The Brighton Lake Subwatershed Management Plan:

A Strategy to meet the Total Maximum Daily Load for Brighton Lake

Prepared by the
Brighton Lake Subwatershed Workgroup

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"The 19th century was the century of exploration of our rivers,
and the 20th century of their exploitation and destruction.
Now it's up to us to make the new century one of restoration."

Robert Hass, U.S. Poet Laureate (1995-97)

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EXECUTIVE SUMMARY

Introduction to the Brighton Lake Subwatershed

The Brighton Lake Subwatershed is located in southwestern Livingston County. This 23 square mile (14,730 acres) area extends from the headwaters of South Ore Creek downstream to the Brighton Lake impoundment just south of the City of Brighton. The subwatershed lies within Livingston County and comprises all or portions of Hartland, Oceola, Genoa, Brighton, and Hamburg Townships and the City of Brighton. Land use in the Brighton Lake Subwatershed ranges from heavily commercial and residential settings in the south to small rural farms and housing in the north.

Problem Statement

Based on water quality monitoring studies, in 1998 the Michigan Department of Environmental Quality (MDEQ) listed Brighton Lake as threatened on the State's 303(d) list of impaired waters requiring Total Maximum Daily Load (TMDL) establishment. The reason for the threatened status was cited as excess nonpoint source phosphorus loading in the subwatershed that eventually enters Brighton Lake.

Simply stated, nonpoint source pollution is defined as a diffuse source of pollution that cannot be traced to a particular discharge such as an industrial or wastewater treatment plant. Rainfall or snowmelt moving over and through the ground is the main cause of nonpoint source pollution. As the runoff travels, it picks up and carries pollutants to lakes, rivers, and wetlands, or even to underground sources of drinking water. Pollutants often found in stormwater runoff are numerous and include phosphorus and nitrogen, dirt and sediments, oils/greases, vehicle lubricants, herbicides and insecticides, metals, and garbage.

The intensity and frequency of nonpoint source pollution is directly related to the amount of hard (impervious) surfaces in a subwatershed because these areas facilitate the travel of water over ground. The anticipated increase in development and subsequent hard surfaces in the Brighton Lake Subwatershed, combined with the loss of unaltered land, is expected to cause an increase in already excessive nonpoint source pollution situation.

Purpose of the Brighton Lake Subwatershed Management Plan

The Brighton Lake Subwatershed Management Plan sets forth a comprehensive, long-term effort to restore and protect water quality of the area with the goal of attaining the Total Maximum Daily Load for Brighton Lake. Secondly, the Townships of Brighton, Genoa, Hamburg, and Hartland and the City of Brighton will be required to obtain a state or federal permit by March 2003 for stormwater runoff under the National Pollutant Discharge Elimination System Phase II program. This plan aims to establish a protocol to help those communities wishing to meet the minimum requirements of the program.

Brighton Lake Subwatershed Workgroup

In 2000, communities, county agencies, key business interests, citizen groups, and other stakeholders in the subwatershed were invited to participate in establishing a Workgroup to help guide the development of the comprehensive subwatershed plan. This Workgroup has met quar-

terly since the fall of 2000 and is the essential guiding group in the development of this subwatershed plan.

Management Alternatives

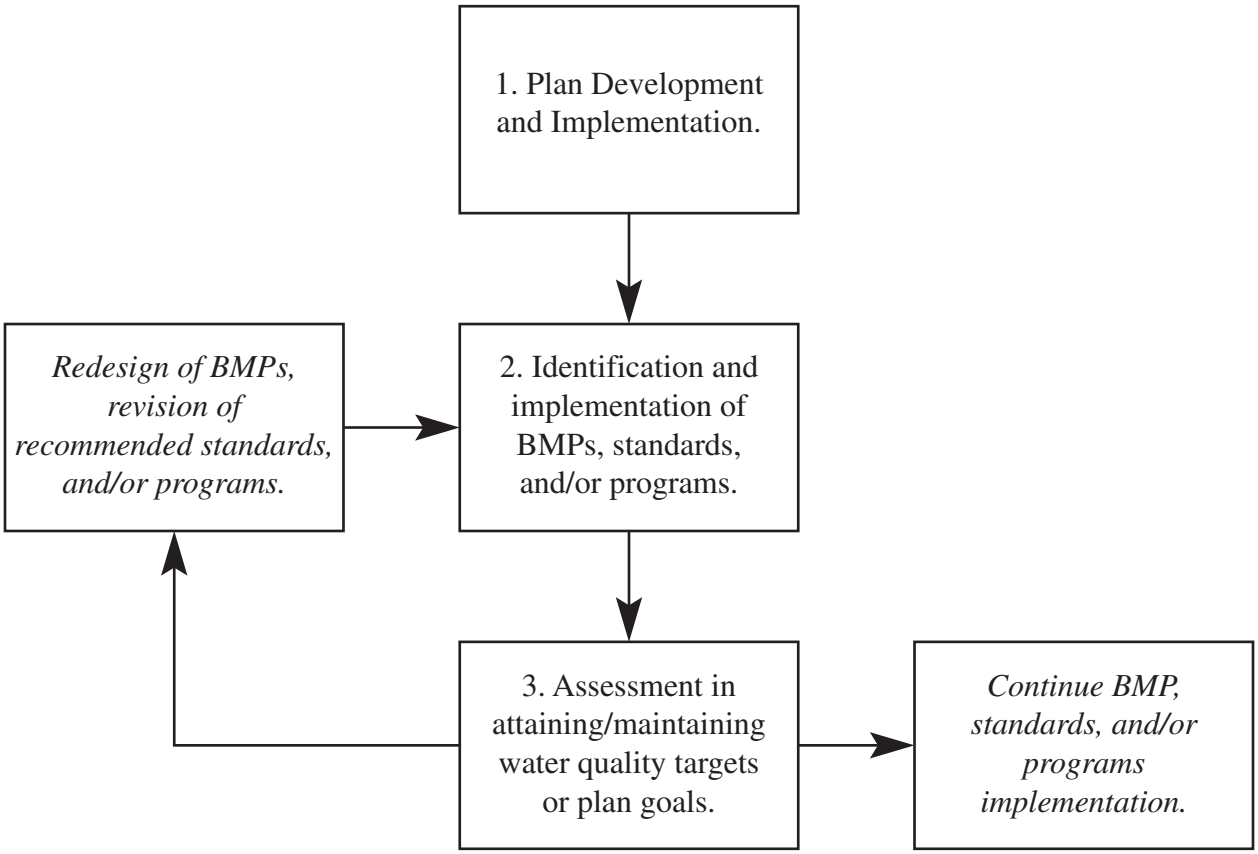
After establishing goals for the subwatershed, the Workgroup discussed various management alternatives that would conceivably meet the Total Maximum Daily Load and address subwatershed concerns. This resulted in four distinct categories of management alternatives, or Best Management Practices (BMPs), for the subwatershed.

- ***Structural Stormwater BMP Retrofitting.*** Based on studies performed by Tetra Tech MPS as part of this effort, the subwatershed exhibits numerous conditions where the control and mitigation of stormwater runoff is either non-existent or inadequate. Utilizing a cost-efficiency model, this condition can be significantly mitigated and the Total Maximum Daily Load met by the implementation of grassed swales, constructed wetlands, infiltration, bioretention, and other BMPs in key areas of the subwatershed.
- ***Conservation Planning and Standards Adoption/Revision.*** The future of the subwatershed holds many concerns, including increased nonpoint source pollution from projected land use change. To mitigate the impact of these changes, the plan recommends enhanced planning and standards such as natural resource inventories and assessments, wetland, stormwater, and natural features protection ordinances, and the revision of community design standards to promote low impact design.
- ***Waterbody Restoration.*** During the course of plan development, it was noted that several waterbodies in the subwatershed were exhibiting degraded conditions. To address this situation, actions to control the impact of peak flows or address destabilized streambeds and streambanks were considered and an initiative for study and implementation presented.
- ***Education and Stewardship.*** The short and long-term success of any subwatershed plan is depends on enhancing the knowledge of water quality and watershed issues. This plan provides the framework for information and education (I/E) plan and program initiatives to promote stewardship.

Subwatershed Plan Institutionalization, Coordination, and Assessment

One of the most important aspects of any subwatershed plan is assuring implementation, coordination of activities, and assessment of successes and failures. In order to provide a well-organized process for implementing this subwatershed plan, a Huron Headwaters Steering Committee (Committee) of Workgroup members and other key stakeholders is proposed as well as a resolution for local government and agency adoption. The basis of the resolution and Committee is the Middle Huron Initiative (MHI) and to a lesser extent the Lake Macatawa Coordinating Committee. During implementation and review of the plan, new data and information may become available which might require a decision to revise or not to revise the plan. The process used to make this decision at regular Committee meetings is based on the Middle One Rouge River Subwatershed Management Plan and is illustrated below.

Subwatershed Plan Revision Process



CHAPTER 1. INTRODUCTION

1.1 Value of Watershed Protection

Healthy watersheds are important to all communities as they embody our sense of place in the landscape, protect economic and personal interests (e.g., flood protection), provide sources of drinking water and recreation, and support wildlife and sensitive plant species habitat, among other benefits. As a result, communities quickly find a vast number of reasons to take an interest in and protect local watersheds.

However, across the nation, scientists and communities are finding that their water resources are degrading in response to past and present growth and development methods. They now find themselves facing billions of dollars in expenses in order to restore our waters because of the impact of our actions. They are also discovering that they can only protect these local water resources by thinking on a new level—a watershed level. Numerous diverse local watershed management efforts have begun to be initiated in recent years in response to the observed water quality degradation. For example, some communities are trying to save salmon habitat in the Pacific Northwest or Maryland crab and oyster populations in Chesapeake Bay, while others are striving to maintain drinking water quality for New York City reservoirs. In the Huron River area, communities surrounding Ann Arbor and Ypsilanti have sought to reduce and prevent lake degradation caused by excess phosphorus loading that resulted in recreational and property value loss for Ford and Belleville Lakes since the late 1990s.

Each community often has their own unique rationale for protecting watersheds. Some may place a high value on the aquatic biological community living in waters or wildlife protection for sensitive mammals and amphibians, while others will be more concerned about reducing flood events or stream channel erosion to the real estate in their back yard. Regardless of the reasons, it is clear that most communities are recognizing the value of local watersheds and are taking steps to restore and protect these resources (CWP, 1999).

Watersheds provide billions of dollars worth of protection due to their natural attributes and functions. For instance:

- ***Human Life and Property Protection.*** Estimates indicate the United States loses billions of dollars each year from flood damage to buildings, not including loss of life (CWP, 1999). Wetlands, floodplains, and undeveloped open spaces in watersheds help protect adjacent and downstream properties from potential flood damage and even death by collecting and slowly releasing floodwater. The cost of replacing natural flood control function in a watershed can sometimes be several million dollars.

- ***Recreation.*** More than half of all U.S. adults hunt, hike, fish, canoe, birdwatch, or photograph nature, spending billions of dollars annually. Recreational fishing by Americans alone generates at least $37.8 billion annually in revenue (CADFG, 2002). Kent Lake, and the associated Kensington Metropark, receives approximately 2 million visitors each year who spend money at local restaurants and other local businesses (Schafer, 2000).

- ***Water Supply***. Healthy watersheds provide clean drinking and recreational waters. Wetlands, kettle lakes, prairie potholes, and other open spaces have significant water storage and groundwater recharge. However, groundwater supplies are sensitive to activities that alter watershed hydrology. Improper development lowers the water table and reduces the groundwater recharge and discharge.

- ***Water Quality.*** Healthy watersheds maintain and improve the water quality of our nation's streams, rivers, lakes, and wetlands. As runoff and surface water pass through these systems, pollutants are removed or transformed through physical, chemical, and biological processes. This cycle helps protect the water we drink, and uses for recreation, as well as the water animals and plants depend on to survive.

- ***Erosion Control.*** The native trees and plants surrounding lakes, streams, and wetlands in healthy watersheds protect soil from the erosive energy and flows of water. These areas help protect water quality, reduce the need and dependence on seawalls and dredging, and provide valuable habitat for wildlife.

- ***Culture.*** Watersheds have archeological, historical, and cultural values. Most societies traditionally formed along bodies of water. The cultures of Egypt, Louisiana, and the Chesapeake Bay formed as a result of their vibrant watersheds. Many painters and writers have used watershed landscapes as their subject matter. Now, people with cameras and camcorders spend billions of dollars to capture the scenery that healthy watersheds provide.

- ***Economic Vitality.*** A study by the American Farm Trust looked at the local government costs and revenues associated with different land uses in Marshall, MI. They found that for every $1.00 in revenue generated by residential development, $1.47 was required in public services (e.g. schools, fire and police protection, infrastructure, and road maintenance). For every $1.00 generated by farms and open land, only $0.27 was required for associated services, and for every $1.00 of revenue from commercial/industrial uses, $0.20 was spent in services (AFT, 2001). Healthy watersheds provide a basis for commercially important products harvested from them. This includes fish, shellfish, agriculture, timber, and even some medicines derived from soils and plants.

- ***Habitat.*** Diverse species of plants, insects, amphibians, reptiles, birds, fish, and mammals depend on healthy watersheds for food, breeding, habitat, and shelter.

- ***Science.*** Scientists are only beginning to understand the complex processes of watersheds. Because most watersheds have been significantly altered, protecting what is left for study and understanding is a prime concern for many water-quality professionals.

In addition to the cultural benefits of healthy watersheds, watershed planning and protection holds notable benefits to local governments. Most significantly, watershed planning can:

- ***Proactively address*** forthcoming federal and state regulations on TMDLs and watershed plans,
- Allow communities opportunities to progress towards requirements of the ***Michigan Voluntary NPDES Phase II stormwater permit,***
- Avail local governments access to specialized state and federal ***grant programs*** (e.g., Clean Michigan Initiative, Clean Water Act Section 319 funds, etc.),
- ***Reduce costs*** of remedial actions by preventing future problems,
- Maintain ***quality of life*** within region,
- Heighten ***public awareness and support,***
- ***Enhance decision making*** on land use requests,
- ***Streamline development review*** processes,
- ***Enhance coordination*** of government resources and programs in the watershed, and
- ***Reduce*** potential of legal actions within TMDL watersheds.

1.2. Problem Statement

The Huron River supplies drinking water to nearly 140,000 people, supports one of the Michigan's best smallmouth bass fisheries, and is the State's only designated scenic river in southeast Michigan. However, numerous waterbodies in the Huron River Watershed are encountering ever-increasing incidences of nuisance algae blooms as the result of phosphorus enrichment. These algae—or algal—blooms threaten to alter the structure of flora and fauna, decrease dissolved oxygen in the water, and degrade designated uses for waterbodies by causing recreational loss, fish kills, and other environmental and human health consequences.

In recent years, Livingston County, the Brighton Lake Subwatershed, and the Huron River Watershed as a whole, have experienced increased developmental pressures from a flourishing economy and urban flight. In fact, according to the Livingston County Planning Department, the population of Livingston County increased from 58,967 to 156,951 individuals. Projections

by the Southeast Michigan Council of Governments (SEMGOG) estimate that by 2030 the area will house 282,405 residents. In order to accommodate the increased population and the businesses and services to serve them, much of the remaining open spaces will need to be developed within the watershed; hence, further threatening to alter the hydrology and water quality of groundwater and surface waters.

The projected increase in development and subsequent hard (impervious) surfaces combined with the loss of unaltered land is of particular concern since these areas are significant contributors of nonpoint source pollution (NPS). Simply stated, NPS is defined as a diffuse source of pollution which cannot be traced to a particular discharge such as an industrial plant. For instance, when rain or snowmelt occurs on impervious surfaces such parking lots, rooftops, lawns, and roads or disturbed land like found on construction sites, the resulting water runoff—called stormwater runoff—picks up pollutants that may be on these surfaces and carries them, often untreated, to local streams, lakes, or wetlands. Pollutants often found in stormwater runoff are numerous and include phosphorus and nitrogen, dirt and sediments, oils/greases, vehicle lubricants, herbicides and insecticides, metals, animal waste, and garbage. But because there are hundreds of thousands of such instances in the subwatershed, addressing nonpoint source pollution is often complex and problematic.

While NPS is often directly associated with stormwater runoff, there is another source of NPS that is not associated with such runoff. Impaired or compromised decentralized wastewater treatment systems—septic systems—can be a significant yet difficult to quantify source of phosphorus and nitrogen, bacteria, and untreated medicines to surface and ground waters.

Based on water quality studies performed on Brighton Lake in the 1970s and 1990s, MDEQ determined that although relocation of the Brighton Wastewater Treatment Plant's discharge to downstream of the lake had improved water quality from 1970s levels, increased nonpoint source loading is threatening to negate these improvements. According to the MDEQ studies, nonpoint source phosphorus loads currently account for all of the total phosphorus load to Brighton Lake (Alexander, 1999a).

In response to these findings, MDEQ listed Brighton Lake as threatened on the State's 1998 303(d) list of impaired waters requiring Total Maximum Daily Load (TMDL) establishment due to excess nonpoint source phosphorus loading from upstream sources. A TMDL is the maximum amount of a particular pollutant a waterbody can assimilate without violating numerical and/or narrative water quality standards.

The threatened status was assigned to Brighton Lake because of the increased developmental pressures in the subwatershed that threaten to increase the contribution of nonpoint source pollution, resulting in an expected violation of the State's narrative water quality standards. As a result of extensive field studies, MDEQ has established a TMDL of 30 micrograms per liter (mg/L) phosphorus concentration so as to assure satisfactory water quality for Brighton Lake (Alexander, 1999b).

1.3 Purpose of the Watershed Plan

The Brighton Lake Subwatershed Management Plan represents a broad effort to restore the water quality integrity of Brighton Lake and upstream waterbodies that drain into South Ore Creek above the lake. The purpose of the plan is to present a quantifiable methodology to diminish the adverse effects of nonpoint source phosphorus pollution. This plan outlines the steps considered necessary to meet the phosphorus TMDL for Brighton Lake. This plan also provides a framework for the protection of sensitive habitats for rural character, water quality, and wildlife sustainability.

In order for a watershed plan to be approved by the state of Michigan, it must meet the following criteria as established in State Rule 324.8810:

> *A watershed management plan submitted to the MDEQ for approval under this section shall contain current information, be detailed, and identify all of the following:*
>
> *(a) The geographic scope of the watershed.*
> *(b) The designated uses and desired uses of the watershed.*
> *(c) The water quality threats or impairments in the watershed.*
> *(d) The causes of the impairments or threats, including pollutants.*
> *(e) A clear statement of the water quality improvement or protection goals of the watershed management plan.*
> *(f) The sources of the pollutants causing the impairments or threats and the sources that are critical to control in order to meet water quality standards or other water quality goals.*
> *(g) The tasks that need to be completed to prevent or control the critical sources of pollution or address causes of impairment, including, as appropriate, all of the following:*
> *(i) The best management practices needed.*
> *(ii) Revisions needed or proposed to local zoning ordinances and other land use management tools.*
> *(iii) Informational and educational activities.*
> *(iv) Activities needed to institutionalize watershed protection.*
> *(h) The estimated cost of implementing the best management practices needed.*
> *(i) A summary of the public participation process, including the opportunity for public comment, during watershed management plan development and the partners that were involved in the development of the watershed management plan.*
> *(j) The estimated periods of time needed to complete each task and the proposed sequence of task completion.*

In addition, there are numerous communities in the Kent Lake Subwatershed who will be required to obtain a state or federal permit for stormwater runoff under the National Pollutant Discharge Elimination System (NPDES) Phase II program. The Townships of Brighton, Genoa, Hamburg, Hartland, and Oceola, and the City of Brighton are included within the regulation areas.

1.4 Establishment and Role of Community Liaison Workgroup

Community-based partnerships are key to effective watershed management. Through a partnership, different people and organizations work together to address common interests and concerns. As such, partnerships represent the easiest way to develop and implement a successful watershed management plan because everyone is involved from the initiation. Consequently, the final plan achieves input and consensus of all parties who have a stake in the watershed.

A community liaison-working group (Workgroup) was formed in Fall 2000 in order to understand the water quality and environmental concerns for the subwatershed by local communities and residents and to garner grassroots support for the watershed management process. Overall, the goal of the Workgroup was to guide the creation of a watershed management plan to meet TMDL targets for the Brighton Lake Subwatershed. To facilitate this goal, key stakeholders throughout the subwatershed were identified and contacted about possible participation. Invitees included representatives from all local governments within the subwatershed, county health, road, drain, and planning department representatives, state agency employees, environmental interest groups, concerned citizens, development interests, chambers of commerce representatives, and community engineers. It is important to note that while all communities were invited, not all chose to participate. A list of workgroup participants is presented earlier in this document.

CHAPTER 2. MAJOR CHARACTERISTICS OF THE HURON RIVER WATERSHED AND BRIGHTON LAKE SUBWATERSHED

2.1 Huron River Watershed

The Huron River Watershed is located in southeastern Michigan and encompasses approximately 900 square miles (576,000 acres) of Ingham, Jackson, Livingston, Monroe, Oakland, Washtenaw, and Wayne counties (Figure 1). The Huron River, whose drainage area forms the watershed, is approximately 140 miles in length, with its origin located at Big Lake and the Huron Swamp in Springfield Township, Oakland County. From this headwater area, the mainstem of the river meanders through a complex series of wetlands and lakes in a southwesterly fashion to the area of Portage Lake. Here, the river begins to flow south until reaching the Village of Dexter in Washtenaw County, where it flows southeast and proceeds to its final destination of Lake Erie.

The Huron River Watershed is a unique and valuable resource in southeast Michigan that contains twenty-nine creeksheds, ten Metroparks, two-thirds of all southeast Michigan's public recreational lands, and abundant county and city parks,. In recognition of its value, the State has officially designated 37 miles of the river and three tributaries as Michigan Department of Natural Resources Country Scenic River under the State's Natural Rivers Act (Act 231, PA 1970).

Another unique aspect of the watershed is the presence of 96 dams or impoundments, of which 17 are on the mainstem of the river and 79 on tributaries. Private citizens as well as local, state, and federal governments own these barriers, and they serve numerous purposes ranging from hydroelectric power generation to recreational and waterfront housing enhancement.

2.2 Brighton Lake and its Subwatershed

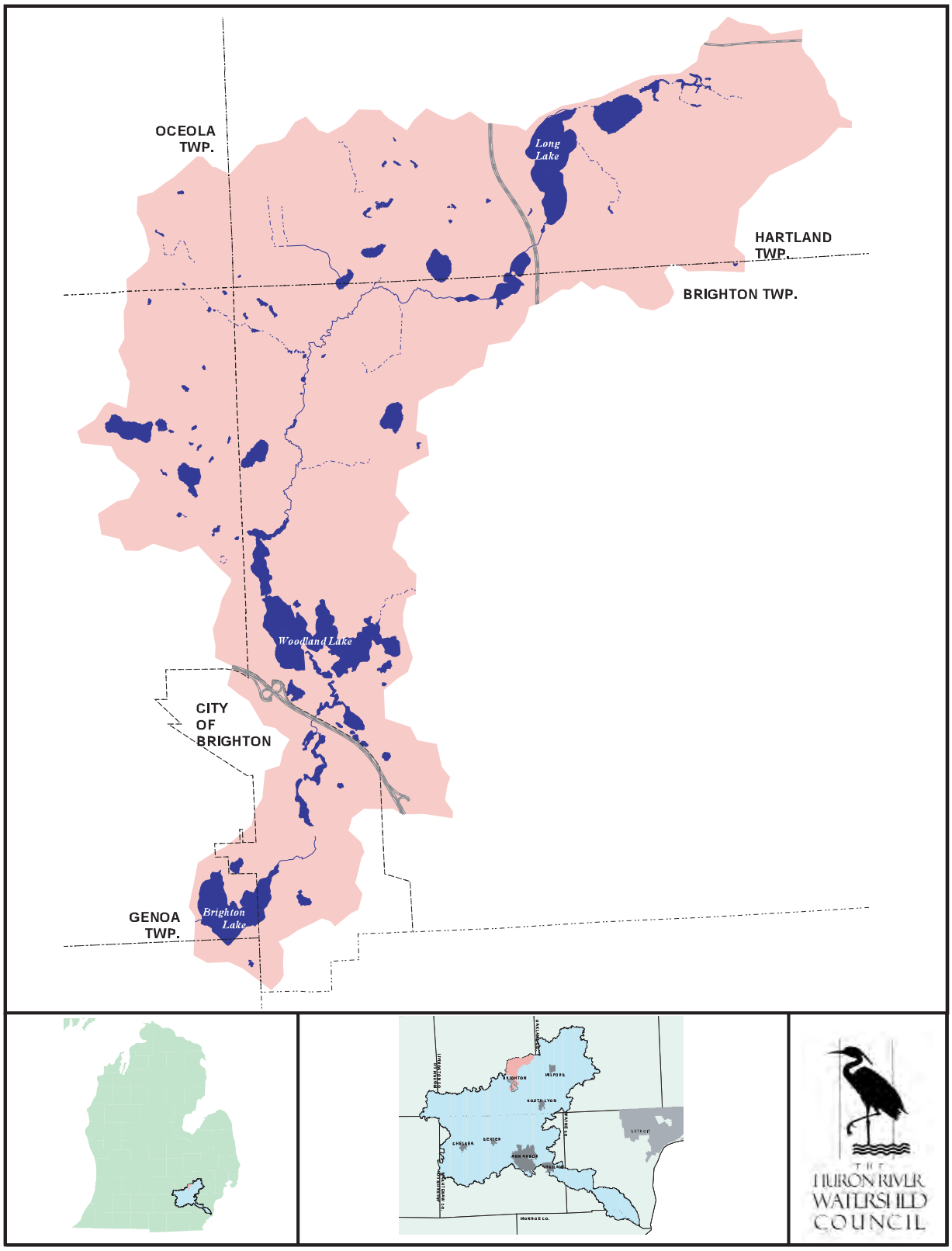
The drainage area which provides water to Brighton Lake is located in the upper Huron River Watershed and is designated the Brighton Lake Subwatershed (Figure 1). This 23 square mile (14,730 acres) area extends from the headwaters of South Ore Creek downstream to the Brighton Lake impoundment within the southwestern portion of the City of Brighton (Figure 1). The subwatershed lies within Livingston County and comprises all or portions of Hartland, Oceola, Genoa, Brighton, and Hamburg Townships and the City of Brighton.

The exceptional ecological value of a portion of this area is such that The Nature Conservancy recently deemed it as an "Aquatic Priority."

2.2.1 History and Demographics

Livingston County is located in the southeastern section of Michigan's Lower Peninsula. Its county seat is the City of Howell. This county was named after Edward Livingston, Secretary of State under President Andrew Johnson, and Minister to France.

Figure 1. Location of the Brighton Lake Subwatershed



Although the U.S. Surveyor-General in 1815 reported the soil in this area to be of such poor quality that it was unsuitable for farming, the Chippewa and Potawatomi Native American tribes had farmed it for years. The error was eventually realized and the region subsequently became an important agricultural area for livestock and grain in the 19th century. The babyboom, increased automobile ownership, and establishment of better road systems that occurred after World War II catalyzed growth in Livingston County. As a result, the influence of agriculture began to diminish as land was transferred to suburban uses in a trend that continues today.

The City of Brighton, the largest population center in the subwatershed, is situated upon the four corners of Brighton, Genoa, Hamburg and Green Oak Townships in the southeast quadrant of Livingston County. The city was incorporated as a village in 1867 only later to become a city. Early growth centered near the Mill Pond and the Village's location along the Grand River Trail. Today, the City of Brighton is the second most populated among the two cities in Livingston County and its growth continues to be spurred today by the junction of two interstate expressways, US-23 and I-96.

According to the Livingston County Planning Department, in 2000 the Brighton Lake area had approximately 156,000 residents, an increase of 38,400 from 1990 and 97,000 from 1970 population levels. Eighty-five percent of the residents hold a high school degree while 20% have a bachelors degree or higher. The annual median household income in 2000 was estimated to be $49,910. The Michigan average in 1997 was $28,104 while the national average was $28,546. Ninety-seven percent of the population is Caucasian. The largest employment sectors in 2000 were service industries (30%), manufacturing (23%), and retail trade (16%).

2.2.2 Political Structure

The subwatershed lies within southeastern Livingston County and comprises portions of the municipalities Brighton, Genoa, Hamburg, and Hartland and the City of Brighton (Figure 1). A portion of southeast Oceola Township, which elected not to participate in this planning process, also falls within the subwatershed boundary.

Each jurisdiction is zoned and holds regularly scheduled meetings of township government bodies 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 jurisdictions have the power to formulate land management, land use and development policy, amongst other important activities.

Land and water regulation, management, and protection within the Kent Lake Subwatershed is the responsibility of the state, county, and local governments. Private residents undertake specific nonregulated actions such as yard maintenance, landscaping, and waste disposal on a daily basis.

In some cases, essential regulatory and enforcement responsibility for water quantity and quality regulation lies with the United States Environmental Protection Agency (USEPA) and MDEQ. However, county government assumes responsibility for carrying out certain state policies. For instance, in most cases the Office of the Drain Commissioner's Office of Livingston County

has the responsibility of enforcing 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. Local governments may also administer this program. Public road maintenance and road drainage in each township is the responsibility of the Livingston County Road Commission.

Although state and county governments take an active role in many local policies, local governments at the city, village, and township level take a significant leadership role in land and water management by passing and enforcing safeguards that can be more protective than state laws. Working under numerous established procedures, local governments may enact ordinances to control stormwater runoff and soil erosion and sedimentation, protect sensitive habitats such as wetlands and woodlands, establish watershed friendly development standards and lawn care and landscaping practices and so forth. Under these circumstances the local government oversees enforcement.

2.2.3 Land Use Trends

Grasslands of oak barrens and openings and forests of several species of oaks, beeches, and maples dominated the landscape of the Brighton Lake Subwatershed before it was settled by permanent residents, according to Michigan Resource Information System (MIRIS) Land Cover. Multiple types of nontidal wetlands, such as emergent and forested, could also be found throughout the landscape (Figure 2).

Upon permanent settlement, the land began to be used for human benefit. Initial activities on the land centered on the transformation of grasslands for agricultural production and the use of forested areas for wood and wood by-products. By 1995, SEMCOG aerial photographic data indicates that the landscape of the subwatershed had changed significantly (Figure 3). Permanent mixed density residential, agriculture, and grass and shrublands dominated the landscaped. Forested lands, grasslands, and to a lesser extent wetlands experienced moderate to significant reductions in coverage as the area developed in the mid 1800s to late 1900s.

Land use data after 1995 are not available to discuss more current land use conditions of the subwatershed. However, future land use and impervious rates can be predicted. Utilization of current zoning land use codes and maps and their associated imperviousness rates from the

Figure 2. Brighton Lake Subwatershed Pre-settlement Land Use

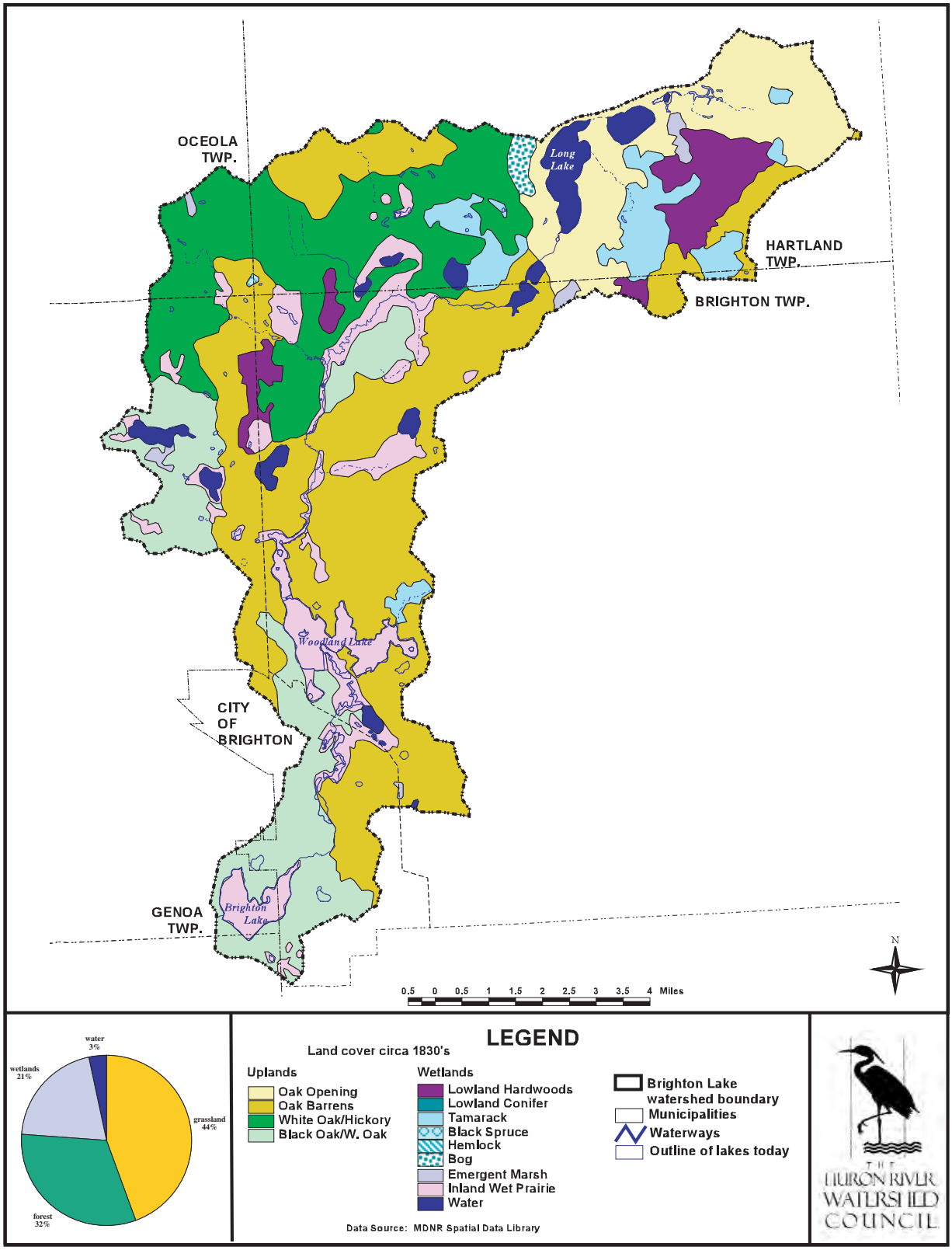


Figure 3. Brighton Lake Subwatershed 1995 Land Use

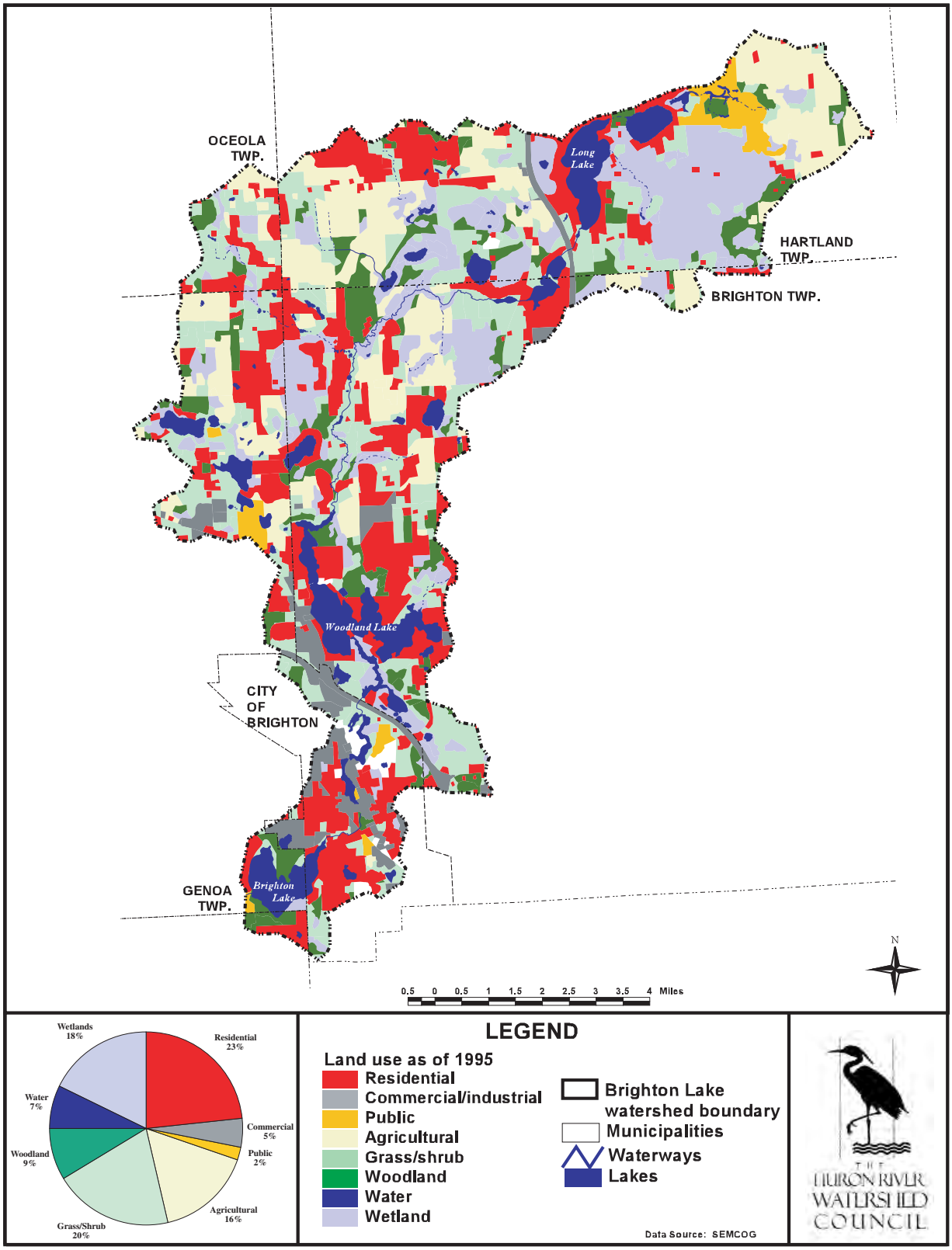
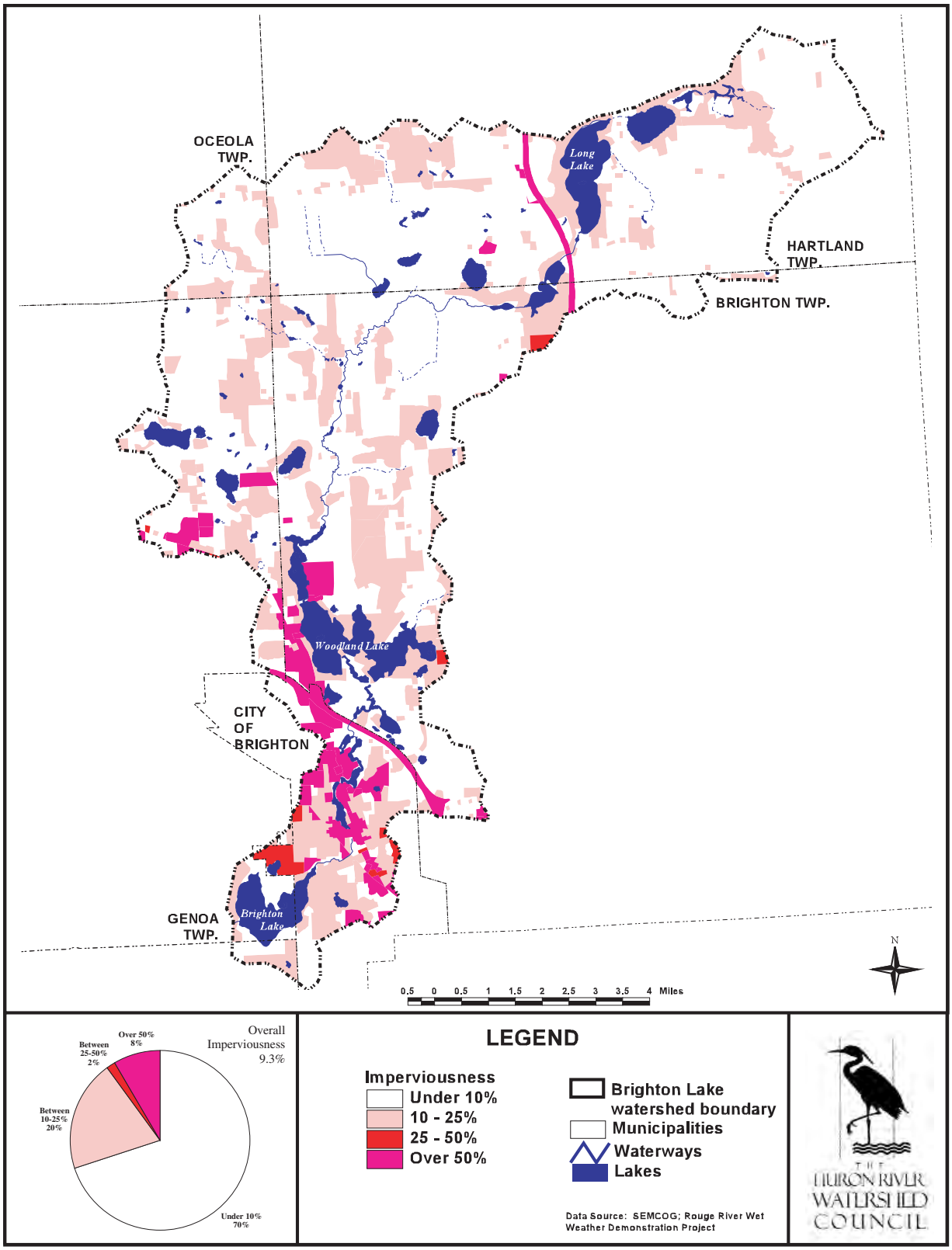


Figure 4. Brighton Lake Subwatershed 1995 Imperviousness



Rouge River Project can be used to predict potential future land use and impervious conditions of the subwatershed. Such analysis is often referred to as a "build-out" analysis as it establishes a snapshot of the land use circumstances that may exist when all lands meet zoning codes. Thus, such analysis is considered the ultimate build-out scenario. Such analysis predicts that the subwatershed will be 63% residential, 8% commercial, 0% native shrub or grassland, 0% agriculture, and 0% native woodland. Remaining land will be either public lands or wetlands (Figures 5 and 6).

2.2.4 Imperviousness of the Subwatershed

When native open spaces and features are converted to residential, commercial, and industrial land uses, the result is an increase in the impervious surfaces. Roads, parking lots, rooftops, and to a lesser degree managed lawns, all add to the amount of these surfaces in a subwatershed. Many of these can be directly connected—areas that drain directly to a waterbody—without the benefit of water quality improving treatment such as detention or infiltration.

The amount of impervious surface in a subwatershed is directly related to its water quality. It is now thoroughly documented that, as the amount of these surfaces increases in a subwatershed, the velocity, volume, and pollution of surface runoff also increases (Center for Watershed Protection, 2000). Subsequently, flooding, erosion, and pollutant loads in receiving waters also tend to increase while groundwater recharge areas and water tables decline, streambeds and flows are altered, and aquatic habitat is lost.

As of 1995, SEMCOG aerial photographic data indicates the Brighton Lake Subwatershed imperviousness rate was approximately 9.3% (Figure 4). Research indicates that water quality degradation is first notable as impervious surfaces in a subwatershed achieves 10% of the landscape (Center for Watershed Protection, 2000). In our area, however, such water quality degradation has been observed at imperviousness rates of only 8% (Wiley and Martin, 1999). When a subwatershed achieves this percentage, the impacts of incremental increases in surface runoff begin to affect the aquatic macroinvertebrate populations as well as fish species and subsequently recreational and property value of waterbodies.

Using SEMCOG master plan information from each community in the subwatershed, which can change over time, we can predict that when each land area meets its zoning code (i.e., build-out) the overall subwatershed imperviousness rate may double to approximately 25%. As indicated in Figure 3, those communities currently considered substantially built (e.g., City of Brighton) will see slight to moderate increases in imperviousness. However, currently less developed areas such as the Townships of Hartland, Brighton, and Genoa may experience substantial increases in imperviousness in the future (Figure 5 and 6).

Figure 5. Brighton Lake Subwatershed Build-Out Land Use

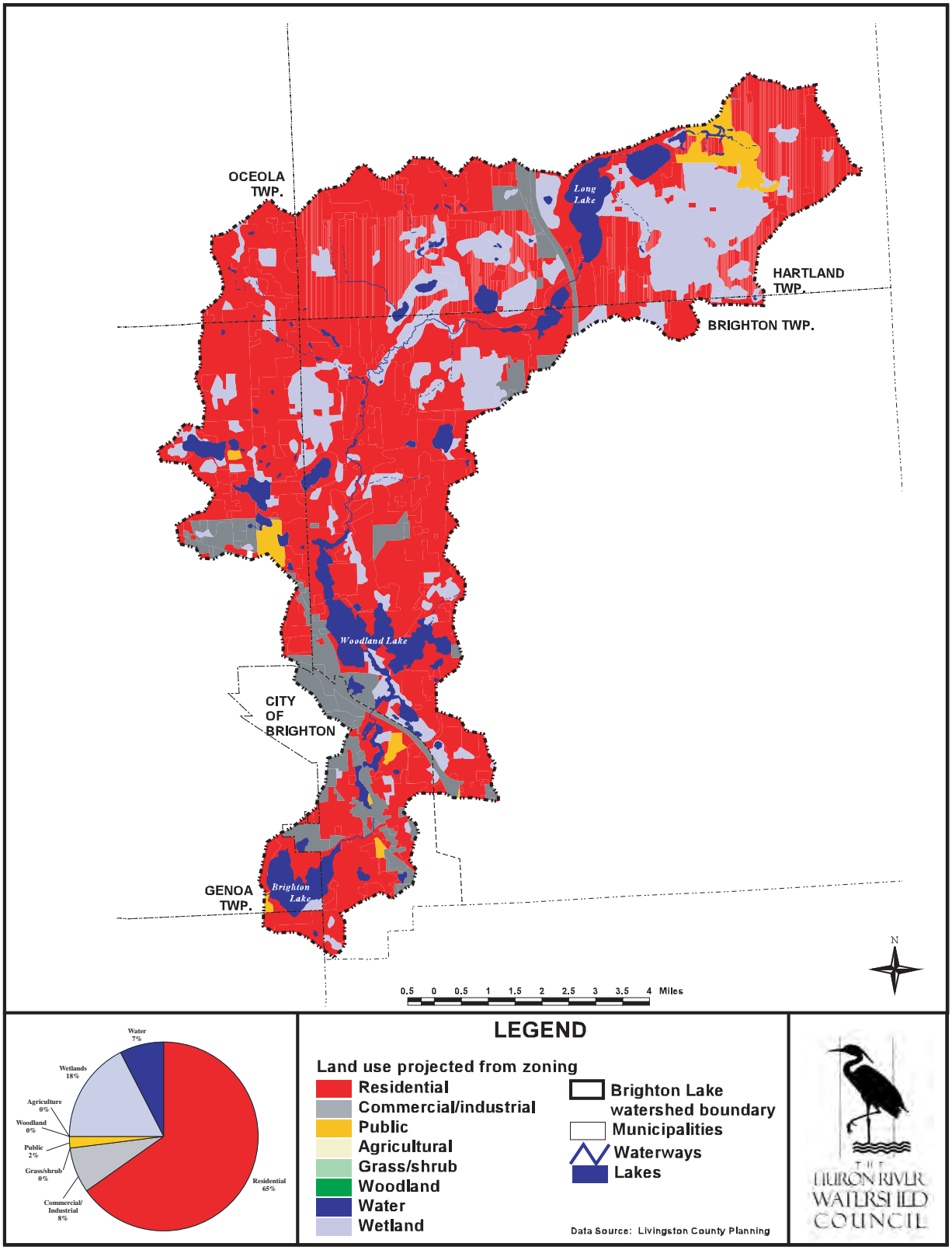
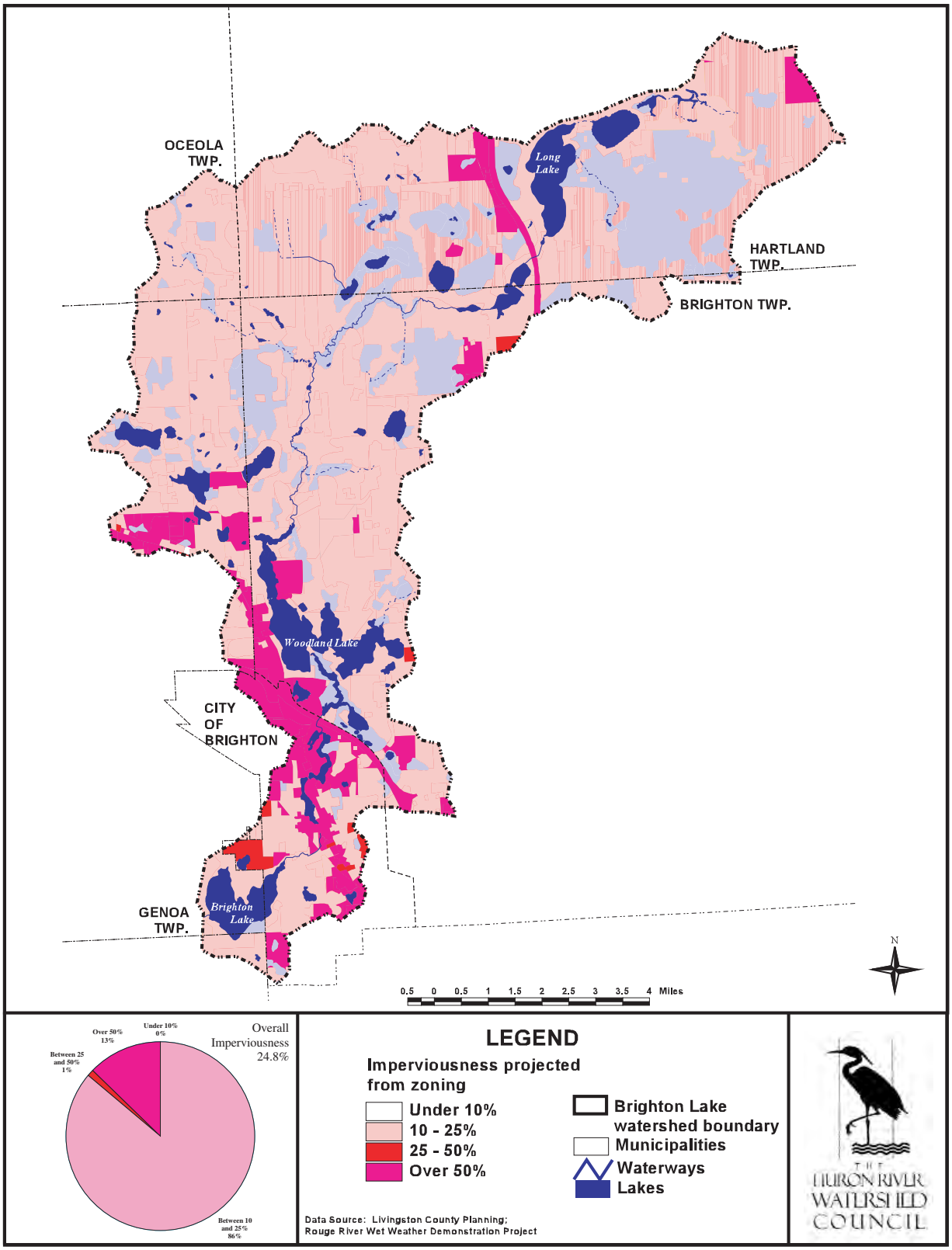


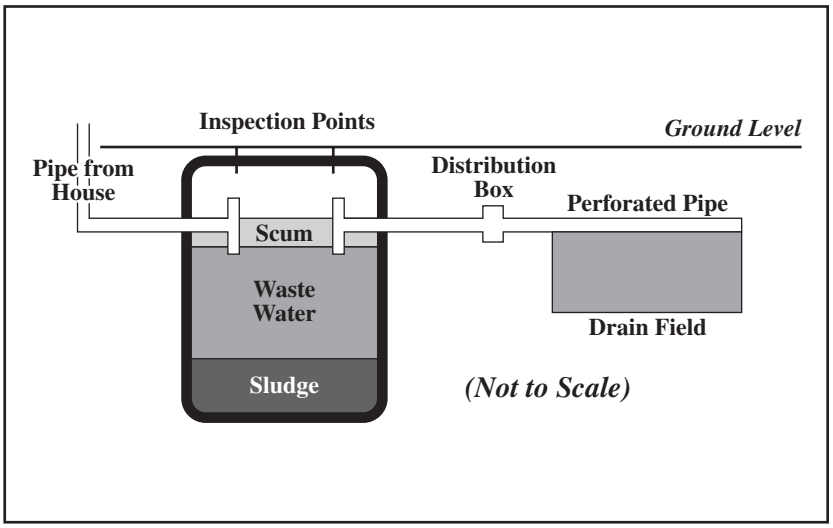
Figure 6. Brighton Lake Subwatershed Build-Out Imperviousness



Such increases in impervious rates threaten to have a critical impact on the quality of South Ore Creek, Brighton Lake, and the Huron River due to the aforementioned consequences of such surface. Therefore, significant efforts to mitigate such should be a priority in the corresponding communities.

2.2.5 Current Sewer Service Areas

The Brighton Lake Subwatershed has a diverse mix of households whose waste discharges are treated via municipally owned wastewater treatment plants or on-site decentralized wastewater systems (privately owned septic systems). Sanitary sewer systems rely on the connection of pipes from residential, commercial, and industrial sites that ultimately are received at a wastewater treatment plant where treatments are applied before discharge. Privately owned septic systems or septic tanks allow wastewater from a single, or sometimes multiple, entity to be treated via biological and infiltration processes.

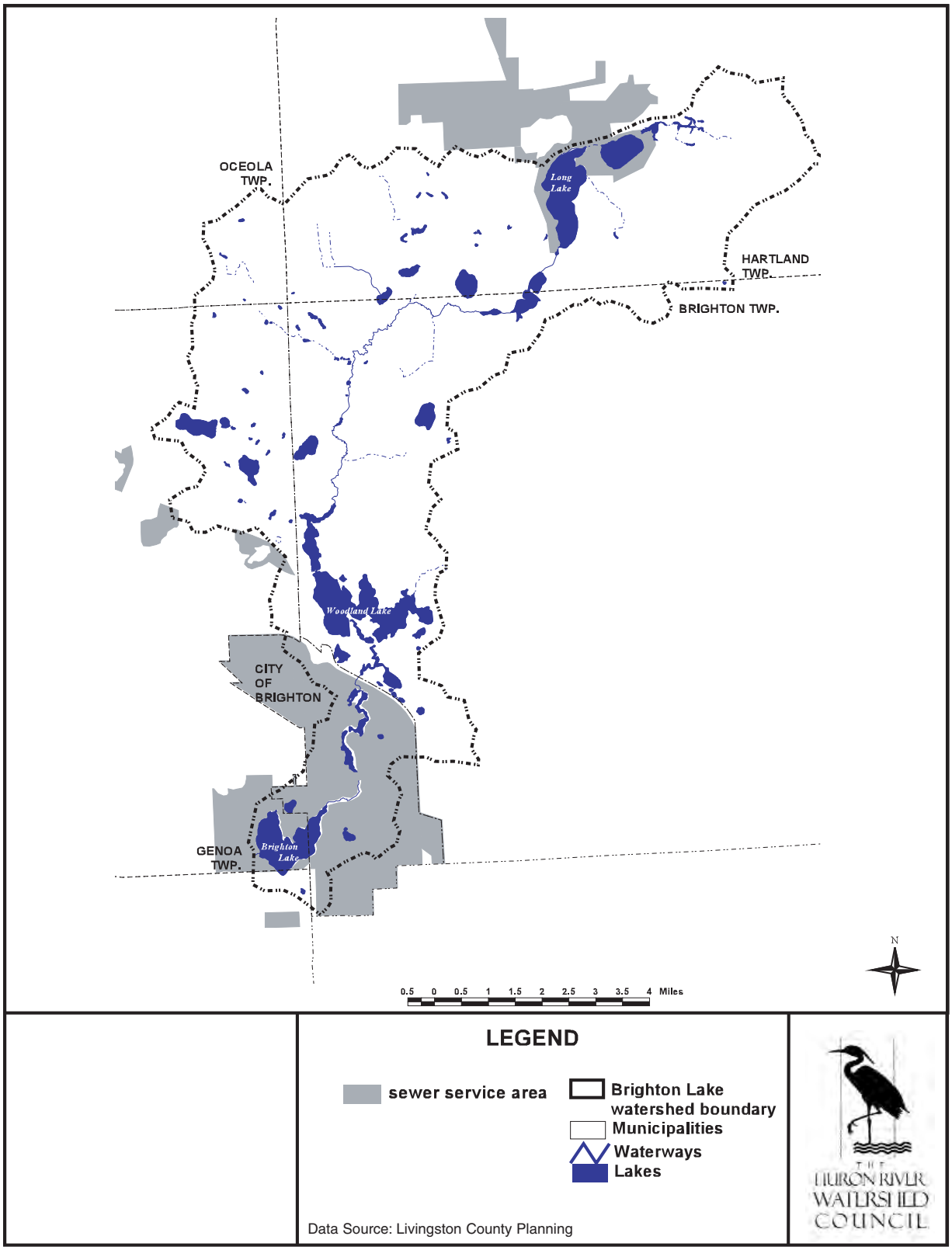


Both technologies are effective methods of wastewater treatment if maintained and operated properly; however, impairments still do occur. If either system is designed, constructed, or maintained improperly, it can be a significant source of water pollution and a threat to public health. As such, most county health departments regulate the design, installation, and repair of private septic systems; however, only a relatively small portion require regular maintenance and inspection to assure proper functioning of these systems (e.g., Washtenaw County, Michigan).

Sanitary sewer systems can also 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. Many county drain commissioners offices have active programs to identify and rectify such connections, such as the Drain Commissioner's Office of Oakland County's Illicit Discharge and Elimination Program (IDEP); however, this program is currently concentrated in the Rouge River Watershed.

In general, households served by sewers are located in the southern urbanized areas of the subwatershed while northern portions are typically served by septic systems (Figure 7). Overall, approximately 26% of households rely on sewer systems for waste treatment while the remaining 74% of households employ septic systems.

Figure 7. Current Sewer Service Areas of the Brighton Lake Subwatershed



Impaired or compromised septic systems can have a profound impact on the water quality in a subwatershed. By carrying nutrients (phosphorus and nitrogen), bacteria, medicinal and chemical agents, and other pollutants to waterbodies with little or no treatment, these systems can cause a loss of recreational value of water bodies because of the unhealthful conditions to humans (i.e., bacterial contamination) that result.

2.2.6 Existing Point Sources

No known or permitted surface water discharge point sources currently discharge to South Ore Creek upstream of Brighton Lake.

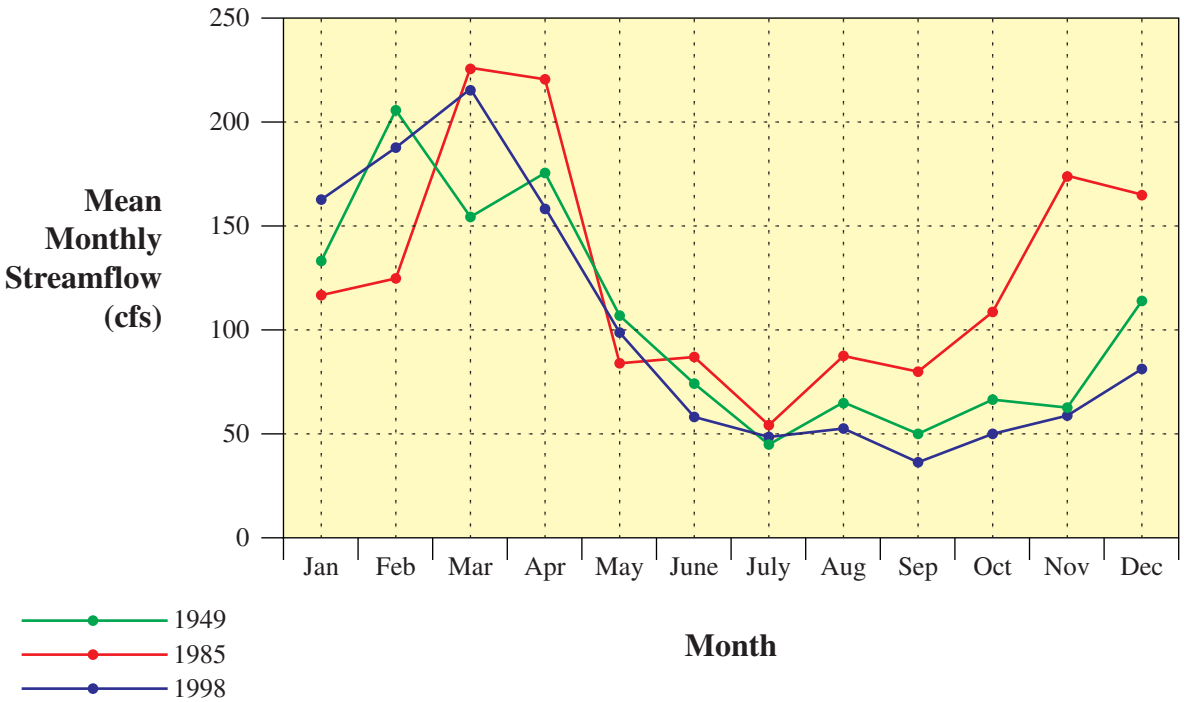
2.2.7 Hydrological Conditions

This region of the Huron River Watershed is blessed with one of the highest incidences of lakes in the United States. This unique attribute of the area results from the recessional moraines, till plains, and outwash deposits formed during the last ice age (Hay-Chmielewski, et. al., 1993). The resulting landscape harbors approximately 700 lakes, 126 of which are greater than five acres in size with 57 greater than 20 acres in size.

The mean monthly streamflow in cubic feet per second (ft3/sec), according to the U.S. Geological Survey (USGS) gage station at Huron River at Milford (#04170000), is presented in Figure 8. The information presented represents the monthly mean streamflow for three typical rainfall years of 1949, 1985, and 1998. The data represents a drainage area of 132 square miles or one-fifth of the Brighton Lake Subwatershed. As illustrated by Figure 8, in general, flow conditions of the subwatershed have remained relatively similar over the last 60 years although specific year flow conditions may vary. One hypothesized reason for this observation is the large number of lakes, wetlands, and impoundments in the subwatershed that act as stormwater and flood control storage.

Yet as the landscape is converted from native to suburbanized uses, the incidence of surface water runoff and its impacts tend to increase considerably (Table 1). Correspondingly, groundwater recharge tends to decrease when impervious surfaces proliferate. Groundwater tends to supply cool water to streams, lakes, and wetlands during dry periods such as late summer. However when groundwater discharges to the surface decrease, streams tend to “dry-up”, lake levels decrease, and dependant aquatic organisms are deprived of oxygen rich water, all of which has a negative impact on aesthetic and recreational value.

Figure 8. Mean Monthly Streamflow for Three Typical Hydrologic Years for the USGS Gage Station # 04170000, Huron River at Milford (cfs = cubic feet per second).



Extensive flow data for South Ore Creek was limited to the findings of Alexander (1999a) who observed an annual average flow of 11 cfs with a range of 6.7 in September 1998 to 29 in April 1998.

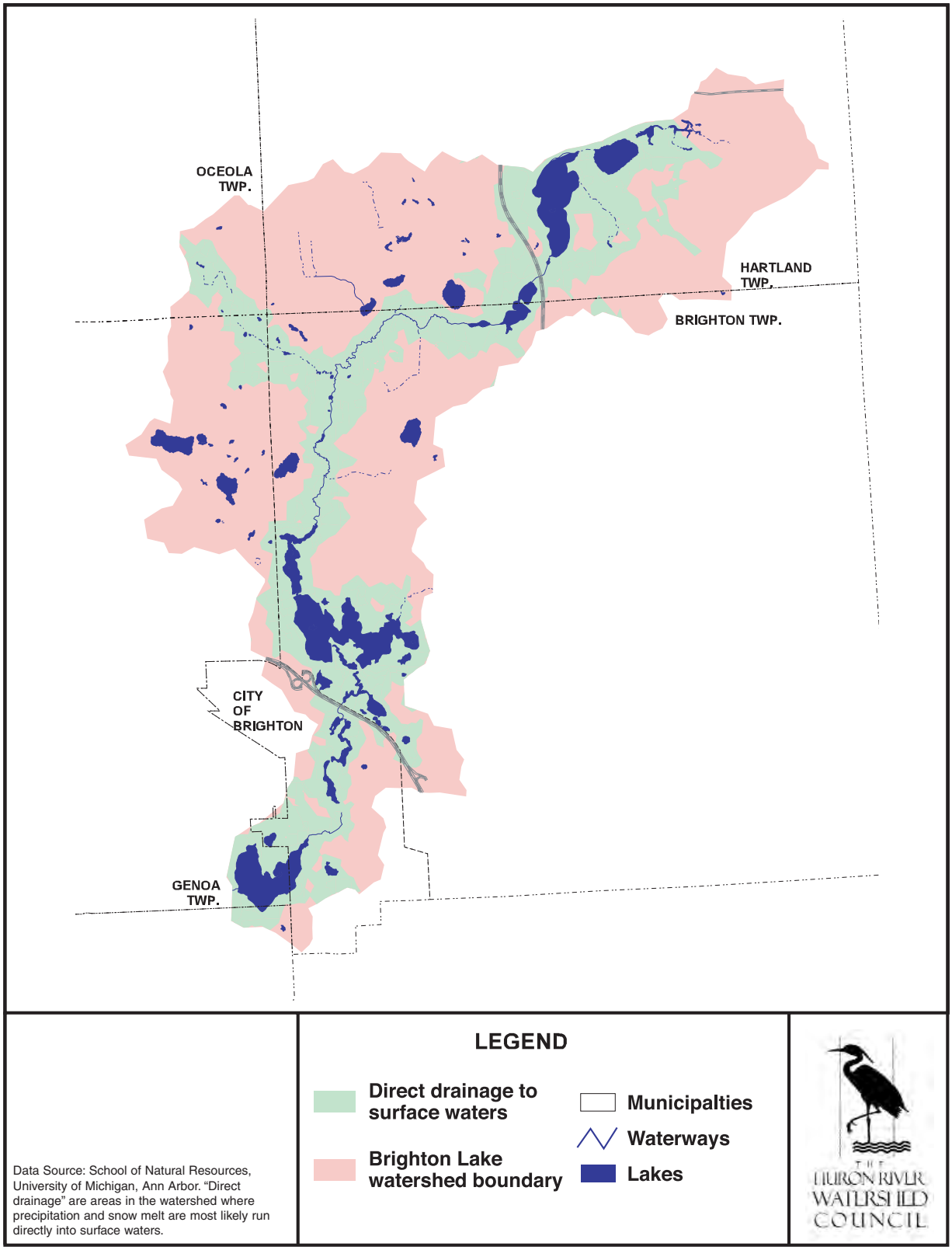
Table 1. Impacts of Development on Hydrological Conditions (source: MOSAG, 2001).

	Storm Frequency (yr)	*24-hour Rainfall (in)*	*Estimated Runoff (in)*	*Runoff as Percentage of Rainfall*
Half-Acre Undeveloped Forest	2	2.8	0.14	5
	10	4.0	0.53	13
	100	5.0	1.4	24
Half-Acre Residential	2	2.8	0.60	21
	10	4.0	1.33	33
	100	5.0	2.64	66

Other subwatershed ambient factors important in reviewing and understanding the hydrology of the subwatershed are the direct surface water drainage, Darcy Law, the depth to groundwater, and soil permeability maps that reflect either the potential passage or infiltration potential of surface or groundwater in the subwatershed (Figures 9, 10, and 11).

The Darcy Law map utilizes its namesake's hypothesis to predict the probability of groundwater recharge areas in subwatersheds. As illustrated in Figure 10, the Darcy Law predicts that, in general, areas adjacent to the river and tributary streams hold the most probability of being an area of groundwater recharge. Figures 11 and 12 illustrate the depth to groundwater and soil permeability characteristics for the subwatershed. Such information is useful when considering the applicability of certain stormwater control structures (i.e. best management practices or BMPs), especially infiltration-based, and the appropriateness of certain development proposals that may required added water quality precautions within the subwatershed (i.e., gas stations, chemical storage facilities, etc.).

Figure 9. Direct Drainage Area of the Brighton Lake Subwatershed



Data Source: School of Natural Resources, University of Michigan, Ann Arbor. "Direct drainage" are areas in the watershed where precipitation and snow melt are most likely run directly into surface waters.

Figure 10. Probability of Groundwater Recharge Areas for the Brighton Lake Subwatershed

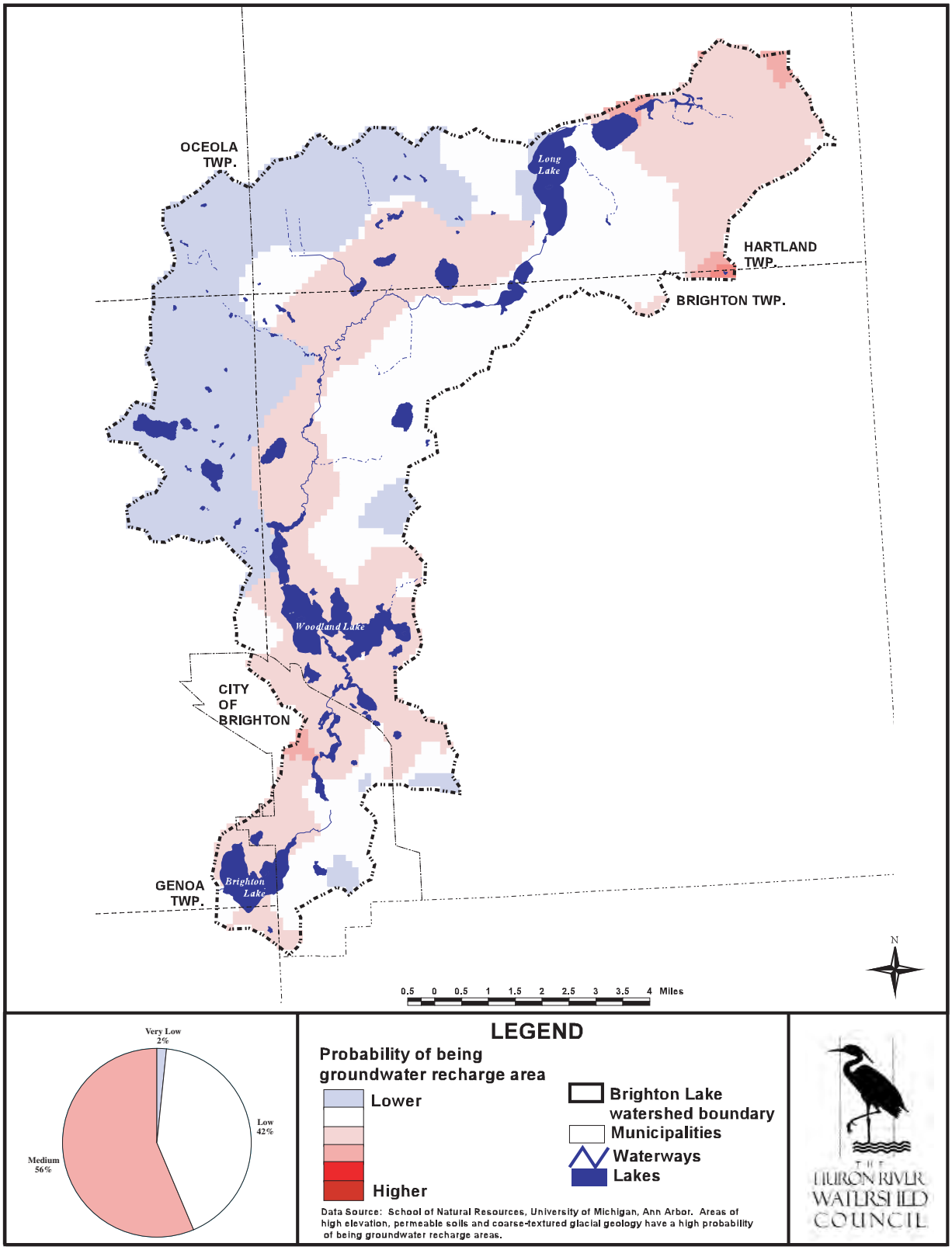


Figure 11. Depth to Water Table for the Brighton Lake Subwatershed

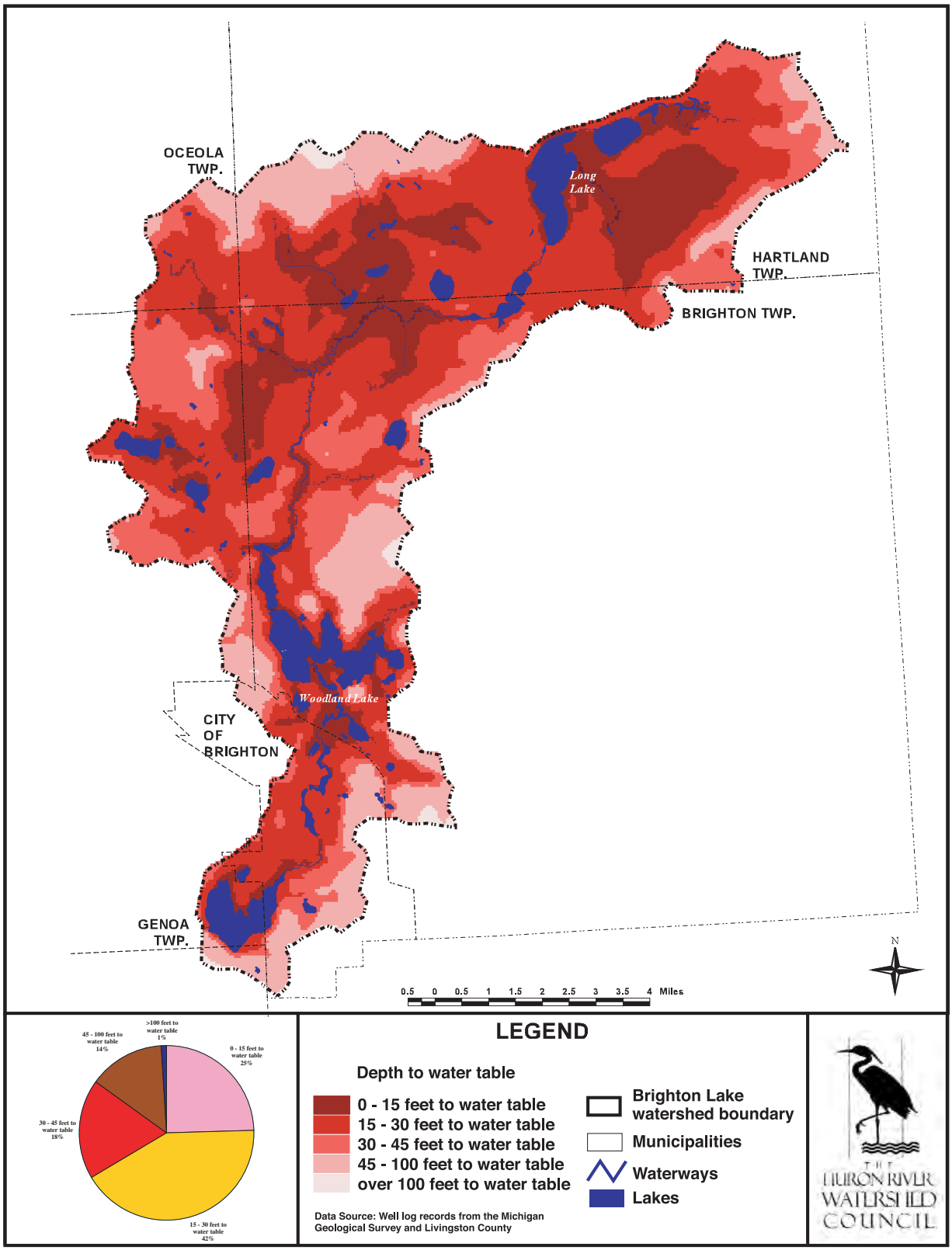
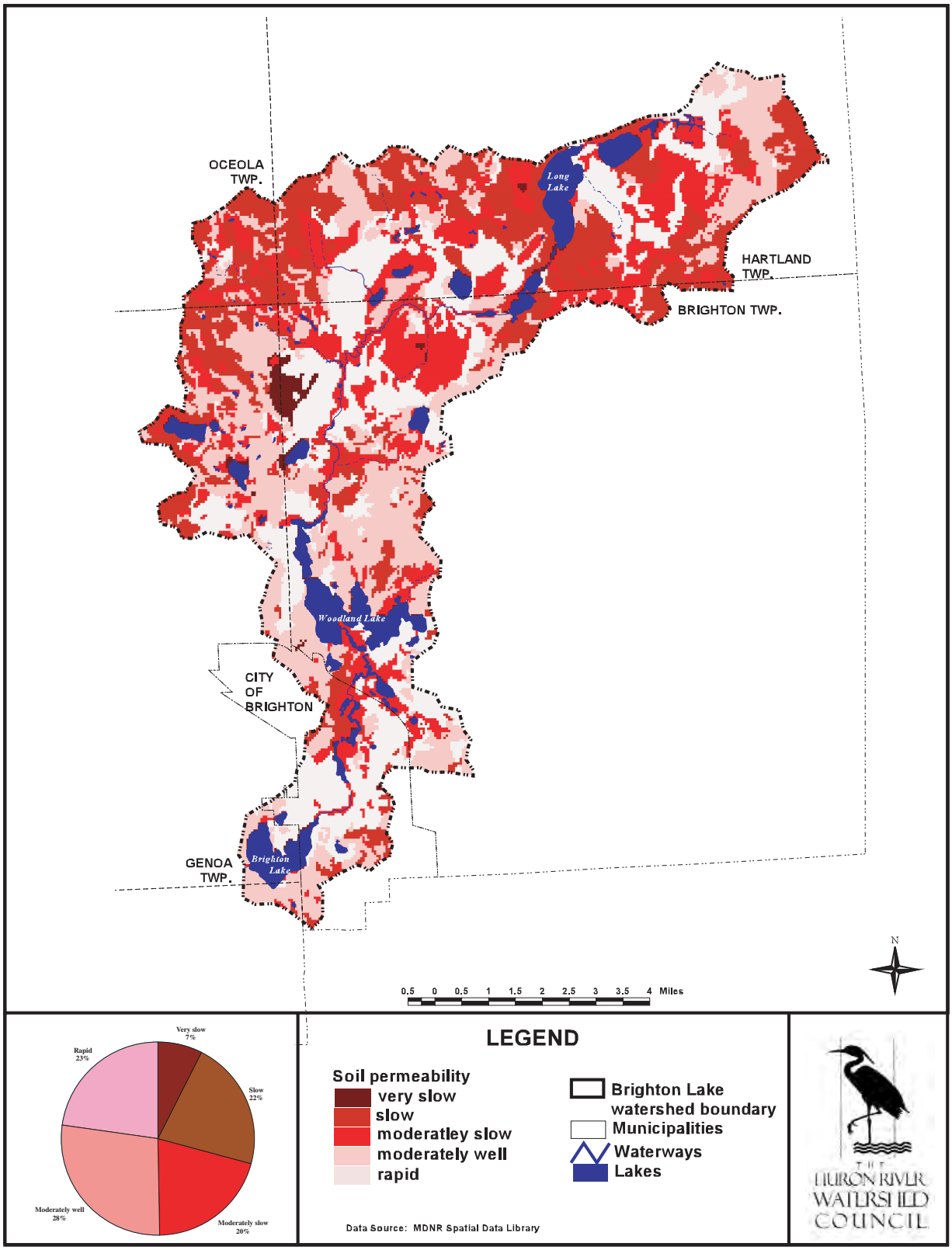


Figure 12. Soil Permeability Properties of the Brighton Lake Subwatershed



Another attribute contributing to the overall hydrological condition of the Brighton Lake Subwatershed is the presence of dams or impoundments. According to the U.S. Environmental Protection Agency (EPA) BASINS program, four of the 96 identifiable dams or impoundments in the Huron River Watershed are located within the subwatershed (Figure 13 and Table 2).

Table 2. Name, location, and Waterway of the Dams of the Brighton Lake Sub-watershed.

Dam Name	Human Hazard	Community	Waterway
Long Lake	*N/A*	*Hartland*	*South Ore Creek*
Woodland Lake	*N/A*	*Brighton*	*South Ore Creek*
Mill Pond	*N/A*	*City of Brighton*	*South Ore Creek*
Brighton Lake	*N/A*	*Genoa/Hamburg*	*South Ore Creek*

2.2.8 Geomorphology and Soils

The majority of the soils in the subwatershed are poorly drained organic soils of moderately course texture of outwash plain. The Carisle-Houghton-Gilford associations predominant; however, other soil associations are also present within the Subwatershed, specifically Miami-Conover in Hartland Township and Fox-Boyer-Oshtemo in Brighton Township. Both associations exhibit moderate drainage (USDA, 1974).

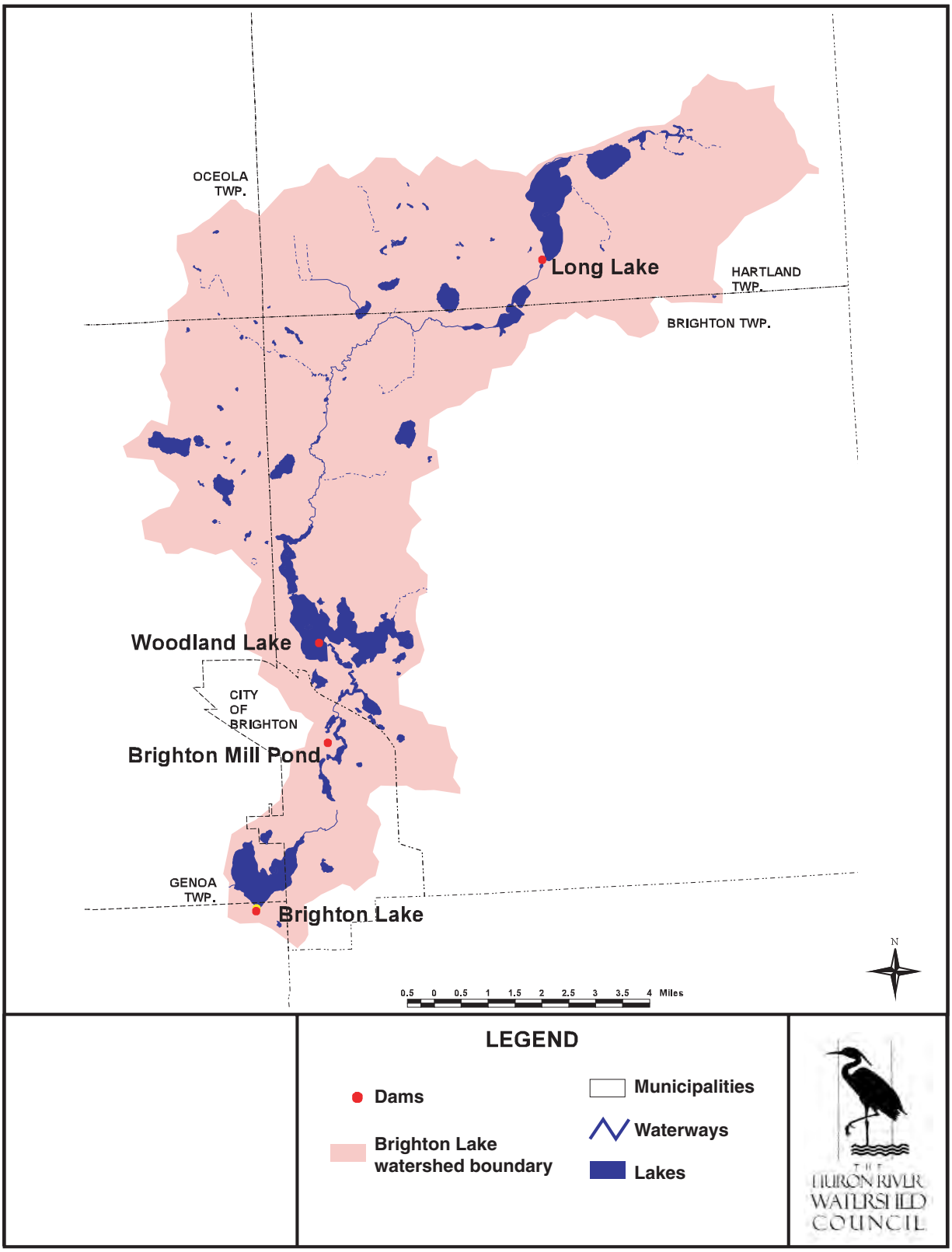
From its headwaters northeast of Maxfield Lake to Brighton Lake, South Ore Creek is a narrow channel of mostly run habitat and silty substrates. Substrate consists mostly of sand, gravel and rubble substrates. Fish cover, in parts, is sparse and the stream is dominated by run habitat with very few pools or riffles. Portions of the creek exhibit the narrowing effects of historical flow alteration (e.g., dredging) while other areas show widening effects due to fluctuating flow or sedimentation (Hay-Chmielewski, et. al., 1993).

The geomorphology and habitat of the South Ore Creek appeared fairly stable. However, slight evidence of erratic flows, undercut and eroding streambanks, and sedimentation was observed. Such observations were particularly evident in the portion of the creek between the Mill Pond in the City of Brighton and Brighton Lake.

2.3 Brighton Lake

Of 96 dams or impoundments in the Huron River Watershed, four lie within the Brighton Lake Subwatershed. These structures currently act as recreational and waterfront housing enhancement structures within the entire subwatershed. One of the four, the Brighton Lake impoundment, which was built in 1929, forms the 158-acre Brighton Lake and is classified as a privately owned recreational enhancement structure. The lake has an average depth of 2.05 meters and a detention time of 40 days (Alexander, 1999a).

Figure 13. Dams in the Brighton Lake Subwatershed



The Boy Scouts historically used the lake primarily as a recreational area. However, since area population increased and subsequent land cover alterations began to accelerate in the late 1950s, the lake has become an amenity for the increasing number of suburban homeowners who use the lake for boating, fishing, and swimming, as well as property value enhancement.

2.4 Key Natural Area Protection Opportunities

The extent of stewardship of sensitive open spaces and native habitats can directly impact the quality of life and quality of water in a subwatershed.

- ***Impoundment's forming Maxfield, Long, and Woodland Lakes and the Mill Pond:*** The subwatershed is blessed with several areas that act as property value and recreational amenities. Thus, the water quality of these areas is crucial to these uses as well as supporting healthy fish and other aquatic species. Protecting and restoring these lakes is expected to bring improved aesthetics and public understanding and support for restoration activities throughout the subwatershed.

- ***South Ore Creek and its Riparian Corridor:*** The drainage area of South Ore Creek forms the subwatershed of Brighton Lake. Therefore, its health is invariably linked to the health of Brighton Lake and the Huron River. An undisturbed vegetated riparian corridor (i.e., land adjacent to the creek) provides shading and cooling of water, floodwater storage and property protection, organic debris to feed aquatic organisms, habitat for wildlife, band stabilization via root structures, and a buffer for pollutants and sediments from surface runoff. Based on inventories of the area, the riparian corridor of South Ore Creek is currently in fair condition, but is becoming increasingly mowed lawn. Local natural feature setback or buffer ordinances in some communities are serving to protect these important systems, yet older development and many new developments, are putting these areas at risk. Maintaining and restoring the creek will require thoughtful planning of development and stormwater management practices as well as preservation of priority natural areas.

- ***Wetlands in the Brighton Lake Subwatershed:*** Since pre-settlement, many acres of wetlands have been lost in the subwatershed, either by natural processes or by agriculture and development. Studies suggest that half of the State's inland wetlands have been lost, and 70% of the coastal wetlands no longer exist (MLUI, 1999), and an estimated 500 acres of wetlands are filled

statewide each year. While wetland loss rates currently in the Brighton Lake Subwatershed are undocumented, the Huron River Watershed has lost approximately 66% of its wetlands to human activities (HRWC, unpublished). According to State law, only wetlands over five acres in size or those contiguous to or within 500 feet of a waterbody are protected by the State. Smaller wetlands, and those not connected or not within 500 feet to a waterbody are not given State oversight. These wetlands can be filled, according to State law, unless there is a local wetland protection ordinance. Large and small wetlands provide numerous benefits to humans. In fact, smaller wetlands often provide more beneficial functions than do larger ones (HRWC, 1999). Six benefits provided by wetlands are floral and wildlife habitat (aesthetics), fish and amphibian habitat, flood water storage, nonpoint source pollution abatement, shoreline and stream bank protection, and recreational enhancement. All wetlands, especially those along South Ore Creek and its waterbodies, need to be protected. There are many recommendations in this plan that guide the protection of these areas including maintaining connections between waterways, not mowing or disturbing native vegetation, removal of invasive species, limiting pesticide and fertilizer use near waterbodies, and creating no or limited-development buffer zones or overlay districts along South Ore Creek.

- ***Woodlands:*** Like wetlands, woodlands (forests) provide numerous benefits to water quality, groundwater recharge, water quantity regulation, and wildlife habitat. Wooded areas improve water quality, in part, by cooling and shading rainfall and stormwater runoff. For instance, as the leaf and trunk surface areas and leaf litter captures the water, they help disperse heat while increasing infiltration and groundwater recharge. Wooded areas also have great aesthetic value.

2.5 Programs of Water Quality Significance

2.5.1 National Pollutant Discharge Elimination System Phase II

USEPA is implementing the Phase II Storm Water Regulations that require approximately 125 Southeast Michigan municipalities to obtain a NPDES permit by March 2003 to cover their storm water discharges. In the Brighton Lake Subwatershed, the Townships of Brighton, Genoa, Hamburg, and Hartland and the City of Brighton will need to obtain a permit by March 2003.

The MDEQ is offering two distinct permit coverage options—Jurisdictional and Watershed-based General Permit Coverage. The Jurisdictional permit covers the standard EPA six minimum measures. The Watershed-based permit covers the six minimum measures through cooperative watershed planning, action planning that is customized to the characteristics and programs applicable to that watershed, as well as strong components of public education and illicit discharge elimination. This program involves multiple communities in meeting the requirements rather than making the jurisdiction responsible for all minimum measures and planning.

As mentioned above, the Townships of Brighton, Genoa, Hamburg, and Hartland and the City of Brighton will need to obtain a permit by March 2003. However, as population growth continues throughout the region it is expected that all communities will be required to conform to such regulations in the future. Therefore, it is intended that this planning process to improve and protect the water quality of Brighton Lake will sufficiently address the MDEQ General Permit requirements for Federal Phase II Storm Water Regulations. However, expansion or revision of activities and text in this plan to reflect specific jurisdictional conditions will be required.

2.5.2 Total Maximum Daily Load Program and Brighton Lake

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a waterbody can receive or assimilate without resulting in a failure, or threatened failure, to meet state, territory, or tribally set quantitative or qualitative water quality standards, and an allocation of that acceptable amount of a pollutant's sources (e.g., point sources and nonpoint sources).

Specifically, a TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonable variation in water quality (USEPA, 2000).

2.5.2.1 Federal TMDL Program

Section 303(d) of the Clean Water Act provides that states, territories, and authorized tribes are to list waters for which technology-based limits alone do not ensure attainment of water quality standards. While this section of the Clean Water Act has required TMDLs since 1972, states, territories, authorized tribes, and the USEPA have not taken the initiative to establish them until recently. As a result, beginning in the early to mid-1990s, numerous citizen organizations brought legal actions against the USEPA seeking the listing of impaired waters and establishment of TMDLs. To date, there have been about 40 legal actions in 38 states. The resulting court orders or consent decrees call for the agency to ensure that TMDLs are established, either by the state or by the USEPA (USEPA, 2000).

Beginning in 1992, states, territories, and authorized tribes were required to submit their list of impaired waters to the USEPA each even-numbered year and to include a set of priority rankings for all listed waters, taking into account the severity of the pollution and the intended uses of the waters.

Further information regarding regulations for implementing section 303(d) are codified in the Water Quality Planning and Management Regulations at 40 CFR Part 130, specifically sections 130.2, 130.7, and 130.10.

2.5.2.2 Michigan TMDL Program

The Michigan Natural Resources and Environmental Protection Act (NREPA), Public Act 451 of 1994, authorizes the Michigan Department of Environmental Quality (MDEQ), Great Lakes and Environmental Assessment Section (GLEAS), to develop Water Quality Standards (WQS) to protect the quality of state waters. The purposes of the Water Quality Standards are to:

(1) establish water quality requirements for the Great Lakes, their connecting waterways, and all other surface waters of the state, (2) protect public health and welfare, (3) enhance and maintain the quality of water, (4) protect the state's natural resources, and (5) carry out the aims of the federal Clean Water Act (CWA) and the Great Lakes Water Quality Agreement between the U.S. and Canada. These standards are used to set the minimum water quality requirements for state waters.

Michigan's WQS for surface waters are based on uses designated by the state and are protected accordingly. These designated uses are: agricultural, industrial, and public water supply, navigation, warmwater fishery, coldwater fishery, partial body contact recreation, total body contact recreation between May 1 and October 31, and use by aquatic life and wildlife. Fishable waters are those where the protection and propagation of fish, shellfish, and wildlife are guaranteed. Swimmable waters are those that are safe for recreation on and in the water.

After it designates the uses of its waters and develops water quality requirements to protect them, the state monitors surface water quality to determine the adequacy of point source pollution controls that discharge to the waters. For those surface waters that do not or are not expected to meet the requirements with technology-based point source controls alone, the CWA requires the state to develop additional water quality-based requirements, called a TMDL, to restore and protect water quality.

To gain a picture of the water quality of the state, MDEQ evaluates each watershed in the state and National Pollutant Discharge Elimination System (NPDES) permits once every five years. Monitoring of water quality in a watershed generally occurs two years prior to reissuing NPDES permits and NPDES permits. All waterbodies in a watershed are assessed at the same time. In addition, the monitoring program identifies those waters in nonattainment and/or threatened to be in nonattainment of designated uses.

Nonattainment waterbodies either contain contaminant concentrations that exceed the state water quality values or are expected to exceed those values with the application of technology-based point source controls. Similarly, threatened waterbodies are those that currently have contaminant levels that do not exceed the maximum acceptable concentrations, but are expected to exceed them before April 2000. The list of Michigan waterbodies identified as in nonattainment or threatened is the basis for the TMDL program.

The draft 2002 state report of Impaired Waters, called the Michigan 303(d) Report, identifies 21 waters in the Huron River Watershed which do not meet water quality standards, 10 of which are in the upper Huron. This list is available to the public from MDEQ.

Table 3. Impaired Waters of the upper Huron River Watershed, Livingston and Oakland Counties. (Source: Draft 2002 Michigan Section 303(d) Report. MI/DEQ/SWQ-02/013)

Waterbody	Pollutant	TMDL Developed and Approved	ID
Bishop Lake	*Mercury*	*No*	*MI061206N-1998*
Brighton Lake	*Phosphorus*	*Yes*	*MI061205O-1998*
Horseshoe Lake Drain	*Biological Impairment*	*No*	*MI061205R-1998*
Kent Lake	*Phosphorus; Polychlorinated Biphenyl*	*Yes; No*	*MI061206D-1998*
Limekiln Lake	*Phosphorus*	*No*	*MI061205T-1998*
Norton Creek	*Biological Impairment*	*No*	*MI061206M-1998*
Ore Lake	*Phosphorus*	*Yes*	*MI061205S-1998*
Pontiac Lake	*Polychlorinated Biphenyl*	*No*	*MI061206G-2000*
Strawberry Lake	*Phosphorus*	*Yes*	*MI061205U-1998*
Whitmore Lake	*Polychlorinated Biphenyl*	*No*	*MI061205H-2000*

2.5.2.3 Total Maximum Daily Load for Brighton Lake

In April of 1998, a 12-month phosphorus loading analysis was initiated by the MDEQ to investigate the water quality of Brighton Lake and its upstream sources. The analysis showed that Brighton Lake was threatened to fail to meet water quality standards due to phosphorus enrichment. Based on water quality sampling and accepted mathematical models, a phosphorus TMDL of 30 µg/L for Brighton Lake was established. According to MDEQ, this value should assure the attainment of water quality standards for the lake in addition to meeting the requirements of Water Quality Standard R 323.1060(2) which states "nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi, or bacteria which are or may become injurious to the designated uses of the waters of the state."

Based on three years of scheduled monitoring and the employment of the Reckow methodology of lake trophic assessment, the TMDL estimates that the current annual phosphorus load is 973 pounds/year, all of which is from nonpoint sources. Therefore, MDEQ prescribes a 10% reduction (approximately1000 pounds/year) of nonpoint source phosphorus loading to the lake to meet the TMDL.

The phosphorus TMDL for Brighton Lake was approved by the USEPA in March 2000. See Appendix A for the federally approved Brighton Lake TMDL.

2.5.3 City of Brighton Wellhead Protection Initiative

Wellhead protection is a planning and management approach designed to protect public groundwater supply systems from contamination. The City of Brighton plans to embark on such an initiative for areas within their jurisdiction in 2002 with the objective to protect public water supply wells by controlling or managing all potential sources of contamination within a designated area surrounding the well or well field.

The wellhead protection area is that part of the landscape that contributes water, and therefore potential contaminants, to the public water supply wells. An active wellhead protection program identifies areas that contribute water to public water supply wells, potential sources of contamination within those areas, and educates residents on developing best management practices that minimize threats to public water supplies.

The goals of the wellhead protection program are to complete a comprehensive groundwater protection plan that address each of the following elements:

1. Wellhead Protection Area Delineation for the Ten Year Capture Zone.
2. Identify and Inventory Potential Sources of Contamination
3. Develop Management Approaches for Wellhead Protection
4. Contingency Planning for a Water Supply Emergency
5. Sitting of New Wells for Population Growth or Replacement
6. Public Participation, Agency Duties, and Public Authority

This initiative upon completion will give the City the advantage of building a proactive rather than reactive program for groundwater protection.

CHAPTER 3. SUMMARY OF WATER QUALITY CONDITIONS

An effort was made to collect all readily available water quality data to establish a baseline comprehension of the water quality conditions of the subwatershed. This effort included, but was not limited to, requests to Workgroup members, lake associations, and researchers in the area. Numerous studies and datasets of relevance were obtained in this process; however, the information reviewed here cannot be considered comprehensive.

Prior to exploring readily available and relevant data, a general review of the study of lake water quality and typically variables of water quality concern is warranted.

3.1 Variables of Concern

In order to provide a perspective on the general water quality conditions of Brighton Lake and the Brighton Lake Subwatershed, readily available and relevant water quality data were complied and summarized. Not surprisingly, but disappointingly, spatial and temporal data for the subwatershed was found to be somewhat limited.

In each drainage area, four variables of concern were selected. These include total phosphorus, total nitrogen, suspended sediment, and dissolved oxygen. The selection of these variables was based, in part, on relevancy to water quality, lake trophic status, and availability of the data. Total phosphorus and total nitrogen loads were calculated where sufficient data existed. While the results are unreliable due to limited data sets, the results are informative on a comparative basis. In addition, other parameters typically of concern such as organic chemical concentrations are presented if available.

3.1.1 Phosphorus

Phosphorus and nitrogen are nutrients essential for the growth of all plants in waterbodies such as lakes. As mentioned previously, phosphorus is often considered the limiting nutrient (regulating growth) in the production of in-lake algae and is the main parameter of concern in regards to lake and impoundment eutrophication. By quantifying phosphorus concentration, a trophic status for a lake can be determined.

As phosphorus is naturally encountered in the environment typically bound to soil particles, stormwater runoff from activities that dislodge soil or introduce excess phosphorus, such as conversion of land to urban uses and over-fertilization of lawns, is frequently considered the major source of phosphorus contribution to waterbodies. Septic system failures, illicit connections, and permitted point sources are also cited as major routes of phosphorus introduction.

3.1.2 Nitrogen

Nitrogen is also considered essential in determining algae growth in lakes, and it is often found in waterbodies at higher concentrations than phosphorus. Consequently, nitrogen is often not considered the limiting nutrient to detrimental growth. Additionally, unlike phosphorus loading, nitrogen loading is often difficult to reduce due to the high water solubility of nitrogen. Therefore, concerns regarding nitrogen and its role in eutrophication are often considered sec-

ondary to phosphorus. Typical sources of nitrogen in surface waters include human and animal wastes, decomposing organic matter, and runoff from fertilizers. Poorly operated wastewater treatment plants, septic systems, and sewer pipeline leaks can also act as additional sources of nitrogen to waterbodies.

3.1.3 Suspended Sediment

Suspended sediment concentrations are often analyzed as a measure of water column clarity. As a broad measurement, suspended sediments include organic matter and inorganic matter such as sand, silt, and clay particles. Suspended sediments are often of water quality concern because they tend to carry adsorbed phosphorus and to increase biological oxygen demand, and hence reduce dissolved oxygen levels, in waterbodies. Sources of suspended solids include, but are not limited to, runoff from disturbed land (e.g., construction activities and impervious surfaces), certain illicit discharges, poorly operating wastewater treatment plants, and erosion of stream banks.

3.1.4 Dissolved Oxygen

Reduced levels of dissolved oxygen (DO) are often detected in waters where eutrophication is present. This observation is due to the fact that nuisance algae blooms and excessive plant growth utilize large amounts of DO for respiration. Because DO in surface waters is important to support all aquatic life, sufficient DO levels are vital to sustaining desirable fish, plant, and macroinvertebrate species. In addition, suppressed levels of DO in bottom layers of lakes tend to act as a catalyst for the release of sediment bound phosphorus, hydrogen sulfide, metals, and ammonia into the aqueous phase (USEPA, 2000). Typically, DO levels greater than 8 mg/L indicate adequate conditions (Sawyer, et. al., 1994).

Table 4 presents typical pollutant concentrations from stormwater runoff in southeast Michigan. As one would assume and as indicated by the table, the suburban uses of residential, commercial, and roads have noticeably higher concentrations of pollutants compared to managed and unmanaged open space.

Table 4. Pollutant Concentrations per Land Use in Runoff from a Typical Rain Event. (Cave, K., et. al., 1994)

Land Use	Total Phosphorus	Total Phosphorus	Total Suspended Sediment	Biological Oxygen Demand	Lead
Road	*0.43*	*1.82*	*141*	*24*	*0.014*
Commercial	*0.33*	*1.74*	*77*	*21*	*0.049*
Low-Density Residential	*0.52*	*3.32*	*70*	*38*	*0.057*
High-Density Residential	*0.24*	*1.17*	*97*	*14*	*0.041*
Forest	*0.11*	*0.94*	*51*	*3*	*0.000*
Urban Open	*0.11*	*0.94*	*51*	*3*	*0.014*
Pasture/Agriculture	*0.37*	*1.92*	*145*	*3*	*0.000*

3.1.5 Other Water Quality Reflective Data

While gathering and reviewing historical water quality data, several relevant and informative datasets and reports on variables other than those reviewed above were collected and are reviewed below. These include such studies as those on stream macroinvertebrate or fish population community assessments, organic contamination, and bacteriological surveys.

3.2 General Limnology

Prior to exploring reported water quality data and studies for the subwatershed, a general review of the limnology—the study of lake conditions—is warranted.

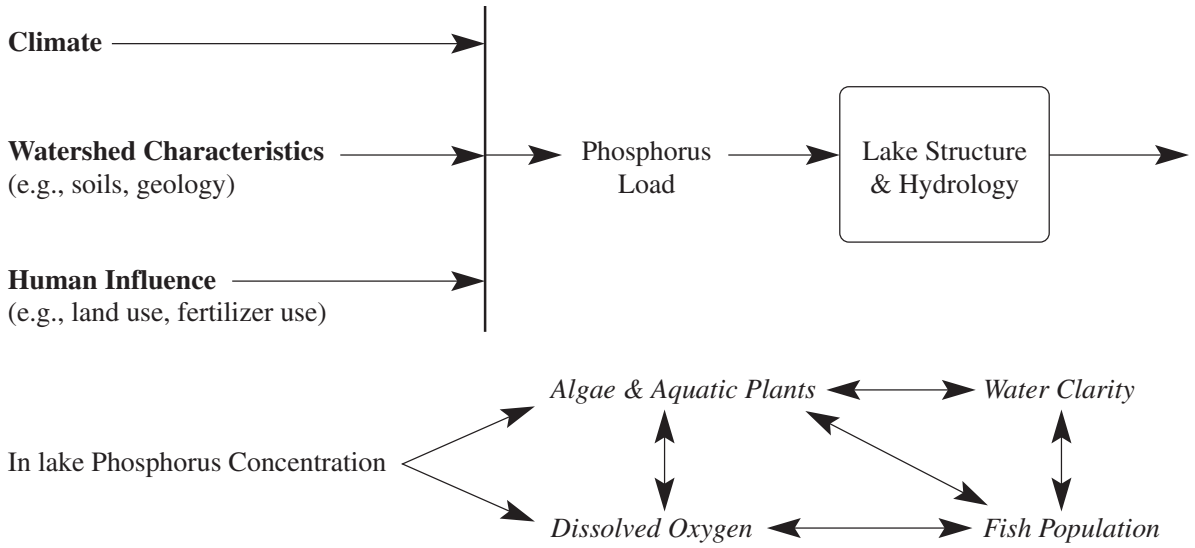
Limnology is the physical, chemical, and biological science of lakes. While numerous water quality parameters are normally appraised to determine the trophic status, or a lake's general water quality status, in-lake phosphorus concentrations are often an overriding factor. Therefore, as commonly accepted lakes with concentrations of phosphorus less then 10 micrograms/liter (µg/L) are often considered oligotrophic, 10 to 20 µg/L mesotrophic, and eutrophic to hypereutrophic at or greater than 30 µg/L (U.S. EPA, 2000).

Oligotrophic and mesotrophic lakes normally support uses such as cold water fisheries (e.g., trout, various species of bass) and numerous recreational activities. The water in these lakes is also often suitable for drinking water supply. Eutrophic lakes often support warm water fisheries (e.g., carp) and comparatively limited recreational and drinking water value to oligotrophic or mestrophic lakes due to periodic nuisance algae blooms and potential fish kills. Hypereutrophic lakes, which experience frequent and intense nuisance algae blooms, ordinarily do not support cold or warm water fisheries and offer little or no recreational value. In addition, these lakes often exhibit decreasing open water surface areas due to layers of algae and aquatic plant masses.

As with all temperate zone lakes, Brighton Lake experiences changes in water chemistry and biology throughout the year. During the winter months, lake water temperature, dissolved oxygen, and other parameters are essentially equal at all depths. As ice thaws when spring approaches, winds and temperature changes to surface waters cause a mixing within the water column. This event is often referred to as a spring turnover. Progressing into the summer months, warm air temperatures which interact with surface waters cause stratification or layering of lake water due to water temperature and density relationships. During this time of thermal stratification, little mixing of lake water occurs. Because of the lack of water mixing, lakes that receive increased pollutant loading can exhibit quantifiable reductions in water quality at this time. As the season enters fall, cooler air temperatures increase surface water density and mixing proceeds to establish uniformity within the water column in what is termed as fall turnover.

While the limnological analysis sheds light on the water quality condition of lakes, most lakes are supplied water via upstream tributary sources. As such, the quality of water flowing into the lake has a profound impact on the overall water quality of a lake and, therefore, requires consideration when examining lake quality issues.

Figure 14. Illustrative Schematic of Phosphorus Load Determinants and Lake Response. (Adapted from USEPA, 1980)



3.3 Historical Water Quality Review

The drainage area of South Ore Creek defines the Brighton Lake Subwatershed. The creek begins at the headwaters in southern Hartland Township upstream of Maxfield Lake and drains in a southerly route through the City of Brighton which lies upstream of Brighton Lake (Figure 1).

Review of key waterbodies and readily available associated water quality data are provided below. Note that not all the lakes within the subwatershed are reviewed as either these lakes have not been studied, or data requests and review did not reveal such studies. Hence, this may not be considered a comprehensive review of water quality in the subwatershed, but rather a snapshot.

3.3.1 Maxfield Lake

Maxfield Lake, located in southwest Hartland Township, is a private lake of approximately 90 acres in size and is in an area of several lakes all in close proximity. Maxfield, and the nearby lakes, have been dominated by substantial residential development since the 1960s. No bathometric data for the lake was found.

Information regarding historical or current water quality of Maxfield Lake did not appear extensive. However, the Michigan State University performed a bacteriological analysis of the lake in 1971. While sampling points and events were too limited to garner relevant information, total fecal coliform was found to range from 0 to 16 counts per 100 milliliters (MSU, 1971). Typically, counts averaging greater than 200 per 100 milliliters of water are considered unsafe for total body contact (e.g., swimming).

3.3.2 Long Lake

Long Lake, also located in southwest Hartland Township, is 171-acre lake just downstream of Maxfield Lake. Similarly, the lake has been dominated by substantial residential development since the 1960s. Unlike Maxfield Lake, however, Long Lake's water storage capacity is enhanced by an impoundment. No bathometric data for the lake was found.

Little relevant information regarding the historical water quality of Long Lake was found. Nonetheless, in 1971 the Michigan State University (MSU) performed a bacteriological analysis of the lake. And like that of Maxfield Lake, sampling points and events were too limited to garner relevant information; however, total fecal coliform was found to range from 0 to 16 counts per 100 milliliters (MSU, 1971), well below conventional standards.

In addition, the Michigan Department of Natural Resources reported via their Self-Help Program that during the years 1974-76, Long Lake was classified as mesotrophic (SEMCOG, 1978).

While no studies on the lake were found for the decade of the 1980s, Dr. Wallace Fusilier performed several sampling events in the mid-1990s. For the periods of study from 1994 to 2001 (n = 49), total phosphorus concentration averaged 15 µg/L with a range of 3 to 37 micrograms per liter (µg/L), nitrogen as nitrate average concentration of 13 with a range of 3 to 34 µg/L. Secchi depths hovered around 10 feet during the period of study and routinely the DO level of the lake was near saturation (Fusilier and Fusilier, 1994-01).

A unique aspect to Dr. Fusilier's methodology of assessing lake water quality is the assignment of "grade" based the results of parameter analysis and known lake characteristics such as hydraulic residence time. On average, Long Lake was determined by Dr. Fusilier to have a grade of "B" or above average.

3.3.3 Woodland Lake

Located in Brighton Township, this 300-acre artificial lake is the result of an impoundment to South Ore Creek. The immediate land surrounding the lake has been dominated by residential development beginning in the 1940s and intensifying in subsequent years. The lake exhibits an average depth of around 15 feet and a maximum of approximately 35 feet.

Several studies outlining various attributes of the water quality status of Woodland Lake were found. The Michigan Water Resources Commission (MWRC) performed the earliest study found which collected data on variables of concern in 1965. Utilizing a ranking system devised for the project and based on weighting of common water quality parameters, the researchers ranked Woodland Lake fourth in quality out of ten lakes. Specifically, the study found phosphorus concentrations averaging around 200 µg/L and nitrogen concentrations around 800 µg/L, indicating possible hypereutrophic status. Suspended solids in the lake were found to be approximately 6 to 8 mg/L in concentration (MWRC, 1965).

Analysis by MSU (1971) reveled that Woodland Lake had an average phosphorus concentration, of 162 µg/L (n=5), confirming the range of phosphorus concentrations found in 1965. Nitrogen concentrations, in the form of nitrate, were found to be lower on average, 300µg/L, than reported by the Resource Commission (1965).

During a 1977 water quality study of inland lakes in Southeast Michigan, SEMCOG found an average phosphorus concentration of 500 µg/L, 600 µg/L of total nitrogen, and a secchi depth of 5 feet. Of particular note, the report indicates that swimmer's itch, a condition caused by blood fluke (trematode) larvae in which larva bore into the skin causing irritation, has occurred at Woodland Lake. The larvae of swimmer's itch are found naturally in most lake systems; however, when growth conditions are enhanced via anthropogenic (man-made) (human) pollution or natural means, outbreaks can occur.

Dr. Wallace Fusilier for Brighton Township performed numerous studies assessing Woodland Lake. For the periods of study from 1994 to 1999 (n = 159), total phosphorus concentration averaged 36 µg/L with a range of 11 to 133 µg/L, nitrogen as nitrate average concentration of 41 with a range of 2 to 1094 µg/L. Secchi depths hovered around 6 feet during the period of study and routinely the DO level of the lake was near saturation (Fusilier and Fusilier, 1994-99).

On average, Woodland Lake was determined by Dr. Fusilier to have a grade of "B" or above average. However, on several occasions the lake did receive both "D" and "E" grades, below average and failing, respectfully.

3.3.4 South Ore Creek

As the tributary water source to Brighton Lake, the water quality of South Ore Creek greatly impacts the integrity of the lake. Hence, careful analysis of readily available data regarding the variables of concern is warranted. Unfortunately, relevant data for the creek is sparse.

According to MDEQ data reported to the U.S Environmental Protection Agency STORET database, the total phosphorus concentrations for South Ore Creek in Brighton Township, at Interstate 96, ranged from 9 to 46 µg/L (n=12) from 1977-78, with a mean of 8.25 µg/L. The average flow for this period was not reported for the 1977-78 period; therefore, loading estimates are not feasible. However, a sampling station of South Ore Creek at North Street in the City of Brighton and performed by the Michigan Department of Natural Resources (MDNR) with reported values in 1977-78, indicates an annual total phosphorus load of 584 lbs/yr.

At the mouth of South Ore Creek entering Brighton Lake, a 1975 USEPA study established a total phosphorus loading of approximately 700 pounds per year (lbs/yr) (USEPA, 1975), all of

which was from nonpoint source loading. In a more recent MDEQ loading study for the watershed, Alexander (1999b) determined the monthly phosphorus load for the same site to be approximately 1,070 lbs/yr, again all was attributed to nonpoint sources.

Readily identifiable and available total nitrogen measurements were limited in scale for South Ore Creek. The 1975 USEPA study found a total nitrogen loading of 25,950 lbs/yr, all of which is attributed to nonpoint sources. No other relevant total nitrogen data for the creek was obtained.

STORET data for the creek indicate dissolved oxygen levels averaged near saturation for the 1977-78 sampling stations. According to Sawyer and others (1994), these levels are adequate to support aquatic life.

Suspended sediment and other water quality indicator data were either not collected, not reported, or not readily available.

3.3.5 Brighton Lake

As previously discussed, the subwatershed which contributes water to Brighton Lake is approximately 22.7 square miles, or 14,500 acres, in size. The immediate drainage area, which is the land area that contributes water directly to the lake, is estimated at 1.32 square miles (844 acres). The lake has an average depth of approximately 2 meters, a maximum depth of 6.1 meters, and a hydraulic residence time of 40 days or 0.11 years (MDNR, 1978).

Investigation into readily available and obtainable data concerning the lake indicated that in addition to the recent water quality study by Alexander (1999a), a few accessible and pertinent historical water quality and fish community assessment studies of the lake exist.

MSU (1971) studied the water quality of Brighton Lake in several locations during the summers of 1970 and ‘71. The investigators, during October 1970 sampling, observed instances of total fecal coliform exceeding 11,300 counts per 100 ml of water in some locations of the lake. Counts averaging greater than 200 per 100 ml of water are usually considered unsafe for total body contact (e.g., swimming). However, other study points in the lake during April and July of 1971, showed lower but still potentially problematic average count concentrations for total fecal coliform.

Water chemistry samples taken in October 1970 and April 1971 yield contradictory information. Ortho-phosphate, often considered the most biologically available form of total phosphate, concentrations for the two sampling events ranged from 0 to 1000 µg/L (n=12) with a mean of 223 µg/L. Nitrate, a form of nitrogen, concentrations ranged from 0 to 129 µg/L (n=12) during the study period and a mean of 13.5 µg/L (MSU, 1971).

As part of the National Eutrophication Survey, in 1975 the U.S. EPA, with the cooperation of the Michigan DNR and the Michigan National Guard, performed a water quality assessment of Brighton Lake. The study determined the trophic status of the lake to be eutrophic. The authors noted that algae blooms were reported to have been frequent and intense for the lake. Of particular note, results indicated that nitrogen was the limiting nutrient in June and September 1975 while phosphorus was limiting in November of 1975. This was attributed to the Brighton Wastewater Treatment Plant (WWTP) discharge, which now releases below Brighton Lake.

Determination of total loads and load source from this study indicated that 1,280 lbs/yr (59%) of the phosphorus load to Brighton Lake was from the WWTP. Nonpoint source loads comprised approximately 720 lbs/yr (34%) of the total phosphorus load, while septic systems, immediate drainage area, and precipitation contributed the remaining for a total yearly phosphorus load of 2,150 lbs/yr. The mean total phosphorus concentration for the period of study was found to be 109 µg/L (USEPA, 1975).

The USEPA determined that the total load of nitrogen to the lake in 1971 was 53,140 lbs/yr. Load sources for nitrogen were found to be dominated by nonpoint sources with a load of 25,950 lbs/yr (48%). The Brighton WWTP was determined to contribute 18,590 lbs/yr (34%) of the total. Septic systems, immediate drainage area, and precipitation contributed the remaining nitrogen load (USEPA, 1975).

A 1978 water quality study of Brighton Lake by MDNR concluded the lake was in very poor condition, primarily due to the WWTP discharge. The researchers noted frequent and intense algae blooms, persistent anaerobic conditions (lack of oxygen), failure to meet state standards for total fecal coliform, and moderately contaminated sediments. During May 1977 and April 1978, MDNR determined the nonpoint source load to the lake to be 584 lbs/yr (19%), which is less than the 1975 USEPA conclusion. Loading from the WWTP was determined to be 2336 lbs/yr (76%) with remaining from septic systems, immediate drainage area, and precipitation. This represents a phosphorus concentration of 126 µg/L (MDNR, 1978).

The MDNR report suggests that increased regulation and improvement to the WWTP would reduce nutrient loading to Brighton Lake. The magnitude of this reduction, the authors contended, will allow phosphorus to become the limiting nutrient and reduce algae bloom frequency; however, given that the lake is shallow, reintroduction of phosphorus bound in lake sediments could impact the lake water quality for an extended period of time. As noted earlier, the WWTP point source was removed from discharge to the lake in the late 1970s and has resulted in no authorized point source activity discharging to the lake.

A major conclusion of a 1978 SEMCOG survey, which investigated several water quality indicative biological and chemical parameters, determined Brighton Lake to have the worst overall water quality of 78 lakes sampled in southeast Michigan. In the SEMCOG study, Brighton Lake had the highest concentrations of total phosphorus, ammonia, second highest concentration of total nitrogen, and the lowest average secchi depth of all the lakes studied.

From April 1998 to April 1999, the MDEQ Great Lakes and Environmental Assessment Section (GLEAS) conducted a phosphorus loading and lake quality analysis of Brighton Lake. The objective of the study was to determine the quantity and source areas of annual and monthly phosphorus loads to the lake. Brighton Lake was chosen due to its worrisome water quality history and the significant increase in developmental pressures in the area and subsequent increased nonpoint and, potentially, point source pollution (Alexander, 1999a).

With an average annual total phosphorus concentration in 1998 of 29 µg/L and 39 µg/L for 1999 (Alexander, 1999a), Brighton Lake shows vast improvement from 1970s levels. As was mentioned earlier, this can be attributed to the increased efficiency and ultimate relocation of the Brighton WWTP discharge downstream of the lake.

The MDEQ study determined that during the period of study the average annual phosphorus load to Brighton Lake was 1,070 lbs/yr, all of which is attributed to nonpoint source loading from South Ore Creek, surface runoff from the immediate drainage area (land area surrounding the lake), and precipitation. Approximately 96% of the total phosphorus load to the lake can be attributed to pollution entering South Ore Creek upstream of the lake.

Information regarding suspended sediment and other parameter of concern data were not collected, not reported, or not readily available.

CHAPTER 4. SUBWATERSHED CONCERNS, CRITICAL SUB-BASINS, POLLUTANT SOURCES, AND GOALS

4.1 Identification and Prioritization of Subwatershed Concerns and Desired Uses

It is important for stakeholders to identify community-centered concerns for the subwatershed in order to develop a grassroots appeal and sustainability for any watershed management project. By being familiar with the stakeholders' concerns and desires, the plan focuses on the goals and objectives that will produce tangible results that can be physically identified by the citizenry of a watershed.

The established Workgroup identified several desired uses of water resources and subwatershed resources potentially needing protection through subwatershed planning:

- Rural Character;
- Agriculture (e.g. horse farms);
- Groundwater protection
- Habitat protection;
- Biodiversity;
- Sustainable development;
- Restoration of waters for body contact recreation (e.g., swimming);
- Recreation–active and passive (Canoeing/boating);
- Water-related and watershed related uses (aesthetics); and
- Property values.

4.2 Identification and Prioritization of Concerns

Because of the diverse and ever-changing landscape of the Brighton Lake Subwatershed, the Workgroup identified many challenges to preserving the current and future water quality of the streams, lakes, wetlands, and river. The group developed the following inventory of threats and concerns to gain a greater understanding of the concerns and priorities of local officials and the public. The group then ranked these threats and concerns based on apparent importance. The top concerns are reviewed below in Table 5.

Table 5. Prioritized List of Subwatershed Concerns

Rank	Concern/Need
1.	*Water Quality Monitoring Programs and Data;*
2.	*Community Land Use Planning & Standards;*
3.	*Excessive Impervious Surface Generation;*
4.	*Stormwater Mitigation, Management, and Runoff issues;*
5.	*Watershed Education*
6.	*Septic System Failures and Groundwater Contamination;*
7.	*Resource respect (e.g. keyholing, fertilizer over usage, use of high-powered boats, illegal dumping);*
8.	*Need for vegetative buffers around waterways and wetlands;*
9.	*Intensive landscaping among residents and businesses;*
10.	*Coordination between different lake and homeowner associations;*
11.	*Unknown frequency and level unconventional contaminants (e.g. volatile organic carbons, endocrine disrupters, ecotoxicity);*
12.	*Golf courses (increase of and pollution from);*
13.	*Need for greater citizen involvement;*
14.	*Awareness and connection to watershed.*

4.2.1 Concern #1. Water Quality Monitoring Programs and Data

While local governments and lake associations have, in several cases, funded monitoring of lakes and other waters, the Workgroup identified enhancement of integrated and coordinated water quality and other environmental monitoring throughout the subwatershed. For instance, many of the readily available and relevant datasets were considered to be somewhat incomplete for addressing some subwatershed concerns; others were non-existent, especially regarding stormwater indicators such as sediment contamination, metals, and organics, in addition to, illicit connection and septic system impairment rates, and emerging issues such as the presence or absence endocrine disrupting chemicals in surface waters. Limited inference towards trend detection can be employed using existing data, specifically for South Ore Creek, given the lack of time-series studies.

4.2.2 Concern #2. Community Land Use Planning & Standards

Protecting a watershed from uncoordinated, poorly planned development is far less expensive than restoring one after such development has occurred. It is estimated that economic impacts of such changes in land use are significant. In fact, the Michigan Economic and Environmental Roundtable (2001) concludes that the state loses $66 billion of economic output annually from decreased tourism and recreation, farming, forestry, and mining due to uncoordinated suburbanization. While many communities have made great strides towards implementing greater planning and stewardship tools, the Workgroup believed that if we are to address the issues of land use while balancing conservation and development, ecosystem health, and natural and cultural resource protection management, we should begin with a solid ecosystem-based land use plan-

ning initiative. Therefore, enhanced utilization of watershed-friendly land use planning and design was deemed essential to the protection of water quality and other natural resource management issues. In essence, the impacts of impervious surface generation, wetland loss, fragmentation and loss of open space, and the majority of all other water quality concerns for the subwatershed are rooted in land use planning and design issues.

4.2.3 Concern #3. Impervious Surfaces

Addressed as an issue of both nonpoint source pollution and land use, the Workgroup believed the increase in impervious surfaces is the greatest threat to the water quality of the subwatershed, and the region in general. The group was very concerned about the impact of future development, especially in the less developed areas of the subwatershed. When open land is converted to residential, commercial, or industrial use using typical site preparation and development methods, water quality and quantity is often affected negatively. Results include increased rates and volume of runoff, causing increases in in-stream flow rates and temperature, reduced infiltration and groundwater recharge, and loss of wildlife habitat and recreational uses. In addition, contaminants, such as metals, oils/greases, lawn chemicals and fertilizers, road-deicing agents, “cides” (herbicides and insecticides), cleaning agents, yard waste, and garbage are routinely found in stormwater runoff from impervious surfaces. Some Workgroup members identified local standards for sizing parking lots, road widths, and other development standards as prime issues associated with impervious surface introduction. Workgroup members also were concerned that large storms and subsequent runoff would cause property damage, bank erosion and subsequent habitat loss, destruction of fish and wildlife habitat, and potentially loss of human life.

4.2.4 Concern #4. Stormwater Mitigation, Management, and Runoff Issues

When native lands are converted to parking lots, roads, subdivisions, and other urban and suburban uses, the ability of the land to absorb and filter rainwater is dramatically decreased. The result is an increase in run off over the land during rain or snowmelt events in what is commonly called stormwater runoff. Research across the country indicates that the amount and impact of stormwater runoff on water quality is often directly associated with impervious surfaces. The resulting stormwater runoff from these surfaces carry a variety of contaminants, including phosphorus, sediments, and toxic compounds. But stormwater runoff does not have to be treated as a nuisance to be managed at an undesirable or low corner of a property. Runoff issues such as sewer overflows, flooding, and stream channel erosion can be successfully addressed by multiple, yet small, unobtrusive techniques incorporated into developments or retrofitted into the existing built environment. The methods are many, but the approach is consistent: "softening" the urban landscape to allow

water to soak into the soil, where it nourishes plants, recharges groundwater, and supports the base flow of streams during dry periods. We also gain the added benefit of allowing the soil and vegetation to filter, transform, and bind up (adsorb) many of the pollutants typically found in stormwater runoff. Practices such as impervious surface reductions, small surface and subsurface infiltration basins, constructed wetlands, bioretention cells, vegetated swales, soil rehabilitation, native plantings, green roofing, and other designs can reduce the quantity and quality impacts of stormwater runoff while supporting wildlife habitat, beautifying properties and neighborhoods, providing recreational amenities, creating jobs, and reducing urban "heat island" effects (RMI, 2002). Workgroup members expressed the hope that site design and stormwater best management practice (BMP) implementation in the Brighton Lake area could be used towards protection of water quality.

4.2.5 Concern #5. Watershed Education

Numerous surveys throughout the country have indicated that the general public does not always practice good watershed ethics and in many cases, contributes directly to water quality problems via their own behaviors. Education on water quality and watershed issues is the primary tool for addressing such behaviors. Such educational initiatives begin with two premises: we all live in a watershed, and how we live in it affects it's quality. While this is a simple concept to most, the challenges are many. For instance, within a watershed or subwatershed there will be thousands of people to reach and minds to change, yet most of us are only slightly aware of the watershed concept, the funding resources are often limited, and the marketing we can afford is typically the least effective (Center for Watershed Protection, 2000). Nonetheless, without education and understanding of basic watershed issues, most protection and restoration efforts are simply infeasible. The Brighton Lake Workgroup identified the need for enhanced and coordinated education on the relationship between community and human health, watersheds, and water quality as a major concern.

4.2.6 Concern #6. Impaired or Compromised Septic Systems

Many of the communities within the subwatershed have been making concerted efforts to address the issue of impaired or compromised septic systems near waterbodies via the installation of sewers. Such is the case in Brighton Township and the Woodland Lake sewer installation project. Yet some areas of the subwatershed have yet to shift to a community-based treatment system such as sewers. While the exact nature and extent of impaired or compromised septic systems is somewhat ambiguous, in general, such a system is considered to be one that discharges effluent without the benefit of designed treatment. Improperly functioning septic systems are recognized as a significant contributor of pollutants and microbiological pathogens; these systems discharge more than one trillion gallons of waste each year to subsurface and surface waters (NSFC, 1995). Identifying and restoring such septic systems can help address contamination of ground and surface water supplies from untreated wastewater discharges given that they can carry nutrients, such as phosphorus, bacteria, medicinal and chemical agents, and

other pollutants to waterbodies with little or no treatment. Impairment of on-site disposal systems can be due to a number of causes, including unsuitable soil conditions, improper design and installation, or inadequate homeowner maintenance practices. Despite the fact that no specific studies on impairment rates in the Brighton Lake Subwatershed or in Livingston County have been reported, the Workgroup determined the presence of such systems are of concern given results found in neighboring Oakland County. A recent survey of septic systems in selected areas of Southfield and Farmington Hills found a substandard operation rate (undefined) of 50% (Johnson, et. al., 2000). Given that numerous individuals rely on septic systems for waste treatment in the subwatershed, there is a potential for water quality and health impacts from faltering septic systems.

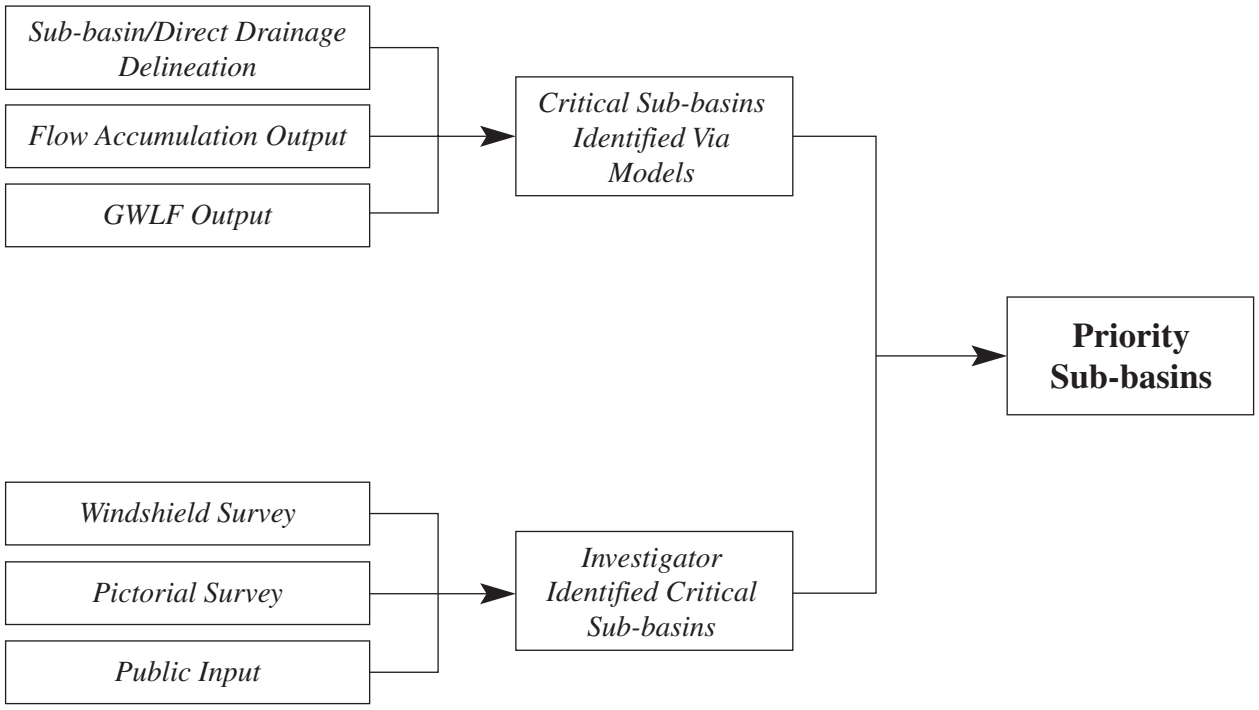
4.3 Defined Critical Areas

4.3.1 Purpose and Methodology

A crucial factor in establishing objectives and developing cost-effective subwatershed protection and restoration techniques is the ability to prioritize areas where application of such techniques will achieve maximum benefits at minimal costs. Specifically, this includes the establishment of new stormwater BMPs or the retrofitting of existing ones, streambank and other restoration initiatives, and land acquisition considerations. Consequently, a subwatershed-based approach to area prioritization was employed.

This process is based on the hypothesis that prioritization to address watershed restoration and protection via targeted initiatives will produce the most cost-effective solutions. The specific methodology employs consideration of (a) information on current land use, associated impervious cover, and period of development, (b) areas of hydrological direct drainage to the river system, (c) indications from phosphorus flow accumulation model, (d) phosphorus loading output utilizing the Generalized Watershed Loading Function (GWLF) model, (e) pictorial survey results, and (f) identification of areas by the public.

Figure 15. Components of the Watershed Critical Area Prioritization methodology.



4.3.2 Sub-basin Delineation

In order to focus investigations to specific areas of water quality concern and influence, the sub-watershed was segmented into a series of sub-basins based on predominant land use, topography, and relation to direct surface water drainage to the river system (hydrological connectivity). This delineation produced 11 sub-basins for the Brighton Lake Subwatershed.

4.3.3 Critical Sub-basins Identified via Models

The methods to identify these areas utilized subwatershed geographic and land use information as the premise for investigation. The sub-basin delineation is presented in Figure 16. This information was obtained from research conducted by Dr. M. Wiley of the University of Michigan. Direct drainage areas represent those areas that have significant spatial and temporal influence on the quantity and quality of water entering the river system via groundwater or surface water flows. This information along with information pertaining to geographic characteristics was utilized to establish sub-basins within the subwatershed.

The Generalized Watershed Loading Function (GWLF) model was employed to establish yearly phosphorus loading rates on a sub-basin scale to achieve a greater degree of specificity regarding the source location of significant phosphorus loading. GWLF provides a moderately detailed simulation of precipitation-driven runoff, pollution, and sediment delivery within a watershed or subwatershed. The model uses watershed specific information regarding number and type of septic systems, land use and cover, pollutant event mean concentrations, soil type

and physical characteristics, known point sources, evapotransporation, and other specific variables to predict particulate and dissolved-phase pollutant loading to a stream, river, or lake. It is a continuous simulation model that uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads based on the daily water balance accumulated to monthly values. The GWLF model was found to provide an excellent predictor of annual phosphorus loads for this subwatershed as compared to MDEQ water quality monitoring. Acceptable ranges of error for such models are typically 25-30%. The GWLF model exhibited a 3% error rate for this subwatershed. See Appendix B for more information regarding GWLF.

Normalized (for area) phosphorus annual phosphorus loads per sub-basin are presented in Figure 17. Unsurprisingly, the model indicates that the sub-basins of greatest phosphorus loading to the subwatershed lie within the existing urban and suburban fringe.

Figure 16. Sub-basins of the Brighton Lake Subwatershed

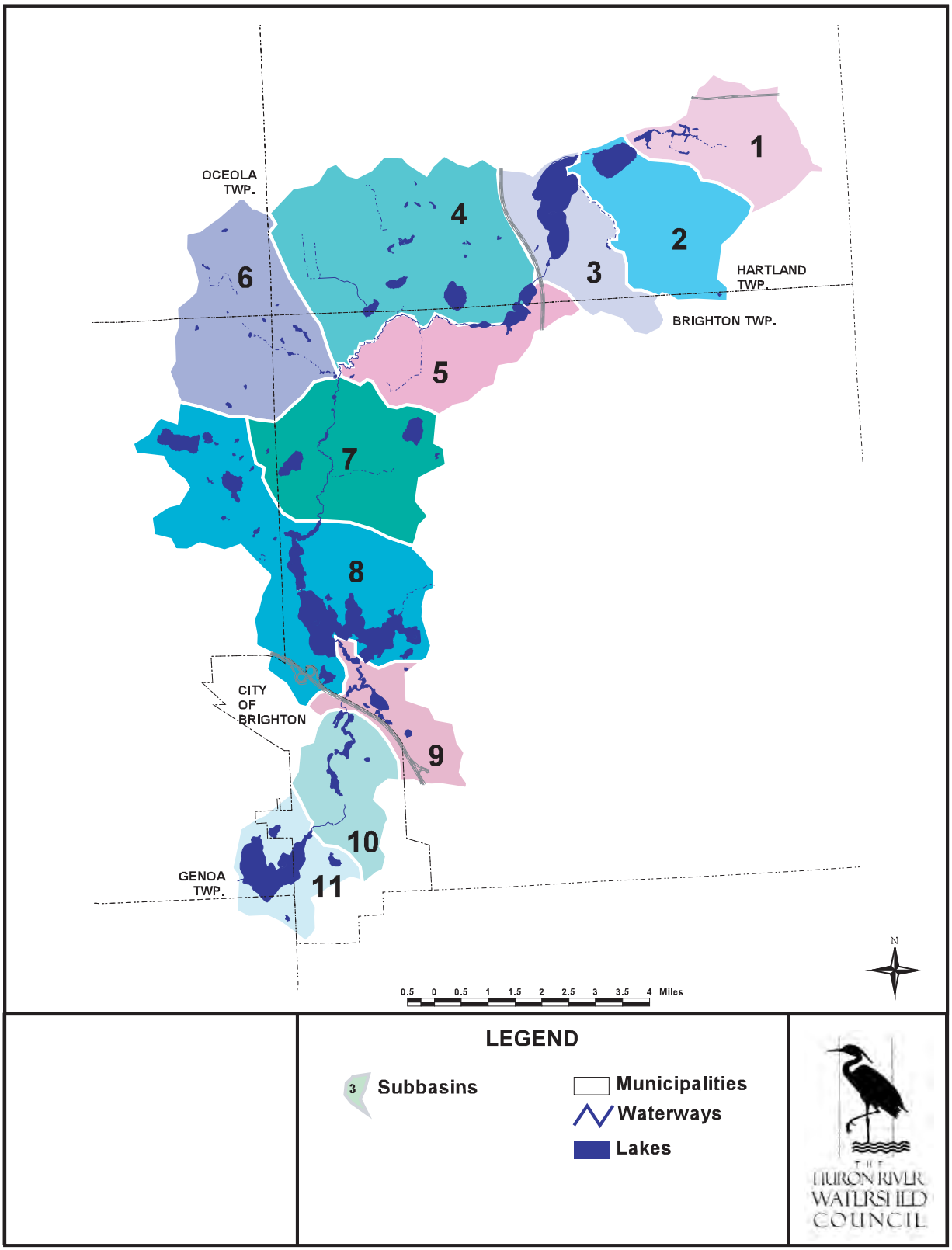
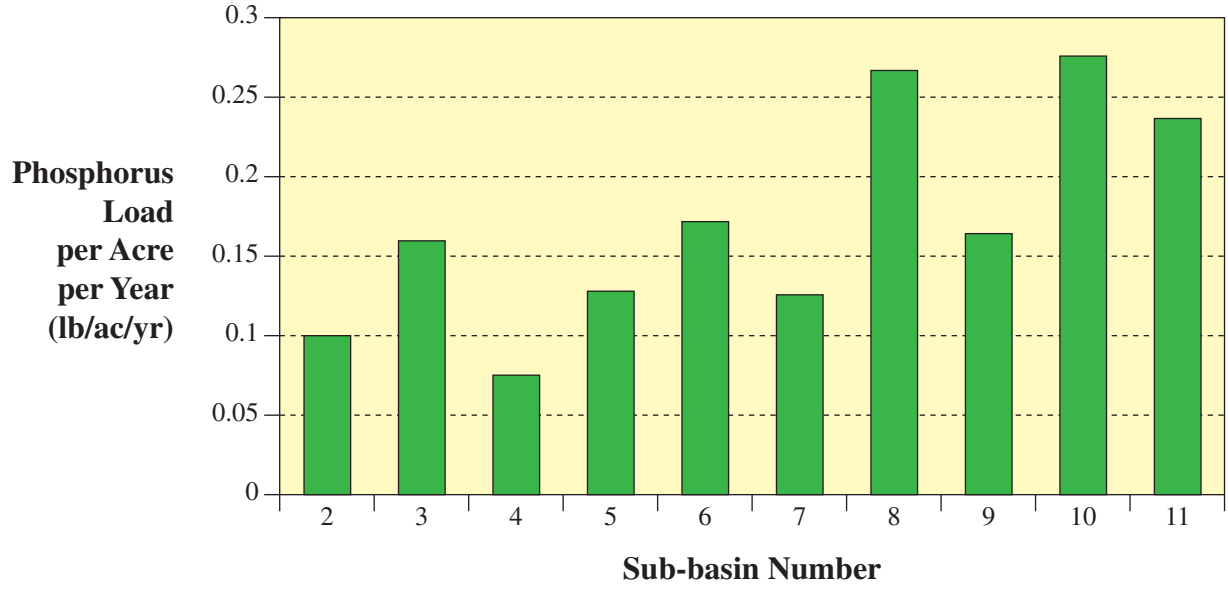


Figure 17. Normalized Annual GWLF Phosphorus Nonpoint Source Load Estimate for Brighton Lake Sub-basins (lb/ac/yr).



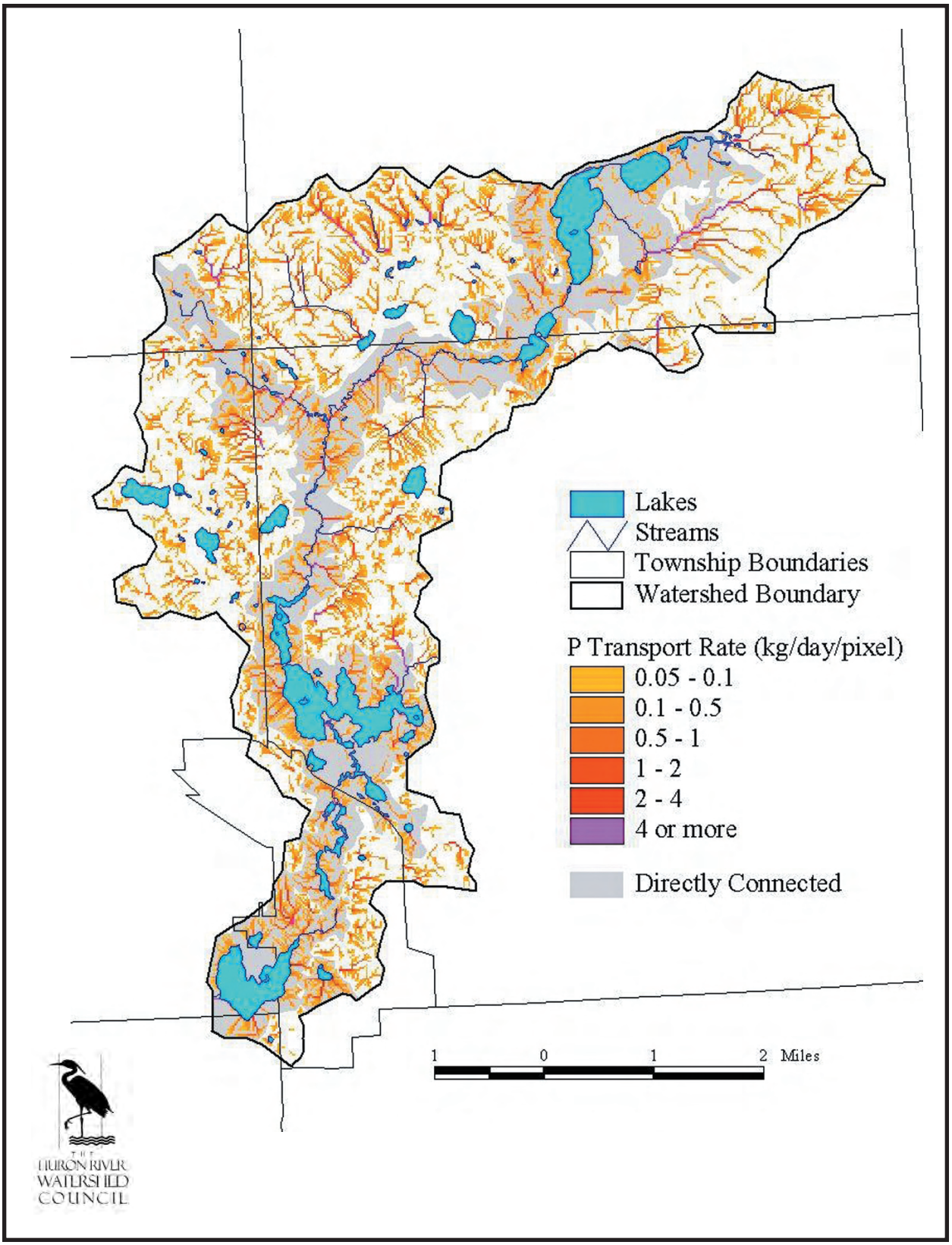
Note that due to anomalies in pollutant loading analysis, sub-basin 1 was eliminated from further consideration in this prioritization process.

To further establish and refine areas where phosphorus loading to the watershed could potentially originate and enter the river system, a phosphorus flow accumulation model was utilized in conjunction with GWLF outputs. The approach employs existing land cover and geographic information to identify locations in the Brighton Lake Subwatershed where topographic and land cover characteristics cause them to receive large quantities of total phosphate. The model was utilized to further establish critical areas within the subwatershed and indicate locations that, by virtue of their slope and aspect, intercept runoff flow paths from large areas. Identified sites are potentially perfect locales to place structural best management practices for the reduction of phosphate and sediment pollution.

The key to identifying these sites is to isolate parts of the watershed where surface water flowpaths drain from areas that produce high phosphorous loads (e.g., suburban, commercial, agricultural land) since this is the pollutant of main concern for the subwatershed and the subject of the TMDL. The result is a simple picture of where runoff is flowing on the land surface.

Figure 18 presents the results of the flow accumulation modeling process. Those brightly colored areas indicating progressively increasing intensity represent higher potential phosphorus load sites. Paths that indicate flow directly to a waterbody were considered to be of higher significance in terms of potential water quality impact. See Appendix C regarding methodology of flow accumulation analysis.

Figure 18. Phosphorus Flow Accumulation Model Results for the Brighton Lake Subwatershed



Utilizing the conclusions of the sub-basin and direct drainage delineation and the GWLF and Flow Accumulation model outputs, a set of critical sub-basins identified by models was established. These sites were hypothesized to be the sub-basins of 3, 4, 7, 8, 10, and 11 (Figure 19).

4.3.4 Investigator-Identified Critical Sub-basins

In addition to the model-based approach, study coordinators embarked upon an method which relied heavily on expert theorizing, field observations, and public input to determine a set of sub-basins identified from field observations (Figure 15).

This method of gaining a better understanding of the source of phosphorus pollution in the subwatershed is based heavily on the evidence gathered via field reconnaissance studies and information received from the public. Specifically, results from the analysis of existing water quality data and review of current and future land use information, guided a photographic inventory of the subwatershed performed in June and July 2000 by Huron River Watershed Council (HRWC) staff (Appendix E). The purpose of inventory was to identify and document the general condition of the subwatershed in addition to discovery of source areas of water quality degradation, as well as documenting current tributary and river physical conditions.

Tetra Tech MPS (TTMPS), the contracting engineers to this effort, conducted a windshield survey of the mathematically identified critical sub-basins and other significant areas in the summer and fall of 2001. The goal of this survey was to identify and verify critical areas noted and suspected in the photographic inventory performed in the summer of 2000 and determined from modeling efforts. TTMPS staff visited older urban and suburban sites, based on sub-basin map review, to view drainage patterns, existing stormwater conveyance and treatment infrastructure, and location of outlets to surface waters. Special focus was given to those areas where development had occurred prior to 1990. These observations were utilized to identify potential BMPs for recommendation.

The results of the survey suggested that a few subdivisions and older developments had stormwater systems that were either (a) non-existent, or consisted of (b) grassed ditch systems, (c) piped or guttered directly to wetlands, streams, lakes, and the Huron River, and (d) roadside ditch cuts left to fill with vegetation naturally. Specific review of methodology, observations, and recommendations of the TTMPS survey can be found in Appendix D.

Results from the inventory indicated recent and continual growth within the area. Numerous examples of increased imperviousness, large lot residential development, and fragmentation of undeveloped areas were documented. Non-existent and failing best management practices (BMPs) were also present at

somewhat disturbing rates, especially in older development sites. Results from the inventory suggest remaining open space areas are being rapidly encroached upon as development in rural areas mounts.

The physical structure (geomorphology) and habitat of South Ore Creek appeared somewhat stable in most cases. However, evidence of increased flows, undercut and eroding streambanks, and accelerated sedimentation were observed in the segment of South Ore Creek extending downstream from the Mill Pond in the City of Brighton to the mouth of Brighton Lake.
In addition to field reconnaissance, HRWC held a series of public meetings in the summer of 2001 throughout the subwatershed. These meetings were intended to get insight and input from the public in the identification of areas of potentially critical significance. Attendees noted several development sites which, in the publics' opinion, had inadequate stormwater control. In most cases, such situations were identified in older developments, prior to the establishment of many stormwater standards (Appendix W).

Public meeting attendees also noted degradation of South Ore Creek at its mouth with Brighton Lake. Residents in the area noted that in recent years there had been noticeable increases in suspended solids and sedimentation at this location, resulting in a loss of recreational access to Brighton Lake.

Attendees also noted several development sites that, in their opinion, had inadequate stormwater BMPs. In most cases, such situations were identified in older developments prior to the establishment of many stormwater standards. However, many attendees noted that existing stormwater facilities also appear to be failing. In these cases they cited design issues and maintenance as the problem.

Based on the observed conditions, windshield surveys, and public input, a set of investigator-identified critical sub-basins was established. These sites were postulated to be the sub-basins of 1, 4, 7, 8, 10, and 11 (Figure 19).

4.3.5 Priority Sub-basins
Combining the results from the mathematically identified critical areas and investigator identified critical area methodologies, researchers developed the following Priority Sub-basins: 4, 7, 8, 10, and 11 (Figures 19 and 20). These areas represent sites of significant pollutant load or where observations indicate such and where employment of restoration and protection techniques will theoretically achieve maximum benefits.

For this planning effort, the employment of retrofitted and new stormwater BMPs to meet the TMDL target of a 10% reduction in current nonpoint source phosphorus loading will focus on these priority sub-basins.

Figure 19. Brighton Lake Subwatershed Priority Sub-basins results from the Watershed Critical Area Prioritization Methodology.

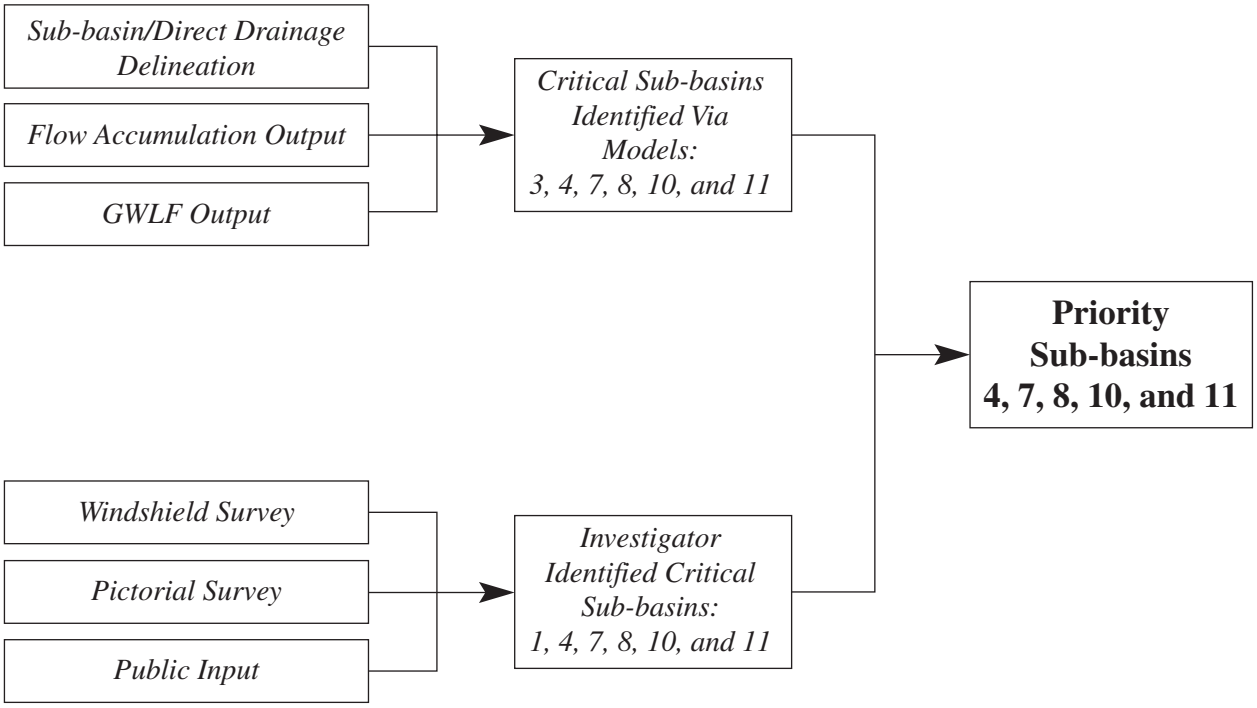
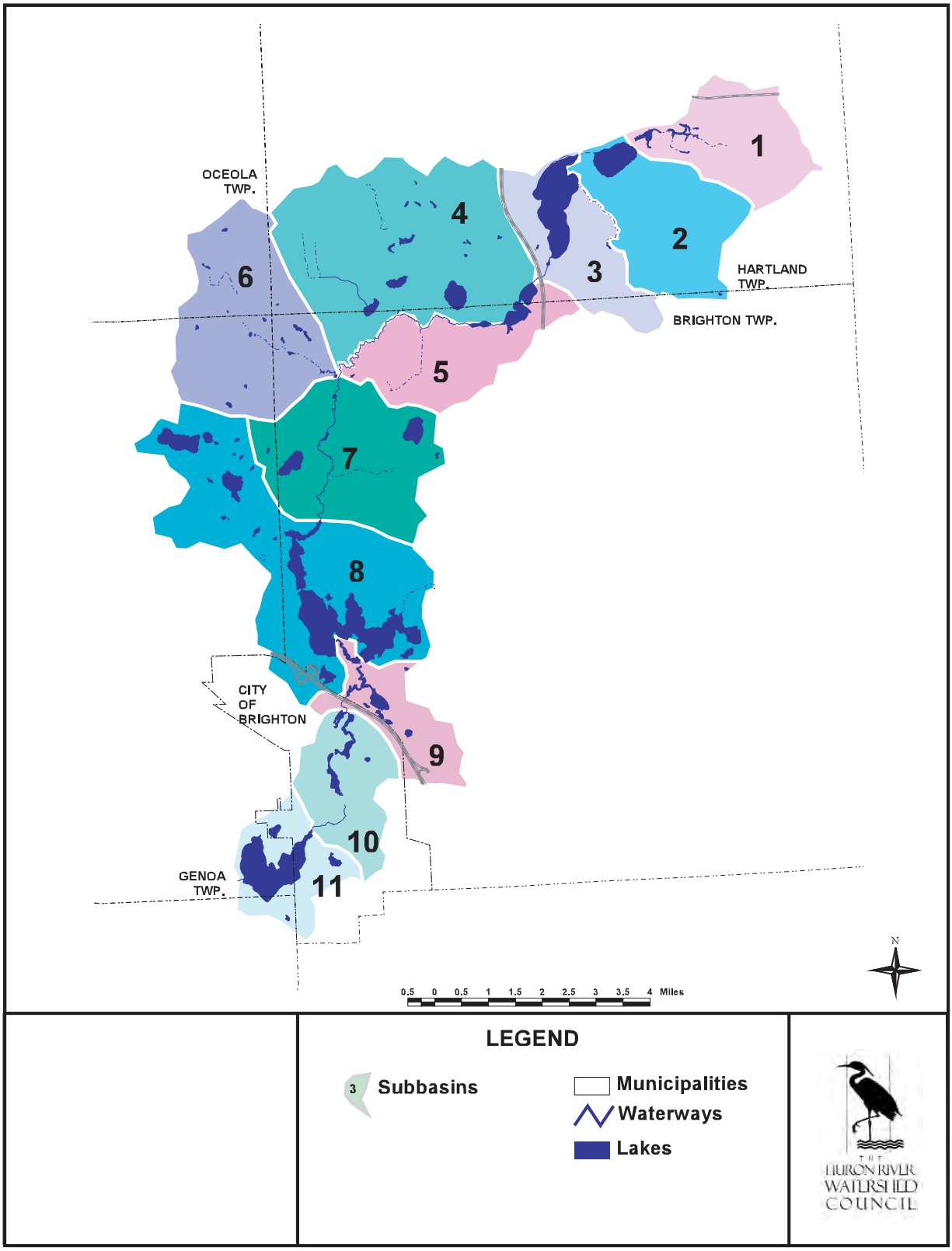


Figure 20. Brighton Lake Subwatershed Priority Sub-basins



4.4 Probable Pollutant Sources and Causes

Given that the subwatershed consists of large areas of developed lands, most human-influenced or created (anthropogenic) sources of water quality pollution can be reliably presumed to originate in these areas. Such conclusions are also based on the methodology employed to determine critical areas as outlined in Section 4.3. As such, several potential sources and/or causes of water quality impairment, with special attention to established Workgroup concerns, to the subwatershed were observed and documented in the Brighton Lake Subwatershed. The most significant sources and corresponding causes were determined to be:

- **Nonpoint Source Runoff:** Increased impervious cover and decreased native landscapes have a negative impact on the water quality of the area. Stormwater runoff from these lands typically carries a variety of contaminants, including phosphorus, from impervious surfaces such as roads, parking lots, roofs, lawns, and other surfaces. Metals, oils/greases, lawn chemical and fertilizers, road-deicing agents, herbicides and insecticides, cleaning agents, and yard waste and garbage have routinely been found in stormwater runoff. Large storms and subsequent runoff can also cause property damage, loss of human life, bank erosion, and the destruction of fish and wildlife habitat.

- **Loss of Natural Habitat:** The loss of natural habitat (e.g., wetlands, woodlands, prairies, floodplains, etc.) can drastically alter the health of waterways. Increased stormwater runoff associated with impervious surfaces often begins a chain of events that increases the frequency and intensity of flooding, erosion, stream channel alteration, and overall ecological damage. There are two main consequences to watersheds from habitat loss, (1) alteration of the water cycle and (2) mutation of stream form and function. Combined with an increase in human-influenced or created pollutants, these changes in waterways' form and function result in degraded systems no longer capable of providing good drainage, healthy habitat, or natural pollutant processing (i.e. filtering and retention). Habitat loss, especially along riparian corridors, exacerbates the impact of nonpoint source runoff.

- **Impaired Decentralized Onsite Disposal Systems (Septic Systems) and Illicit Connections:** While the researchers and Workgroup members for this project did not perform a failure rate inventory or find published studies regarding septic system impairment or failure rates in the subwatershed, as noted in Concern #6, studies of the area have indicated potentially significant impairment of such waste treatment systems. Such conditions are often found in historical development sites commonly with lakefront property and are not considered unique to the studied areas. Impaired systems carry nutrients, bacteria, medicinal and chemical agents, and other pollutants to waterbodies with little or no treatment. In some cases, failing systems have been implicated in the loss of recreational value of waterbodies because of the associated hazards to human health (i.e., bacterial contamination).

4.5 Subwatershed Vision and Goals Formation

The priority concerns, designated and desired uses, the vision for the subwatershed, as well as citizen input, provide the basis for goals establishment for this planning process. It is important to note that this plan not only strives to meet the established TMDL phosphorus reduction target of 10% but also to maintain and protect the subwatershed from the incremental increases in nonpoint source pollution associated with current and expected land use changes. Community resolutions of support and a community-based steering committee are proposed to facilitate implementation, institutionalization, and administration of the plan. See Chapter 10 for more information.

Goals are defined for the purpose of this effort as the future condition of the subwatershed that communities, agencies, or other stakeholders of the Workgroup will endeavor to create. Progress towards achieving the goals will be determined by rates of implementation for programs and standards, and, most importantly, monitoring of physical, chemical, and biological conditions in the subwatershed and Brighton Lake. These goals have been established on a subwatershed-wide basis. Hence, they represent goals towards which all stakeholders will collectively work over time.

It should be noted that, given the diversity among subwatershed communities and stakeholders, some of the goals might not be directly applicable to a specific jurisdiction or stakeholder. Thus, not all subsequent recommendations apply to all communities and stakeholders throughout the subwatershed.

4.5.1 Long-term Subwatershed Vision

The vision of this effort is to protect and preserve Brighton Lake and South Ore Creek and its floodplains, lakes, and associated wetlands so that water quality standards and beneficial functions and uses are achieved and maintained now and in the future.

4.5.2 Goal Re-categorization

Several of the major concerns identified for the subwatershed are intimately related. An effort to consolidate certain concerns was considered to reduce the repetition of related recommendations. It was determined that segmenting the subwatershed recommendations into the probable pollutant sources and causes was most applicable. To further simplify the presentation of related recommended action items, the related concerns of community land use planning and impervious surfaces, open space, habitat, and wetland fragmentation and loss, and impaired septic systems and illicit connections were merged. Actions to address probable pollutant sources and established concerns are presented below in Table 6:

Table 6. Categorization of Probable Pollutant Sources and Subwatershed Concerns.

Pollutant	*Subwatershed Concern (#)*	*Consolidated Concern (if applicable)*
Nonpoint Source Pollution	• Impervious Surfaces (3) • Community Land Use Planning (2) • Stormwater Mitigation, Management, and Runoff Issues (4)	• Community Land Use Planning and Design Standards
Habitat Loss and Fragmentation	• Community Land Use Planning (2) • Stormwater Mitigation, Management, and Runoff Issues (4)	• Open Space Protection
Impaired Decentralized Onsite Disposal Systems (Septic Systems) and Illicit Connections	• Impaired or Compromised Septic systems (6)	• Decentralized Wastewater Treatment and Illicit Connections
Other	• Water Quality Monitoring Programs and Data (1) • Watershed Education (5)	• Water Quality Monitoring Programs and Data (1) • Watershed Education

Listed below are the collective goals for each probable pollutant source or cause of impact to the subwatershed. Note that these probable sources and goals are not prioritized based on suspected water quality impact or by any other means.

Nonpoint Source Pollution

Community Land Use Planning and Design Standards

Goal 1: Promote local site planning standards that foster stewardship, open space, mixed land use design, and reduced open space fragmentation.

Goal 2: Adopt local site design principles that consider both water quantity and quality impacts, and that require that drainage and stormwater management solutions be developed with protection of receiving waterway quality and habitat value as the basis for design.

Goal 3: Encourage local standards, strategies, and programs that prevent unnecessary addition of impervious surfaces.

Goal 4: Minimize the adverse effects from existing and future impervious surfaces via retrofitting activities and adoption of appropriate community standards.

Habitat Loss and Fragmentation

Open Space Protection

Goal 5: Conduct on-going programs to raise the public and practitioners' awareness of the importance of wetlands and other natural features in watershed protection and non-point pollution.

Goal 6: Establish a mechanism towards greater coordinated protection and identification of wetlands and other natural features throughout the subwatershed.

Impaired Decentralize Onsite Disposal Systems (Septic Systems) and Illicit Connections

Decentralized Wastewater Treatment and Illicit Connections

Goal 7: Conduct on-going programs to raise the public and practitioners' awareness of the impacts of impaired septic systems on water quality and human health.

Goal 8: Establish a mechanism towards identification and correction of illicit connections within critical areas of the subwatershed.

Other

Monitoring Programs and Data

Goal 9: Establish a mechanism towards greater dissemination of data and coordination and promotion of water quality monitoring and assessment throughout the subwatershed.

Goal 10: Conduct on-going programs to raise the public and practitioners' awareness of volunteer monitoring activities, watershed protection, and nonpoint pollution issues.

Watershed Education*

Goal 11: Enhance riparian landowner, public, local government, and builder knowledge and nonpoint source, watershed, and water quality issues and concerns.

*Given the numerous topics associated with Watershed Education, this issue is addressed separately in Chapter 9.

4.6 Designated Uses of Waterbodies in the Brighton Lake Subwatershed

As reviewed in Chapter 2, the MDEQ considers whether the waters in question meet certain designated uses when determining whether a waterbody meets state water quality standards. In Michigan, the goal is to assure that all waters meet all state designated uses that are applicable. While not all the designated uses may be attainable, they do provide significant direction toward which the subwatershed may progress. In addition, threatened or impaired designated use(s) helped provide the framework for recommending waterbody specific restoration activities as presented in Chapter 8.

CHAPTER 5. STRATEGY TO ATTAIN WATER QUALITY TARGETS AND ADDRESS SUBWATERSHED CONCERNS AND GOALS

5.1 Management Alternatives

The approach to address the threatened water quality status of Brighton Lake in this planning process consisted of two somewhat distinct factions. The first section (Part I) centers on establishing a quantitative plan to meet the TMDL target phosphorus reduction of 16%. The focus of this effort consisted of the formulation of recommendations to address current nonpoint source phosphorus loading, specifically enhanced application of structural stormwater BMPs, to the lake. The second section (Part II) focuses on addressing the potentially significant increases in nonpoint source pollution that may result as land use changes continue throughout the subwatershed. As such, the majority of recommendations in this section involve land use planning and protection approaches known to protect water quality.

Waterbodies identified as potentially exhibiting physical degradation (e.g., streambank erosion) from various nonpoint source related stresses and potential restorative actions are presented after the methodologies to manage current and future sources of nonpoint source pollution in the subwatershed. Finally, the Workgroup developed an information and education (I/E) plan as part of this planning effort. This I/E framework is considered integral to attaining the milestones established in the plan. Nonetheless, specific message pieces still need to be identified or developed.

The recommendations, for the purpose of this effort, define a toolbox of options for reaching established subwatershed goals. It should be emphasized that the recommendations and action plan are not mandatory. It should be further emphasized that given the diversity among subwatershed communities and stakeholders, some of the recommendations have or are already being implemented while others will need to be implemented or are not applicable. Thus, not all objectives apply to all communities and stakeholders throughout the subwatershed; rather, the recommendations represent actions or practices that should be applied where feasible and appropriate to enable progress towards subwatershed goals. The following narrative presents a holistic strategy to meet and sustain the quantifiable TMDL target for Brighton Lake.

5.1.1 Structural Best Management Practices

Structural BMPs, or stormwater BMPs, are physical systems that are constructed for a development—new or existing—to reduce the stormwater impacts of development. These systems are variable in nature as they can be applied underground (e.g., catch basin inserts and in line storage vaults), or more commonly aboveground (e.g., engineered grass swales and constructed wetlands). However, some BMPs that work well in new or urbanizing areas (e.g., detention basins) may not be feasible for application in older developments. Consequently, each land area offers unique opportunities for BMP selection.

Structural Stormwater BMPs are traditionally focused upon capturing and treating runoff from

an entire drainage area or development. However, there are many structural BMPs available for application at individual home sites, most of which are designed to reduce stormwater runoff via capture and later use by homeowners or via enhanced onsite infiltration. Examples of such practices include rain barrels (cistern), rainwater gardens, concrete grid walkways, green roofs, and dispersion trenches. These types of BMPs hold the most promise in older development areas where space is limited (e.g., cities and villages) but can be effectively employed in newer developments as well. Appendix F provides information on these options.

Because the application of individual homeowner BMPs can sometimes be variable and with uncertain pollutant removal rates, drainage area or development-based structural BMPs were the main focus of the effort to demonstrate the ability to meet the established TMDL phosphorus reduction goal of 16%. In certain existing urbanized areas and for new developments, structural BMPs can be implemented to address a range of water quantity and quality considerations. These practices are the focus of this plan for meeting the TMDL for Brighton Lake because the effect of these physical systems' pollutant removal efficiencies have been quantitatively measured by monitoring inflow and outflow variables. However, the importance of individual homeowner BMPs should not be discounted, and recommendations for their use are summarized in Section 6.7.

There are a number of factors involved when selecting the appropriate structural and non-structural BMPs or combinations (i.e., treatment trains) of BMPs for an area or community. It is important to note that when selecting an approach, all the factors must be adequately considered and addressed so that BMPs will most likely result in the intended improvements. These factors include maintenance, land requirements, community acceptability, upstream conditions, etc.

5.1.2 Non-Structural Best Management Practices

Non-structural BMPs include institutional, educational, regulatory, and pollution prevention practices designed to prevent pollutants from entering stormwater runoff or reduce the volume of stormwater requiring management. These BMPs include educational programs, public involvement programs, enhanced land use planning, natural resource protection, site design standards, municipal good housekeeping operation and maintenance, or any other initiative that does not involve designing and building a structural stormwater management mechanism.

The pollutant removal efficiency of the majority of non-structural BMPs is very difficult to measure quantitatively. However, these BMPs are vital to sustaining water quality improvements, building public awareness, and enhancing the knowledge of watersheds. Therefore, non-structural BMPs are vital to this subwatershed plan.

The non-structural BMPs outlined in this document center on providing an action plan to address the major concerns for the subwatershed as identified by the Workgroup and is presented in Section 4.2.

5.2 Phasing and Sequencing of Recommendations

The sequence of the implementation of structural or non-structural BMPs is often based on several considerations, such as fiscal constraints, potential effectiveness, degree of difficulty or planning required, community acceptability, political realities, and ecological factors. The consideration of how various methodologies can or will be sequenced over time either independently or in relation to one another is critical to the successful planning and implementation of either type of BMP to satisfy subwatershed goals.

In order to devise a general schedule of implementation, recommendations in this plan were categorized under three major phases which are listed below. The presented sequence of implementation is intended to act only as a guide for communities and other participants, and as such, can be altered as opportunities arise.

- **Phase I.** Represent activities that can be initiated with little or moderate planning or start-up, require minimal cost, and address sources and causes of water quality problems. Usually non-structural or educational in nature. Examples include education programs, standards adoption, and some master plan revisions/updates. Actions under this category may be completed in 1 to 3 years; however, certain actions may require continual implementation.

- **Phase II.** These actions require significant planning and development, detailed design specifications, require moderate to high costs, and address sources/causes. Can be non-structural or structural in nature. Examples include new projects/programs, pilot projects or demonstration sites, studies, and design and construction of structural BMPs. Actions under this category may be completed in 2 to 5 years; however, certain actions may require continual implementation.

- **Phase III.** Activities where successful implementation may rely on previously employed actions/programs, typically structural in nature. Examples include instream and streambank restoration projects, lake treatment techniques, and nutrient/sedimentation reduction techniques such as dredging. Actions under this category may be completed in 4 to 8 years; however, certain actions may require continual implementation.

See Table 7 for the assigned phase for each recommendation in this plan, whether structural or nonstructural.

Table 7. Matrix of Actions for the Brighton Lake Subwatershed Plan

Potential Action	Primary Goals Addressed	Phase*			Intended Participants								Subwatershed-wide Estimated Cost per Category***
							Livingston County			State			
		I	II	III	Local Governments	HHSC**	Drain Commission	Health Department	Road Commission	MDOT	MDEQ	MDNR	
PART I. ACTION PLAN TO ATTAIN TOTAL MAXIMUM DAILY LOAD—STRUCTURAL BEST MANAGEMENT PRACTICES (BMPS)													$1.8–$226 Million****
Stormwater Best Management Practices													
Implementation of Structural BMPs Retrofit Recommendations	--			X	X	X	X		X	X	X		
Individual Homeowner Structural BMP Recommendations	--			X	X	X	X						
PART II. ACTION PLAN TO ADDRESS SUBWATERSHED CONCERNS AND GOALS													400,000--$800,000
Nonpoint Source Pollution Reduction Actions													
Community Land Use Planning and Design Standards													
Revision of Community Master Plans	1		X		X	X							
Environmental Advisory Team and Task Force	1	X			X	X							
Education Plan and Program Implementation	1, 6, 7, 9, 11	X			X	X	X	X	X	X	X	X	
Implementation of Low Impact Design Principles	2		X		X	X	X	X	X				
Water Quality-Based Stormwater Standard	2		X		X	X							
Enhanced Site Plan Review Requirements	2	X			X	X							
Enhanced Site Plan Review Tallysheet	3, 4	X			X	X			X				
Water Efficiency Policies for Commercial Landscaping	2		X		X	X							
Fertilizer Application Standards or Resolution	2		X		X	X			X	X		X	
Impervious Surface Limitations	3, 4		X		X	X							
Reduction of Parking Lot Minimums, Size, and Design	3, 4		X		X	X							
Private Roads Ordinance	3, 4	X			X	X							
Private Drive Standards	3, 4	X			X	X	X	X	X				
Promotion of Conservation or Cluster Subdivisions	3, 4	X			X	X							
Habitat Loss and Fragmentation Actions													
Open Space Fragmentation													
Education Plan and Program Implementation	1, 6, 7, 9, 11	X			X	X	X	X	X	X	X	X	
Natural Features Mapping Initiative	8		X		X	X						X	
Natural Features Setback Standard	8		X		X	X							
Floodplain Management Mapping and Standards	8			X	X	X	X				X		
Wetland Stewardship Ordinance	8		X		X	X							
Establishment of a Conservation Task Force	8	X			X	X						X	
Impaired Decentralized Onsite Disposal Systems and Illicit Connections													
Decentralized Wastewater Treatment and Illicit Connections													
Education Plan and Program Implementation	1, 6, 7, 9, 11	X			X	X	X	X	X	X	X	X	
Program for Periodic and Time of Sale Septic System Inspection	9			X	X	X	X	X					
Illicit Connection Detection and Elimination Initiative	10			X	X	X	X	X					
Other													
Monitoring Data and Programs													
Development of a Coordinated Subwatershed-wide Volunteer Monitoring Program	11		X		X	X	X	X			X	X	
Creation of a Lake and Creek Drainage Area planning and Protection Service	11		X			X					X		
Establishment of a Water Quality Task Force	11	X			X	X	X	X			X	X	
Expansion of HRWC Stewardship Network	12	X			X	X	X	X					
Education Plan and Program Implementation	1, 6, 7, 9, 11	X			X	X	X	X	X	X	X	X	
Watershed Education													
Education Plan and Program Implementation	1, 6, 7, 9, 11	X			X	X	X	X	X	X			
PART III. STRATEGIES FOR WATERBODY SPECIFIC RESTORATION													$200,000--$300,000
Waterbody Specific Restoration	--			X	X	X	X				X	X	
PART IV. STRATEGIES TO INFORM AND EDUCATE THE PUBLIC													$170000--$320,000
Education Plan and Program Implementation	1, 6, 7, 9, 11	X			X	X	X	X	X	X			

* Implementation
** Huron Headwaters Steering Committee
***Majority of monies expected from grants
****See *Stormwater BMP Prioritization Analysis for the Kent and Brighton Sub-basins, Oakland and Livingston Counties, Michigan.* 2002. By Tetra Tech MPS for more information.

CHAPTER 6. PART I—ACTION PLAN FOR STRUCTURAL STORMWATER BEST MANAGEMENT PRACTICE IMPLEMENTATION

Subwatershed communities are faced not only with the daunting task of reducing the current level of phosphorus loads to these lakes, but they must also plan to maintain these lower annual loads as population in the subwatershed continues to increase and as land cover continues to change.

Stormwater retrofits—the addition of new, or the modification of existing, stormwater management infrastructure where little or no stormwater quality treatment existed previously—can help reduce pollutant loads, minimize accelerated channel erosion, improve aquatic habitat, and correct past mistakes. The variety of available BMPs generally allows for the use of some form or another in most locations. Because many stormwater BMPs can help attenuate the hydrologic modifications caused by urban stormwater runoff and water quality impacts, retrofits can also be viewed as a means of ensuring the success of other habitat improvement or restoration efforts.

The principal goals of the analysis were to (1) identify possible stormwater retrofit options for developed areas of the Brighton Lake Subwatershed, (2) to determine if TMDL phosphorus reduction targets could be met using these stormwater BMP retrofits and, if so, (3) to compare various BMPs for their cost effectiveness in meeting TMDL targets. While these analyses do not determine the optimal mix of BMPs to implement or specific locations for use in the subwatershed, they do provide guidance with which communities may identify retrofit opportunities and determine which BMPs may be best applied.

The following represents major findings and recommendations by TTMPS for the Brighton Lake Subwatershed. The full report can be found in Appendix D.

6.1 Structural Stormwater BMP Matrix

We conducted a literature search and review of Internet databases to collect information regarding common structural stormwater BMPs as an initial step for further modeling and BMP prioritization. Information collected on various BMPs included:

- Site constraints and space and soil requirements;
- Reported pollutant removal efficiencies for individual water quality parameters;
- Required maintenance activities;
- Construction and maintenance costs;
- Safety concerns and mitigation measures;
- Design considerations.

The information collected as part of this literature and database review was summarized in a spreadsheet matrix. An early draft of this matrix was presented to members of the Brighton Lake Subwatershed Workgroup on March 14, 2001. A revised final version of the matrix is provided

as Appendix D. It should be noted that information regarding the pollutant removal efficiency, costs, and designs of structural stormwater BMPs is constantly evolving and improving. As a result, information contained in this matrix is dynamic and therefore subject to evolution.

6.2 Windshield Surveys of Existing Stormwater Infrastructure

Site visits (referred to here as "windshield surveys") to select areas of existing development within the subwatershed were conducted to identify possible retrofit opportunities and to select BMPs to include in further modeling. A preliminary review of watershed maps and known areas of older, pre-existing urban and suburban developed areas was conducted prior to site visits to identify potential locations for assessment. TTMPS then toured areas of the subwatershed on May 15, May 16, and June 27, 2001, to view drainage patterns, existing stormwater conveyance and treatment infrastructure, and outlets to surface waters, and to identify which types of BMPs might be utilized to improve stormwater treatment in these areas.

The urban and suburban land uses in areas visited during these site visits were primarily developed before any local or countywide requirements for stormwater detention existed. Some areas of newer housing development were included. The following communities were included in the windshield surveys, and specific areas of concern within each are listed:

Brighton Township

- Residential housing abutting Woodland Lake

City of Brighton

- Grand River Avenue Commercial developments
- Residential streets off Brighton and Brighton Lake Roads

Genoa Township

- Residential streets both sides of Brighton Road

These areas were not intended to represent the worst or the only areas in need of stormwater infrastructure retrofits. Instead they were investigated to provide a representative overview of the kinds of existing infrastructure, the opportunities for alteration of the existing infrastructure, and the possibility of adding new stormwater treatment facilities/technologies.

6.2.1 Windshield Survey Findings

The areas surveyed included subdivisions (built primarily between 1950 and 2001), lakeshore properties (built between 1950 and 2001), residential neighborhoods in city and village centers (some pre-dating 1950), and commercial and industrial city and village center properties (built between 1950 and 2001). These areas exhibited a variety of stormwater drainage and detention infrastructure, including:

- Residential areas with no coordinated grading patterns or drainage systems,
- Residential and commercial zones with large expanses of grassed and/or paved surfaces draining directly to adjacent wetlands, lakes, streams, or to South Ore Creek directly,

- Residential neighborhoods drained by traditional grassed ditches, and
- Piped storm systems with outfalls in extended wet detention basins and/or natural wetland, lake, or stream systems.

However, observations indicate that detention, and even cohesive drainage patterns through large sections of a single subdivision development, are the exception rather than the rule. Stormwater conveyance infrastructure was either (1) non-existent, or consisted of (2) grassed ditch systems within residential housing developments, (3) roadside ditch cuts (dirt or vegetated and un-maintained), and (4) piped curb and gutter system. These systems are generally designed only for the conveyance of stormwater runoff and few of the systems observed included infrastructure designed to treat and remove stormwater pollutants. Some of these systems, as currently designed and maintained (e.g., bare soil ditch cuts or eroding grassed ditches on inappropriate slopes) likely add suspended solids and adsorbed nutrients to stormwater flows.

As is the case in most urban areas, there is relatively little room in many of the residential and commercial sites surveyed for adding stormwater infrastructure. In locations where grassed ditch systems already exist, end-of-pipe detention or treatment systems may need to be constructed at several locations because areas where the ditch system encompassed and collectively drained large portions of a given development were seldom found. Creating regional detention or linear collection and conveyance systems would, in most cases, require significant grading and earth-moving.

Use of "ecological infrastructure" was extensive and notable. Outlets of many of the observed stormwater systems discharge directly to small pocket wetlands or larger wetland/riparian systems. This pattern spans the entire period of development from pre-1950 through the 1990s and includes the outlets of grassed ditches, roadside ditch cuts, and curb and gutter systems. It is especially notable that even in the more recently developed areas, the predominant form of stormwater capture and treatment involves conveyance and discharge to local wetland resources. The extensive use and availability of wetlands is likely a major factor in the sustained overall quality of the subwatershed, despite the heavy development pressure surrounding many of its waterways. However, the use of these systems denotes the failure of both local and state permitting practices to require pre-treatment prior to discharge. Studies show that natural systems receiving stormwater runoff in this fashion experience marked declines in plant and wildlife diversity and habitat quality over time.

6.3 Sub-basin Analysis

In order to initiate the process of establishing structural BMP recommendations to meet the TMDL target, information described in part in Section 6.2 and sub-basin use/land cover composition was summarized and reviewed. MIRIS land use codes were combined into the following four categories in preparation for BMP economic optimization modeling (described below):

- Residential
- Commercial and Industrial (including transportation and extractive uses)
- Agriculture
- Forest/Open (including wetlands and water)

Summary percentages for each of these land use categories were compared as part of the process used to prioritize sub-basins for BMP modeling analyses. For the economic optimization modeling, sub-basins were labeled urban, urbanizing, or agricultural based in part on these land use summaries. Areas of dense, primarily older, residential lands in urban centers (e.g., the City of Brighton) were identified as urban, whereas sub-basins dominated by residential and/or commercial and industrial land uses, without such urban centers, were labeled as urbanizing. Tables 8 describes the land use composition of each sub-basin. The data presented here are from 1995 aerial photos. Changes in land use and/or land cover since that time will not be captured in these statistics.

Table 8. Brighton Lake Sub-basin Land Use/Land Cover Composition.

	Residential		Commercial/Industrial		Agriculture		Open/Forest		
Sub-basin	***Acres***	***Percent***	***Acres***	***Percent***	***Acres***	***Percent***	***Acres***	***Percent***	***Total Acres***
1	16.8	11.30	0	0	0	0	131.6	88.70	**148.4**
2	60.8	13.85	0	0	0	0	378.1	86.15	**438.9**
3	176.2	26.41	32.5	4.87	15.0	2.25	443.4	66.48	**667.0**
4	82.3	20.15	9.9	2.41	49.1	12.01	267.3	65.42	**408.6**
5	90.0	20.92	12.5	2.91	66.2	15.38	261.6	60.79	**430.4**
6	206.5	37.41	0	0	12.4	2.25	333.1	60.34	**552.1**
7	140.2	30.26	1.9	0.40	97.2	20.98	224.0	48.36	**463.3**
8	336.2	31.79	95.8	9.06	29.1	2.75	596.3	56.39	**1057.4**
9	44.0	12.66	45.2	13.03	0	0	257.9	74.31	**347.1**
10	167.6	46.56	98.6	27.40	0	0	93.7	26.04	**359.9**
11	217.8	35.70	69.8	11.44	0	0	322.6	52.86	**610.2**

6.4 Structural Stormwater BMP Selection

BMPs were selected for inclusion in the modeling analysis based upon discussions between TTMPS and HRWC, observations made during the watershed windshield surveys, and on the availability and quality of pollutant removal efficiency and cost data for individual BMPs found during literature and database searches as presented in the BMP matrix (Appendix D). BMPs assessed in the modeling analyses included a mix of both common BMPs and BMPs not observed in the subwatershed, but deemed suitable for retrofit applications given the landscape and existing infrastructure observed during the windshield surveys.

BMPs were compared as stand-alone practices, where appropriate, and in series as "treatment trains." Treatment trains combine two or more treatment systems or technologies for added pollutant removal. Infiltration trenches were not considered as a stand-alone practice due to the particular needs of that technology. Suspended solids in the influent stream tend to clog and limit the efficacy and longevity of infiltration systems. The use of infiltration trenches was considered among the treatment train options with appropriate pre-treatment for solids reduction.

Additional information on each BMP can be found at:

http://www.tetratech-test.com/bmpmanual/htmfolder/menu.htm

Based on a review of stormwater management literature and discussions between TTMPS and HRWC, the following eight BMPs were evaluated further for their relative cost-effectiveness:

6.4.1 Extended Wet Detention Basins

Wet ponds, or extended wet detention basins, are constructed basins designed to contain a permanent pool of water. Wet basins primarily remove pollutants through settling as stormwater runoff resides in this pool. Pollutant removal, particularly of nutrients, is also provided through biological activity in the pond. Wet ponds are among the most cost-effective and widely used stormwater practices.

6.4.2 Constructed Wetlands

Stormwater wetlands, or constructed wetlands, are similar to wet ponds but incorporate wetland plants into the design and are generally shallower in depth. As stormwater runoff flows through the wetland, the wetland plants dissipate velocities for increased settling and provide additional biological uptake. Stormwater wetlands exhibit some of the highest pollutant removal efficiencies since they are designed specifically for the purpose of treating stormwater runoff. While such wetlands typically contain less diverse plant and animal communities than natural wetlands, they can still provide secondary aesthetic and wildlife habitat values.

6.4.3 Grassed Channels

Grassed channels and dry swales are open channel management practices designed to treat and attenuate stormwater runoff. As stormwater runoff flows through these channels, it is treated through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. The specific design features and methods of treatment differ between these designs, but both are improvements on the traditional drainage ditch and are well suited for treating highway or residential road runoff. Grassed channels are the most similar to a conventional drainage ditch, with the major differences being flatter side and longitudinal slopes and a slower design velocity for water quality treatment of small storm events. The type and coverage of vegetation grown in the swales will influence pollutant treatment. Pollutant reduction values in this analysis assume the use of well-established turf grasses consistent with traditional residential settings. Other plantings may provide greater pollutant reduction, but may also alter conveyance hydraulics.

6.4.4 Engineered Dry Swales

Dry swales incorporate porous soil and underdrain systems (usually perforated pipe) within a grassed channel system, making them similar in design to bioretention areas. Stormwater is initially treated as it flows through the soil bed. The underdrain system conveys this treated stormwater to the storm drain system and allows for further percolation into native soils. While dry swales are a relatively new design, studies suggest high pollutant removal.

6.4.5 High Efficiency Street Sweeping

High efficiency street sweeping is a management measure that involves pavement cleaning practices on a regular basis to minimize pollutant export to receiving waters. These cleaning practices are designed to remove sediment debris and other pollutants from road and parking lot surfaces that are a potential source of pollution impacting urban waterways. Performance monitoring for the Nationwide Urban Runoff Program (NURP) in the early 1980s indicted that street sweeping was not very effective in reducing pollutant loads. However, recent improvements in street sweeper technology (e.g., regenerative air or vacuum assisted systems) have enhanced the ability of the current generation of street sweeper machines to pick up the fine grained sediment particles that carry a substantial portion of the stormwater pollutant load. Many of today's sweepers can now dramatically reduce the amount of street dirt entering streams and rivers. Street sweeping is recommended in cold climate areas during, or prior, to spring snowmelt as a pollution prevention measure.

6.4.6 Infiltration Trenches

An infiltration trench is a rock filled trench with no outlet that receives stormwater runoff. Stormwater runoff must pass through a pre-treatment measure, such as a swale or detention basin, to remove or reduce the amount of suspended solids prior to reaching the infiltration trench. Within the trench, runoff is stored in the voids of the stones and infiltrates through the bottom where it is again filtered by the underlying soils.

6.4.7 Bioretention

Bioretention areas are landscaping features commonly located in parking lot islands or within small pockets of residential land uses that are adapted to provide on-site treatment of stormwater runoff. Surface runoff is directed into shallow, landscaped depressions where it pools above the mulch and soil in the system, then filters through the mulch to underdrain systems and a prepared soil bed. Typically, filtered runoff is collected in a perforated underdrain and returned to the storm drain system. Emergency overflow outlets are provided to direct flows in excess of the system's capacity to the stormwater conveyance system during large storm events.

6.4.8 Catch-basin Inserts

A catch-basin is an inlet to the storm drain system that typically includes a grate or curb inlet and a sump to capture sediment, debris, and associated pollutants. A number of proprietary technologies are now available to augment the pollutant capture of these systems. These technologies generally employ additional sump chambers to enhance the capture of solids, and many employ filtering media to capture additional pollutants or fractions of the pollutant inflows. The generic term "catch-basin inserts" is used here to describe a variety of in-sump or in-line designs.

6.5 Spreadsheet Model Development for BMP Comparison

A spreadsheet model was developed to estimate and compare annual pollutant load reductions for various BMP scenarios. Land use data for the direct drainage portions of each sub-basin modeled pollutant load estimates for each residential or commercial and industrial land use code within each sub-basin provided by the HRWC. BMP specific phosphorus removal efficiency data were used to calculate estimated reductions in annual loads of total phosphorus.

Phosphorus removal efficiencies for each BMP were assigned based on information included in the USEPA BMP Menu website (http://www.epa.gov/npdes/menuofbmps/menu.htm), and the range of phosphorus removal efficiencies found in the literature search and recorded in the BMP Matrix (Appendix D). Although many of these BMP technologies remove a variety of pollutants to varying degrees, total phosphorus was selected as the variable for analysis based on the TMDL targets established for Brighton Lake.

Cost data, like the values for phosphorus removal efficiencies, were based on the USEPA BMP Menu website and the range of costs found in our literature search and recorded in the BMP Matrix. Cost estimates for high efficiency street sweeping, on a monthly basis, were taken from a study conducted in Jackson County, Michigan. Cost values or formulas for the various BMPs are shown in Table 9. Methods described in the most recent Procedures & Design Criteria for Subdivision Drainage in Oakland County (OCDC, 1974) were used to determine the volume requirements of extended wet detention basins and constructed wetlands. Pollutant removal estimates and cost calculations are presented in the spreadsheet model output. See Appendix D for more information.

Table 9. Model Inputs and Assumptions for BMP Spreadsheet Analysis.

Best Management Practice (BMP)	*Phosphorus Removal Efficiency (%)*	*Construction Costs* *Dollars*	*Annual Maintenance Costs* *Dollars*
Wet Detention Basins[1]	48	$24.5V^{0.705}$	5% construction cost
Constructed Wetland[2]	51	$30.6V^{0.705}$	5% construction cost
Grassed Channels[3]	29	\$0.65 per ft^2	N/A
High Efficency Street Sweeping[4]	30	\$250,000 per Sweeper Purchased	\$940
Catch-basin Inserts[5]	17	\$19,750	\$300
Bioretention Islands[6]	76	$7.30V^{0.99}$	20% construction cost
Infiltration Trenches[7]	65	\$5 per ft^3 treated	20% construction cost
Engineered Dry Swales[3]	65	\$5.50 per ft^3 treated	N/A

V= Volume

References for Phosphorus Removal Efficiency and Cost Data:

1 http://www.tetratech-test.com/bmpmanual/htmfolder/post_26.htm
2 http://www.tetratech-test.com/bmpmanual/htmfolder/post_27.htm
3 http://www.tetratech-test.com/bmpmanual/htmfolder/post_24.htm

4 TTMPS (Tetra Tech MPS), 2001. Quantifying the Impact of Catch Basin Cleaning and Street Sweeping on Storm Water Quality for a Great Lakes Tributary: A Pilot Study. Project report for the Grand River Inter-County Drainage Board, September 2001.
5 Claytor, R.A. 1999a. Performance of a Proprietary Stormwater Treatment Device: The Stormceptor. Watershed Protection Techniques, 3(1): 605-608. Center for Watershed Protection, Ellicott City, MD.
6 http://www.tetratech-test.com/bmpmanual/htmfolder/post_4.htm
7 http://www.tetratech-test.com/bmpmanual/htmfolder/post_14.htm

6.6 Results and Recommendations for Structural Stormwater BMP Employment

It is important to note that the results of this investigation do not provide a detailed blueprint or identify the specific location, for individual retrofit applications. However, the results do provide information that can be used to develop further strategies to reduce phosphorus loads to the upper Huron through the use of stormwater infrastructure retrofits.

The analysis shows that TMDL targets for reducing overland phosphorus import to Brighton Lake can be met given sufficient retrofit opportunities. However, the cost and the number of required treatment units (individual BMPs) or equivalent acreage of drainage area required are high (See Spreadsheet Model of BMP Analysis and Comparison—Brighton Lake Residential and Commercial Land Use as presented in "Appendix C" in TTMPS report, included as Appendix D of this document).

Results of this analysis lead to the following conclusions:

A. In the Brighton Lake Subwatershed, the use of extended wet detention basins, grassed channels, constructed wetlands, and the combinations of catch-basin inserts discharging to wet ponds, and grassed channels discharging to ponds, allow communities to reach phosphorus reduction targets at the lowest construction cost.

B. The relative ranking of costs, however, differs slightly. For instance, commercial land use applications in the subwatershed followed the ranking presented in A, in order of increasing construction cost. For residential land use only BMP applications, however, TMDL targets can be met at the lowest cost with the use of extended wet detention basins, constructed wetlands, the combination of catch-basin inserts discharging to extended detention wet ponds in a treatment train series, the combination of grassed channels discharging to wet ponds, and grassed channels (in order of increasing construction costs).

C. The combinations of BMPs when applied as treatment trains (i.e., several practices in series) listed in A, although generally higher in cost, result in higher pollutant removal efficiencies and, as a result, may require fewer applications. Because the number of retrofit opportunities and the amount of available land are limited, application of these combinations, when possible, is recommended to take advantage of the reduction in required applications.

D. Lower implementation costs of non-construction options (e.g., street sweeping, catch-basin inserts, etc.) cannot offset the poorer treatment efficiencies of these technologies. These technologies, however, hold a great deal of promise and should be considered as part of the toolkit that communities can draw upon, to reduce pollutants and prevent further impairment.

E. Although a mix of commercial, industrial, and residential land applications is recommended, phosphorus reduction targets can be met at a slightly lower cost by focusing retrofit applications within commercial and industrial properties, as land and opportunities allow

With the information provided in this report, community and watershed planners can now begin the process of identifying specific locations where individual stormwater controls may be added to the developed landscapes of the subwatershed, and identifying locations, planned for redevelopment. The following table is excerpted from retrofit suggestions from the Center for Watershed Protection (CWP, 2000):

Table 10. Potential Structural Stormwater BMP Retrofits based on Existing Condition or Potential Location.

Condition/Location	*Type of Retrofit*
Existing stormwater detention facilities	*Can be retrofitted to a wet pond or stormwater wetland*
Immediately upstream of existing road culverts	*Can be retrofitted to a wet pond or stormwater wetland*
Immediately below or adjacent to existing storm drain outfalls	*Retrofit to water quality BMPs, such as sand filters, vegetative filters or other small storm treatment facilities*
Directly within urban drainage and flood control channels	*Addition of small-scale weirs or other flow attenuation devices to facilitate settling of solids within open channels*
Highway rights-of-way and cloverleaves	*Variety of options, but usually application of stormwater ponds or wetlands*
Within large open spaces, such as golf courses and parks	*Variety of options, but usually application of stormwater ponds or wetlands*
Within or adjacent to large parking lots	*Retrofit to water quality BMPs, such as sand filters or other organic media filters (e.g., bioretention)*

To implement these recommendations in a coordinated and cost-efficient manner, the following implementation process should be employed by all communities within the Brighton Lake Subwatershed with involvement of the Huron Headwaters Steering Committee (see Chapter 10):

1. **Identify Specific Locations per Sub-basin.** Identify retrofit opportunities in both commercial and residential land settings, based upon sub-basin load weighting and with an emphasis on commercial land applications, where possible. Local investigations, to identify specific retrofit opportunities in each of the critical sub-basins and land use types, would also yield site specific information (e.g. available area, soils, slopes, availability of existing infrastructure, etc.) that could then be used, along with the cost data to determine which technology was best suited to each retrofit opportunity. Similarly, the remaining sub-basins and land use types can be ranked in the order of pollutant removal cost-effectiveness and opportunities identified. The spreadsheet model (see Appendix D) provided can be adapted to calculate and compare costs and pollutant load removals as additional opportunities and technologies are selected.

2. **Determine Retrofit Options based on Model Results.** In drafting specific retrofit plans, planners should look first to opportunities provided on commercial and industrial land within the directly connected drainages in the subwatershed (Figure 9). Retrofit opportunities for the most cost-effective BMP technologies—extended wet detention basins, grassed channels, constructed wetlands, and the combined treatment trains of catch-basin inserts discharging to extended wet detention basins, and grassed channels discharging to wet basins—will likely be limited. Specific residential land applications will also need to be identified. Results suggest that a strategy that maximizes commercial land retrofit applications will achieve desired phosphorus removals at a slightly lower cost. Extended wet detention basins, grassed channels, or constructed wetlands employed singly, or the combinations of catch-basin inserts discharging to extended wet detention basins, and/or grassed channels discharging to wet basins are the most cost-effective BMPs of those reviewed. Individual site requirements and community preferences will require a mixture of these technologies to meet TMDL pollutant load reductions. Combinations of BMPs (treatment trains) will reduce the amount of land that must be converted with stormwater treatment retrofits. Also, retrofits should take advantage of existing infrastructure where possible. Finally, retrofits in the immediate drainage areas of the subwatershed will benefit both the adjacent lake(s) and the downstream receiving waters of the subwatershed. Part of this process should include public participation.

3. **Revise municipal policies and procedures.** All subwatershed communities should revise or initiate programs that trigger reviews for potential retrofit opportunities. For example when a parking lot for an existing commercial development is set for redevelopment or extensive maintenance, a community program that reviews and promotes stormwater BMP retrofits will precipitate application.

4. **Retrofit plans should take advantage of existing infrastructure:** Nestled within the subwatershed are numerous other lakes, many of them surrounded by older residential housing development. As recorded during the windshield surveys, many of these older neighborhoods have some form of existing grassed ditch systems to convey stormwater runoff from roads and lawns, but little or no infrastructure to treat the collected stormwater runoff and remove pollutants. These grassed ditch systems could be

re-engineered as grassed channel or dry swale systems (e.g., to include under-drains, check dams, proper grades, etc.) to provide improved stormwater treatment and pollutant removal. Likewise, in some locations where adequate land is available, additional treatment from small, extended wet detention basins, constructed wetlands or some other treatment technology may also be added for improved pollutant removal. BMP placement in these locations, where feasible, will not only help achieve the phosphorus reduction target for Brighton Lake but could also improve water quality in these other individual lakes and stream segments. This would not only multiply the water quality benefits, but could also assist in building grassroots support for further retrofits and other subwatershed improvements.

Although extended wet detention basins, grassed channels, constructed wetlands, and the combined treatment trains of catch-basin inserts or grassed channels to wet basins were shown to be the most cost-effective technologies for the focus of retrofit planning, other BMPs investigated should not be summarily dismissed. Catch-basin inserts, infiltration trenches, and bioretention systems all should be considered parts of the toolbox community planners have at their disposal to meet these goals. Infiltration and bioretention technologies should be considered, where applicable, for new development where it may be easier to incorporate the higher cost of these technologies. Demonstration projects, funded in part by grant dollars, may also be a means to develop these in retrofit situations. Catch-basin inserts, although providing lower phosphorus removal rates, do substantially reduce suspended solids, another significant pollutant within the Huron River system, and are ideally suited for retrofits in areas serviced by storm sewer systems where space is limited. Specific areas, such as commercial land uses in downtown Brighton could be specifically targeted for the use of some catch-basin insert technologies. Communities should also consider requiring some form of catch-basin treatment technology as a standard for new development. Additional BMP technologies of this sort for new development can help augment existing land use policies and diminish the cumulative hydrologic and water quality impacts of new development.

Despite the inability of non-structural BMP options, such as high efficiency street sweeping and catch-basin inserts, to achieve the targeted pollutant reductions in a cost-effective manner by themselves, these technologies hold a great deal of promise. TTMPS's investigation of higher efficiency street sweeping technologies in the Jackson, Michigan, area demonstrated that monthly sweeping can remove 50% of the street dirt solids now reaching streams through storm sewers. Application of this BMP technology may be most appropriate in the highly developed areas, such as the City of Brighton, but may also be viewed as an important component in the overall maintenance program for other BMPs. Removal, or reduction of solids, before they reach other BMP controls will increase the longevity and the efficacy of these other technologies.

It is important to note that there are currently no policies, programs, or regulatory mechanisms to trigger the implementation of retrofits for existing developments in the subwatershed. Communities are further recommended to review their policies for site redevelopment or the issuance of building permits for site improvements and build in checklists and requirements for evaluating stormwater retrofit opportunities to parallel the process of identifying specific, desired locations of potential retrofit opportunities.

6.7 Individual Homeowner Structural Stormwater BMP Options

The potential for water quality improvement via implementation of individual stormwater BMPs is enormous because of the thousands of homes in the subwatershed acting as nonpoint source pollution agents combined with aging stormwater infrastructure in many urbanized areas.

Homeowner-based stormwater BMPs, most of which are designed to reduce stormwater runoff via capture and later use by homeowners or via enhanced onsite infiltration, have several attractions. For instance, these practices can be readily applied in older development areas where space for drainage area BMPs is often limited. They are often low in cost, easily installed and maintained, and act as an educational vehicle for pollution reduction. Examples of such practices include rain barrels (cisterns), rainwater gardens, concrete grid (porous pavers) walkways, green roofs, and dispersion trenches. See Appendix F for more information on these alternatives. The Bay Area Stormwater Management Agencies Association presents additional alternatives in Start at the Source (1997).

6.7.1 Rain Barrels (Cisterns)

Rain barrels are containers located to receive stormwater runoff that has been collected via gutters from rooftops. In the past, the primary objective of rain barrels was to assist in the conservation of water, and while this benefit is still true, more recent uses have focused on reducing stormwater runoff from rooftops in urbanized areas. Numerous manufacturers and styles are available.

6.7.2 Rain Gardens

The term "rain garden" refers to a constructed depressional area that is used as a landscape tool to improve water quality. Typically these gardens are placed along impervious surfaces such as driveways, sidewalks, or below downspouts. Rain gardens are gardens designed to allow for increased infiltration and plant uptake of stormwater runoff. Plant choices should center on native wildflowers and grasses. With a little planning, a rain garden is as simple to establish and maintain as a traditional garden.

6.7.3 Porous Pavers

Porous pavers are permeable or semi-permeable surfaces that replace asphalt and concrete, usually on driveways or walkways. By replacing impervious surfaces, these pavers create less stormwater runoff. The two broad categories of alternative pavers are paving blocks and other surfaces including gravel, cobble, wood, mulch, brick, and natural stone.

6.7.4 Green Roofs

The green roof concept is akin to the popular, but traditionally heavy and difficult to maintain, garden roofs found atop buildings worldwide. Essentially, a green roof is the structural addition of plants over a traditional roof system. Green roofs offer reduced stormwater runoff and increased energy efficiency. In the past there were many concerns regarding the safety and durability of these structures; however, recent advances have dramatically and successfully addressed these concerns.

6.7.5 Dispersion Trenches

Dispersion trenches involve the creation of short, small, aggregate-filled areas designed to accept and infiltrate runoff from small outlet discharges such as gutters or downspouts or vegetative area of less than 50 linear feet.

Such practices hold promise for reducing the influence of stormwater in the subwatershed. But these practices will not become prevalent throughout the subwatershed area without coordinated and consistent programs. Therefore, this plan recommends that the homeowner-based Stormwater BMP Initiative (Section 9.5.2) be implemented throughout the subwatershed to reduce the effect of stormwater runoff from older developments where space is often limited, or to help further mitigate the impacts of new development. Initial efforts should focus on the urbanized areas such as the City of Brighton and residential areas around Brighton Lake, Long Lake, and Woodland Lake.

CHAPTER 7. PART II—ACTION PLAN TO ADDRESS SUBWATERSHED CONCERNS AND GOALS

This section of the subwatershed plan for Brighton Lake focuses on establishing a framework for addressing the concerns already noted in the area while minimizing the impact of future land use changes on water quality. In order to create the "toolbox" of recommendations and actions, Workgroup members informally discussed potential options and methodologies needed to address the major concerns for the subwatershed that the group identified.

It is important to note that many of the recommended actions addressed below are already in place in many of the subwatershed communities, to varying degrees. These communities may wish to review their existing programs or standards and revise as they see fit. In other cases,, model provisions are provided in the appendices of this document for communities that have no such existing program or standard.

One should also note that many of the recommendations set forth in this section require further and more advanced analysis before they can be applied and are, therefore, considered long-term. Under such circumstances, the formation of concern-specific task forces may be needed. The task forces will be coordinated by the Huron Headwaters Steering Committee (Committee) and will study and make specific policy or standards recommendations for the subwatershed on specific issues of concern. Participants in each task force can either be members of the Committee or a person appointed by a Committee member. Chapter 10 presents information on the purpose of the Huron Headwaters Steering Committee.

Actions to address probable pollutant sources and established concerns presented below are shown in Table 7 along with an assigned implementation phase. While phase assignment should not be considered absolute, it does provide general guidance on expected timeframes for initiating action.

7.1 Nonpoint Source Pollution Reduction Actions

7.1.1 Community Land Use Planning and Design Standards

Goal 1: Promote local site planning standards that foster stewardship, cluster and mixed land use design, and reduced open space fragmentation.

A. Revision of Community Master Plans (Phase II). A community's master plan lays forth the overall vision community leaders have established for the next 10 to 20 years. Unlike zoning ordinances, master plans are not a legal document; however, all zoning ordinances need to be consistent with master plans. Thus, the revision of such plans is often needed before adopting zoning changes.

i. Expand Plan Goals & Objectives Language—Based on Holly Township, Oakland County, Michigan. Provides basis for direction and character of future growth with an emphasis on preservation. Stated goals to "Protect, enhance, restore natural resources; retain community character; allow wide range of reasonable growth." Two major policies to include are Land Use (guidelines for location and type), and Natural Resource Capacity Analysis.

ii. Enhanced Supportive Background Information—Identification, mapping, and narrative review of community resources (e.g. surface waters, wellhead protection zones, floodplains, steep slopes, prime farmland, wetlands, woodlands, remnant prairies, land unsuitable for development, and other sensitive areas).

iii. Enhanced Land Use Maps—Based upon Supportive Background Information mapping results. Represents the basis for directing growth patterns and preservation with inclusion of community resource mapping results.

iv. Special Planning Areas Inclusion—Identification of areas of potential special protection given community significance, such as historical sites/farms, special MNFI sites, waterway zones, and greenways, with establishment of Conservation Overlay District.

The formation of these recommendations is based on the MSU Extension's Better Designs for Development in Michigan (http://www.msue.msu.edu/msue/aoe/landuse/BDBrochure.pdf) and the Shiawassee Huron Headwaters Resource Protection Project (http://www.co.oakland.mi.us/arc/c_serv/ced/products/bulletin/article1.html).
See Appendix G for guidelines.

B. Environmental Advisory Team per community and Task Force (Phase I). Establishes a committee populated by citizens to assist trustees, zoning administrators, zoning board of appeals, and planning commission on significant environmental issues. Possible duties include periodic assessment of the community's environmental quality, investigation/recommendation on measures to protect/restore sites, assessment of environmental impact from new developments, and coordination and involvement with Huron Headwaters Steering Committee. Appendix H provides the by-laws for such a committee and is based on Hamburg Township's Environmental Review Board and can be considered a blueprint for such a committee.

C. Education Plan and Program Implementation (Phase I). Audiences are to include local governments, riparian landowners, lake and home associations, commercial fertilizer applicators, businesses, home and garden center employees and customers (see Chapter 9). The plan includes programs on watershed issues for personal communication and passive media outlets. Task Force charged with implementation and refinement of the subwatershed education plan and programs.

Goal 2: Adopt local site design principles that consider both water quantity and quality impacts, and require that drainage and stormwater management solutions be developed with protection of receiving waterway quality and habitat value as the basis for design.

D. Implementation of Low Impact Design Principles (Phase II). Revision of community development design standards to reflect Low Impact Design (LID) or Development Principles. LID is a low cost alternative to traditional structural stormwater BMPs. It combines resource conservation and a hydrologically functional site design with pollution prevention measures to reduce development impacts to better replicate natural watershed hydrology and water quality. Through a variety of small-scale site design techniques, LID reduces the creation of runoff, volume, and frequency. Essentially, LID strives to mimic pre-development runoff conditions. This micro-management source control concept is quite different from conventional end-of-pipe treatment or conservation techniques. Less developed communities in the subwatershed should be especially interested in adopting LID principles. See Appendix I for more information.

E. Water Quality-based Stormwater Standard (Phase II). In response to the need for enhanced mitigation of the impacts of future impervious surfaces and resulting stormwater runoff, many communities have developed and adopted standards that control both the quantity and quality of stormwater that is permitted to leave a developed site. For instance, Salem Township, and the counties of Washtenaw and Wayne have embraced such standards. Communities in the less developed areas of the subwatershed or those adjacent to the river should be especially interested in this approach. The focus of this policy is to promote the use of natural drainage features for stormwater management, utilization of innovative stormwater practices, and the consideration of water quality in design and sizing criteria. This approach is particularly effective when applied in combination with LID principles. See Appendix J for the Salem Township, Washtenaw County, Michigan, ordinance.

F. Enhanced Site Plan Review Requirements (Phase I). Revision of community site plan review standards to include, if applicable, the 100-year floodplain, location of waterbodies and their associated watersheds, location of slopes over 12%, site soil types, location of landmark trees, groundwater recharge areas, vegetation types within 25 feet of waterbodies, woodlands and other vegetation on site, and site topography.

G. Enhanced Site Plan Review Tallysheet (Phase I). A nonbinding and nonregulatory scorecard for utilization by planning commission officials and Environmental Review Committee members which provides a general guidance on potential water quality impacts of proposed developments. Appendix K includes the High Point, North Carolina, approach which can be altered to community specific situations prior to incorporation.

H. Water Efficiency Policies for Commercial Landscaping (Phase II). Policy with the intent to guide the design, installation, and maintenance of commercial landscapes, so as to be both attractive and water efficient (Appendix L contains sample standard).

I. Fertilizer Application Standards or Resolution (Phase II). Program which outlines timing and placement (e.g., 25 feet) of fertilizer adjacent to any lake, stream, drain, river, wetland or natural waterway. Requires commercial applicators to take precautions against applying fertilizer to impervious surfaces like driveways or sidewalks, where the nutrients would simply runoff into storm sewers or nearby waterways. Based on West Bloomfield Township program. See Appendix M for illustrative policy.

Goal 3: Encourage local standards, strategies, and programs that prevent unnecessary addition of impervious surfaces.

Goal 4: Minimize the adverse effects from existing and future impervious surfaces via retrofitting activities and adoption of revised community standards.

J. Impervious Surface Limitations (Phase II). Consider the enactment of impervious limitations on a per development basis, based on the type of development proposed (e.g., commercial versus residential), or develop impervious surface limits or caps for different areas within the jurisdiction, as implemented in the Green Oak Township, Livingston County, Michigan Spring Mill Creek/Davis Creek Overlay District (Appendix N).

K. Reduction of Parking Lot Minimums, Size, and Design (Phase II). Consider revision of parking lot standards, both lot and space requirements, to reflect locally specific needs. Revise design standards to promote angled parking, water-efficient landscaping, and utilization of bioretention islands and other vegetative stormwater BMPs. See Appendix O for specific considerations.

L. Private Roads Ordinance (Phase I). Enact or revise private road ordinance that promotes narrow (i.e., traditional) road widths while enhancing rural character. Hamburg Township, Livingston County, Michigan, and Ann Arbor Township, Washtenaw County, Michigan have these ordinances (Appendix P).

M. Private Drive Standards (Phase I). Also referred to as access controls. Encourages the use of a common drive to serve multiple residences or businesses. The technique is also implemented as a traffic safety tool given the reduction of access points on major roads. Many standards also require parking lots to be located behind commercial buildings, thus improving the aesthetic design of commercial sectors. See Appendix Q for model language.

N. Promotion of Conservation or Open Space Subdivisions (Phase I). Recent state law now requires that communities have a form of conservation subdivisions as a development option. This development method allows for a plot of land to maintain density of the underlying zoning, but on smaller lots. Hamburg Township, Livingston County, Michigan, has a nationally recognized ordinance specific to non-sewer areas, while Ann Arbor Township's ordinance focuses on sewer developments. Both are presented in Appendix R.

7.2 Habitat Loss and Fragmentation Actions

7.2.1 Open Space Protection

Goal 5: Conduct on-going programs to raise the public and practitioners' awareness of the importance of wetlands and other natural features in watershed protection and nonpoint pollution.

O. Education Plan Implementation (Phase I). See above and Chapter 9.

Goal 6: Establish a mechanism towards greater coordinated protection and identification of wetlands and other natural features throughout the subwatershed.

P. Natural Features Mapping Initiative (Phase I or II). Expansion of Shiawassee Huron Headwaters Resource Preservation Project (S&H) methodology to subwatershed communities who did not participate in the initial program. Develops maps of important natural features maps, such as wetlands, lakes, streams, floodplains, steep slopes, woodlands, remnant prairies, and so on for incorporation into community Master Plans. See Section 2.4 for currently identified key natural areas protection opportunities.

Q. Natural Features Setback Standard (Phase I or II). To protect human health, welfare, and life from flooding, while benefiting the ecological quality wetlands and other watercourses via establishment of minimum setbacks. Ann Arbor and Superior Townships, Washtenaw County, Michigan are developing such standards. See Appendix S for model.

R. Floodplain Management Mapping and Standards (Phase III). To reduce hazards to persons and property as the result of flood conditions and to comply with the conditions of the National Flood Insurance Program. Superior Township, Washtenaw County, Michigan, has this standard. See Appendix T for model standard.

S. Wetland Stewardship Standard (Phase II). To protect human property and water quality and wildlife support properties of non-state regulated wetlands. Numerous townships throughout the area have wetland standards, such as the Townships of Ann Arbor, Genoa, West Bloomfield, Milford, White Lake, and the City of Wixom. See Appendix U for a model standard.

T. Establishment of a Conservation Task Force (Phase I). Coordinated by the Huron Headwaters Steering Committee, this Workgroup will bring together local officials, representatives from the local land conservancy and watershed council, concerned citizens and other partners to further identify natural resource corridors in the community, opportunities for preservation and restoration, and tools for implementation. Task Force to consider, promote, coordinate, and facilitate open space and natural features protection. Specific task force actions to include:

   i. Conservation Easement with Conservancies—This is a legal agreement a landowner

makes to restrict development on the property. Conservation easements are usually donated but may be purchased by Conservancies. The landowner retains ownership and conveys certain rights to Conservancies. Each conservation easement is specifically tailored to the individual parcel, landowner, and natural features being protected.

ii. Registry Program with Conservancies—Landowners who are concerned about preserving the natural features on their property, but are not ready to commit to more permanent protection measures, such as conservation easement, may be interested in registry. Registry is a listing of significant natural areas that are being voluntarily protected by their owners and keeps communication open between the landowner and Conservancies about future protection.

iii. Investigation into Open Space Acquisition Referenda—Many communities all over the country are successfully asking voters to designate public funds for open space protection. Funds may be used to purchase development rights that help farmers keep their land agricultural, protect forests and natural areas on urban fringes and rural areas, and create new parks.

7.3 Impaired Decentralized Onsite Disposal Systems (Septic Systems) and Illicit Connections

7.3.1 Decentralized Wastewater Treatment and Illicit Connections

Goal 7: Conduct on-going programs to raise the public and practitioners' awareness of the impacts of impaired septic systems on water quality and human health.

U. Education Plan and Program Implementation (Phase I). See above and Chapter 9.

V. Program for Periodic and Time of Sale Septic System Inspection Program (Phase III). Based on the Oakland County proposal and the Washtenaw and Wayne County Time of Title Transfer Programs. See Appendix V.

Goal 8: Establish a mechanism towards identification and correction of illicit connections within critical areas of the subwatershed.

W. Illicit Connection Detection and Elimination Initiative (Phase II). Initiative will focus on establishing areas of concerns for such connections via Water Quality Task Force facilitation. Based on the existing Drain Commissioner's Office of Oakland County's Illicit Discharge-Elimination Program whose goal is to rectify such connections throughout communities via identification and correction in critical areas. Primary focus will be placed on existing urbanized areas of the subwatershed and those communities under NPDES Phase II requirements.

7.4 Other

7.4.1 Monitoring Data and Programs

Goal 9: Establish a mechanism towards greater coordination and promotion of water quality monitoring and assessment throughout the subwatershed.

X. Development of a Coordinated Subwatershed-wide Volunteer Monitoring Program (Phase II). Conceived on the River Watch Network Two-Tiered Approach of watershed and segment specific targeted monitoring. Program to promote expansion of the Huron River Watershed Council's Adopt-A-Stream Program to include sampling stations upstream of Brighton Lake, expansion of the Michigan Lakes and Streams Association Cooperative Lakes Monitoring Program to the majority of lakes with the subwatershed, and increased dialogue and coordination with MDEQ on continued regular monitoring of TMDL sampling stations.

Y. Creation of a lake and creek drainage area specific planning and protection service (e.g., lake wide and creekshed management plan development) (Phase II). A program of guidelines and services that may center on the study and establishment of critical lake nutrient concentration and loading levels in conjunction with direct drainage area protection and restoration planning.

Z. Establishment of a Water Quality Task Force (Phase I). Populated by Huron Headwaters Steering Committee members, concerned citizens, and scientists tasked with the exploration, implementation, and coordination of the aforementioned activities and site selection and implementation of certain structural stormwater BMP recommendations and restoration activities.

Goal 10: Conduct on-going programs to raise the public and practitioners' awareness of volunteer monitoring activities, watershed protection, and nonpoint pollution issues.

AA. Expansion of the Huron River Watershed Council's Stewardship Network (Phase I). Currently limited in geographical scope, the Network brings together volunteer stewards from around the Huron River Watershed to share their experiences and learn from each other about how to protect and restore natural areas in and around their neighborhoods. Volunteers study creeks, remove invasive species, collect seed from native plants, map the land around waterways, burn prairies, and participate in many other activities that are as varied as the participants.

BB. Education Plan and Program Implementation (Phase I). See above and Chapter 9.

7.4.2 Watershed Education

Goal 11: Enhance riparian landowner, public, local government, and builder knowledge and nonpoint source, watershed, and water quality issues and concerns.

CC. Education Plan and Program Implementation (Phase I). See above and Chapter 9.

7.5 Summary of Potential Task Forces and Intended Actions

The Brighton Lake Subwatershed includes a diverse range of community types, from areas that are somewhat rural to urban centers. Consequently, no one set of recommendations can or should apply to each community. Rather, a variety or "toolbox" of activities available to each jurisdiction is often more effective and conducive to realizing water quality restoration and community goals.

With that in mind, this subwatershed plan recommends the formation by the Huron Headwaters Steering Committee (Committee) of four task forces to assist, if needed, in the implementation of programs or actions in the subwatershed. The following narrative briefly reviews the objective of each task force, potential matters for study and recommendation, and key task force members.

The intent for the task forces is to report to the Committee findings and recommendations specific to its purpose as outlined below. The Committee will engage in discussions regarding task force findings and, based on consensus building processes, make recommendations for further action. Each task force has the opportunity to coordinate investigations with members of the Kent Lake Subwatershed.

7.5.1 Environmental Advisory Team Task Force

The task force is designed to assist in facilitating the implementation of community land use planning and design standards and other related issues. Duties may also include generating reports summarizing annual activities designed to implement the plan for each community to be submitted to the state and federal governments. The Huron Headwaters Steering Committee (Committee) will serve as the guiding body of the task force.

Key members include, but are not limited to, community environmental advisory team members, local government officials, county agencies, and concerned citizens and groups.

7.5.2 Conservation Task Force

A subcommittee charged with the investigation, recommendation, and coordination of financing opportunities in the acquisition of wetlands and other key open spaces. This task force may facilitate the identification of natural resource corridors in the subwatershed, opportunities for preservation and restoration, and tools for implementation. The Committee will serve as the guiding body of the task force.

Key members include, but are not limited to, representatives from local governments, land conservancies, conservation districts, business interests, concerned citizens and groups, academia, and county planning department.

7.5.3 Water Quality Technical Task Force

Group intended to study, recommend, and implement strategies to expand the scientific body of knowledge pertaining to the condition of the subwatershed with particular emphasis on water quality. Specific duties may include development of a comprehensive monitoring program, prioritization of potential areas of illicit connection, and coordination of stormwater best management practice retrofitting and water resource restoration activities. The Committee will serve as the guiding body of the task force.

Key members include, but are not limited to, scientists, academia, concerned citizens and groups, county drain commission and health department staff, conservation districts, and other interested parties.

7.5.4 Education Task Force

This task force expands and coordinates implementation of the established educational plan for the subwatershed (see Chapter 9). It may also develop specific timetables and funding sources and seek cooperative arrangements. The Committee will serve as the guiding body of the task force.

Key members may include local government representatives, numerous county department agencies and staff, concerned citizens and groups, business interests, conservation districts, academics, and media and marketing experts.

CHAPTER 8. PART III—ACTION PLAN FOR WATERBODY SPECIFIC RESTORATION

8.1 Identification and Recommendation

Restoring degraded waterbodies, such as stream segments, is an important component of sub-watershed renewal. Techniques of "bioengineering" and similar non-obtrusive approaches to stabilizing streambanks, streambeds, and riparian zones offer the ability to reestablish the hydraulic and biological function of waterways, while improving landowner and recreational access. Methodologies of restoration vary greatly and are dependent on site specific and upstream conditions such as hydrology, adjacent land use, and project goals.

Table 11 represents site locations, degraded condition(s), potential source(s) of pollution, and potential recommendation(s) established via field surveys and public comment.

It is intended that the Water Quality Task Force will act as the main investigating and coordinating body for the implementation of restorative techniques. Anticipated funding sources for these activities include monies from the Clean Michigan Initiative, federal nonpoint source program (e.g., Clean Water Act Section 319 grants), private foundations, local communities, and citizens.

All activities are considered Phase 3 in sequence; however, as opportunities arise planning and implementation may commence.

Table 11. Sites of Potential Restoration in the Brighton Lake Subwatershed.

Waterbody	*Location of Concern*	*Designated or Desired Use Threatened or Impaired*	*Pollutant*	*Potential Cause/Source*	*Potential Action*
South Ore Creek	Mill Pond to mouth with Brighton Lake	Aquatic life/wildlife; Recreation	Excessive Sedimentation	Incremental degradation of sub-basin 8 (figure 16)	Streambank restoration and sediment removal techniques

Extensive planning and organization is required in order to assure successful implementation of restoration techniques. Typically, the major phases of plan development after identifying potential areas for restoration, are to establish goals and objectives, collect required information and data, select restoration designs, obtain required permits, secure funding, initiate construction, and establish monitoring and management guidelines. Many activities, such as exploration into funding mechanisms can occur concurrently with other phases of the planning process. It is intended that restoration planning will follow guidelines proposed by The Federal Interagency Stream Restoration Working Group (2001).

CHAPTER 9. PART IV—ACTION PLAN TO INFORM AND EDUCATE THE PUBLIC

Since the recommended policy shifts and behavioral changes are voluntary, systematic plans to convey the extent and causes of water quality impairment, along with motivational corrective actions, are vital to this comprehensive subwatershed plan. The education plan must create an understanding of the connection between individual actions and watershed health.

Through a series of meetings and discussions held in the summer of 2001, the Workgroup developed the basis of an information and education (I/E) plan by reviewing the vision and goals for the subwatershed and following the general framework of the HRWC Communications Plan guidance (HRWC, 2000).

The first step in this process is to develop an overall vision and a set of objectives for the I/E plan. Through several discussions, the Workgroup established:

9.1 I/E Plan Vision

The vision of this I/E plan is to instill a heightened level of awareness within households, businesses, and communities in the subwatershed, regarding water quality and watershed issues so changes in daily action may ultimately reduce nonpoint source pollution (NPS).

9.2 I/E Plan Objectives

A) Education of the public regarding acceptable application and disposal of pesticides and fertilizers and simple lawn water quality friendly maintenance alternatives.*

B) Education of the public on the availability, location and requirements of facilities for disposal or drop-off of household hazardous wastes, travel trailer sanitary wastes, chemicals, grass clippings, leaf litter, animal wastes, and motor vehicle fluids.*

C) Encouragement of public reporting of the presence of illicit discharges or improper disposal of materials into the applicant's separate storm water drainage (e.g., OCDC Illicit Discharge & Detection Program). *

D) Education of the public concerning preferred cleaning materials and procedures for residential car washing.*

E) Education of the public about their responsibility for and stewardship of their watershed. And promote awareness of and participation in existing stewardship and monitoring programs.*

F) Education of the public concerning management of riparian lands to protect water quality.*

G) Education of the public concerning the ultimate discharge point and potential impacts from pollutants from the separate storm water drainage system serving their place of residence (e.g., promote awareness of stormwater runoff, simple runoff reducing activities, and the importance of imperviousness). *

H) Increase knowledge of the impacts on water quality of "failing" or unmaintained septic systems and promote simple maintenance guidelines.

I) Increase the awareness of the watershed concept, sense of place within the watershed, and the benefits of a healthy watershed.

J) Promote public knowledge on the importance of proper erosion and soil control measures and existence of current oversight programs, and encourage public participation in the identification of potentially failing control mechanisms.

K) Promote education of local government employees on water quality related good housekeeping/pollution prevention.

L) Increase the knowledge of alternatives to current development and land use practices within the watershed.

M) Assure understanding, knowledge, awareness, and support of the watershed plan and its recommendations.

N) Encourage watershed friendly business practices and site development (e.g., Washtenaw County's Community Partners for Clean Streams).

** Addresses NPDES Phase II & MDEQ General Watershed Permit requirements*

9.3 Target Audiences and Messages

After establishing a vision and objectives for the educational plan, Workgroup members began discussions on who should be the primary audience(s) targeted in the I/E plan and the messages that the plan should present. The Workgroup identified households, businesses, farmers, land developers, local government officials, schools, and partner organizations as the primary audience(s).

Next, the Workgroup established and prioritized a list of issues the I/E plan is designed to address with each audience. The process of prioritization is imprecise; nonetheless, the process addressed the question of which issue will have the greatest effect (potential impact) and what can be accomplished given the given the area dynamics and our resources (feasibility).

The top five prioritized messages per identified audience were:

9.3.1 Households

1. Sense of place within watershed,
2. Awareness of water cycle and how we impact it (including key pollutant sources),
3. Less intensive lawn and garden practices (e.g., mowing habits, fertilizer & pesticide use, yard waste disposal, animal waste disposal, erosion control, native plant use, lake friendly landscaping, water conservation),
4. Septic system maintenance,
5. Surface water retention (e.g., retaining water via rain barrels and washing cars on lawn).

9.3.2 Businesses

1. Less intensive lawn and garden practices (e.g., mowing habits, fertilizer & pesticide use, yard waste disposal, animal waste disposal, erosion control, native plant use, lake friendly landscaping, water conservation),
2. Toxic chemical use, storage and disposal,
3. Innovative stormwater management,
4. Participation in Community Clean Streams Program,
5. Storm drain use and awareness.

9.3.3 Agriculture

1. Advantages/Opportunities for partnerships and land conservation,
2. Importance of soil erosion and sedimentation control practices,
3. Less intensive fertilizer and pesticide use, water practices/irrigation issues,
4. Advantages/Opportunities for buffer and filter strips,
5. Importance of wetlands.

9.3.4 Land Developers/Contractors

1. Advantages/Opportunities for land use planning,
2. Advantages/Opportunities for open space protection & financial incentives for conservation,
3. Low Impact Site Design,
4. Enhanced erosion control,
5. Awareness of water cycle and how we impact it.

9.3.5 Governmental Organizations/Local Decision-Makers

1. Participation in watershed and education plan network,
2. Identification and protection of key habitats and features (e.g., aquatic buffers, woodland, wetlands, steep slopes, etc.),
3. Coordination of master plans and planning issues with neighboring communities,
4. Progress to ensure use of watershed friendly site design (e.g., neo-traditional),
5. Progress to ensure use of innovative stormwater BMPs.

9.3.6 Educators/School Systems

1. Adoption and promotion of state approved watershed curriculum,
2. Active participation in watershed activities/stewardship,
3. Awareness of water cycle and watershed and how we impact it,
4. Partnerships with business,
5. Communication of school involvement and/or place in watershed.

9.3.7 Riparian/Watercourse Landowners

1. Riparian/Watercourse landowner responsibilities and rights,
2. Less intensive lawn and garden practices (e.g., mowing habits, fertilizer & pesticide use, yard waste disposal, animal waste disposal, erosion control, native plant use, lake friendly landscaping, water conservation),
3. Habitat protection/enhancement/management,
4. Invasive species,
5. Illicit Discharge and Illegal Dumping.

9.3.8 Recreational Users

1. Invasive Species & the Boaters role,
2. Watershed Education (e.g., "you are here" signage, historical uses, etc.),
3. Boat discharge,
4. Curtailing accidental spills,
5. "Don't feed the Animals" and bacterial impacts.

9.4 Prioritized Audiences—Which audience do we address first?

It is necessary to further prioritize our effort by ranking the most important and influential audiences for the success of the overall plan given the ever-decreasing amount of resources available for many watershed programs, including educational initiatives. The target audiences can be viewed as the groups who will receive the majority of the I/E effort. As success is achieved and positive behavioral changes occur over time, the prioritized audiences may change with a corresponding level of effort.

Hence each Workgroup member was asked to evaluate the eight identified audiences with particular reflection on "Which audience would be most important for our education program to target so as to restore and protect water quality?"

The resultant prioritized audiences for the I/E plan were determined to be:

1. Governmental Organizations/Local Decision-Makers
2. Riparian/Watercourse Landowners
3. Land Developers/Contractors
4. Households
5. Businesses
6. Educators/School Systems/Partner Organizations
7. Recreational Users
8. Agriculture

9.5 Audience Approach

To establish a framework methodology for reaching the prioritized audiences with prioritized messages, a two-tiered strategy was developed and projected for three consecutive years. Upon completion of the third year, a full review of the plan should be conducted.

The first tier of the strategy involves passive mechanisms to reach target audiences via multiple mass media outlets. This can include print, radio, television advertising, and direct mail, marketing, door hangers, or point of sale literature. The audiences deemed appropriate by the Workgroup for the strategy were (1) riparian landowners, (2) households, (3) recreational users, and (4) agriculture.

This second tier of the strategy is more hands-on and interactive in approaching audiences about targeted behaviors which affect watershed quality and what audiences can do to alter their behavior for the better. The Workgroup determined that the focus of this effort should be on local government decision-makers, land developers, schools, and potential partners via presentations and other face-to-face interaction/communication. As such, these audiences are not included in the mass media efforts, but in the face-to-face interaction/communication. Table 12 represents the envisioned partition of outreach methods per prioritized audience.

Table 12. Prioritized Audiences per Outreach Methodology.

Outreach Method	
Mass Media	***Face-to-Face Interaction***
• *Riparian Landowners*	• *Local government decision makers*
• *Households*	• *Land developers/contractors*
• *Recreational Users*	• *Educators/School systems/Partner organizations*
• *Agriculture Local government*	• *Businesses*

9.5.1 General Level of Effort per Prioritized Audience

In order to assess a general level of effort to be applied per audience, the Workgroup pondered, "To what extent can we target behavior change within each audience through a media campaign and through personal communication?"

To this end, the Workgroup established a general percentage of effort assigned to three to four audiences based upon outreach methodology establishment for the three-year I/E timeframe. The percentages represent the extent the I/E plan should target behavioral change with a media campaign and personal interaction. The exact breakdown of percentages is not crucial. Rather, it represents an overall sense of who is reachable through these approaches.

Figure 21. Percentage of Educational Effort via Mass Media.

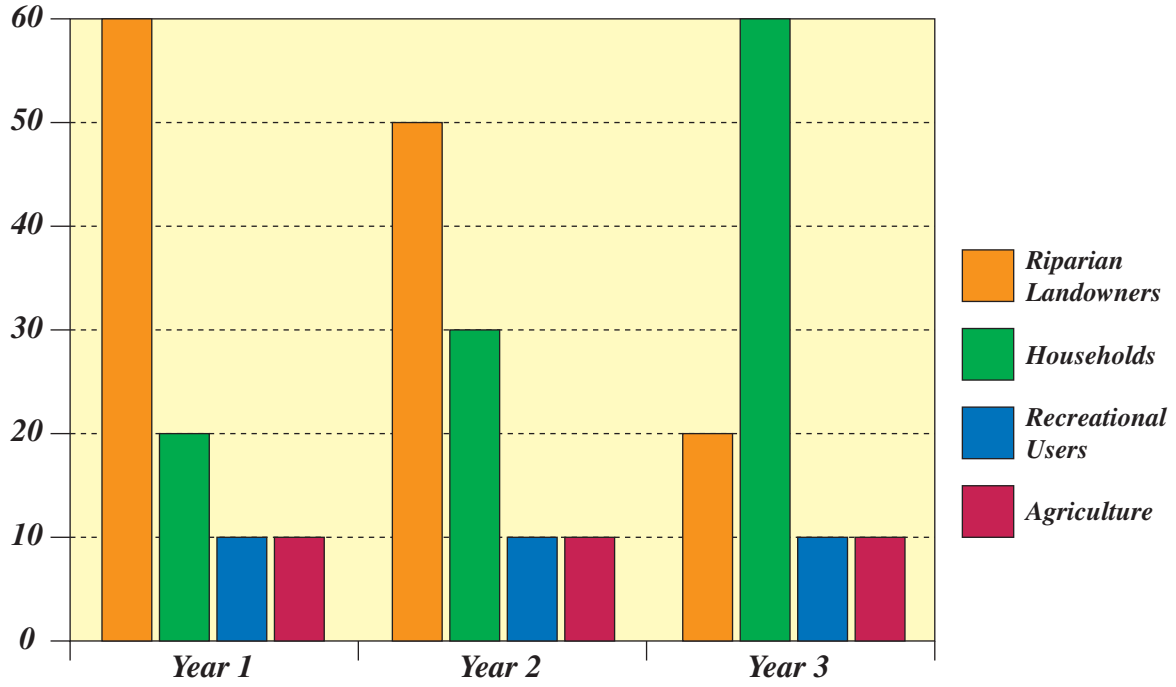
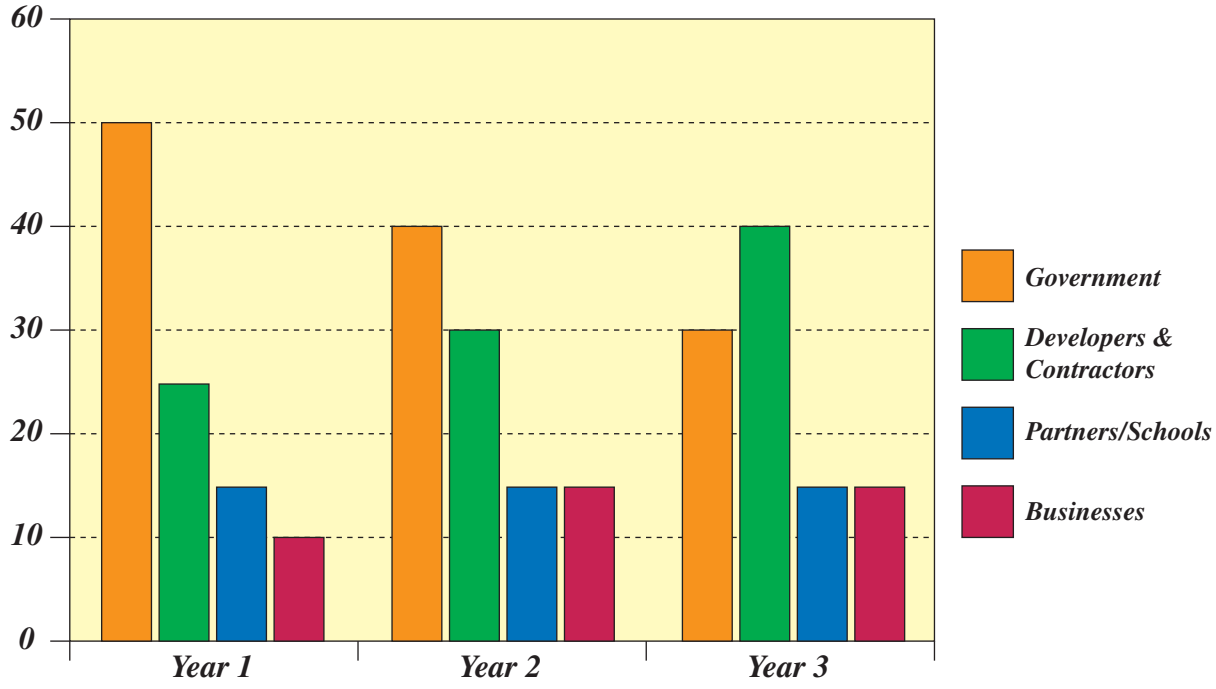


Figure 22. Percentage of Educational Effort via Face-to-Face Interaction/Communication.



It is important to note that the Workgroup intends for the Education Task Force to establish more specific responsibilities, collaborative opportunities, outreach mechanisms, and evaluation processes prior to, upon, and after implementation of the educational plan.

9.5.2 Additional Educational and Public Involvement Activities

In addition to general educational activities outlined above and coordinated by the Educational Task Force and the Committee, several programs and initiatives are recommended for initiation in this subwatershed plan. Below is a list of specific programs which will be implemented as part of this plan, it is intended that these programs will commence planning and implementation in Phase I and II, respectfully.

- **Lake and Riparian Landscaping Alternatives Program and Assistance.** It is intended that this program will provided educational workshops and technical assistance to land owners regarding the use of native landscapes on lakefront properties and other riparian areas. Opportunities to coordinate with MSU Extension, County Conservation District, Master Gardeners, and local businesses will be explored.

- **Community Partners for Clean Streams (CPCS) Program.** Based on the Washtenaw County Drain Commissioners program of developing water quality protection partnerships with all businesses, institutional, and multi-family landowners. Program will provide partners assistance in developing their own "Water Quality Action Plans", and mechanisms for public recognition of their efforts. Educational materials and workshops will also be provided.

- **Homeowner-based Stormwater BMP Initiative.** Program to promote and assist in the implementation of individual homeowner-based stormwater BMPs. Also includes the dissemination of guidebooks for homeowners and homeowners associations on a wide range of water quality topics, such as management of landscapes to citizen-based stormwater BMP maintenance. The MSU Home*A*Syst Program and a "Watershed Pledge Book" will be key components of this activity.

- **Golf Course Nutrient Management Initiative.** The subwatershed contains a large golf course in the headwaters of South Ore Creek. Because these facilities require intensive turf grass management, these areas are probable sources of high nutrient loading. Potential improvements to older and, in some cases, newer courses are alternative turf management, reestablishment of wetland and watercourse buffers, and retrofitting of water hazards to stormwater detention basins. According to the Middle One Rouge River Subwatershed Management Plan (2001), Canton Township has initiated a study with MSU Extension turf management staff to refine possible actions for this program. Lessons learned will be applied in the Kent Lake Subwatershed.

- **Native Landscaping in Public Localities Initiative.** A program to study, locate, coordinate, and implement native landscaping techniques and demonstration projects in key public locations throughout the subwatershed. This initiative will focus on

replacing turf grass with native plantings in appropriate publicly owned locations. Particular emphasis will be placed on reestablishing native habitats in key locations along the shoreline of Mill Pond.

- **Stormdrain Stenciling and Door Hanger Program.** Initiative to label storm drains with "Dump no Waste, Goes to River" or similar wording. An educational door hanger will also be designed for distribution in conjunction with labeling efforts. Significant opportunity exists to work local governments in initiating community volunteers in helping to organize this program.

- **Watershed and Stream Crossing Signage Program.** It is hoped that a partnership with the Drain Commission and Road Commission can and will be developed to place signage on County roadways at key areas within the subwatershed. Ideally, signage will identify the waterbody while being attractive and educational in nature. The Education Task Force will contact and coordinate with the Road Commission on this issue.

CHAPTER 10. FRAMEWORK FOR IMPLEMENTATION AND PROGRESS APPRAISAL

10.1 Huron Headwaters Steering Committee Formation and Purpose

The success of the Brighton Lake Subwatershed plan depends upon consistent involvement and support from local, county, and state governments, citizens, and business interests. It is recognized that each community has varying situations which require individual consideration and implementation; hence, the recommendations in the plan are voluntary. Yet, many of the recommendations in the subwatershed action plan require coordination among all the communities of the drainage area to be cost-effective at reducing pollutant loads. The Huron Headwaters Steering Committee (Committee), and associated Task Force subgroups, are designed to provide such sustainability towards plan implementation, coordination, evaluation, and amendment.

Communities not part of the Brighton Lake Subwatershed, yet considered part of the upper Huron (e.g., Green Oak Township and others), may need to initiate their own discussions on ways to reduce current, and limit future, nonpoint phosphorus pollution. Additional concerns regarding excessive flooding, low summer flows and dam operations, and poor biota also need to be addressed. The Committee will serve as a forum for discussing these issues and generating support for improved watershed planning.

By approving the non-binding Local Government/Agency Partner Resolution or Community Associate Agreement, a community/agency or concerned party publicly acknowledges the problem of nonpoint source pollution and expresses support and intent to participate in the Committee and to consider and implement voluntary pollution reduction recommendations.

The basis of the resolution and agreement and Committee is the Middle Huron Initiative (MHI) and to a lesser extent the Lake Macatawa Coordinating Committee. The MHI Steering Committee, managed by the Huron River Watershed Council, is composed of agreement partners (local, county, state governments and utilities) who form the Ford and Belleville Lake Subwatersheds. Each signatory partner is represented at semi-annual meetings, prepares written implementation status reports, participates in subgroups, and generally puts forth best efforts to reduce nonpoint source pollution. Summarization of meetings, water quality sampling, and progress and successes are gathered by the Huron River Watershed Council and submitted yearly to the MDEQ and USEPA for approval.

Based on the overall success of the MHI in the implementation, assessment, and coordination of programs to reduce nonpoint source pollution, the Brighton Lake Subwatershed plan proposes use of this framework to assure to the state and federal government that progress and appraisal of water quality improvements occurring within the subwatershed. The Committee will be coordinated and managed by the Huron River Watershed Council and will integrate with the Brighton Lake Subwatershed Workgroup and future watershed planning initiatives to form a comprehensive Huron Headwaters Steering Committee.

10.2 Local Government Partner Resolution

A sample Local Government Partner Resolution is presented below; however, it is realized that a number of language alterations may occur upon consideration by local governments. This resolution is targeted towards local and county governments/agencies:

> *WHEREAS the (community) recognizes that the quality of life and economic well-being in the Huron River Watershed are inextricably linked to the health of the river system; its tributaries, lakes, groundwater, wetlands, and uplands; and*
>
> *WHEREAS studies have shown that the only significant source of phosphorus within the Brighton Lake Subwatershed is from nonpoint source runoff; and*
>
> *WHEREAS the Michigan Department of Environmental Quality determined and the United States Environmental Protection Agency has concurred, that the level of phosphorus in Brighton Lake from upstream nonpoint sources has reached unacceptable levels, and have therefore established a phosphorus reduction target; and*
>
> *WHEREAS such phosphorus levels are damaging to the aquatic ecosystem and are preventing recreational use of waterways, and that the problem will likely intensify unless a comprehensive, coordinated, cross-jurisdictional plan is enacted to reduce phosphorus loading from nonpoint source pollution;*
>
> *THEREFORE BE IT RESOLVED, that (community) shall implement, where feasible, the recommendations in the Brighton Lake Subwatershed Plan to address nonpoint source phosphorus pollution.*

10.3 Community Associate Agreement

The Community Associate Agreement is targeted towards non-governmental bodies who participated in the plan development process or who feel compelled to officially acknowledge support for the plan and assist in its implementation. Such groups may take the form of subdivision associations, lake associations, citizen groups, businesses, etc. A draft agreement is presented below.

> *We the undersigned are committed to the Huron Headwaters Initiative and Partnership and are united by a mutual concern for the environmental integrity of the Huron River Watershed, specifically the Upper Huron River and the Brighton Lake Subwatershed, for use and enjoyment by current and future generations. The undersigned recognize that the subwatershed's future quality of life and economic vitality are fundamentally dependent upon the preservation, maintenance, restoration, and sustainability of the natural resources of the Upper Huron River Area.*

This agreement is voluntary and non-binding.

Background

Located in southeastern Michigan and encompassing approximately 900 square miles (576,000 acres) of Ingham, Jackson, Livingston, Monroe, Oakland, Washtenaw, and Wayne counties, the Huron River Watershed is one of the State's most significant natural and cultural resources.

Important linkages exist between the basin's land and water resources and its residents' quality of life and economic well being. The watershed contains two-thirds of all southeast Michigan's public recreational lands while serving as a source of industrial water supply, hydroelectricity, and drinking water for over 140,000 of the approximately 530,000 residents. In recognition of its value, the State has officially designated 37 miles of the river and three tributaries as Michigan Department of Natural Resources Country Scenic River under the State's Natural Rivers Act (Act 231, PA 1970).

The Brighton Lake Subwatershed is located in the headwaters of the Huron River Watershed. The subwatershed, which extends from its headwaters at the Big Lake area in southern Springfield Township downstream to the Brighton Lake impoundment in the Kensington Metropark, lies within Oakland County and comprises all or portions of 13 communities.

So significant is the Upper Huron area, that The Nature Conservancy has deemed portions of our subwatershed as a Globally Significant Resource requiring special protection.

Initiative Vision

1. A restored and protected Upper Huron River, including its floodplains, lakes, tributary waterways, and associated wetlands so that their beneficial functions and uses are achieved and maintained while supporting a strong economy and high quality of life for current and future generations.

2. To meet, sustain, and potentially surpass water quality standards for Brighton Lake by meeting the federally approved Total Maximum Daily Load.

Signatory Beliefs

We, the undersigned, acknowledge the importance of Brighton Lake and its drainage area (i.e., subwatershed) as an immensely valuable yet vulnerable resource to all Southeast Michigan. Specifically:

1. We the undersigned acknowledge that the Michigan Department of Environmental Quality (MDEQ) developed and U.S. Environmental Protection Agency approved the document entitled "Total Maximum Daily Load for Phosphorus in Brighton Lake" (TMDL document), published January of 1999, by the MDEQ. The document states that nonpoint source phosphorus loading to Brighton Lake accounts for the entire annual phosphorus load to the lake.

2. We the undersigned acknowledge the need to improve the water quality and health of the resource and to attain water quality standards through nonpoint source phosphorus load reductions. Nonpoint sources of phosphorus occur from a variety of rural and urban land uses within the watershed.

3. We the undersigned agree to implement, to the greatest degree feasible, the voluntary Brighton Lake Subwatershed Plan to meet TMDL targets.

4. We the undersigned may terminate our involvement in this agreement at any time. Notice of such termination shall be given in writing to all other signatory parties thirty (30) days prior to the effective date of termination.

5. This agreement shall expire three (3) years from adoption, at which time, signatory parties to the agreement may renew.

Organization:

_____

Signed: _____

Date: _____

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ADDENDUM FOR THE
BRIGHTON LAKE SUBWATERSHED MANAGEMENT PLAN

This addendum was prepared to bring the 2002 Brighton Lake Subwatershed Management Plan into compliance with new US EPA standards for watershed management plans under Section 319 of the Clean Water Act. US EPA now requires all implementation, demonstration, and outreach-education project funded under Section 319 to be supported by a watershed plan which meets nine specific required elements. This document addresses gaps in the Brighton Lake Subwatershed Management Plan as identified by the MDEQ in meeting the EPA's nine elements.

References for newly added text are superscripted and included as end-notes to this addendum.

For Element A: revised/ additional text for Sections 4.2.2 to 4.2.8 (on pages 44-47 in the original WMP). Used to better describe and quantify sources and causes listed on pp. 56-57.

4.2.2 Concern #2. Community Land Use Planning & Standards

In essence, the impact of impervious surface generation, wetland loss, and the majority of all other concerns for the Brighton Lake Subwatershed are rooted in land use planning. The Workgroup believed that if we are to address the issues of sustainability, urban flight, and growth, while balancing conservation and development, ecosystem health, natural and cultural resource protection management, we must begin with a solid natural resource based land use planning initiative. Therefore the Workgroup expressed the identification and promotion of "Watershed-Friendly" land use planning to be essential to the restoration and protection of water quality and livability of the subwatershed.

Between 1982 and 1992, Michigan lost approximately 854,000 acres of farmland, or 85,000 acres per year to suburban development, which is comparable to losing the area of 3.75 Michigan townships per year (AFT, 2001). The economic impact of such changes in land use is potentially significant. In fact the Michigan Economic and Environmental Roundtable (MLRP, 2001) estimates that the state loses $66 billion of economic output annually from decreased tourism and recreation, farming, forestry, and mining due to uncoordinated suburbanization.

From 1990-2000, developed land in Livingston County increased by 40% as 25,745 acres was converted from undeveloped to developed land; the area was 24% developed in 2000. During the same time period, active agricultural land decreased by 10% from 125,098 acres to 112,782 acres for a loss of 12,316 acres. Grassland and shrub decreased 13% from 66,980 acres to 58,129 acres for a loss of 8,85 acres. Woodland and wetland decreased 6.3% from 101,982 acres to 95, 656 aces for a loss of 6,417 acres. The vast majority (85%) of the undeveloped land was converted to single family residential land use, which increased by 21,945 acres (43%). In 1990, the average density of single family land use was .74 units per acre. In 2000, the average density decreased to .73 units per acre.[1] Furthermore, SEMCOG predicts that the population of portions

of the Huron River Watershed in Livingston County will increase from 85,000 in 2000 to 144,000 in 2030, an increase of 41%. During this same time period, the number of households will increase from 60,000 to 97,000 – an increase of 47%.[2]

4.2.3 Concern #3. Impervious Surfaces

Addressed as an issue of both nonpoint source pollution and land use, the Workgroup believed the increase in impervious surfaces is the greatest threat to the water quality of the subwatershed, and the region in general. The group was very concerned about the impact of future development, especially in the less developed areas of the subwatershed. When open land is converted to residential, commercial, or industrial use using typical site preparation and development methods, water quality and quantity is often affected negatively. Results include increased rates and volume of runoff, causing increases in in-stream flow rates and temperature, reduced infiltration and groundwater recharge, and loss of wildlife habitat and recreational uses. In addition, contaminants, such as metals, oils/greases, lawn chemicals and fertilizers, road-deicing agents, "cides" (herbicides and insecticides), cleaning agents, yard waste, and garbage are routinely found in stormwater runoff from impervious surfaces. Some Workgroup members identified local standards for sizing parking lots, road widths, and other development standards as prime issues associated with impervious surface introduction. Workgroup members also were concerned that large storms and subsequent runoff would cause property damage, bank erosion and subsequent habitat loss, destruction of fish and wildlife habitat, and potentially loss of human life.

Many studies have shown a correlation between imperviousness and a wide variety of measures of water quality. These measures include stream temperature, biodiversity, and pollution (Schueler, 1994). These studies have shown a remarkable consistency in that, when the amount of imperviousness in a watershed exceeds about 8 – 10%, streams start to show these impacts. Above these imperviousness levels, water quality degrades. These levels of imperviousness are reached very easily with minimal development.

In addition, the Huron River Watershed Council's Adopt-A-Stream Program, which monitors the health of the tributaries by measuring temperature, sampling for aquatic invertebrates, and assessing other indicators, has performed a study comparing creek water quality and imperviousness levels. Their results conform closely with imperviousness studies conducted nationwide, finding that Huron Watershed subwatersheds begin to suffer loss of biodiversity and water quality at about 8% imperviousness, and begin to see the most severe impacts past 25% imperviousness (Wiley, 1999).

Whether studies relate imperviousness or residential density to water quality, a remarkably consistent threshold arises. The imperviousness threshold (over 10%) where watersheds begin to suffer is reached at relatively low densities: ½ to 1 dwelling unit per acre (1 to 2 acre lot) densities.[3]

While aware of this connection between density and imperviousness (and, therefore, watershed health), planners continue to recommend developing more densely. This is because the imperviousness threshold is so easily reached with conventional, cookie-cutter style zoning. As density decreases, a longer and wider road, driveway, and parking network must be built to

accommodate it (along with the accompanying commercial services and employment centers developed along with the new subdivisions), which means an actual *increase* in imperviousness to accommodate those households. In fact, research shows that subdivisions designed in a typical pattern, where one single family residence is located on its own lot, increase imperviousness by 10 - 50% compared to developments that group the same number of households onto smaller areas.[4]

As shown in Figure 4 on p. 13, the overall imperviousness of the Brighton Lake Subwatershed is estimated at 9.3%. This impervious percentage was derived by linking land use/cover using 1995 SEMCOG aerial photo data with imperviousness coefficients developed through the Rouge Program Office. Seventy percent of the subwatershed has an imperviousness of less than 10%; 20% of the watershed has an imperviousness rate between 10% and 25%; 2% of the subwatershed area is between 25% and 50% impervious; and 8 % is over 50% impervious. This estimate of imperviousness includes open waters with an impervious value estimate of 0% (complete perviousness) and wetland areas with an impervious value estimate of 2%.

However, another method of calculating imperviousness involves removing all open waters and wetlands from the total land area before calculating the overall imperviousness. This method is used by the Center for Watershed Protection and has since been adopted by HRWC as the standard method for calculating imperviousness in the Huron River Watershed. When this method is used, the total imperviousness for the Brighton Lake subwatershed rises to 12.0%, as shown below in table 6.5, which shows the land use/ land composition for the subwatershed (excluding water and wetlands), the impervious coefficient used for each land use, and the total acres of imperviousness attributed to each land use.

Table 6.5: Brighton Lake Subwatershed Land Use / Land Composition and Imperviousness

Land Use Category	Total Acres	Percentage of Subwatershed Land Area	Impervious Coefficient	Impervious Acres
Res / Low Rise	109	0.7%	51.4%	56
Single Family	3,215	21.8%	19.0%	611
Mobile Home	94	0.6%	60.0%	56
Mixed Use	45	0.3%	76.3%	34
Shopping Center / Mall	26	0.2%	80.0%	21
Secondary / Neighborhood Service	177	1.2%	88.0%	156
Institutional	109	0.7%	28.0%	31
Industrial	57	0.4%	75.9%	43
Industrial Park	66	0.4%	65.9%	44
Air Transportation	48	0.3%	16.8%	8
Road Transportation	170	1.2%	52.9%	90
Utilities	8	0.1%	69.2%	5
Outdoor Recreation	285	1.9%	10.9%	31
Cemetary	38	0.3%	12.8%	5
Cropland / Agriculture	2,379	16.2%	2.0%	48
Rural Residential	6	0.0%	11.0%	1
Nonforested Open	2,934	19.9%	2.0%	59
Woodland	1,270	8.6%	2.0%	25
TOTALS	**11,039**	**100.0%**	**12.0%**	**1,324**

Table 8 on page 68 shows the same land use/land cover composition data (consolidated into four broad land use categories) for each sub-basin in the watershed.

4.2.4 Concern #4. Stormwater Mitigation, Management, and Runoff Issues

When native lands are converted to parking lots, roads, subdivisions, and other urban and suburban uses, the ability of the land to absorb and filter rainwater is dramatically decreased. The result is an increase in run off over the land during rain or snowmelt events in what is commonly called stormwater runoff. Research across the country indicates that the amount and impact of stormwater runoff on water quality is often directly associated with impervious surfaces. The resulting stormwater runoff from these surfaces carry a variety of contaminants, including phosphorus, sediments, and toxic compounds. But stormwater runoff does not have to be treated as a nuisance to be managed at an undesirable or low corner of a property. Runoff issues such as sewer overflows, flooding, and stream channel erosion can be successfully addressed by multiple, yet small, unobtrusive techniques incorporated into developments or retrofitted into the existing built environment. The methods are many, but the approach is consistent: "softening" the urban landscape to allow water to soak into the soil, where it nourishes plants, recharges groundwater, and supports the base flow of streams during dry periods. We also gain the added benefit of allowing the soil and vegetation to filter, transform, and bind up (adsorb) many of the pollutants typically found in stormwater runoff. Practices such as impervious surface reductions, small surface and subsurface infiltration basins, constructed wetlands, bioretention cells, vegetated swales, soil rehabilitation, native plantings, green roofing, and other designs can reduce the quantity and quality impacts of stormwater runoff while supporting wildlife habitat, beautifying properties and neighborhoods, providing recreational amenities, creating jobs, and reducing urban "heat island" effects (RMI, 2002). Workgroup members expressed concerns that current stormwater mitigation standards via site design and stormwater best management practice (BMP) implementation in the Brighton Lake area could be enhanced towards protection of water quality.

4.2.5 Concern #5. Watershed Education

Numerous surveys throughout the country have indicated that the general public does not always practice good watershed ethic and in many cases, contributes directly to water quality problems via their own behaviors. Education on water quality and watershed issues is the primary tool for addressing such behaviors. Such educational initiatives begin with two premises: we all live in a watershed, and how we live in it affects it's quality. While this is a simple concept to most, the challenges are many. For instance, within a watershed or subwatershed there will be thousands of people to reach and minds to change, yet most of us are only slightly aware of the watershed concept, the funding resources are often limited, and the marketing we can afford is typically the least effective (Center for Watershed Protection, 2000). Nonetheless, without education and understanding of basic watershed issues, most protection and restoration efforts are simply infeasible. The Brighton Lake Workgroup identified the need for enhanced and coordinated education on the relationship between community and human health, watersheds, and water quality as a major concern.

During the summer of 2004, SEMCOG conducted a Regional Public Education Survey of the Huron Chain of Lakes watershed area, which is a portion of the Huron River Watershed located

primarily in Livingston County that includes the Brighton Lake subwatershed. The major findings of public perception, knowledge, and practices related to water quality issues, as reported by SEMCOG, are presented below.[5]

Perceptions and Value of Water Resources
Residents were asked to rate the quality of water in lakes, rivers, and streams in the community where they live. Twenty-nine percent of those surveyed thought water quality was remaining the same and twenty-six percent thought it was getting "somewhat worse." Eighteen percent reported that they thought water quality was getting "somewhat better."

The activities that households were most likely to have done in or near lakes and streams in the region during the past year were: hiking/walking (55%), boating (53%), and swimming (53%). Only sixteen percent (16%) of those surveyed indicated that they did not participate in activities in or near lakes and streams in the region during the past year.

74% of those surveyed thought the way they cared for their lawn and home affects the quality of water in lakes and streams in the community where they live; 26% did not.

47% of those surveyed indicated that their household had taken some type of action to protect water resources in the past two years; 45% had not, and 8% indicated that they "didn't know" if they had done anything that would have helped protect water resources.

Connection of Stormwater Runoff and Water Resources
Fifty-one percent of those surveyed thought stormwater runoff was the greatest contributor of pollution to lakes, rivers and streams. Industrial discharges were second (27%), followed by sewage overflows (14%), and wastewater treatment plant discharges (8%).

Fifty-three percent of those surveyed indicated that they know that stormwater flows directly to lakes and streams without treatment. Thirty-six percent of those surveyed indicated that they "didn't know" where stormwater goes after it enters a storm drain or roadside ditch.

Twenty-five (25%) of those surveyed knew that they lived in a watershed. Thirty-seven percent (37%) indicated that they did not know if they lived in a watershed.

Seventy-three (73%) of those surveyed agreed with the statement that the quality of local streams where they live affects the Great Lakes and Lake St. Clair.

Fifty-two (52%) percent of the respondents indicted that they had not seen road signs identifying rivers or watersheds in their community. Forty-six percent (46%) of those surveyed indicated that they had seen signs identifying rivers in their community.

Current Activities
Twenty-four percent of those surveyed indicated that they typically wash their vehicles at home in the driveway. Most (71%) of those surveyed indicated that they use a car wash.

Twenty percent of those surveyed indicated that members of their household usually change motor

oil, transmission fluid or radiator fluid for a vehicle at their home.

Sixty-nine percent of those surveyed indicated that their household uses a community collection site to dispose of household hazardous waste, such as old oil, fluids from vehicles, batteries, and pesticides; 19% of those surveyed indicated that their household typically disposes of household hazardous wastes with their regular trash.

Forty-seven percent of those surveyed who were not using a community collection site for household hazardous waste indicated that the reason they did not use a community collection site was because they did not know where one was located.

Thirty-nine percent of those surveyed indicated that their household seldom uses fertilizers on their lawn. Thirty-two (32%) indicated they use fertilizer on their lawn at least once a year.

The types of fertilizer that households were most likely to use on their lawn were: weed and feed (38%), slow release nitrogen (17%), seasonal varieties (15%), and low phosphorous (11%).

The most common reason residents gave for selecting the type of fertilizer or pesticide they use was previous experience with a product (38%).

Thirty percent of those surveyed indicated that their household uses a lawn service for fertilizer and/or pesticide applications.

Willingness to Take Action to Help Reduce Pollution of Streams and Lakes
Residents were asked how willing they would be to perform various actions to help reduce pollution in lakes and streams. Residents were most willing to (1) change car care practices (85%), (2) dispose of hazardous waste at a community collection day (84%), (3) sweep excess fertilizer/grass clippings into their lawn (84%), and (4) have their septic system serviced every 3-5 years (78%). Residents were somewhat less willing to change lawn watering practices (63%).

Best Ways to Inform Residents About Ways to Protect Lakes and Streams
The top four ways residents preferred to receive information about what they can do to protect lakes and streams were from community newspaper (59%), television news (37%), major newspaper (37%), and municipal newsletter (30%).

The results of this survey are particularly useful in determining the types of educational messages that should be targeted to the subwatershed's residents and the media/outreach tools that are likely to reach the greatest number of residents and have the greatest impact on increasing awareness and changing behavior. The survey also provides a baseline against which the results of future surveys can be measured.

4.2.6 Concern #6. Impaired or Compromised Septic Systems

Many of the communities within the subwatershed have been making concerted efforts to address the issue of impaired or compromised septic systems near waterbodies via the installation of sewers. Such is the case in Brighton Township and the Woodland Lake sewer

installation project. Yet some areas of the subwatershed have yet to shift to a community-based treatment system such as sewers.

While the exact nature and extent of impaired or compromised septic systems is somewhat ambiguous, in general, such a system is considered to be one that discharges effluent without the benefit of designed treatment. Improperly functioning septic systems are recognized as a significant contributor of pollutants and microbiological pathogens; these systems discharge more than one trillion gallons of waste each year to subsurface and surface waters (NSFC, 1995). Identifying and restoring such septic systems can help address contamination of ground and surface water supplies from untreated wastewater discharges given that they can carry nutrients, such as phosphorus, bacteria, medicinal and chemical agents, and other pollutants to waterbodies with little or no treatment. Impairment of on-site disposal systems can be due to a number of causes, including unsuitable soil conditions, improper design and installation, or inadequate homeowner maintenance practices.

Despite the fact that no specific studies on impairment rates in the Brighton Lake Subwatershed or in Livingston County have been reported, the Workgroup determined the presence of such systems are of concern given results found in other areas of southeast michigan. A recent survey of septic systems in selected areas of Southfield and Farmington Hills found a substandard operation rate (undefined) of 50% (Johnson, et. al., 2000). A 1997 survey by the Wayne County Environmental Health Division (WCEHD) of 421 septic systems showed a failure rate of 21%. Another study conduced in 2000 by WCEHD showed that 17 of 67 OSDS inspections reported failures, for an average failure rate of 25%.[6] In Washtenaw County, a review of existing data indicated a failure rate of 20% throughout the County. In addition, another 50% were substandard for varying reasons. From January 3 through June 30, 2000, Washtenaw County processed a total of 512 property inspections following the passage of a regulation requiring OSDS inspections at the time of property sale. The OSDS failure rate was 18%. (Johnson, et al., 2000). Given that in approximately 74% of all households in the Brighton Lake subwatershed rely on septic systems for waste treatment, there is a potential for water quality and health impacts from faltering septic systems. While the number of septic systems in the subwatershed area is not known, roughly 42,000 households in Livingston County use septic systems, with approximately 1000 new septic tanks installed each year.[7] Based on these studies of failure rates in surrounding areas, a 20% failure rate of 42,000 OSDS units equates to 8,400 failing OSDS units in Livingston County.

For Element B: additional text for Section 6.5 (to be inserted after first paragraph on page 71 in the original WMP). Used to estimate load reductions expected for the BMPs.

Using the phosphorus load reduction estimates in Tables 4 and 5 of the TTMPS Stormwater BMP Prioritization Analysis (found in Appendix D of the Brighton Lake Subwatershed Management Plan), the following estimates were calculated for recommended structural stormwater BMPs. Note that the following table presents only one possible configuration of BMP combinations. Section 6.6 provides additional information for determining the location and combination of BMPs to optimally balance pollutant reduction efficiencies with costs and land availability.

Table 8.5. Estimated Phosphorus Load Reduction for Select BMPs

Management Practice	*Number of BMPs in Commercial/ Industrial Areas*	*Estimated Phosphorus Load Reductions (lbs/yr)*	*Number of BMPs in Residential Areas*	*Estimated Phosphorus Load Reductions (lbs/yr)*	*Total Estimated Phosphorus Load Reductions (lbs/yr)*
Wet Detention Basins[a]	4	10.6	5	19.5	30.1
Constructed Wetlands[a]	3	8.4	5	20.7	29.2
Grassed Channels[a]	3	4.8	5	11.8	16.6
Catch Basin Inserts[b]	40	0.08	5	0.01	0.1
Bioretention Islands[c]	5	4.2	0	0.0	4.2
Engineered Dry Swales[a]	4	14.3	2	10.6	24.9
Street Sweeping[d]	1	1.5	1	4.1	5.6
TOTALS		**44.0**		**66.7**	**110.7**

[a] *Assumes a treatment area of 25 acres per BMP*
[b] *Assumes a treatment area of ½ acre per BMP*
[c] *Assumes a treatment area of 5 acres per BMP*
[d] *Street sweeping is based on sweeping all curbed streets, estimated at 25% of all roads in the sub-basins.*

Recall that the TMDL for Brighton Lake calls for an average phosphorus reduction of 10 percent (98 pounds/year) in nonpoint source contributions. The estimates in Table 9.5 provide demonstrate how a minimum reduction of 100 pounds/year can be met through applications of the selected structural stormwater BMPs in commercial/industrial and residential areas.

FOR ELEMENT D: see Table 7: Matrix of Actions on page 64 of the Plan for cost estimates of implementation (far right column).

Note: the high-end estimate for stormwater BMP ($226 million) in Table 8 is not a realistic estimate, as it is based on the strictly hypothetical (and very impractical) scenario of using catch basin inserts as the only means of meeting the phosphorus load reductions for Brighton Lake, as shown in Table 4 of the TTMP Stormwater BMP Prioritization Analysis report. The next highest cost estimate for stormwater BMP implementation, which is $7,709,000 is a more practical estimate for the maximum costs of stormwater BMP implementation.

FOR ELEMENT D: Supplemental Information for Table 8: Matrix of Actions for the Brighton Lake Subwatershed Management Plan. Additional Information on Costs and Resources.

Task	Recommended BMP	Primary Goals Addressed	Phase I	Phase II	Phase III	Responsible Parties	Costs	Measurable Milestone	Resources
Structural Best Management Practices	Wet Detention Basin	2, 4			X	Private Landowners, Local Governments, Livingston County	*$24.5V^.705^ ($45,700 for 1 acre facility) Maintenance: 5% construction cost	Pilot retrofit demonstration underway by 2008	CMI, 319 grants, other private/ public grants
	Constructed wetlands	2, 4			X	Private Landowners, Local Governments, Livingston Co.	*$30.6V^.705^ ($57,100 for 1 acre facility) Maintenance: 5% construction cost	Pilot retrofit demonstration underway by 2008	CMI, 319 grants, other private/ public grants
	Grassed Channels	2, 4			X	Private Landowners, Local Governments, Livingston Co.	$.65/f^2	Pilot retrofit demonstration underway by 2009	CMI, 319 grants, other private/ public grants
	High Efficiency Street Sweeping	2, 4			X	Local Governments with curb/gutter storm drain systems, Road Commission	$250,000 per sweeper purchased Maintenance: $940	Programs established in Brighton Twp and Brighton City by 2010	CMI, 319 grants, other private/ public grants
	Catch-basin Inserts	2, 4			X	Private Landowners, Local Governments, Livingston County	$800 each + $150,000 vac truck Maintenance: $300[b]	Install 10 catch basin inserts on existing commercial/industrial properties by 2010	CMI, 319 grants, other private/ public grants
	Bioretention Islands	2, 4			X	Private Landowners, Local Governments, Livingston Co.	$7.30V^.99^ Maintenance: 20% construction cost	Pilot retrofit demonstration (5 acres of treatment) completed by 2010	CMI, 319 grants, other private/ public grants
	Infiltration Trenches	2, 4			X	Private Landowners, Local Governments, Livingston Co.	$5/f^3 Maintenance: 20% construction cost	Pilot retrofit demonstration (as part of a treatment train) complete by 2012	CMI, 319 grants, other private/ public grants
	Engineered Dry Swales	2, 4			X	Private Landowners, Local Governments, Livingston County	$5.50/f^3	Pilot retrofit demonstration site complete by 2012	CMI, 319 grants, other private/ public grants

[*] where V= Volume in the basin to include the 10-year storm (ft^3).
[a] Combined Downriver WMP
[b] Mill Creek WMP
[c] HRWC estimate
[d] Lower Huron WMP
[e] Lower Grand WMP

Task	Recommended BMP	Primary Goals Addressed	Phase I	Phase II	Phase III	Responsible Parties	Costs	Measurable Milestone	Resources
Land Use Planning and Design Standards	Revise Community Master Plans to address water quality goals	1	X			Local Governments	$10k – 20k	All communities to include water quality goals in next scheduled revision of mater plans (every 5 years)	County Drain Comm., Planning; Sample Master Plans; SEMCOG; HRWC
	Low Impact Design Principles in Community Development Design Standards	2		X		Local Governments,	$5k – 10k	Implemented by 2 local governments by 2008	County Planning, Drain , Road Commission; Sample Master Plans; SEMCOG; HRWC;
	Stormwater Management Ordinance	2		X		Local Governments	$5k – 10k + Enforcement[a]	Implemented by 2 local governments by 2008; implemented by all local governments by 2010	HRWC, County Drain Commission
	Enhanced Site Plan Review Requirements	2	X			Local Governments	$5k – 10k	Implemented by 2 local governments by 2008	
	Enhanced Site Plan Review Tally Sheet	2	X			Local Governments	N/A (cost included with Site Plan Review Requirements BMP above)	Implemented by 2 local governments by 2008	
	Impervious Surface Limitations	3,4		X		Local Governments	$3000[b]	Standards adopted by 2 local governments by 2008; implemented by all local governments by 2010.	HRWC: County Planning Dept.
	Reduction of Parking Lot Minimums, Size, and Design	3,4		X		Local Governments	$5k – 10k	Adoption by 2 communities by 2009	County Planning Dept., Drain Comm.
	Private Roads Ordinance	3,4	X			Local Governments; Livingston County	$5k – 10k[d]	Adoption by all communities by 2008	HRWC; County Planning Dept., County Road Commission
	Promote Conservation or Cluster Subdivisions	3, 4	X			Local Governments	$5k – 10k[a]	Adoption by all communities by 2008	County Drain Commission, Planning Dept.
	Environmental Advisory Team Task Force	1	X			Local Governments, County, Headwaters Steering Committee	$100/hr per municipal staff	Formation by 2007 with regular meetings, all communities represented on task force	HRWC; concerned citizens

[a] Combined Downriver WMP
[b] Mill Creek WMP
[c] HRWC estimate
[d] Lower Huron WMP
[e] Upper 2 Shiawassee River WMP

Task	Recommended BMP	Primary Goals Addressed	Phase I	Phase II	Phase III	Responsible Parties	Costs	Measurable Milestone	Resources
Intensive Landscaping and Over-fertilization	Water Efficiency Policies for Commercial Landscaping	2		X		Local Governments;	$5k – 10k	Adoption by 2 communities by 2010;	MSU Extension
	Fertilizer Ordinance or Resolution	2		X		Local Governments	$10k[d]	Adoption by 1 community by 2009	HRWC: MSU Extension; other local governments with existing ordinances
	Golf Course Nutrient Management Improvements	2		X		Private Landowners; Livingston County	Little to no cost to municipalities through information provided through websites, MSU Extension, etc… Maintenance: cost varies by practices used	50% of all golf courses certified by Michigan Turfgrass Stewardship Program by 2008	MSU Extension; County Drain, Planning
Habitat Loss and Fragmentation	Natural Features Mapping	6		X		Local Governments; Livingston County; Conservation Task Force	$24k – 48k (varies widely)[e]	Mapping of all watershed communities completed in 2004 by County Planning. Maps to be updated by County on a regular basis.	County Planning; MNFI
	Natural Features Setback Ordinance	6		X		Local Governments	$5k – 10k[c]	Adoption by all 4 communities by 2010	HRWC
	Floodplain Mapping and Ordinance	6			X	Local Governments	$5k – 10k	Floodplain mapping complete. Standards/ordinance in place by 2 communities by 2010	MDEQ, County Drain Commisioner
	Wetland Protection Ordinance	6		X		Local Governments	$5k – 10k[c]	Adoption by 6 communities by 2008	HRWC: model ordinance, policy assistance
	Conservation Task Force	6	X			Local Governments, Headwaters Steering Committee	$100/hr per municipal staff	Formation by 2007 with regular meetings, all communities represented on task force	
Impaired Septic Systems and Illicit Connections	Septic System Ordinance	7		X		Livingston County Local Governments Private Landowners	$5k – 10k + $300 per inspection[a]	Adoption by 1 local government or county-wide by 2009	County Health Dept. Drain Comm., Wayne Co. Dept. of Environment, and Washtenaw Co. Environ. Health Dept.
	Illicit Detection & Elimination Program	12			X	Local Governments, Livingston County, OCRC	$2000/mile of open channel survey; $2800/lmile of closed sewer survey; $660 per individual building $600/dye test; $100/staff investigation per property; $5000-$15000 enforcement per property[e]	Programs underway in all communities by 2006. Investigations 50% complete by 2010	Livingston Co. Drain Commission, Livingston Co. Health Dept.

[a] Combined Downriver WMP
[b] Mill Creek WMP
[c] HRWC estimate
[d] Lower Huron WMP
[e] Upper 2 Shiawassee River WMP

Task	Recommended BMP	Primary Goals Addressed	Phase I	Phase II	Phase III	Responsible Parties	Costs	Measurable Milestone	Resources
Monitoring Data and Programs	Water Quality Task Force	9	X			Steering Committee, Local Governments	$100/hr per municipal staff	Formation by 2007 with regular meetings, all communities represented on task force	
	Subwatershed Volunteer Monitoring Program	9		X		Local Governments; HRWC	$5,000 annually[c]	Training and monitoring begun by 2008	HRWC
	Expansion of HRWC Stewardship Network	10	X			Local Governments, HRWC	$5000 start-up $3000/annually[b]	Program expanded to Livingston Co. area by 2009	HRWC; Stewardship Network
	Lake and Creek Drainage Area Planning and Protection Services	9		X		Local Governments; Water Quality Task Force	$7,5000 - $15,000 per drainage area plan[c]	Water Quality Task Force to determine need and potential locations by 2009 and seek funding for potential sites	MDEQ, HRWC,
Education Plan Implementation	Formation of Education Task Force	5, 7, 9, 10, 11	X			Local Governments, Steering Committee	$100/hr per municipal staff	Formation by 2006 with regular meetings, all communities represented on task force.	
	Community Partners for Clean Streams	5, 7, 9, 10, 11		X		Livingston County Local Governments	$5K – 15k for start-up $5 – 10k annually	Program initiated by 2008. Minimum of 15 partners from Brighton Subwatershed by 2009	Washtenaw Co. Drain Commissioner, HRWC] 319 grants, other grant sources
	Homeowner-based BMP Initiative	2, 3, 4, 11			X	Local Governments Livingston Co. Education Task force	$2.5K – 5K annually	Homeowner BMP workshop presented annually starting in 2008. Minimum of 5 residential demonstration sites using rain barrels, rain gardens, porous pavers, etc… completed by 2010.	HRWC, MSU Extension Home*A*Syst program and 'Watershed Pledge Book", possible grant funding
	Storm Drain Stencil/MarkingProgram	10, 11	X			Local Governments with curb/gutter storm drains	$1.50 per lexon marker; $3.00 crystal-coated marker[d]	Markers placed on 25% of all storm drains by 2008; 100% by 2010	HRWC; possible grant funding; volunteers apply markers and distribute flyers
	Watershed and Stream Crossing Signage Program	5, 11	X			Local Governments Education Task Force	$25 - 50 per sign + installation costs (Co. Road Commission may do for no cost?)[c]	Signs at all county road and highway crossings of Huron River and at select stream crossings by 2007	HRWC, Livingston Co. Road Commission, SEMCOG
Plan Implementation	Establish Huron Headwaters Steering Committee	All goals	X			Local Governments, Livingston County,	$100/hr per municipal staff	Formation by 2007 with regular meetings, all communities represented on task force	In conjunction with upstream (Oakland Co.) watershed planning efforts

[a] Combined Downriver WMP
[b] Mill Creek WMP
[c] HRWC estimate
[d] Lower Huron WMP
[e] Upper 2 Shiawassee River WMP

FOR ELEMENTS G, H, AND I: the following pages are to be inserted between pages 96-97 of the Brighton Lake Subwatershed Plan. These additional pages address gaps in the original plan for Elements H and I of the new EPA requirements for Section 319 watershed plans.

A successful watershed plan is ultimately defined not by what is written on the pages of the plan, but by how the recommended plans and programs are put into action. A successful plan for implementation and evaluation also recognizes that the state of the watershed changes over time. As such, evaluating the effectiveness and appropriateness of the actions taken to implement the plan, as well as the ability to adapt these actions to the changing conditions of the watershed, is critical.

To ensure successful implementation of a watershed plan, nine key elements should be addressed, as summarized in Table 10.1.

Table 10.1. Nine Key Elements of Successful Watershed Plan Implementation[8]

1. Appoint a single lead agency to act as an advocate and facilitator for the plan with the community and with political representatives.
2. Strong linkages to existing programs, including local and regional land use planning processes, water quality and flow monitoring programs, and similar programs, to optimize use of available information and minimize duplication of effort.
3. Clear designation of responsibilities, timetables, and anticipated costs for project actions.
4. Effective laws, regulations, and policies to provide a framework for the tasks identified in Element 3.
5. Ongoing tracking of the degree of implementation of management actions and of the success of those actions once implemented.
6. Ongoing monitoring and reporting of progress, both to assess the effectiveness of individual actions and to sustain public and political interest in and enthusiasm for the plan.
7. Ongoing public education and communication programs to consolidate and enhance the social consensus achieved in the planning process.
8. Periodic review and revision of the plan.
9. Adequate funding for these activities.

To facilitate implementation of the Brighton Lake Watershed Management Plan over time, The Huron Headwaters Steering Committee and the four task forces (Environmental Advisory, Conservation, Water Quality Technical, and Education) will provide the framework for determining how, and the extent to which, the goals and objectives of the Plan are being successfully implemented. The Steering Committee and Task Forces will ideally be comprised of the following groups of stakeholders:

- Local and County Government elected officials and staff (managers, trustees/ council members planners, coordinators)
- Volunteers (citizens and watershed stewards)
- Local environmental / land use-related organizations
- Funding groups

These groups of stakeholders should ultimately allow for input and implementation assistance from a broad cross-section of all stakeholder and interest groups in the watershed. This committee structure should be used to implement, evaluate, and revise the watershed plan over time. The Steering Committee and Task Forces should be staffed by land use planners, commissions, boards, interested citizens, environmental group advocates, scientists, etc. that will pull together various aspects of the data and results during the implementation phases of the Plan (i.e. water quality data, public education initiatives, restoration activities, etc.).

The importance of public representation and broad stakeholder involvement throughout any advisory committee structure must be stressed, as these individuals are in a position to explain and influence community opinion and help to build support for needed changes.

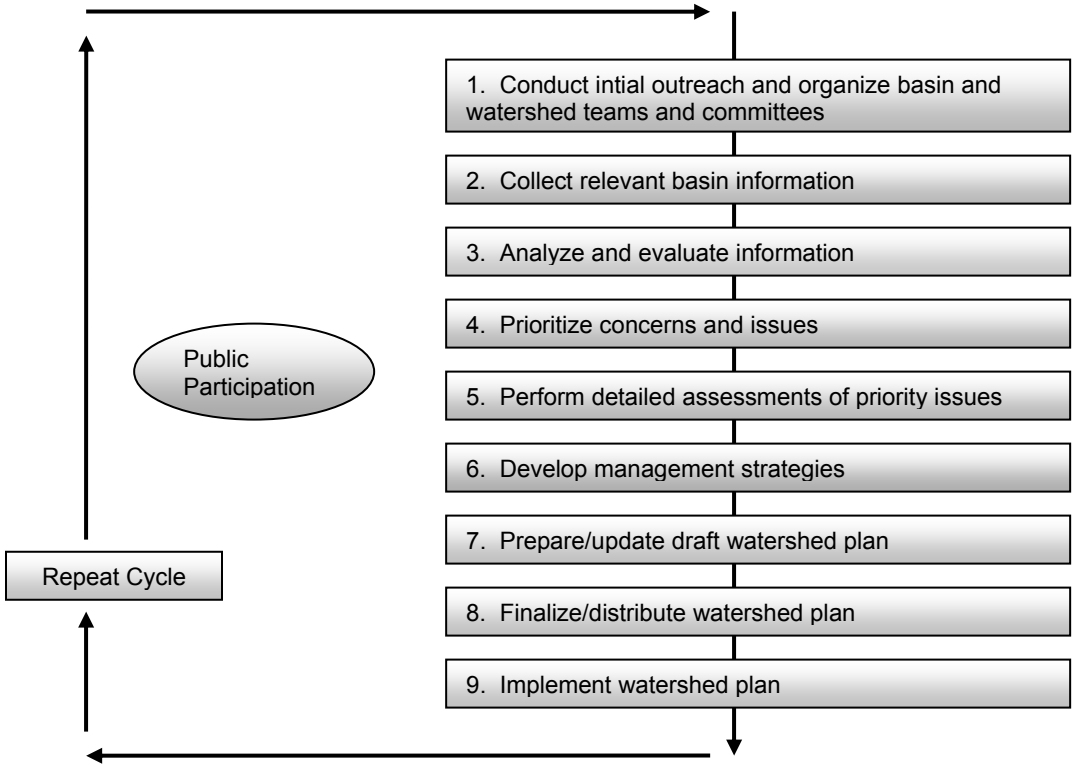
Watershed Plan Revision

A watershed is a complex integrated system with the whole being greater than the sum of its parts. This complexity stems from the ever-changing interaction of social, economic, and biophysical forces. The interplay of these forces is the basis for the concept of integrated watershed management. Integrated watershed management is, by definition, dynamic in nature. Implementing the Brighton Lake Subwatershed Management Plan in a way that follows the principles of integrated watershed management therefore requires continuous evaluation of the effectiveness of the management alternatives in meeting the Plan's goals and objectives. The concept of "adaptive management" is central to successful implementation of the Plan. Adaptive management incorporates research into conservation action. Specifically, it is the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn.

The goals and recommendations of this Plan are based on the understanding of the conditions of the natural watershed ecosystem at the time this Plan was developed. However, both the conditions of the watershed and the goals and actions will change over time as new information is gathered, available resources for implementation are assessed, and the values and needs of the watershed's residents evolve. Changes in social and economic forces can trigger changes in watershed management practices. Similarly, changes in a watershed ecosystem can also indicate a need for altered watershed management practices. Adaptive management recognizes the dynamic interplay of these forces, which implies a need to continually evaluate progress toward meeting the Plan's goals and objectives.

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 10.1.

Figure 10.1. Typical Steps in a Watershed Management Cycle[9]



EVALUATION METHODS FOR MEASURING SUCCESS

How can we measure whether the recommended management have been successful at reducing pollutants? That is to say, have changes in behavior occurred among target audiences, how many management practices have been implemented, or have documented improvements in water quality occurred? There are a number of different ways to measure progress toward meeting the goals for the Brighton Lake subwatershed. Objective markers or milestones will be used to track the progress and effectiveness of the management practices in reducing pollutants to the maximum extent possible (see Table 10.2). Evaluating the management practices that are implemented helps establish a baseline against which future progress at reducing pollutants can be measured. The U.S. EPA identifies the following general categories for measuring progress:

1. **Tracking implementation over time.** Where a BMP is continually implemented over the permit term, a measurable goal can be developed to track how often, or where, this BMP is implemented.
2. **Measuring progress in implementing the BMP.** Some BMPs are developed over time, and a measurable goal can be used to track this progress until BMP implementation is completed.

3. **Tracking total numbers of BMPs implemented.** Measurable goals also can be used to track BMP implementation numerically, e.g., the number of wet detention basins in place or the number of people changing their behavior due to the receipt of educational materials.
4. **Tracking program/BMP effectiveness.** Measurable goals can be developed to evaluate BMP effectiveness, for example, by evaluating a structural BMP's effectiveness at reducing pollutant loadings, or evaluating a public education campaign's effectiveness at reaching and informing the target audience to determine whether it reduces pollutants to the MEP. A measurable goal can also be a BMP design objective or a performance standard.
5. **Tracking environmental improvement.** The ultimate goal of this Plan is environmental improvement, which can be a measurable goal. Achievement of environmental improvement can be assessed and documented by ascertaining whether state water quality standards are being met for the receiving waterbody or by tracking trends or improvements in water quality (chemical, physical, and biological) and other indicators, such as the hydrologic or habitat condition of the waterbody or watershed.

Although achievement of water quality standards is the goal of plan implementation, the Steering Committee members need to use other means to ascertain what effects individual and collective BMPs have on water quality and associated indicators. Instream 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 BMP-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 BMPs.

Environmental indicators are relatively easy-to-measure surrogates that can be used to demonstrate the actual health of the environment based on the implementation of various programs or individual program elements. Some indicators are more useful than others in providing assessments of individual program areas or insight into overall program success. Useful indicators are often indirect or surrogate measurements where the presence of the indicator points to likelihood that the activity was successful. Indicators can be a cost-effective method of assessing the effectiveness of a program because direct measurements sometimes can be too costly or time-consuming to be practical. For example, macroinvertebrate populations can be used to assess habitat conditions; aquatic plant and algae growth is good for assessing nutrient concentrations; and optical brighteners can be used to tracking failing septic systems.

Table 10.2 presents environmental indicators that have been developed specifically for assessing stormwater programs.[10] Water quality indicators 1 through 16—physical, hydrological, and biological indicators—can be integrated into an overall assessment of the program and used as a basis for the long term evaluation of program success. Indicators 17 through 26 correspond more closely to the administrative and programmatic indicators and practice-specific indicators.

Table 10.2. Environmental Indicators for Assessing Watershed Management Programs

Category	#	Indicator Name
Water Quality Indicators This group of indicators measures specific water quality or chemistry parameters.	1	Water quality pollutant constituent monitoring
	2	Toxicity testing
	3	Loadings
	4	Exceedence frequencies of water quality standards
	5	Sediment contamination
	6	Human health criteria
Physical and Hydrological Indicators This group of indicators measures changes to or impacts on the physical environment.	7	Stream widening/downcutting
	8	Physical habitat monitoring
	9	Impacted dry weather flows
	10	Increased flooding frequency
	11	Stream temperature monitoring
Biological Indicators This group of indicators uses biological communities to measure changes to or impacts on biological parameters.	12	Fish assemblage
	13	Macroinvertebrate assemblage
	14	Single species indicator
	15	Composite indicator
	16	Other biological indicators
Social Indicators This group of indicators uses responses to surveys, questionnaires, and the like to assess various parameters.	17	Public attitude surveys
	18	Industrial/commercial pollution prevention
	19	Public involvement and monitoring
	20	User perception
Programmatic Indicators This group of indicators quantifies various non-aquatic parameters for measuring program activities.	21	Number of illicit connections identified/corrected
	22	Number of BMPs installed, inspected and maintained
	23	Permitting and compliance
	24	Growth and development
Site Indicators This group of indicators assesses specific conditions at the site level.	25	BMP performance monitoring
	26	Industrial site compliance monitoring

Measurement and evaluation are important parts of planning because they can indicate whether or not efforts are successful and provide a feedback loop for improving project implementation as new information is gathered. If the Steering Committee is able to show results, then the plan

likely will gain more support from the partnering communities and agencies, as well as local decision makers, and increase the likelihood of project sustainability and success. Monitoring and measuring progress in the watershed necessarily will be conducted at the local level by individual agencies and communities, as well as at the watershed level, in order to assess the ecological affects of the collective entity actions on the health of Brighton Lake, the Huron River and its tributaries in the Subwatershed.

Monitoring and measuring progress in the watershed will be two-tiered. First, individual agencies and communities will monitor certain projects and programs on the agency and community levels to establish effectiveness. For example, a community-based lawn fertilizer education workshop will be assessed and evaluated by that community. Also, with the implementation of a community project such as the retrofitting of detention ponds, the individual community responsible for the implementation of that task may monitor water quality/quantity parameters before and after the retrofit in order to measure the improvements.

Secondly, there will be a need to monitor progress and effectiveness on a regional – subwatershed or watershed – level in order to assess the ecological affects of the collective community and agency actions on the health of the river and its tributaries. The Steering Committee recognizes the importance of long-term water quality, quantity and biological monitoring programs to determine where to focus resources as they progress toward meeting collective goals. These physical parameters will reflect improvements on a regional scale. MDEQ conducts ongoing monitoring of Brighton Lake as part of the established phosphorus TMDL for the Lake. In addition, MDEQ evaluates the entire Huron River Watershed every five years to gain a picture of its overall water quality. This monitoring program is used for (re)issuing NPDES permits and for identifying those waters in non-attainment and/or threatened to be in non-attainment of designated uses.

Qualitative Evaluation Techniques

A set of qualitative evaluation criteria can be used to determine whether pollutant loading reductions are being achieved over time and whether substantial progress is being made toward attaining water quality standards in the subwatershed. Conversely, the criteria can be used for determining whether the Plan needs to be revised at a future time in order to meet standards. A summary (Table 10.3) of the methods provides an indication of how these programs might be measured and monitored to evaluate success in both the short and the long term. Some of these evaluations may be implemented on a watershed basis, such as a public awareness survey to evaluate public education efforts, but most of these activities will be measured at the local level. By evaluating the effectiveness of these programs, communities and agencies will be better informed about public response and success of the programs, how to improve the programs and which programs to continue. Although these methods of measuring progress are not tied directly to measurements in the river, it is fair to assume that the success of these actions and programs, collectively and over time, will impact positively on the instream conditions and measurements of the river system that are investigated concurrently as described below.

Table 10.3. Summary of qualitative evaluation techniques for the Brighton Lake Subwatershed

Evaluation Method	Program/Project	What is Measured	Pros and Cons	Implementation
Public Surveys	Public education or involvement program/project	Awareness; Knowledge; Behaviors; Attitudes; Concerns	Moderate cost. 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	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	Current and first-hand information. Time-consuming. Some cost involved.	Identify parameters to evaluate. Use form, such as Stream Crossing Inventory, to record observations. Summarize findings to identify sites needing observation.
Visual Documentation	Structural and vegetative BMP installations, retrofits	Aesthetics. Pre- and post- conditions.	Easy to implement. Low cost. 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.	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	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	Medium to high cost to do well. Instant identification of motivators and barriers to behavior change.	Select random sample of population as participants. 6-8 people per group. Plan questions, facilitate. Record and transcribe discussion.

Adapted from: Lower OneSWAG, 2001

Quantitative Evaluation Techniques

In addition to measuring the effectiveness of certain specific programs and projects within communities or agencies, it is beneficial to monitor the long-term progress and effectiveness of the cumulative watershed efforts in terms of water quality, water quantity and biological monitoring. Table 10.4 shows selected indicators and key milestones for measuring watershed health in the Brighton Lake Subwatershed.

Table 10.4: Selected Parameters, Indicators, and Key Milestones for the Brighton Lake Subwatershed

Parameter	Pollutants/ concerns Addressed	Selected Indicators	Key Milestones
Chemical: Nutrients (TP, TN)	Nutrient loads	WQ pollutant concentration and loading N:P ratio	3% reduction in nonpoint source TP loads to Brighton Lake by 2010 Maintain Redfield's N:P ratio
Physical: Sediment	Sedimentation and erosion	Bottom deposition: % of silt/sand fines	Maintain % fines at Huron R. at Adopt-A-Stream monitoring sites on South Ore Creek @ Lake Ridge Rd. and Hamburg Rd. Decrease % fines at South Ore Cr. @ Bauer to 50% by 2010
Physical: Stream Habitat	High stormwater peak flows/ altered hydrology Sedimentation and erosion	HRWC Adopt-A-Stream ecological condition score (expanded from SWAS Procedure 51)	Increase South Ore Cr. @ Lake Ridge Rd. site from "poor" to "fair" by 2010 Increase South Ore Cr. @ Bauer Rd. and Hamburg Rd. sites from "fair" to "good" by 2010.
Biological: Freshwater Biota (benthic macroinverte-brates)	High stormwater peak flows/ altered hydrology Sedimentation and erosion Nutrient loads	Macroinvertebrate assemblage Composite indicator: EPT species Composite indicator: sensitive species	Using Adopt-A-Stream data for average # of macroinvertebrates: Increase Lake Ridge Rd. site from 7 to 12 by 2010 Maintain average macroinvertebrate #s at Bauer Rd. and Hamburg Rd. sites Using Adopt-A-Stream data for # of EPT species: Maintain avg. EPT scores above 5 for Bauer Rd. and Hamburg Rd. sites Increase # of EPTs at Lake Ridge Rd. site to 5 by 2010 Using Adopt-A-Stream data for # of sensitive species: Maintain average of 1 sensitive species at Bauer Rd. and Hamburg Rd. sites Increase # of sensitive species at Lake Ridge Rd. sites to 1 by 2010
Programmatic: Impaired septic systems and illicit discharges	Nutrient loads E. Coli	Inspection and correction of illicit discharges and failing septic systems County-wide septic system inspection program	As determined by individual community and Livingston County Phase II SWPPIs (to be completed in May 2006) Septic inspection program initiated by 2008

Subwatershed-wide long-term monitoring will address many objectives established for the Brighton Lake Subwatershed, and Goals 9 and 10 that address establishment of a monitoring program and data collection. A monitoring program at the subatershed level will require a regional perspective and county or state support. Communities and agencies in the subatershed agree that there has not been adequate data collection (number of sites or frequency) to most effectively manage the subwatershed. Wet and dry weather water quality, stream flow, biological and other monitoring will afford communities and agencies better decision making abilities based on more data as implementation of this plan continues. Suggestions for the monitoring program are presented below. Details for the monitoring program will be decided and approved by the Water Quality Task Force.

Parameters and Establishing Targets for River Monitoring

Upon reviewing the data collected for the Plan, the Workgroup members recognize the need to augment the type of parameters monitored, the number of locations in the watershed, and the frequency of wet weather monitoring. A holistic monitoring program will help communities and agencies to identify more accurately water quality and water quantity impairments and their sources, as well as how these impairments are impacting the biological communities that serve as indicators of improvements.

Parameters
Establish a long-term monitoring program so that progress can be measured over time that includes the following components:

- Increase stream flow monitoring to determine baseflows and track preservation and restoration activities upstream. Include as physical and hydrological indicators: stream widening/downcutting; physical habitat monitoring; increased flooding frequency; and stream temperature monitoring.

- Collect wet and dry weather water quality data in the watershed to better identify specific pollution source areas within the watershed, and measure impacts of preservation and restoration activities upstream. Include as water quality indicators: water quality pollutant monitoring; loadings; exceedence frequencies of water quality standards; sediment contamination; and human health criteria.

- Increase biological data monitoring (fish, macroinvertebrates, and mussels) and use these as indicators of the potential quality and health of the stream ecosystem. Include as biological indicators: fish assemblage; macroinvertebrate assemblage; single species indicator; composite indicator; and other biological indicators.

- Identify major riparian corridors and other natural areas in order to plan for recreational opportunities, restoration and linkages.

- Review and revise currently established benchmarks and dates based on new data.

- Increase the use of volunteers where possible, for monitoring program (habitat, macroinvertebrates) to encourage involvement and stewardship.

Based on the goals of the watershed, the monitoring plan should measure Dissolved Oxygen (DO), Bacteria (*E. coli*), Phosphorus (P), total suspended solids (TSS), sediments, stream flow, conductivity, aquatic macroinvertebrates, and physical habitat.

Establishing Targets
Measuring parameters to evaluate progress toward a goal requires the establishment of targets against which observed measurements are compared. These targets are not necessarily goals themselves, because some of them may not be obtainable realistically. However, the targets do define either Water Quality Standards, as set forth by the State of Michigan, or scientifically-supported numbers that suggest measurements for achieving water quality, water quantity and biological parameters to support state designated uses such as partial or total body contact, and fisheries and wildlife. Using these scientifically-based numbers as targets for success will assist the Steering Committee in deciding how to improve programs to reach both restoration and preservation goals and know when these goals have been achieved. These targets are described below.

Dissolved Oxygen: The Michigan Department of Environmental Quality (MDEQ) has established state standards for Dissolved Oxygen (DO). The requirement is no less than 5.0 mg/l as a daily average for all warm water fisheries. The Administrative Rules state:

> . . . for waters of the state designated for use for warmwater fish and other aquatic life, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 4 milligrams per liter, or below 5 milligrams per liter as a daily average, at the design flow during the warm weather season in accordance with R 323.1090(3) and (4). At the design flows during other seasonal periods as provided in R 323.1090(4), a minimum of 5 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.
>
> (Michigan State Legislature. 1999)

Bacteria: State standards are established for Bacteria (*E. coli*) by the MDEQ. For the designated use of total body contact (swimming), the state requires measurements of no more than 130 *E. coli* per 100 milliliters as a 30-day geometric mean during 5 or more sampling events representatively spread over a 30-day period. For partial body contact (wading, fishing, and canoeing) the state requires measurements of no more than 1000 *E. coli* per 100 milliliters based on the geometric mean of 3 or more samples, taken during the same sampling event. These uses and standards will be appropriate for and applied to the creek and those tributaries with a base flow of, or greater than, 2 cubic feet per second.

Phosphorus: The state phosphorus (P) concentration limit is a monthly average of 0.5 mg/L for surface waters in order to prevent nuisance plant growth in receiving lakes and impoundments. The State also requires that "nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi or bacteria which are or may become injurious to the designated uses of the waters of the state." Monitoring frequency and number of sites for phosphorus needs to be increased to capture seasonal variation and dry and wet weather conditions. As previously discussed, the phosphorus TMDL for Brighton Lake calls for a 10% reduction in phosphorus loads to reach the goal of 30 µg/L.

Total Suspended Solids/Sediment: No numerical standard has been set by the state for Total Suspended Solids (TSS) for surface waters. However, the state requires that "the addition of any dissolved solids shall not exceed concentrations which are or may become injurious to any designated use." To protect the designated uses of fisheries and wildlife habitat, as well as the desired recreational and aesthetic uses of the surface waters in the watershed, there are recommended targets established on a scientific basis. From an aesthetics standpoint, it is recommended that TSS less than 25 mg/l is "good", TSS 25-80 mg/l is "fair" and TSS greater than 80 mg/l is "poor." The TSS target, therefore, will be to maintain TSS below 80 mg/l in dry weather conditions. Another measurement that can be used to determine sediment load is to determine the extent of embeddedness of the substrate (how much of the stream bottom is covered with fine silts) and the bottom deposition (what percentage of the bottom is covered with soft muck, indicating deposition of fine silts). These are measurements taken by the SWQAS protocol habitat assessment conducted by MDEQ every five years, and by the Adopt-A-Stream program more frequently. Rating categories are from "poor" to "excellent." The target should be to maintain SWQAS designations of "excellent" at sites where they are attained currently, "good" at sites where they are attained currently, improve "fair" sites to "good," and improve "poor" to "good" through the implementation of this plan.

Stream Discharge: Stream flow, or discharge, for surface waters do not have a numerical standard set by the state. Using the health of the fish and macroinvertebrate communities as the ultimate indicators of stream and river health is most useful in assessing appropriate flow. Recommended flow targets for the South Ore Creek will be established once the necessary research has been conducted that will determine the natural, pre-development hydrology and current hydrology. Peak flow data is needed to compare more accurately observed flow to the target flow.

Conductivity: Conductivity measures the amount of dissolved ions in the water column and is considered an indicator for the relative amount of suspended material in the stream. The scientifically-established standard for conductivity in a healthy Michigan stream is 800 microSiemens (µS), which should be the goal for the Huron River and its tributaries. Levels higher than the standard indicate the presence of stormwater runoff-generated suspended materials.

Fisheries: Numerical or fish community standards have not been set by the state. However, the Michigan Department of Environmental Quality has developed a system to estimate the health of the predicted fish communities through the GLEAS 51 (Great Lakes Environmental Assessment

Section) sampling protocol. This method collects fish at various sites and is based on whether or not certain expected fish species are present, as well as other habitat parameters; fish communities are assessed as poor, fair, good, or excellent. The state conducts this protocol every five years in the Huron River Watershed. The target should be to maintain GLEAS 51 scores of "excellent" at sites where they are attained currently, "good" at sites where they are attained currently, improve "fair" sites to "good," and improve "poor" to "good" through the implementation of this plan. The GLEAS 51 protocol also identifies whether or not there are sensitive species present in the Huron River and its tributaries, which would indicate a healthy ecosystem. Certain species are especially useful for demonstrating improving conditions. These species tend to be sensitive to turbidity, prefer cleaner, cooler water, and their distribution in the Huron Watershed is currently limited. The target is to continue to find species currently found, assuming that stable or increasing numbers mean that habitat and water quality is maintained or improved.

Benthic Macroinvertebrates: Similar to the assessment of fish communities, the state employs the GLEAS 51 protocol for assessing macroinvertebrate communities on a five-year cycle for the Huron River Watershed. The Adopt-A-Stream program of the Huron River Watershed Council currently monitors macroinvertebrate health and physical habitat on only one site in the Brighton Lake Subwatershed (as well as two more outside of the subwatershed on South Ore Creek, downstream from Brighton Lake), using an adaptation of the GLEAS 51 procedure. The sites are monitored for macroinvertebrates two or three times each year and periodically for physical habitat health. The monitoring target for macroinvertebrate communities will be to increase MDEQ and Adopt-A-Stream monitoring sites to improve the existing database and attain GLEAS 51 scores of at least "fair" at sites that currently are "poor," and improve "fair" sites to "good," and maintain the "good" and "excellent" conditions at the remaining sites.

Temperature: The state standard lists temperature standards only for point source discharges and mixing zones – not ambient water temperatures in surface water. However, recommendations for water temperature can be generated by assessing fish species' tolerance to temperature change and these guidelines are found within the statute. Although some temperature data have been collected in Brighton Lake Subwatershed by the Adopt-A-Stream program of the Huron River Watershed Council, additional studies are needed to establish average monthly temperatures and whether increased temperatures are a problem for stream health.

Wetlands: An annual review should be done of MDEQ wetland permit information and local records in order to track wetland fills, mitigations, restoration and protection to establish net loss or gain in wetlands in the watershed. The target for this parameter is to track the net acres of wetland in the watershed to determine action for further protection or restoration activities.

Details regarding responsible parties, monitoring standards, sampling sites, and frequency of monitoring for qualitative and quantitative evaluation techniques will need to be defined and approved by the Water Quality Technical Task Force.

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