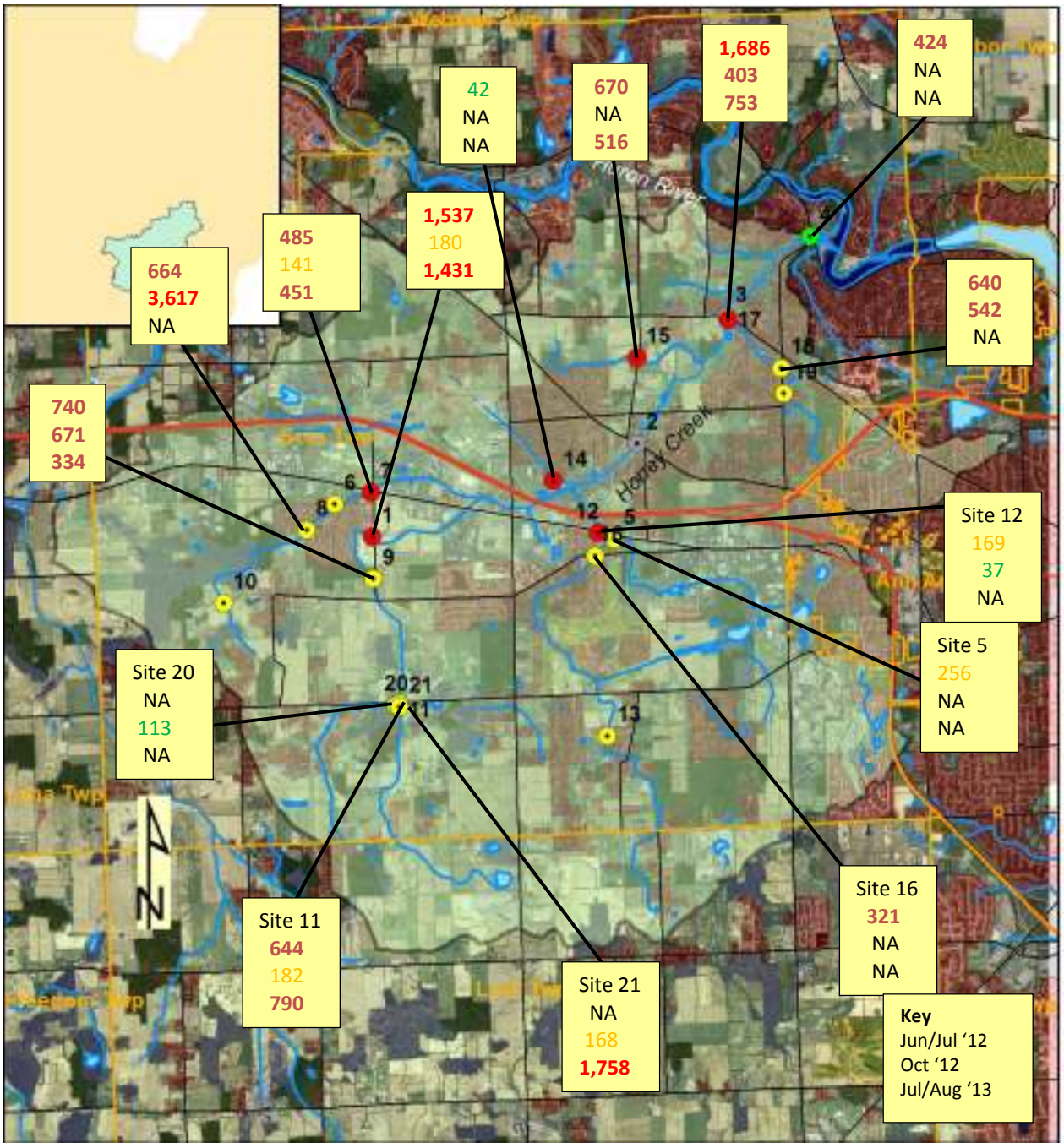


Figure 14. Geomeans of multiple sampling events at Honey Creek sites in cfu/100 ml *E. coli*. Red concentrations exceed 1,000 cfu, purple exceed 300 cfu, orange exceed 130 cfu, and green are below 130 cfu. The sequential order of results reflects the sampling period identified in the key.

three different seasons. Following initial sampling, additional sites were selected upstream of branch or tributary sites that yielded E. coli concentrations above the sampling event standard of 300 per 100 mL. Detailed sampling methodology and complete sampling results are included in Appendix C.

Figure 14 depicts the results of sampling at Honey Creek branches and tributaries. The spring/summer 2012 geomean near the creek mouth was 425, exceeding the TBC standards for single sample and 30-

day mean. Sample results at two branches were below concern levels and were not subsequently sampled in October. Those branches are represented by sampling sites HC12 and HC14. All other branches had bacteria concentrations well above TBC standards as well as the level at the downstream station HC04. Branches represented by sampling stations HC01 and HC17 had geomeans for June/July sampling that exceeded the PBC standard. Sampling upstream of these two stations did not result in levels that were substantially lower. Therefore, potential sources upstream cannot be ruled out.

Several interesting observations emerged from October sampling. First, bacteria concentrations were generally lower. This may be primarily the result of lower temperatures. The second observation is that the levels at upstream station HC09 (671 cfu) were significantly higher than those downstream at HC01 (180 cfu) as well as the levels further upstream at station HC11 (182 cfu).

Sampling during the following summer period in July and August of 2013 was focused on sites with previously high bacteria counts. Count results for this period were roughly consistent with those from June/July 2012.

The results in Figure 14 combine bacteria levels detected in both wet and dry periods. It is important to look at the hydrologic state to gain an understanding of the relative contribution of consistent inputs or point sources (which should be detectable in dry conditions, but less so in wet conditions) and runoff sources (which should be absent in dry conditions and high in wet conditions). To look at this, one can compare results to the preceding rainfall conditions. Figure 15 and Figure 16 show the bacteria concentrations at the main branch stations along with the preceding 48-hours of rainfall. Downstream station HC04 is shown to be above the TBC standard in dry conditions, but then in excess of the PBC standard following a significant rain event. This suggests that the Honey Creek system has a combination of point sources and runoff sources. Likewise, upstream branches contributing to sites HC07 and HC01 show a similar pattern. Mean concentrations at HC01 are higher than HC07 or HC04 under all conditions.

In contrast, Figure 16 shows that the stream contributing to HC15 shows the opposite trend. Bacteria concentrations are high during dry conditions, but seem to get diluted following rain events. This suggests that there may be a consistent source in that branch. The trend for HC17 appears to be relatively unaffected by runoff conditions. Concentrations increase somewhat, but are also high during dry conditions.

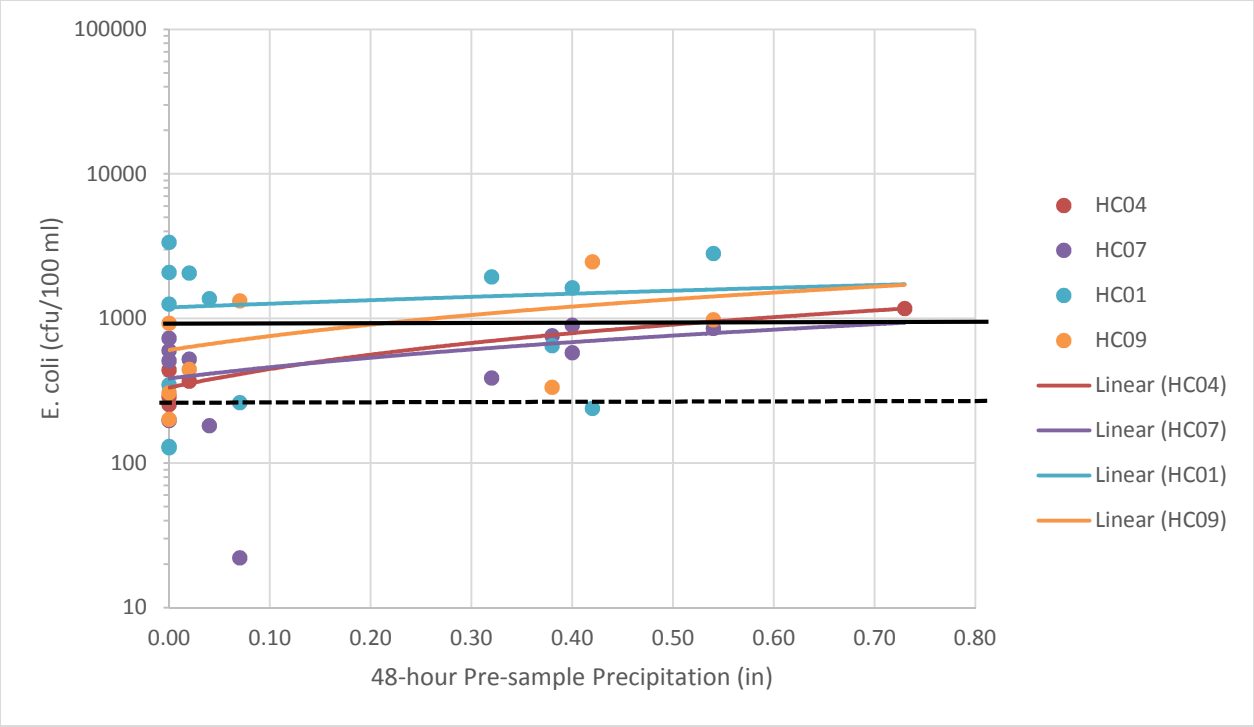


Figure 15. Maximum daily *E. coli* concentrations at 4 sites matched with precipitation for the 48-hours preceding sample collection. Colored lines indicate site trends (not significant), and black lines indicate PBC (solid) and TBC (dashed) daily standards.

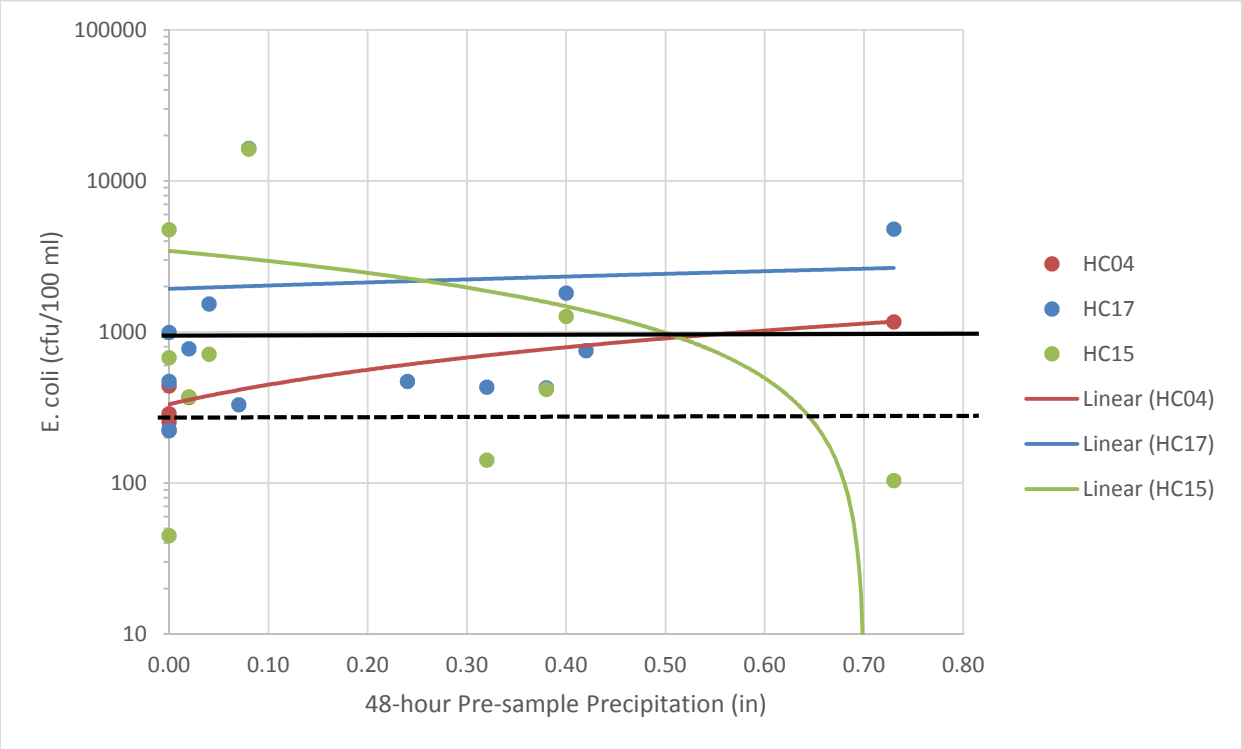


Figure 16. Maximum daily E. coli concentrations at 3 sites matched with precipitation for the 48-hours preceding sample collection. Colored lines indicate site trends (not significant), and black lines indicate PBC (solid) and TBC (dashed) daily standards.

Bacterial Source Tracking

A subset of samples from sites that exceeded the TBC standard were set to a lab to conduct Molecular Source Tracking (MST) analysis of *bacteriodes* cells extracted from the samples. DNA material was assessed for the presence of five markers for which positive references were established: human (Hu), bovine or cow (B), canine or dog (C), Equine or horse (Eq) and goose (G).

Results of this analysis conducted at 12 sites is summarized in Table 2. The downstream station (HC04) was positive for all 5 markers as was HC01 and the two stations upstream of that. Stations HC17 and HC05 were also positive for all sources. Many sites were positive for human sources of bacteria. This suggests that there may be septic system issues in these drainages. Bovine sources were positively identified at all sites tested. Since there are no active cattle or dairy operations in the Honey Creek watershed, this suggests that there may be active bacteria in manure or compost applications throughout the watershed. Canine sources were identified at all but one site. This indicates that pet waste is a source of bacteria throughout the watershed. Geese and horses were positively identified as a genetic source for bacteria in all the upstream branches, as well as HC17.

Samples from the summer of 2013 were evaluated for relative quantification in addition to the presence or absence of animal source markers (see Table 3). This analysis was done to determine which of the markers was most prevalent. Four sites were assessed in this way. HC01 showed a prevalence of bacteria from canine sources. The one sample from HC07 had an equal representation of human and canine sources. The analysis of the HC15 provided further evidence that there is an issue with contamination from human sources as the human marker was the most prevalent by a strong margin. Surprisingly, equine sources were the most prevalent in the HC17 samples despite there being no horse paddocks or stables in that drainage.

Complete results of BST analysis are included in the sampling report in Appendix C.

Table 2. Percent of BST tests showing positive for DNA markers by type.

Site ID	Human	Bovine	Canine	Equine	Goose
HC01	80%	100%	80%	60%	60%
HC04	100%	100%	100%	100%	100%
HC05	100%	100%	100%	100%	100%
HC07	50%	75%	75%	50%	75%
HC08	0%	100%	100%	0%	100%
HC09	67%	100%	100%	67%	67%
HC11	100%	100%	100%	100%	100%
HC12	100%	100%	100%	100%	50%
HC14	0%	100%	50%	0%	0%
HC15	67%	100%	100%	33%	67%
HC16	100%	100%	100%	0%	100%
HC17	100%	100%	100%	60%	60%

Percentages exceeding 50% positive are highlighted

Table 3. Mean relative quantification of BST tests showing positive for DNA markers by type for Honey Creek.

SiteID	Test count	Human	Bovine	Canine	Equine	Goose
HC01	2	1	1	2	0.5	0.5
HC07	1	1	0	1	0	0
HC15	1	4	2	1	1	2
HC17	2	1	1.5	1	5	2

Quantification established such that the lowest prevalence is established as the base level of 1. Highest quantifications for each site are highlighted.

Load Analysis

The TMDL for Honey Creek determined that quantifying a load for biological content is not appropriate and that the concentration standards for total body contact must be met throughout the watershed to be protective. This standard is only being met in the stream segment represented by sampling station HC14. The 30-day standard is very close to being met at HC12. All other branches can be assumed (if not monitored) to be contributing *E. coli* bacteria that exceeds daily maximum and 30-day geomean concentration standards.

The TMDL also indicated that, while there are a number of facilities with NPDES permits in the watershed, none of them are regulated for bacteria or would be expected to be contributing effluent containing *E. coli*. Sources contributing concentrations of bacteria are therefore either distributed throughout the watershed and contaminating the watershed via runoff flow or as illicit connections or failing septic systems. Specific source characterization and critical area analysis is included in the following chapter.

3. Sources of the Problem and Stakeholders Involved

Potential pathogen sources for Honey Creek include sources typically associated with urban and suburban runoff, as well as many associated with agricultural watersheds. Land uses in the watershed are mixed. A commercial corridor crosses the middle of the watershed, following I-94 and Jackson Road. This corridor makes up most of the 9% commercial and industrial land uses, and a good portion of the 14% impervious cover, as described in chapter 1. This corridor splits the watershed roughly in half, but does not likely contribute significant pathogen concentrations, as it is connected to the Ann Arbor sewer system.

Downstream of the transportation corridor, three branches (flowing to monitoring stations HC14, HC15 and HC17) drain predominantly medium density residential areas to the east (HC17 stream), with some low density residential and row crop agriculture mixed in west of the main creek (HC14 and HC15 streams). Honey Creek itself has good riparian cover in this stretch. Sampling results discussed in the previous section identified HC17 and HC15 as significant pathogen contributing streams. Residential areas along the downstream portions of the HC17 tributary are on on-site wastewater treatment systems (septic systems), unlike the upstream portions east of M-14, which are connected to the Ann Arbor sewer system. Failing septic systems are a potential source of pathogens along the lower reach of the HC17 stream, as are pet and wildlife feces. This stream has not been inspected for illicit connections under any IDEP program, so such connections could also be a source of some contamination.

Sampling results suggest that there is a combination of ongoing release or seepage sources and runoff sources throughout the watershed, with the exception of the branch that contributes to sample site HC15. That branch may be limited to one or more point sources. The tributary drains mostly row crop agricultural areas, with a some portion south of the stream draining from residential on septic systems. It is unlikely that these residences contribute much as the same subdivisions also drain to the HC14 stream, which was below bacteria standards. The District Conservationist with the USDA's Natural Resources Conservation Service (Olds, 2012) indicates that row crop farmers across the watershed may spread manure or biosolids multiple times throughout the growing season. This may be done in solid or liquid form. While it is assumed that bacteria in these applications are inactive, it is possible that live cultures remain active and could run off into nearby streams if a storm follows close enough in time to a manure/biosolids application. Illicit connections could also be an issue in the HC14 drainage, which would exhibit the point source characteristics observed in the sampling data. The stream was inspected once under Washtenaw County Water Resource Commissioner's IDEP program, but no sampling was conducted and there was no follow-up effort.

Upstream or south of Jackson Road, there are two creek branches. The southeastern branch (draining to HC12) was shown to contribute relatively low concentrations of bacteria, so is not a focus of bacteria source identification. The eastern branch splits into two branches draining to stations HC07 and HC01. These branches consistently contained bacteria concentrations above all state standards. Both streams drain a high density manufactured home development, Scio Farms. This development contains multiple detention ponds that ultimately drain stormwater to the Honey Creek streams. Residents maintain a high pet density with little waste control, according to the TMDL, manager interview and windshield survey. Scio Farms is connected to Ann Arbor sewers, so should not be a source of septic leakage. Another small residential development along the HC01 branch is also connected to sewer, but could also contribute pet waste sources. Upstream of both branches is agriculture and low density residential on septic systems. The HC07 branch drains row crop sources, while agriculture upstream of HC01 is a mix of

row crop and low density horse pastures. Animals appear to be excluded from the streams but riparian cover is thin. All animal markers show up in results from these stream segments.

Windshield and Reach Surveys

In an effort to learn more about common practices in the watershed and refine knowledge about potential sources, HRWC conducted two types of surveys of targeted potential source areas. First, a general windshield survey was conducted of residential and agricultural areas in high contamination drainage areas. This was comprised of a visual observation of the targeted areas and included notes on practices observed and photographs. A summary and photos are included in Appendix F. Windshield surveys were timed to correspond to times of the day when residents or farmers were most likely to be engaged in activities. Row crop practices were confirmed throughout the drainage areas upstream of HC01 and HC07 branches, but no manure spreading was observed. Horse pastures were observed south of Liberty Road (HC11) as well as stables near the creek north of Scio Church Road. Numerous dog walking areas were identified and observed in residential areas along the HC01 branch, as well as the HC17 branch. No pet waste practices were observed, but neither were pet waste stations apparent.

The second type of survey conducted was a reach survey of sections of creek branches HC17, and HC01. Teams of two were assigned stream reaches and asked to walk the length of the reach on October 31, 2012 and record observations in and around the creek onto survey forms. They also photographed anything deemed a potential source. The surveys yielded little new information on the HC01 reach between Park and Liberty Roads. Several unidentified outfalls were observed on the HC01 reach along Staebler Road. One was sampled and yielded E. coli at 313 cfu/100 ml (single sample). This pipe was tracked to a small detention pond in the Scio Farms development. A few outfalls were observed along the HC17 stretch, but none with flow or evidence of sewage. A chicken coop was identified to be located adjacent to the stream with free access for the chickens. Copies of completed surveys are included in Appendix G.

Stakeholders

HRWC conducted an initial stakeholders meeting at the beginning of the plan development process, a technical meeting during the mid-term of development and a final meeting to review and comment on the draft plan. HRWC also used the initial stakeholders meeting to recruit sampling volunteers for the water quality study.

Governmental units in the Honey Creek watershed include Scio Township, predominantly, and the City of Ann Arbor, Lodi Township, and Lima Township to a much lesser areal extent. In addition, the Washtenaw Water Resources Commissioner has jurisdiction over some stream reaches that are designated as county drains, the Washtenaw County Road Commission has jurisdiction over drains in the county road right-of-ways, and the Michigan Department of Transportation has jurisdiction over drains in the M-14 and I-94 highway right-of-ways. Of these, the following participate in the Middle Huron Stormwater Advisory Group (SAG) which meets to discuss continued planning and implementation of projects to address stormwater impairments of the middle Huron River watershed:

- City of Ann Arbor
- Washtenaw County Water Resources Commissioner
- Washtenaw County Road Commission.

These agencies also take part in the Middle Huron Partnership, which was developed as a voluntary partnership to address excessive phosphorus in Ford and Belleville Lakes. That group also meets with the SAG to discuss and implement projects to address other impairments, including bacteria. Scio Township is a member of the Partnership.

Table 4 shows the distribution of land in the Honey Creek watershed by government entity. Given that Scio Township contains the vast majority of land in the watershed and all the critical areas (see below), primary emphasis has been made to gain active involvement from the township, along with the Washtenaw County WRC and Road Commission. In addition to these municipal interests, efforts were made to invite the participation of various residential development representatives and agricultural interests. All stakeholders throughout the watershed have equal opportunity to comment on drafts of the implementation plan. A list of stakeholders who participated in initial planning meetings and draft watershed plan review meetings is included in Appendix H.

Table 4. Distribution of land by municipality in the Honey Creek Watershed.

	Watershed Area (sq. mi)	Percentage of Land Area in Watershed
City of Ann Arbor	1.3	5.5
Lima Township	0.2	0.7
Lodi Township	2.1	9.3
Scio Township	19.6	84.5
Total area	23.2	100

Critical Area Analysis

The study of the Honey Creek watershed described in previous sections was designed to identify likely sources of bacterial contamination to the creek. Water sampling points were distributed at tributary end points to isolate watershed sections geographically. Samples were evaluated for bacterial genetics to determine likely animal sources. Stream reaches with consistently high bacteria counts were surveyed for visible signs of bacteria sources. Key watershed areas were evaluated with a windshield survey to identify residential and agricultural practices that may be contributing bacteria to Honey Creek. Finally, interviews were conducted with representatives of area residents to confirm practices.

Water quality sampling indicated that there were occasional sample events at all sites that exceeded the single sample TBC standard. However, several sites were more generally below the standard and even below or near the 30-day standard. These areas will not be the focus of remedial efforts, and thus are not critical areas. The areas that remain are defined the critical subwatershed bacteria source areas (see Figure 17). Gaining control over bacterial contamination sources in these critical areas should lead to lower bacteria levels in the main section of Honey Creek and result in the creek achieving state standards for TBC. These critical areas are designated by subwatershed codes that correspond to sample site numbers.

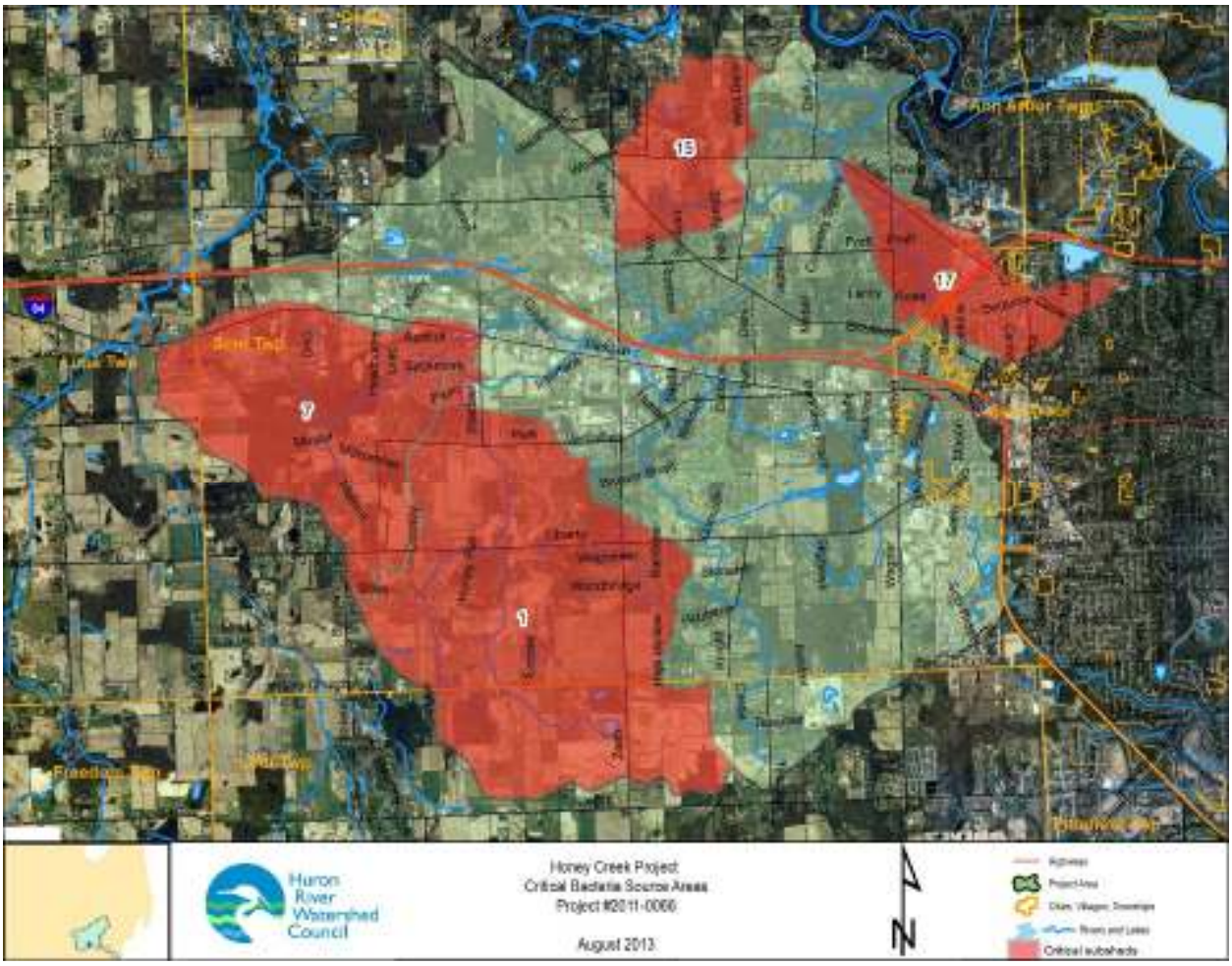


Figure 17. Critical bacteria source subwatershed areas in the Honey Creek watershed. Numbers indicate subwatershed designation and are referenced to downstream sampling stations.

Through the course of investigation, it was determined that multiple sources are contributing bacteria to Honey Creek. All five species markers that were selected for bacteria source tracking were positively identified in multiple samples at multiple locations. However, some markers are more critical to human health and others were more predominant at specific sample sites. The presence, especially the predominance, of the human marker in samples is of particular concern. The presence of human source markers in bacteria was identified in samples from all critical areas. The human marker predominated in subwatershed 15. Sampling in area 15 also suggested a non-runoff source. This combined information suggests that subwatershed 15 should be a high-priority target for investigation and remediation of human fecal contamination sources. Other critical areas should also be investigated for human sources, however, due to the presences and relative predominance of human sources throughout sampling in critical areas.

Other sources are more difficult to define geographically. Bovine, or cow manure source markers were identified in all but one sample, even in subwatersheds such as 17 that have little agricultural land use area. This source should be addressed throughout the watershed. Similarly, canine markers were identified in all critical areas. This source should be addressed in all residential areas within critical subwatersheds or across the entire watershed. Likewise, goose source markers were found in all source areas, though that source did not predominate in areas 1 or 7. Equine or horse fecal source markers

were found in all critical areas, though less often in areas 7 and 15. Surprisingly, it was a predominant source in a sample from area 17 despite little evidence of horse ownership in that subwatershed, though there was evidence of horse traffic in the area. Identification and remediation of horse sources in area 17 are likely localized to the end of that stream, as little evidence of horses was found elsewhere.

4. Watershed Management Objectives

Specific Goals and Objectives

The overall goal for management of the Honey Creek watershed is to achieve all state water quality standards and allow Honey Creek to be fishable, drinkable (with standard treatment) and swimmable. The primary objective of this watershed management plan is to reduce bacteria contamination to achieve 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 in Honey Creek and its tributaries. Data show that urban storm water runoff, with a significant bacterial component attributed to wildlife and pet sources, direct and indirect human septic sources, and agricultural runoff from manure application and light horse pasturing are the dominant source of *E. coli* in this area. Source-related goals include the following:

- Eliminate all human sources in the watershed with particular focus on critical areas 7 and 15;
- Significantly reduce pet sources in all critical areas to meet water quality standards;
- Significantly reduce agricultural and equine sources in all critical areas to meet water quality standards; and
- Where feasible, reduce wildlife sources to meet water quality standards.

Implementation activities to meet the TMDL require measures to reduce *E. coli* sources and loads.

Secondary objectives are consistent with the Middle Huron Watershed Management Plan and include reducing nonpoint source loading of nutrients, increasing public awareness and involvement in watershed planning and management, gaining broad implementation of watershed plans, and continued monitoring and data collection for water quality, water quantity and biological indicators.

Measures to reduce *E. coli* will include some activities that, are already required of the National Pollutant Discharge Elimination System (NPDES) municipal storm water permittees within the watershed under Michigan's municipal storm water permitting program. Currently, the City of Ann Arbor, the Michigan Department of Transportation hold NPDES Phase I municipal storm water permits. The Washtenaw County Water Resources Commissioner and Road Commission hold separate NPDES Phase II municipal storm water permits. In 2003, Lodi Township and Scio Township, were required to obtain NPDES Phase II permits. Both townships eventually had their permits removed. With Scio Township acting as the local government agency with jurisdiction over the vast majority of land in the watershed, some of the lessons learned about stormwater management practices will need to be transferred to and adopted by Scio Township, since the township is not covered by state stormwater regulations, as it does not own or operate stormwater infrastructure.

Municipal storm water permits for county agencies like the Water Resource Commissioner and the Road Commission provide mechanisms for controlling bacterial loads to Honey Creek and its tributaries. Storm water permits require that a plan for effective elimination of illicit discharges and prohibition of illicit discharges be developed, that all catch basins be mapped and regularly cleaned, that effective storm water management in areas of redevelopment and new development occur, and that a public education program regarding storm water management and impacts of storm water pollution be implemented.

5. Management Plan for *E. coli* Reduction in the Watershed

The stakeholders in this TMDL are familiar with watershed-based cooperation, having partnered on point source and non-point source phosphorus reductions with the goal of meeting a nutrient TMDL for Ford and Belleville lakes. The Middle Huron River Watershed Initiative, the partnership working to meet the nutrient TMDL, has pursued pollutant reductions for over 15 years. Most of the stakeholders in the *E. coli* TMDL were signatories on two consecutive five-year agreements to voluntarily reduce phosphorus contributions to the middle Huron River. In the interim, the signatories revised these agreements to reflect current conditions within the watershed and renewed support to continue pollution reduction efforts.

Through the coordinated efforts of all stakeholders, coupled with the expansion of key municipal stormwater programs to areas not covered by regulation and the current and ongoing efforts of the Middle Huron River Watershed Initiative, pathogen inputs to the tributaries and storm sewers can be reasonably controlled, with the possible exception of inputs from wildlife and feral domesticated animals. However, while this plan was developed with the goal and intention to reduce or eliminate bacteria sources in the watershed, it is unlikely that all sources will be effectively eliminated. It is possible that, even if the TMDL plan is fully implemented, enough sources such as wildlife and feral domesticated animals, will keep water bacteria levels above state water quality standards. A literature review conducted by HRWC found few references to successful projects or programs to eliminate or control generalized urban sources. This presents a true challenge to the watershed, the partners within, and the MDEQ.

Programs currently in effect in the watershed, or planned for the near future, include continued and new efforts to reduce illicit discharges, reduce domestic animal and wildlife sources, remove *E. coli* by treatment, and prevent or minimize pollution through land use planning, regulations and protection. A summary list of priority projects for the next 5-10 years is included in Table 5. The overall approach of treatment is engage programs and projects according to the following priorities:

1. Implement programs and projects to identify and eliminate human sources, since those sources of bacteria produce the array of microbial contaminants that most directly impact human health;
2. Implement projects that have a good chance of reducing or eliminating pet and agricultural sources in critical areas over the short-term (1-5 years); and
3. Opportunistically implement broader projects over the long-term (3-10 years) that affect more difficult to control sources (i.e. geese and other wildlife), have a less direct or obvious likelihood of reducing bacteria sources, but may have other beneficial effects on the watershed (e.g. runoff, sediment or other pollutant reduction).

The short-term (5-year) strategy was developed in detail and includes all primary and secondary priority activities. The cost of this strategy is estimated at $345,100. The expectation is that, by completely employing this short-term strategy, bacteria from human, pet and agricultural sources will be significantly reduced or eliminated. These reductions should be sufficient to reduce overall bacteria concentrations below the TBC water quality standard. If monitoring shows this not to be the case, tertiary priority activities are proposed to reduce other sources.

Table 5. Summary of the initial 5-Year E. coli Reduction Strategy, 2015-19

Activity	*E. coli* Source Reduced	Critical Areas	Implementation Timeframe	Cost Estimate 2013-2017	Lead Agency*	Success Measures
1A. Canine source detection	Human	15, 7	2015	$8,500	HRWC, WCWRC	Linear feet inspected; sources identified
1B. Illicit discharge elimination program	Human	15, 7	2015-16, ongoing after	$30,000	WCWRC, WCRC, Scio, HRWC	% sources eliminated; bacteria cfu reduced
1C. Septic Inspection, Education and Remediation Program	Human	15, 7	Ongoing. New targets 2015-17	$27,000	WC Environmental Health, HRWC	Inspection call rate; annual septic remediations
2A. Public Education Program (PEP)	Multiple	1, 7, 17	2015-17	$45,000	HRWC, SAG Members, Scio	Impairment knowledge from survey; participation rates, monitoring
2B. Education on Pet Waste	Pet waste	1, 7, 17	2015-17	Part of PEP	HRWC, SAG Members, Scio	Impairment knowledge from survey; participation rates, monitoring
2C. Agriculture/Farmland Education	Agricultural	1, 7, 17	2015-17	Part of PEP	HRWC, Scio, NRCS, WCCD	Impairment knowledge from survey; participation rates, monitoring
2D. Pooper Scooper Ordinance and education	Pet waste	1, 7, 17	2015-17	$18,000	Scio	Ordinance passed; call volume; violation #
2E. Doggie Bags at target locations	Pet waste	1, 7, 17	2015-17	$15,000	WC Parks, Scio	Stations established; use rate; pounds removed; monitoring
2F. Increasing Farm Bill Program participation	Agricultural	1, 7	2015-19	$140,600	HRWC, NRCS, WCCD	Participation rates; acres treated; monitoring
2G. Buffer Enhancement Program	Multiple	1, 7, 17	2015-19	$40,000	HRWC	Linear feet established; % streams properly buffered; monitoring
2H. Storm Drain Marking Project	Stormwater	1, 7, 17	2015-19	$21,000	WCWRC, AA, Scio	% drains marked; call volume; monitoring
Short-term, Primary & Secondary Projects	**Total**		**2015-19**	**$345,100**		

3A. Rules and Ordinances for Storm Water Management	Stormwater	1, 7, 17	Update in 2014	Not tracked	WCWRC	Reduced runoff and bacteria concentrations; monitoring
3B. Targeted Green Infrastructure Development and Retrofit Program	Runoff	1, 7, 17	2015-25	TBD	HRWC, Scio, WCRC, WCWRC	Reduced runoff and bacteria concentrations; monitoring
3C. Wetlands Restoration and Protection Program	Stormwater	1, 7, 17	2015-25	$2,200/ac + $15,000	Ann Arbor, Scio	Reduced runoff and bacteria concentrations; monitoring
3D. Goose Control Program	Wildlife	1, 7, 17	2015-25	TBD	HRWC, Scio, WC Parks	Goose population estimates
3E. Community Partners for Clean Streams	Multiple	1, 7, 17	ongoing	$16,000	WCWRC	Reduced goose populations; monitoring
3F. Update Storm Water Management Standards (Pond Landscaping Section)	Wildlife	1, 7, 17	2014-25	$5,000	WCWRC, Scio	Revised standards; # ponds with buffers; reduced goose populations; monitoring
3G. Native Landscaping Ordinance Development	Wildlife, stormwater	1, 7, 17	2015-25	$5,000	Ann Arbor, Scio	Ordinance developed; natives planted; reduced goose populations; monitoring
3H. Farmland Protection Program	Stormwater	1, 7	2014-25	TBD	City of Ann Arbor, Scio, NRCS, WCCD	Acres protected; BMPs; monitoring

* Key:
HRWC: Huron River Watershed Council
WCWRC: Washtenaw County Water Resources Commissioner
WCRC: Washtenaw County Road Commission
NRCS: Natural Resources Conservation Service
WCCD: Washtenaw County Conservation District
SAG Members include all entities with stormwater permits who are participating in the Middle Huron Stormwater Advisory Group, as listed in the stakeholder section.

Five-year Strategy

High Priority Projects – Eliminate Human Sources

The top priority in this plan is to identify and eliminate human sources of bacteria contamination of Honey Creek waterway. This will be accomplished with an approach using three project activities: can source identification, illicit discharge elimination and failing septic education and remediation.

1A. Canine Source Detection and Identification

The professional services of a trained sewage detection canine will be contracted to confirm human sewage sources in critical area 15 and then critical area 7 as well. Canine detection has been shown t have a high detection rate with low false positive rate. Canine detection is also specific to human sewage, so can be used to filter out non-human animal sources. Current Illicit Discharge Detection programs in the watershed do not use these services, so they will be contracted for the first time. Th service has been shown to be helpful in identifying illicit connections as well as septic system failures

Surface and outfall connections upstream of sampling sites 15 and 7 will be evaluated by the canine team in coordination with WCWRC (forcritical area 15, the county designated Wing Drain, and Scio Township and Scio Farms MHC (for area 7). Positive detections from surface water connections will b followed upstream until the source is identified. Positive detections from outfalls will be followed up storm system access points for further evaluation until a direct source is identified. Positive detection information will be provided to relevant agencies for follow-up.

Timeframe: 1 year (2015)
Milestones: Conduct detection and identification surveys: 2015, Final detection and identification report: 2015.
Cost: Inspection of 12,000 linear feet in area 15, 8,500 lf in area 7 (20,500 lf total) @ $0.36/lf = $7,500 1260 mi driving @ $0.56/mi = $706; 9 days @ $30 per diem = $270. Total = $8,500
Potential funding sources: Section 319, local government match
Success Measures: Total linear feet inspected, number of human sources identified

1B. Illicit Discharge Elimination Program (IDEP)

The purpose of the IDEP is to remove non-storm discharges to storm sewers and surface waters to improve water quality. This program locates and eliminates any illicit connections in sanitary and sto pipes, thus preventing untreated sewage flow to Honey Creek and the Huron River. The program is a meant to help meet the Honey Creek TMDL, and, in some locations, fulfill storm water permit obligations.

Project data include sampling records, video and a dye-test database. The following entities are involved in the IDEP: Washtenaw County, the City of Ann Arbor, and Michigan Department of Environmental Quality (MDEQ).

The City of Ann Arbor inspects the storm sewer annually by closed circuit T.V., inspecting about 35,00 linear feet and removing debris from about 125,000 linear feet of line. The City sub-contracts to Washtenaw County, approximately four days per month, to do illicit connection screening. This program was in effect until December 2003. The estimated cost of the program is $225,000 per year the City of Ann Arbor and Washtenaw County combined.

Currently, Washtenaw County (via the Water Resources Commissioner) only implements the program on county drains in the urbanized area to meet stormwater regulations. This leaves several county drains outside the urbanized area and many stream reaches that are not county drains, not being inspected.

To address impairments in Honey Creek, results from canine detection will be shared with the WRC, Scio Township and Scio Farms MHC. Area 15 is a county drain in the urbanized area, so WRC will follow up to eliminate illicit connections as part of their program. The stream in area 7 is not a county drain. HRWC will consult with Scio Township, Scio Farms MHC, other private landowners, and, if necessary MDEQ, to remediate any illicit connections found in this area. Parties found responsible for illicit connections will be expected to conduct remediation. Multiple inspections during differing conditions may be needed in these critical reaches to detect contaminated flow and trace it back to the source.

Timeframe: 2 years (2015-16)
Milestones: 1 year summary of illicit discharges detected and eliminated.
Cost: Follow-up inspection and remediation of unknown number of connections estimated at $15,000 per year = $30,000.
Potential funding sources: Section 319, local government match; SAW; agency stormwater funds
Success Measures: Percent of sources identified in item 1A inspected and eliminated, monitoring (see section 6)

1C. Septic Inspection, Education and Remediation Program

Septic System Inspection Programs are meant to identify and correct failing septic systems that discharge human waste into groundwater or on the surface, and directly or indirectly into surface water.

Washtenaw County's "Time of Sale" Ordinance requires that prior to any residential property transfer: 1) the septic system must be inspected by certified inspectors, 2) a report must be submitted to the Environmental Health Regulation Department and 3) the seller must receive an authorization letter from the Department. Over 4,300 systems have been evaluated annually, countywide, with over 540 septic system corrections documented to date.

The current Time of Sale program will serve as the basis for an expanded effort to reach residents on septic systems in critical subwatersheds (areas 15 and 7) to increase inspections and remediate those that are failing. After IDEP inspections following canine source detection, areas confirmed as human source areas but without direct illicit connections, will be identified as likely areas of septic failure. Neighboring residents will be contacted directly about participating in the program.

This new program should remove barriers such as cost and expertise by providing inspections free of charge to residents in target areas and a list of qualified contractors to remediate failing systems. An additional element to the program should be added to help finance failing systems for residents who lack the means to pay for expensive fixes. The availability of assistance may help to address barriers on the part of home owners to participate in the inspection program. The program would host 2 workshops on septic system care and maintenance that would be promoted by direct mail and offer a free "Water Efficiency" kit for those who attend.

The new inspection and remediation program would include messaging and material targeted to program participants to increase awareness about septic systems and their effect on water quality and

educate watershed residents on best practices for maintaining, and identifying and correcting failed septic systems (from the Information and Education Campaign referenced in 2A below).

Inspections: 40 @ $250 = $10,000; Financial Assistance: $10,000; Workshops With Water Efficiency Kits: $2,000; Program/Workshop Promotion: $5,000. Total = $27,000.

Timeframe: 3 years (2015-17)
Milestones: Septic program education materials developed: 2015. Workshops: 2016. Inspections and remediation 2016-17, with annual summaries.
Cost: Follow-up inspection and remediation of unknown number of connections estimated at $15,000 per year = $30,000.
Potential funding sources: Section 319, local government match; local agency stormwater funds
Success Measures: Differential in number of inspection requests (pre-post information distribution), number of septic remediations in target areas, monitoring (see section 6).

Secondary Priority Projects – Eliminate Pet and Agricultural Sources

Concurrent with the goal of eliminating human-sourced microbes is the secondary goal of detecting and eliminating human-controlled pet and agricultural sources. This will be accomplished with a suite of activities ranging from education to policy changes to implementation projects. Figure 18. Location of targets for watershed treatment activities identified to address pet and agricultural sources.identifies locations for implementation of the different types of activities described below.

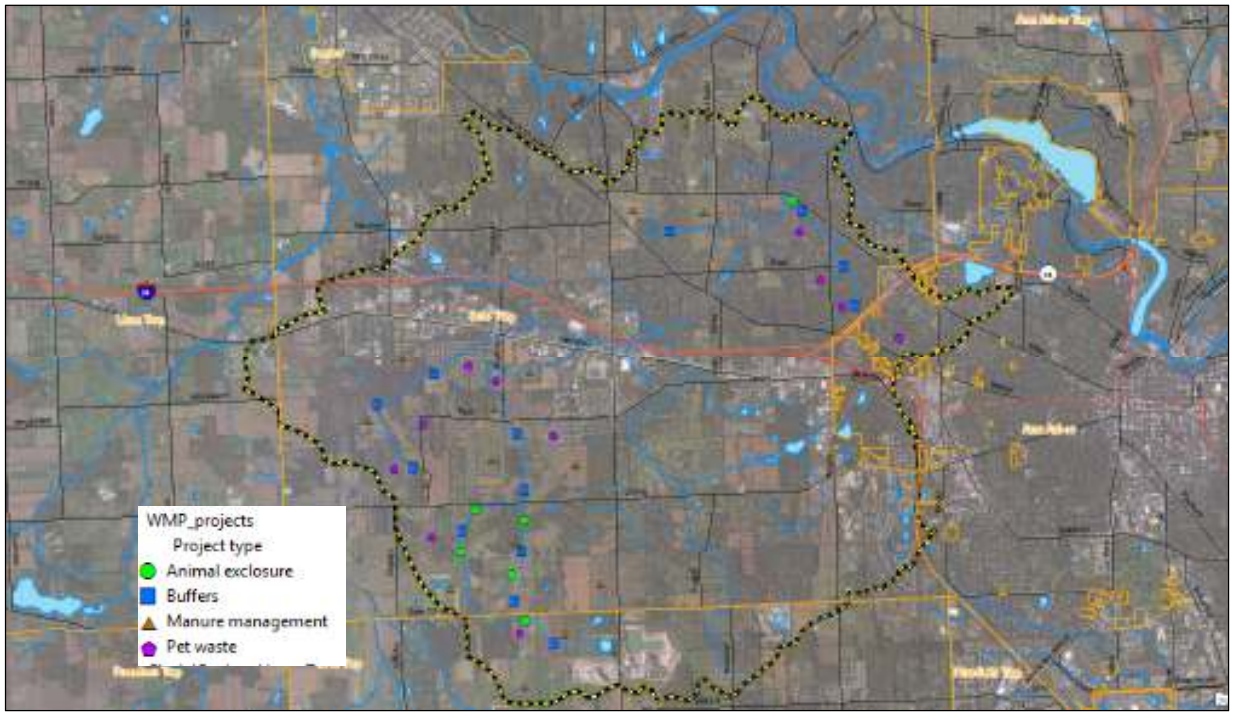


Figure 18. Location of targets for watershed treatment activities identified to address pet and agricultural sources.

2A. Public Education Program (PEP)

2B. Education on Pet Waste

2C. Agriculture/Farmland Education

The goal of this program is to increase awareness and knowledge about 1) septic systems and their effect on water quality, 2) pet waste and its effects, 3) agricultural impacts on water quality, and 4) programs available to help address these issues. Highlighted programs will include: septic inspection and remediation, the "pooper scooper" ordinance and disposal areas, farm bill assistance programs, animal exclosure program, and the buffer enhancement program. As part of the program, materials will be developed to educate watershed residents on best practices for maintaining, and identifying and correcting failed septic systems, caring for pets and their waste, proper manure and nutrient management, keeping animals out of surface waters, and maintaining effective stream buffers. The objective is to conduct an ongoing public education and outreach campaign that targets residents and land owners in specific sections within the critical areas of the subwatershed (see Figure 18) (1, 7 and 17, estimated at 2700 households) in order to reduce bacteria and microbe sources and set the stage for other implementation programs. Household targets for residential education are estimated at 2700 households. GIS and windshield analysis identified 44 total agricultural parcels in 3 targeted critical areas (numbers 1, 7 and 15). Of these, 23 agricultural parcels are in critical area #1, 13 in area 7, and eight in area 15. Of these, there are a smaller number that contain or border surface water streams, that would be targets for buffer education. In addition to agricultural producers, HRWC would target ex-urban residential property owners in critical areas who may own or train horses on their property.

Messaging would include impacts to water quality, and best practices and resources (EPA, HRWC, Washtenaw County Environmental Health Department, etc.) for maintaining and prolonging the life of septic systems, how to recognize a failing system and steps for taking corrective action. HRWC has developed a print brochure and a web page for previous projects that could provide the basis for materials needed for education on septics remediation, buffer management, and dealing with pet waste. Printed information would be distributed to the target audience by direct mail and in-person through inspectors, NRCS and Conservation District representatives, septic system and plumbing service providers, hardware and plumbing retailers, at community customer service counters and at local events. Local homeowners associations and townships would also be recruited to distribute print materials and messaging through their websites, newsletters, emails and social media outlets. To measure effectiveness, local retail participation could be recruited to offer discount coupons on pump outs, pooper scoopers or water efficient fixtures, or an online contest held for prizes where participation levels are tracked.

HRWC has coordinated an "H2O Heroes Scoop Poop" campaign that targets pet owners in Washtenaw County by distributing printed educational materials (posters, tip cards and H2O Hero Award Certificates) at the offices of local vets, pet care providers and pet supply retailers. The program included a press relations effort with photos, blogs and press releases created and distributed for placement with local media. Messaging includes the impacts of pet waste to water quality, proper disposal techniques, and the benefits of picking up and disposing of pet waste. Similar pet waste messaging has also been incorporated into the biannual Watershed Community Calendar (March is Scoop Poop month) (see below).

These efforts should leverage and relate to existing Public Education Program activities conducted by the Middle Huron communities pursuant to their Stormwater Permits and which include the Washtenaw County Water Resources Commissioner, but does not include Scio Township. Since 2003, the Public Education Program has increased awareness of watershed stewardship and storm drain pollution

prevention, which should reduce *E. coli* entering Honey Creek through illicit discharges. Outreach is conducted through the distribution (direct mail and in-person) of a biannual Watershed Community Calendar that includes tips and resources, placing supporting print advertising in local media, distributing print materials at local community events and providing digital content for Program participants' use. A program to increase awareness about bacteria reduction programs could purchase materials produced by the Public Education Program of the Middle Huron communities and distribute them by mail directly to target residences in Scio Township.

Contest participation, coupon redemption, and social indicators would be measured to evaluate effectiveness of the campaign, specifically looking for an increase in awareness of the impacts of personal practices on water quality and an understanding of best practices for maintaining, identifying and correcting problem areas.

Timeframe: 3 years (2015-17)
*Milestones: E*ducation materials developed: 2015. Materials distribution: 2015-16. Survey and evaluation: 2017.
Cost: Calendar Distribution: $5,000; Brochure Production and Distribution: $30,000; Pre and Post Campaign Evaluative Surveys: $10,000. Total: $45,000.
Potential funding sources: Section 319, local government match; local agency stormwater funds
Success Measures: Survey awareness measures, program participation rates, monitoring (see section 6).

2D. Pooper Scooper Ordinance and Education
The purpose of this program is to educate the general public on the impact of pet waste on surface water quality, and to reduce pet waste entering the storm sewer. The program should decrease discharge into Honey Creek by reducing a source of pollution. The City of Ann Arbor has enacted such an ordinance and efforts are made to publicize it through their website. A partnership with Scio Township and HRWC will be developed to assist in the development of an ordinance, combined with proper residential education. Members of the township Planning Board have already expressed interest in such an ordinance. The ordinance would require the removal and proper disposal of pet waste with fines for infractions. While complete enforcement of such an ordinance is unlikely, its existence will serve to raise awareness of township residents.

Passage of a pooper scooper ordinance in Scio Township could be combined with educational information (see 2A and 2B above) and installation of signage and pet waste disposal bags/receptacles at township and county parks to be more effective.

Timeframe: 3 years (2015-17)
Milestones: Draft ordinance developed, revised and passed: 2015-16. Education Materials distribution: 2015-16. Ordinance enacted: 2017.
Cost: Technical assistance with ordinance development: $8,000; Elected official time in review and enactment: $10,000. Total: $18,000. Education costs are included in item 2A.
Potential funding sources: Section 319, local government match
Success Measures: Ordinance enactment, volume of calls about ordinance, ordinance enforcement rate, monitoring (see section 6).

2E. Doggie Bags at Target Locations
This program provides bags for pet waste clean-up. This should reduce pet waste in parks, and other high traffic areas, subsequently reducing the amount of *E. coli* entering Honey Creek from pet waste.

This project can be modeled after an ongoing program in the City of Ann Arbor. Target locations include county parks and residential dog walk areas in Scio Township. Installation of bag dispensers and trash receptacles should be completed in partnership with targeted home owner associations in critical areas of the watershed.

Eleven residential neighborhoods are identified as targets (see Figure 18). Windshield surveys identified a number of high-traffic locations in the neighborhoods where dog walkers congregate. HRWC and partners will work with neighborhood associations to confirm specific installation locations and coordinate with trash pick-up. Bag dispensers will be regularly monitored for resupply as maintenance as well as success measurement. 30 dispensers will be placed initially with additional stations added as use volume warrants.

Timeframe: 3 years (2015-17)
Milestones: Meet with homeowner groups and park officials, confirm locations: 2015. Install 30 stations: 2016. Education Materials distribution (see 2A and 2B): 2015-16. Install additional stations: 2017.
Cost: 50 dog waste stations @ $100 ea.: $5,000; technical assistance, installation, maintenance labor: $10,000. Total: $15,000.
Potential funding sources: Section 319, local government match
Success Measures: Number of stations installed, bag volume utilized, pounds of feces removed, monitoring (see section 6).

2F. Increasing Farm Bill Program Participation

HRWC will work with NRCS, Conservation District and Michigan Agriculture Environmental Assurance Program (MAEAP) staff to communicate directly with all farms and large animal owners in the critical areas and improve bacterial reduction practices with financial support through a range of Farm Bill Programs. The goal of this project is to secure at least 5 locations where farmers pursue best practices through the USDA NRCS cost-incentive programs. The best practices identified as most beneficial and appropriate for the Honey Creek watershed are:

- Stream Buffer Strips
- Comprehensive Nutrient (and Manure) Management
- Livestock Exclusions
- Wetlands Restoration

Stream Buffer Strips: Corridors or strips of land in permanent vegetation, designed to intercept pollution and manage other environmental concerns. Strategically placed buffer strips can effectively mitigate the movement of sediment, nutrients, pesticides, and materials (such as manure) incubating harmful bacteria and microbes within and from farm fields.

Comprehensive Nutrient Management Plan: These plans document practices and strategies adopted by livestock operations to address natural resource concerns related to soil erosion, livestock manure and disposal of organic by-products. The planning process begins with a comprehensive engineering and conservation planning resource assessment of current site conditions. Manure spreading and biosolid spreading practices have not been identified beyond general agreement that they occur on an unpredictable basis. Funds in this program will be used to assist farmers to develop fertilizer plans that minimize manure and biosolid application and time applications to avoid storm runoff. Management options and structural alternatives are developed to address resource concerns identified during the assessment.

Livestock Exclusions: Also known as access control, it is the temporary or permanent exclusion of livestock from a designated area—often to protect streambanks, wetlands, woods, cropland, wildlife habitat or conservation buffers. Access controls can also be used to keep wildlife, people, equipment and vehicles out of an area. In the Honey Creek watershed, several properties with horses do not currently exclude stream access. These will be targeted for funding for exclusion fencing support.

Wetlands Restoration: Wetlands that have been filled or drained retain their characteristic soil and hydrology, allowing their natural functions to be reclaimed. Restoration involves renewing historical wetlands that have been converted or degraded, and reclaiming their functions, such as sediment retention, nutrient uptake and assimilation, bacterial/microbial removal, and floodwater attenuation. See activity 3C for more information on restoration targets.

Interested farmers would be identified through an **agricultural outreach effort** lead by the Washtenaw County Conservation District (CD). Efforts will be focused on the target groups of fields identified in Figure 18. Conservation Districts would be responsible for implementing this effort, with assistance from the USDA Natural Resources Conservation Service (NRCS) and HRWC.

Specific tasks for the activity could include: develop a targeted mailing/contact list of agricultural producers from parcel maps and CD data; prepare informational materials that highlight watershed threats, causes, possible reduction alternatives, and information on available USDA Farm Bill programs that could help address watershed threats (see 2A and 2C); host community meetings to include speakers and/or discussion on bacterial contamination and causes, and how farmers can help address these threats with conservation practice installation; provide opportunity for interested agricultural producers to request a site visit to their farms by NRCS staff; follow-up with contact list via letter and phone to answer questions and remind agricultural producers about the community or neighborhood meetings; make list of site visits requested at meetings, to discuss site-specific alternatives to address threats using available USDA Farm Bill programs; and submit site visit list to NRCS for development of conservation plan(s) for interested farmers and assist with USDA Farm Bill program sign-ups. As appropriate, NRCS to provide technical, engineering or other assistance for practice implementation. Finally, progress reports could be prepared to include success measures.

Timeframe: 5 years (2015-19)
Milestones: Compile and confirm target mailing list: 2015. Introduction letters and education materials distribution (see 2A and 2C): 2015-16. Community meetings and site visits: 2016-17. Implementation of practices: 2017-19.
Cost: Mailing list, letter production: $3,600; meetings, follow-ups, site visits, technical assistance, reporting: $12,000; best practice installations @ $25,000 ea.:$125,000. Total: $140,600.
Potential funding sources: NRCS Programs; Section 319, local government match
Success Measures:

- # of agricultural producers participating in the watershed effort by critical area and practice type
- # of agricultural producers participating in USDA Farm Bill programs
- Amount of conservation practices installed or implemented by critical area:
    - # of & # of acres of comprehensive nutrient management plans
    - # of acres of buffer strips
    - # of wetlands restored and estimated volume treated

    - # and linear feet of livestock exclusions
    - # of other related practices
- Monitoring (see section 6)

2G. Buffer Enhancement Program

Vegetated stream buffers are important permanent measures for water quality and habitat enhancement in the watershed. To reap all the benefits of buffers, they should be at least 100 feet wide on either side of a stream – both intermittent and perennial. A stream buffer zone is a strip of undisturbed native vegetation, either original or reestablished, bordering a stream or river, or wetland. These buffer zones also are known as riparian buffer zones, referring to the zone along a waterway or waterbody where the water meets the shore. The trees, shrubs and plants, and grasses in the buffer provide a natural and gradual transition from terrestrial to aquatic environments.

These areas are critical for wildlife habitat, storing water during periods of high water flow, and protecting lakes and rivers from physical, chemical, and biological pollutants. Establishing buffers that protect riparian corridors, especially floodplains, wetlands, and steep slopes, offers a way to filter material with active microbes before they enter the stream. In addition, as discussed previously in the plan, many reaches of Honey Creek are lacking in buffers.

Restoring natural vegetation in bacteria hot spots will also discourage Canadian geese populations from congregating. Planting and maintaining native grasses and sedges at common geese or animal access areas to replace some of the turfgrass will help reduce *E. coli* counts.

As part of outreach efforts discussed in activity 2F, property owners will be encouraged to seek Wildlife Habitat Incentive Program (WHIP) contracts through the Natural Resource Conservation Service (NRCS). The Conservation Reserve Enhancement Program (CREP) offers additional incentives to encourage landowners to implement practices that will help reduce sediment and nutrients and will improve wildlife habitat, while also removing bacteria and microbes. The USDA Farm Service Agency (FSA) provides an annual land rental payment, including a CREP special incentive payment, plus cost-share of up to 50 percent of the eligible costs to plant grasses or trees on highly erodible cropland, establish vegetated buffers along streams, restore wetlands, provide shallow water areas for wildlife, and restore habitat for rare and declining species.

In addition to agricultural lands, the Buffer Enhancement Program would also encourage residential land owners to establish native vegetation and properly manage stream buffers. Interested land owners would be given planting designs and instruction, management guidelines and native plant seedlings and seed at no or reduced cost. Technical assistance would also be provided. In turn, the land owner would sign a commitment to manage the land as a natural buffer for 15 years.

The goal of this activity is to add 30 stream buffer acres in the Honey Creek watershed across the 13 areas identified in Figure 18; a mix of agricultural and residential ownership.

Timeframe: 5 years (2015-19)
Milestones: Compile and confirm target mailing list: 2015. Introduction letters and education materials distribution (see 2A and 2C): 2015-16. Site visits with interested land owners: 2016-17. Implementation of buffers: 2017-19.

Cost: Plants and seed @ $500/ac for 30 ac: $15,000; mailing, site visits, planning, technical assistance, reporting: $25,000. Total: $40,000.
Potential funding sources: Section 319, local government match; NRCS Programs
Success Measures:

- # of agricultural producers and residential land owners participating in the buffer program by critical area and practice type
- # of acres of buffers installed by critical area
- Monitoring (see section 6)

2H. Storm Drain/Catch Basin Marking

The purpose of storm water drain marking is to eliminate waste entering Honey Creek through storm drains, by means of creating public awareness of the impact from dumping into these drains. Storm drains are marked with a warning stating that any waste entering the drain goes straight to the stream. Along with the marking, the project places educational fliers (produced as part of activity 2A) on the doors of residences in the vicinity of newly marked drains. It is a simple, cos-effective program that should reduce dumping of pet waste and other potentially bacteria-containing material into the drains.

This program began early in the last decade, with approximately 3,000 drain markers having been placed in the City of Ann Arbor, some in the Honey Creek watershed. This is an ongoing project with no end date. Through the Water Resources Commission CPCS program (activity 3E), the WRC gave out 2,500 markers in one year. Markers are continuously placed on drains and replaced every few years, when old markers begin to fade or fall off. New storm drains have a warning engraved or cast into the iron frame stating "Dump No Waste - Drains to Waterways." Scio Township does not currently have a storm drain labelling program.

Under this activity, HRWC, working in coordination with Scio and Lodi Townships, the City of Ann Arbor and WRC will purchase 2,000 lexan markers for placement in the nine Scio Township neighborhoods, and one neighborhood each in Lodi Township and Ann Arbor. Volunteers provide the labor to apply markers and hang educational fliers on doors. Washtenaw County spends approximately $5,000 per year for their markers. Additionally, the City of Ann Arbor spends approximately $1.50 for each new lexan marker, while $3.05 is spent on each "crystal" coated marker.

Timeframe: 5 years (2015-19)
Milestones: Survey neighborhoods to identify needed marker locations: 2015. Produce door hangers (see 2A) and purchase markers: 2015-16. Recruit volunteers to apply markers and place door hangers: 2016. Resurvey neighborhoods for marker maintenance: 2018-19.
Cost: 2,000 markers and adhesive @ 3.00 ea: $6,000; Planning, neighborhood drain surveys, volunteer recruitment and management, reporting: $15,000. Total: $21,000.
Potential funding sources: Section 319, local government match
Success Measures:

- # of markers and door hangers placed
- # of calls from door hangers
- Monitoring (see section 6)

Tertiary Projects – Opportunistically address other bacteria sources

A number of other watershed management programs and projects are in place in the Middle Huron River watershed that may reduce bacteria as one of a set of beneficial outcomes. Also, there are approaches that have been implemented in other watersheds that have been effective at reducing wildlife or other non-human controlled sources. The list below includes projects and programs that could be applied as funding, project locations or interest group opportunities present themselves. They are activities that could also be engaged following primary and secondary projects, if monitoring indicates that bacteria levels remain high. Since these projects are recommended for this long-term (5-10 years) context, timeframe, milestones and cost information is less specific.

3A. Rules and Ordinances for Storm Water Management

This program helps reduce the *E. coli* count of surface water by preventing flooding, controlling flow, treating storm water, and discouraging geese by using native landscape buffers near waterways and ponds. Additionally, this program is meant to revise existing storm water management ordinances to meet required design standards of the Washtenaw County Drain Commissioner. This program was implemented by detaining the first flush for a 24-hour period, thus reducing bacteria count. Revised rules are currently in final draft form and are anticipated to be implemented in 2014. The new standards require infiltration of first flush. All Phase II permitted entities have adopted stormwater ordinances which refer to the Water Resources Commission stormwater standards. In all township areas of the Honey Creek watershed, WRC staff review development proposals to ensure they meet WRC rules. In Ann Arbor, city staff review proposals to meet rules and standards that are based on those of the WRC.

Timeframe: 2014, ongoing
Milestones: Finalize new rules and standards: 2014. Revise as needed.
Cost: Not tracked. Funded by WRC.
Success Measures: Reduced runoff compared to previous standards*, m*onitoring (see section 6)

3B. Targeted Green Infrastructure Development and Retrofit Program

Research on bacteria reduction indicates that few structural BMPs work to significantly reduce bacteria levels in stormwater runoff. However, properly designed detention or retention basins have been shown to reduce bacteria in outflow. A program to incorporate key Green Infrastructure retrofit designs along key roads or other publicly-owned properties based on targets identified in the Green Infrastructure Opportunities map could be developed. Property owners or managers, such as township governments or the Washtenaw County Road Commission would need to participate as willing partners. New and redevelopment projects in the Honey Creek watershed should also be encouraged to use Green Infrastructure approaches. This program would promote the use of designs that slow and settle runoff waters from impervious surfaces like roads, drives and sidewalks and infiltrate as much of the runoff as possible. This allows a greater portion of runoff to be filtered through groundwater, where bacteria will not reproduce, thus reducing stormwater runoff sources of bacteria. Existing detention ponds and stormwater systems in critical areas of the watershed should be evaluated for retrofit opportunities to capture, settle and treat stormwater runoff. One high priority target is the combined set of detention ponds and stormwater system of Scio Farms.

Timeframe: 2015-2025
Milestones: Identify Green Infrastructure project targets and opportunities: 2015-19, recommend Green Infrastructure improvements to development projects: 2015-2025, implement public projects: 2019-2025.
Cost: Highly variable, depending on project, but usually lower than conventional cost of construction or reconstruction and maintenance.

Potential funding sources: Section 319, local government match; local agency or private investment
Success Measures: Reduced runoff volume and bacteria concentration measured from projects compared to conventional development*, m*onitoring (see section 6)

3C. Wetlands Restoration and Protection Program

This program, consisting of local regulations and incentives, is meant to: 1. protect existing wetlands on one-fifth of an acre or larger, and 2. restore significant wetlands that were previously lost. Damaged and

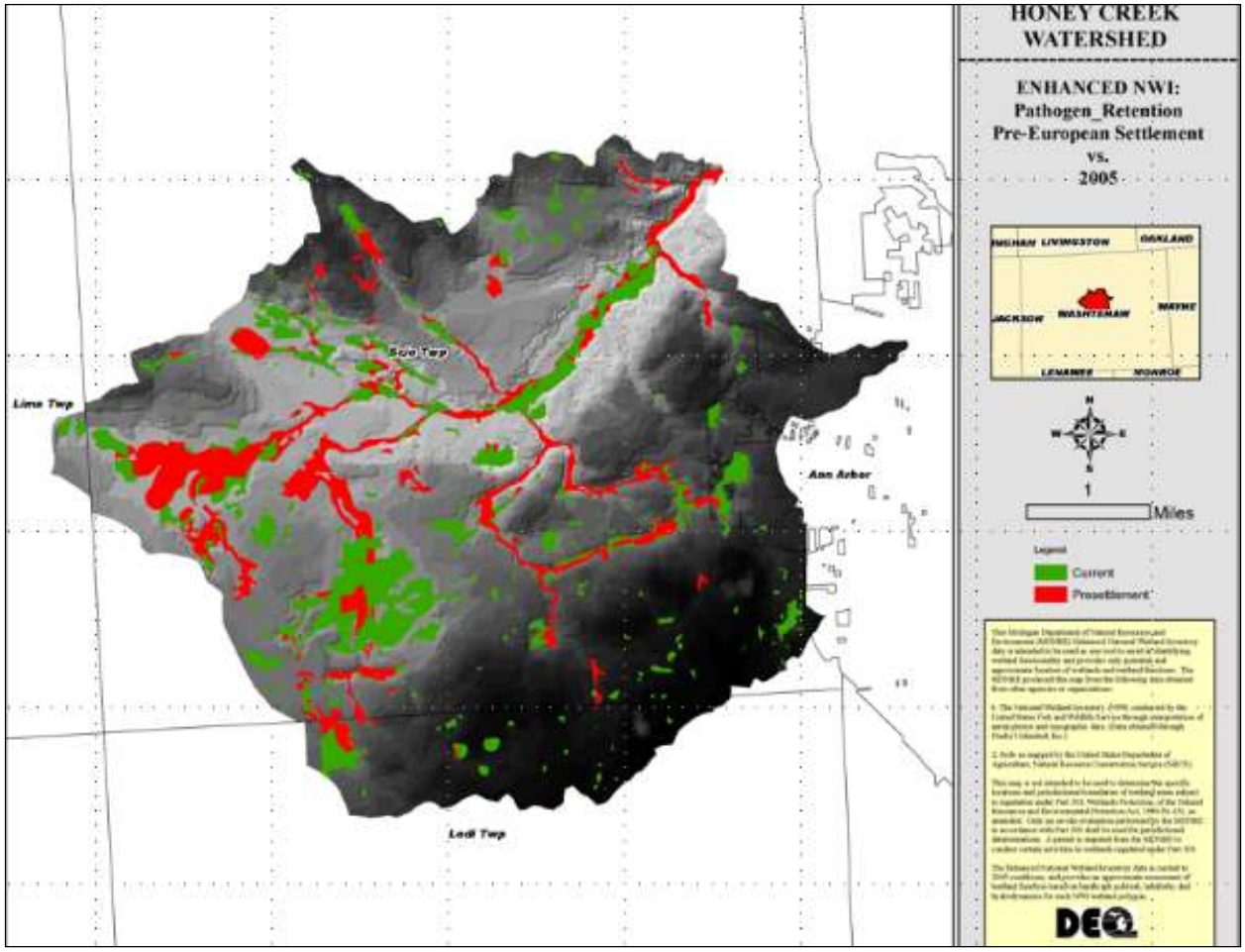


Figure 19. Wetlands with pathogen retention capacity. Wetlands in green exist currently (as of 2005) and areas in red are targets that could be restored to provide pathogen retention. Source: MDEQ, 2012.

destroyed small wetlands cannot provide the services of filtering and cleaning pollutants in storm water, while restored wetlands can add to this benefit. The program will protect numerous wetlands in the Honey Creek watershed. A model local wetland protection ordinance is available from HRWC. Restoration opportunities will be evaluated based on their pathogen retention capacity as evaluated by MDEQ (see Figure 19 and Appendix A). Figure 19 depicts wetland targets for pathogen retention benefits based on MDEQ analysis. This program would apply to Scio and Lodi Townships.

Timeframe: 2015-25
Milestones: Identify wetland restoration targets and policy protection needs: 2015-19, implement wetland restoration projects: 2019-2025.

Cost: $2,000/acre restored plus 10% for staff time for logistics and maintenance. $15,000 for ordinance development in staff and legal time.
Potential funding sources: Section 319, local government match; NRCS Programs; land conservancy funds
Success Measures: Reduced runoff volume, reduced bacteria concentration from site*, m*onitoring (see section 6).

3D. Goose Control Programs
Efforts have been made to decrease *Giant Canada* goose populations, eliminate year-round goose habitation, and in turn, reduce the amount of goose droppings containing *E. coli* that have potential to contaminate waterways in other parts of the Huron River watershed, but not in Honey Creek. Best management practices such as pond buffer plantings, replacing turf with shrubs and trees, and interfering with feeding and nesting will potentially reduce areas of contamination. Plant materials could be obtained from the Washtenaw County Conservation District. Research on goose control BMPs (including programs within the Huron River watershed) shows availability of numerous successful and cost-effective methods. Those with expertise in goose control BMPs should be made available through a workshop for those managing detention ponds and other open water sources in critical areas of the Honey Creek watershed.

Timeframe: 2015-25
Milestones: Identify high-traffic goose areas near streams in critical areas: 2015-19, implement native buffers (see activity 2G): 2017-19, implement other goose control activities: 2019-2025.
Cost: Variable
Potential funding sources: Section 319, local government match; private investment; local agency investment
Success Measures: Reduced goose populations near waterways, *m*onitoring (see section 6).

3E. Community Partners for Clean Streams
This program provides education through public and private partnership, promoting the protection of watersheds and waterways through presentations, print material, and signed agreements to use BMPs and abide by good housekeeping measures. The intent is to address water fowl habitat and discourage geese through landscaping, storm water pond maintenance, and riparian elements. Those involved include Washtenaw County, businesses, institutions, and multi-family residences, totaling 120 partners countywide. This project is ongoing with no end date.

Timeframe: 2015-25
Milestones: Identify partners with water fowl habitat: 2015-19, distribute information on goose control BMPs: 2019-2025.
Cost: Estimated costs are $160,000 per year for the entire program, or $16,000 for Honey Creek critical areas.
Potential funding sources: WRC stormwater funds
Success Measures: Reduced goose populations near waterways, *m*onitoring (see section 6).

3F. Update Storm Water Management Standards (Pond Landscaping Section)
This plan is meant to reduce nuisance geese habitat at storm water ponds by the installation of shoreline buffer planting or other means. The plan is utilized each time the storm water system is reviewed or equivalent, with no end date. Those involved include local units of government. Scio

Township standards should be reviewed for possible revisions. In the future, parks departments may become involved to employ the same strategy near public water features. Estimated costs are unknown.

Timeframe: 2014-25
Milestones: Recommend buffers around stormwater ponds: 2014-19, update pond landscaping standards and revise, as necessary: 2019-2025.
Cost: Estimated costs are $5,000 in municipal staff time in review and revision of standards.
Potential funding sources: Local government investment
Success Measures: Revised standards, increased # of ponds with buffers, reduced goose populations near waterways, *m*onitoring (see section 6).

3G. Native Landscaping Ordinance Development

This program diminishes green grass cover, on which geese enjoy foraging with an unobstructed view, and encourages the growth of tall prairie species. The purpose of this plan is to displace foraging geese by creating an environment unfavorable to geese, subsequently reducing the *E. coli* count in Honey Creek from goose droppings. The City of Ann Arbor has an existing ordinance that can be used as a model for Scio and Lodi Townships. Estimated Costs are $5,000. Scio Township should develop a similar ordinance.

Timeframe: 2015-25
Milestones: Develop draft ordinance or standards and pass: 2015-25. Revise as necessary.
Cost: Estimated costs are $5,000 in municipal staff time in review and revision of standards.
Potential funding sources: Local government investment
Success Measures: Ordinances or standards adopted, native area planted, goose populations reduced, *m*onitoring (see section 6).

3H. Farmland Protection Program

This program prevents surface and storm water pollution through permanently retaining large areas of permeable ground and the natural areas associated with farmland, such as windrows, swales, meadows, small wetlands, and woodlots. Preservation of farmland helps protect the headwaters of Honey Creek tributaries. Implementation of this plan is expected to eliminate future illicit discharges by precluding further urbanization and by promoting BMPs among farmers raising crops and animals. Under Purchase of Development Rights (PDR) programs, landowner applications are awarded points competitively, based on such factors as a history of good conservation and storm water management practices.

This program will be carried out by Ann Arbor City and Scio Township through ongoing implementation of PDR Ordinances, the Ann Arbor Parks Department Green Belt Program, with funding of PDR through local tax millage, the USDA Farm Bill-Farm and Ranchland Protection Program, the Michigan Farmland Preservation Board, and land conservancies. Others involved are: the Washtenaw Farmland Conservation Group, Washtenaw County, Farm Bureau, farmers, farmland owners, the USDA NRCS, WCCD, and the Ecology Center. This project began in 1998 with the passage of the County's PDR Ordinance. Scio Township also adopted a PDR ordinance. Estimated costs are unknown.

Timeframe: 2014-25
Milestones: Purchase rights or land in Honey Creek critical areas: 2015-25.
Cost: Estimated costs are dependent on specific land deals.
Potential funding sources: Local government, private, land conservancy investment

Success Measures: Acres of land in critical areas under protection, # of agricultural BMPs implemented (see activity 2F), *m*onitoring (see section 6).

6. Accountability Structure for Implementation

Overcoming Barriers and Closing Gaps

As framed by the terms of the TMDL, the ultimate measure of implementation success will be documented changes in water quality, showing improvement over time. However, potential barriers to this accomplishment exist and must be considered in implementation planning.

Positive feedback from even the most diligent efforts may be several years in the future due to the lead time needed to implement best management practices throughout the watershed. Participants must set realistic expectations about the amount of time needed to continue identified programs while awaiting positive results. Otherwise, impatience, discouragement, or competition for limited local funding could lead to discontinuation of effective programs. Prompt communication of small successes through news releases, web sites, and community newsletters will be important to encourage the continued efforts of TMDL partner communities.

The tracking of quantitative results over time carries a set of technical and logistical challenges. Variation in weather patterns over the years of a study adds to the complexity of trend analysis of the data. Collecting correctly timed wet weather samples is particularly daunting, as personnel may not be available during a particular major summer storm occurring outside of business hours. Over the past several years, there have been significant advances in source identification for *E. coli* pollution via DNA testing. The 'bacteria source tracking' (BST) methods were successfully used in the study used in this plan, but results were not entirely conclusive.

There are also gaps in our knowledge of bacterial survival and reproduction under conditions found in yards, parks, ditches, and ponds. For example, requiring a certain number of hours of onsite retention for storm water runoff is thought to guarantee that live *E. coli* bacteria will not escape and reproduce elsewhere. This has been established elsewhere. A systematic study of real world conditions to detail the effectiveness of retention, infiltration, and other strategies for control of bacteria, would further confidence in, and understanding of, these control measures. The knowledge gap has begun to close with a recent laboratory study conducted simulating urban stormwater runoff conveyed through conventional bioretention media to investigate the bacteria removal efficiency of this media. It was concluded that bacterial removal could be effective and sustainable, and that indigenous protozoa can facilitate this process. Exploring opportunities with the scientific community, such as this, may prove to be beneficial in finding a workable solution to *E.coli* contamination where the urban sources of the bacteria are difficult to control.

The next few years will provide a challenge to demonstrate that reductions in *E. coli* pollution of Honey Creek, the Huron River, and other rivers can be achieved given the difficulty to control general urban sources as demonstrated previously and in other parts of the country. With the current economic downturn restricting government and institutional resources, another challenge will be to identify the most cost-effective measures and to continue funding them. Managers and programs will both need to become adaptive, while continuing to appeal to the public's expectation that the waters of our state will attain the standards set forth by Congress through the passage of the Clean Water Act in 1972.

Participants, Reporting, Monitoring, Contingency Plans

The stakeholders for this implementation plan are committed to continued water quality improvement in the Honey Creek watershed. Those who have taken on this responsibility are:

- City of Ann Arbor
- Huron River Watershed Council
- Michigan Department of Environmental Quality
- Washtenaw County Water Resources Commissioner
- Washtenaw County Environmental Health Department
- Washtenaw County Road Commission
- Scio Township
- Lodi Township

The following units of government will also be subject to the TMDL:

- Michigan Department of Transportation

Lima Township has a smaller land area within the contributing basin and is not expected to be involved in plan implementation unless new information indicates potential sources within this area.

The stakeholders listed above are committed to continued water quality improvement in the Honey Creek contributing area. Toward this end, local governments, the Huron River Watershed Council have conducted a variety of actions, prior to TMDL development, to improve water quality and promote stewardship. Pre-TMDL activities included bio-monitoring, habitat assessment, septic inspection at time of sale, illicit discharge elimination, mass media educational campaigns, development standards, water resources protection ordinances, wetlands protection and wetlands restoration. Many of these actions have involved stakeholder collaboration; others are unique to individual stakeholders and their constituencies.

Although a great many ongoing actions to restore water quality and habitat in Honey Creek are voluntary, each stakeholder has assumed responsibility to continue their efforts, as resources allow and needs dictate. Through initiating and continuing these voluntary actions, each stakeholder has assumed responsibility for a share of water quality restoration in the Huron River Basin. These discretionary programs are dependent on funding, perceived needs, sound and reliable technical assistance, clear regulatory authority, constituent support, and demonstrated effectiveness. Some actions have been required under the permit regulations of the Clean Water Act.

Phase I communities have been under permit since December, 1995. Their permits specify best management practices to achieve water quality improvement, including *E. coli* reduction. Permit renewal applications will continue to include provisions consistent with the Honey Creek TMDL, such as illicit discharge elimination, and public information and education.

Phase II communities and entities must submit detailed compliance language that must also include provisions consistent with the Honey Creek *E. coli* TMDL. Phase II communities with Certificates of Coverage are required to submit an approvable plan to comply with all six minimum measures, including provisions consistent with any TMDL affecting the jurisdiction or watershed. The Michigan Department of Transportation, the Washtenaw County Water Resources Commissioner's Office, and public school

systems received separate Certificates of Coverage and must meet the same requirements as local governments.

Under their storm water permits, these communities and organizations are obligated to develop, implement, and enforce a storm water management program designed to reduce the discharge of pollutants from the drainage system to the "maximum extent practicable," to protect the designated uses of the waters of the state, to protect water quality, and to satisfy the appropriate water quality requirements of state and federal law. Storm water controls designed to attain the goals of the TMDL must be incorporated into the storm water management plan, and each permittee must implement appropriate best management practices to comply with the TMDL implementation plan. Both separately and jointly, through a coordinated public education and involvement strategy, stakeholders will also engage in communication with the public that addresses *E. coli* TMDL problems, solutions, and successes.

Additionally, the permittees are required to submit biannual progress reports to the MDEQ which shall contain the following: a description of the status of compliance with general permit conditions, an updated assessment of the water quality conditions within their jurisdiction, a description of identified water quality stresses, and a summary of all information collected and analyzed—including monitoring data. The report must include a summary of upcoming storm water activities and a description of planned changes in BMPs or measurement of goals.

Since each storm water permit requires biannual reporting, and TMDL goals and activities must be incorporated into the measures prescribed by the permit, separate TMDL reporting is unnecessary for those partners covered by permits. Scio Township is an active member of the Middle Huron Partners and reports annually to that group. While the focus of that effort is on phosphorus reduction efforts, the township could also report on progress to reduce pathogens. In 2007, and at subsequent five-year intervals, the MDEQ is scheduled to complete basin-wide monitoring of the Huron River watershed. Future projects under this implementation plan may incorporate additional monitoring if resources allow. Stakeholders' storm water permit reporting will include an updated assessment of the water quality conditions within their jurisdiction in either narrative or numeric form. The purpose of this update is to show any obvious changes in *E. coli* levels since the previous progress report. Change may be demonstrated by use of data collected by other sources or a group monitoring program. The partners to this process continue to meet 3-4 times per year as part of a stakeholder group to evaluate progress.

Through adaptive management—a process that assesses conditions and trends throughout plan implementation, and provides feedback to stakeholders so that adjustments can be made—this implementation plan is intended to ultimately achieve TMDL compliance. Through the annual meetings of the Middle Huron Partners and Stormwater Advisory Group, the TMDL Implementation Plan working group will meet to review efforts and plans. The MDEQ will track permit compliance through storm water permit oversight, including monitoring activities that address the TMDL implementation goals. Unless the EPA determines that it is necessary to separate TMDL enforcement from the storm water permit process, enforcement authority will reside in the MDEQ's authority under the provisions of the storm water rules.

Evaluation and Monitoring

The ultimate success of this watershed management plan will be determined by the degree to which it results in a decrease in bacterial contamination in Honey Creek. Although achieving water quality

standards is the goal of plan implementation, other means will need to be employed to ascertain what effects individual and collective best practices have on water quality and associated indicators. In-stream monitoring, such as physical, chemical, and biological monitoring, is ideal because it allows direct measurement of environmental improvements resulting from management efforts. Targeted monitoring to evaluate practice-specific effectiveness is another option, whereas ambient monitoring can be used to determine overall program effectiveness. Alternatives to monitoring include using programmatic, social, physical, and hydrological indicators. Finally, environmental indicators can be used to quantify the effectiveness of best practices.

Quantitative Evaluation

Progress toward the goal of achieving water quality standards will be measured using an existing long-term Water Quality Monitoring Program being supported by the Middle Huron Partners and SAG, supplemented with additional sampling following project implementation. The complete program is outlined in the *Middle Huron Watershed Management Plan.* Table below is an excerpt that includes the ongoing monitoring included for one site at Honey Creek that corresponds to site HC04 discussed elsewhere in this plan.

Table 5. Middle Huron River Watershed Monitoring and Evaluation

Monitoring Site[1]	Parameter Target	Type of Analysis	Protocol	Frequency	Test Agent
Honey Creek Adopt (18,19,20,22) Middle Huron (MH03)	S, N, DO, T, I, B, Bio	Stream Habitat Assessment	HRWC Protocol	3- 5 yr interval	HRWC, MDEQ
		Total Suspended Solids	SM20 2540 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Total Phosphorus, Nitrates, Nitrites	SM20 4500	1-2x/Mo + Rain event	HRWC to AA WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1-2x/Mo Apr-Sept	HRWC
		E. coli	SM20 9213 D	1-2x/Mo + Rain event	HRWC to AA WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/year	HRWC, MDEQ
1) Adopt = HRWC Adopt-a-Stream; Middle Huron = Middle Huron Partners tributary nutrient monitoring; MDEQ = MDEQ lake monitoring					
2) S= Sediment; N= Nutrients; DO= Dissolved Oxygen; T= Temperature; I= Ions; B= Bacteria; Bio= Biota					
3) Specific sites will be included as part of MDEQ Water Bureau's rotational water quality monitoring program; Lakes program monitors water quality monthly					
4) HRWC staff and volunteers to collect samples and deliver to Ann Arbor Water Treatment Plant for analysis under their direction.					
5) Analytical protocols follow “Standard Methods for the Examination of Water and Wastewater”, 20th edition, by the American Waterworks Association					

In addition, stream flow is measured at that site each time samples are collected, and at least once in 5 years, flow is measured continuously from April until the threat of freeze-over (late November).

Following initial implementation of the short-term strategy (year 3, or 2017 at the earliest), additional *E. coli* bacteria sampling will be conducted for five consecutive weeks in summer months at key sites in critical areas. At minimum, sampling should be conducted at sites 1, 7, 15 and 17. In addition, if any sample events at sites 7 or 15 result in bacteria counts above the TBC standard, duplicate samples should be evaluated for human sources using BST methods. Alternatively, canine detection could be re-deployed. A second round of sampling at these sites should be conducted again 1-2 years following completion of the 5-year strategy.

Table 6. Qualitative Evaluation Measures

Evaluation Method	Program/ Project	What is Measured	Pros and Cons	Implementation
Public Surveys	Public education or involvement program/project	Awareness; Knowledge; Behaviors; Attitudes; Concerns	Pro: Moderate cost. Con: Low response rate.	Pre- and post- surveys recommended. By mail, telephone or group setting. Repetition on regular basis can show trends. Appropriate for local or watershed basis.
Written Evaluations	Public meeting or group education or involvement project	Awareness; Knowledge	Pro: Good response rate. Low cost.	Post-event participants complete brief evaluations that ask what was learned, what was missing, what could be done better. Evaluations completed on-site.
Stream Surveys	Identify riparian and aquatic improvements.	Habitat; Flow; Erosion; Recreation potential; Impacts	Pro: Current and first-hand information. Con: Time-consuming. Some cost involved.	Identify parameters to evaluate. Use form, such as the USA, to record observations. Summarize findings to identify sites needing observation.
Visual Documentation	Structural and vegetative BMP installations, retrofits	Aesthetics. Pre- and post- conditions.	Pro: Easy to implement. Low cost. Con: Good, but limited, form of communication.	Provides visual evidence. Photographs can be used in public communication materials.
Phone call/ Complaint Records	Education efforts, advertising of contact number for complaints/ concerns	Number and types of concerns of public. Location of problem areas.	Con: Subjective information from limited number of people.	Answer phone, letter, emails and track nature of calls and concerns.
Participation Tracking	Public involvement and education projects	Number of people participating. Geographic distribution of participants. Amount of waste collected, e.g. hazardous waste collection	Pro: Low cost. Easy to track and understand.	Track participation by counting people, materials collected and having sign-in/evaluation sheets.
Focus Groups	Information and education programs	Awareness; Knowledge; Perceptions; Behaviors	Pro: Instant identification of motivators and barriers to behavior change. Con: Medium to high cost to do well.	Select random sample of population as participants. 6-8 people per group. Plan questions, facilitate. Record and transcribe discussion.

Qualitative Monitoring

Qualitative measurements are important in determining changes in behavior and visible changes in the watershed. Surveys, participation records, and meeting/workshop evaluations can all be used to gauge whether activities aimed at public education and outreach are effective. Better survey results, an increase in participation, and favorable meeting/workshop evaluations can all be an indication of a greater understanding by the public on watershed-related issues. Results that do not yield improvements will signal that current activities and/or education methods should be modified and improved.

Visible changes in the watershed can also be used as an indication of progress in the watershed. Stream surveys can identify riparian and aquatic improvements and help identify recreational opportunities. BMP implementation can also be documented visibly, with the number and location of BMPs recorded.

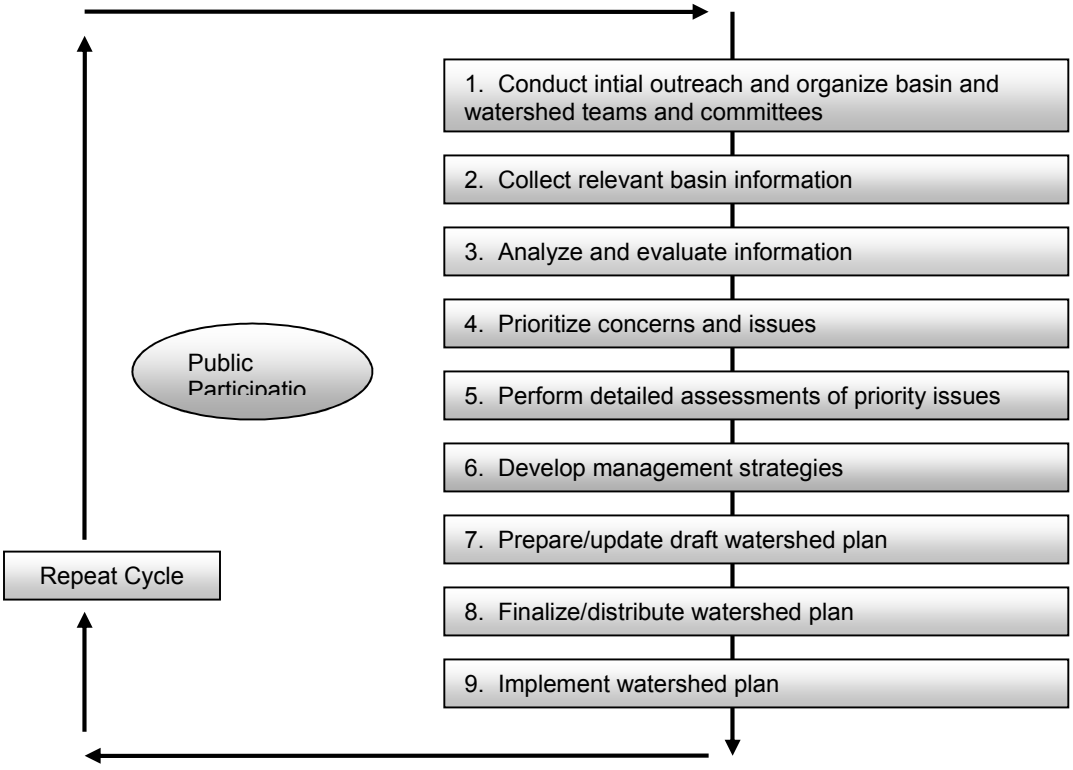
Table 6 summarizes the qualitative methods that will be used to measure progress, with the exception of focus groups, which are determined not to be necessary or helpful for this watershed plan. A simple survey may be deployed if other behavioral and outcome measures cannot provide sufficient success measurement. Surveys are often the only reasonable way to obtain awareness and behavior changes. However, in a small population area like Honey Creek, it is often very difficult to obtain sufficient survey responses to allow for statistical comparisons. Other process measures will be obtained as described in the action plan (see section 5).

Determining the Need for Revisions

It is the intent of TMDL stakeholders in the watershed that this plan should be revised, on average, every five years. Several of the collaborative groups previously mentioned in this plan will continue to meet on a regular basis to ensure that the plan is being implemented on a watershed-wide basis. Many partners have a vested interest in assuring that the plan is implemented. In addition, updates regarding watershed plan implementation and activities related to it will be updated on the HRWC's website.

Applying the concept of adaptive management to the revision process is essential for successful implementation of the plan. Evaluation of a specific management alternative (using the methods discussed in the next section) may suggest a change is needed to affect the desired result, or a shift in focus from one management alternative to another may be needed. The iterative nature of watershed planning, implementation, and revision is shown below in Figure 20.

Figure 20. Typical Steps in a Watershed Management Cycle[vi]



References

[i] MDEQ, Water Bureau. February, 2005. A Biological Survey of the Huron River Watershed: Ingham, Livingston, Monroe, Oakland and Washtenaw Counties, July through September 1997. Lansing, MI: MDEQ.
[ii] MDEQ, Water Bureau. February, 2005. A Biological Survey of the Huron River Watershed: Ingham, Livingston, Monroe, Oakland and Washtenaw Counties, July-September 2002. Lansing, MI: MDEQ.
[iii] MDEQ, *Prohibition Zone – Groundwater Use Restrictions; Gelman Sciences, Inc. Unit E Aquifer; 1,4-Dioxane Groundwater Contamination, Washtenaw County Fact Sheet*, March 2007.
[iv] MDEQ, Water Bureau. February, 2005. A Biological Survey of the Huron River Watershed: Ingham, Livingston, Monroe, Oakland and Washtenaw Counties, July-September 2002. Lansing, MI: MDEQ.
[v] See the Honey Creek TMDL issued by the MDEQ for more in-depth information.
[vi] Adapted from: MSU Institute of Water Research, et al. 2000. Developing a Watershed Management Plan for Water Quality. Lansing, MI: Michigan State University.