The Kent Lake Subwatershed Management Plan:

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

Prepared by the
Kent 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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Prepared by the Kent Lake Subwatershed Management Plan Workgroup:

Harry Campbell, Watershed Specialist, Huron River Watershed Council
Chris Carter, SE MI Chapter of Trout Unlimited
Beth Corwin, Planning & Development Director, Charter Township of Highland
Al Drenchen, Environmental Health Supervisor, Oakland County Department of Health Division
Dan Duncan, Chief Planner, Huron Clinton Metropark Authority
Donna Folland, Executive Director, Oakland Land Conservancy
Kathy Fraser, Environmental Planner, Oakland County Drain Commission
Don Green, Supervisor, Milford Township
Connie Guest, Planning Director, Charter Township of Commerce
Fay Hansen-Smith, Ph.D., Professor of Biology, White Lake Residents CARE
Carolyn Henne, Natural Resource Professional, Oakland County Conservation District
Jeff Holler, Environmental Planner, Oakland County Drain Commission
Jennifer Lawson, Environmental Analyst, Hubbell, Roth, & Clark, for the City of Wixom and Milford Township
John Magee, Chairman, Village of Wolverine Lake Water Management Board
Mike McAdams, Environmental Specialist, Charter Township of White Lake
Nina Misuraca, Associate Planner, Oakland County Planning & Economic Development
William Schimmel, Citizen, Citizens for a Clean Milford Township
Arthur Schufflebarger, Village Manager, Village of Milford
John Scott, Board Member, Village of Wolverine Lake Water Management Board
Nancy Strole, Clerk, Springfield Township
Sue Tepatti, Project Manager, Giffels-Webster Engineers for the Charter Township of Commerce
Megan Wiswesser, Coordinator, Oakland County MSU Extension
Lev Wood, Wetlands Review Board, West Bloomfield Township
Thomas Zoner, Supervisor, Charter Township of Commerce Township

With Assistance from:

Martin Hendges, Environmental Quality Analyst, Michigan Department of Environmental Quality
Jeanne Horvath, Editor, University of Michigan
Scott Miller, Environmental Quality Analyst, Michigan Department of Environmental Quality
Kris Olsson, Watershed Ecologist, Huron River Watershed Council
Paul Rentschler, Senior Ecologist, Tetra Tech MPS
Paul Richards, Ph.D., Assistant Research Scientist, University of Michigan
Ronda Wuycheck, Environmental Quality Analyst, Michigan Department of Environmental Quality

EXECUTIVE SUMMARY

Introduction to the Kent Lake Subwatershed

The Kent Lake Subwatershed is located in southwestern Oakland County. This 556 square-mile (100,000 acres) area, which extends from the headwaters of the Huron River downstream to the Kent Lake impoundment in the Kensington Metropark, contains nearly 700 individual lakes comprising approximately 9,000 acres, Pettibone and Norton Creeksheds, and innumerable wetlands providing water quality and aesthetic value. The subwatershed lies within Oakland County and comprises all or portions of Commerce Township, Highland Township, Lyon Township, Milford Township, Springfield Township, Village of Milford, Village of Orchard Lake, Village of Wolverine Lake, Waterford Township, West Bloomfield Township, White Lake Township, the City of Walled Lake, and the City of Wixom. Land use in the Kent Lake Subwatershed ranges from heavily commercial and residential areas in the east and south to small rural farms and housing in the north and west. Included in the subwatershed are two Metroparks and four state recreation areas, along with numerous county, city, and village parks, totaling roughly 22,000 acres of publicly owned land. So exceptional is the ecological value of this area that The Nature Conservancy recently deemed portions of the subwatershed as "Globally Significant."

Problem Statement

Based on water quality monitoring studies, in 1998 the Michigan Department of Environmental Quality (MDEQ) listed Kent 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 Kent 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 Kent Lake Subwatershed, combined with the loss of open space, is expected to cause an increase in an already excessive nonpoint source pollution situation.

Purpose of the Kent Lake Subwatershed Management Plan
The Kent Lake Subwatershed Management Plan sets forth a comprehensive, long-term effort to restore and protect the water quality of the area with the goal of attaining the Total Maximum Daily Load for Kent Lake. Secondly, the Kent Lake Subwatershed contains numerous communities who will be required to obtain a state or federal permit 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 or required to obtain a permit to meet the minimum requirements of the program.

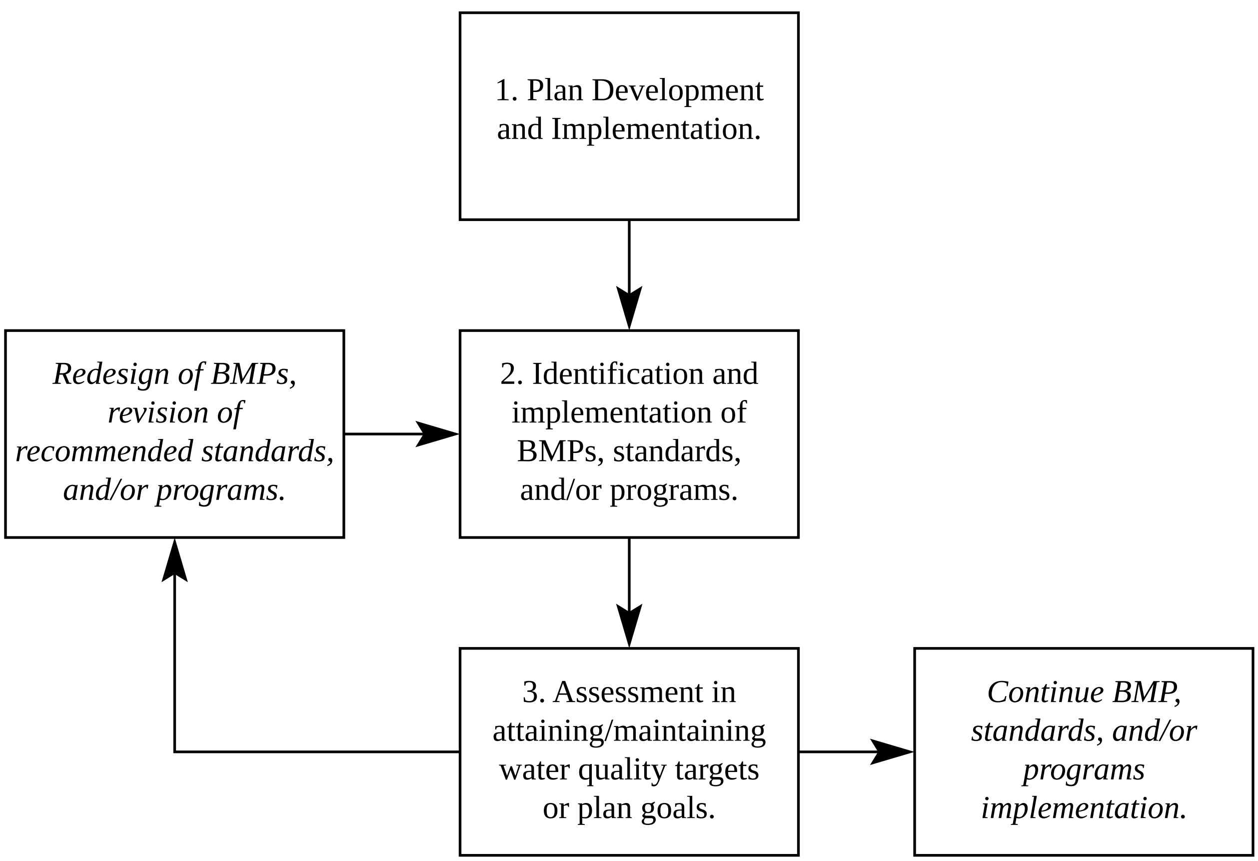
Kent Lake Subwatershed Workgroup
In 2000, communities, county agencies, key business interests, citizen groups, and other stakeholders in the subwatershed were invited to participate in establishing a Workgroup to help guide the development of the comprehensive subwatershed plan. This group has met quarterly since the spring 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 which 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 project, 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 impacts 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 exhibited 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 depends on enhancing the knowledge of water quality and watershed issues. This plan provides the framework for an 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 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 may 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).

Healthy watersheds provide millions of dollars worth of protection due to their natural attributes and functions. Some benefits from healthy watersheds include:

- ***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 use 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.

- ***Scientific Advancement.*** 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,***
- Give 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*** process,
- ***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, the Kent Lake Subwatershed and the Huron River Watershed as a whole have experienced amplified developmental pressures from a flourishing economy and urban flight. In fact, according to the Southeast Michigan Council of Governments (SEMCOG), the population of Oakland County, where the subwatershed is located, increased 16% from 907,871 to 1,083,592 individuals from 1970 to 1990. Projections to 2020 estimate a further 25% increase in population from 1990 levels, or an additional 360,508 individuals. In order to accommodate the increased population as well as the businesses and services to satisfy them, it estimated that under current development practices 40% of the remaining open spaces will be developed within the watershed (HRWC, unpublished). Much of this projected loss of undeveloped land will occur in the Kent Lake Subwatershed where it will further threaten the hydrology and water quality of groundwater and surface waters.

The projected increase in development and corresponding 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 that 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 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, animal wastes, metals, and garbage. But because there are hundreds of thousands of small sources of stormwater runoff in the subwatershed, addressing NPS is often complex and problematic.

There is, however, another source of NPS that is not associated with stormwater 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 Kent Lake in 1979 and 1999, the Michigan Department of Environmental Quality (MDEQ) determined that although point source reductions in phosphorus loading have improved water quality in Kent Lake from 1970s observations, increased nonpoint source loading is threatening to negate these improvements. According to the MDEQ studies, nonpoint source phosphorus loads currently account for 80% of the total phosphorus load to Kent Lake (Alexander, 1999a).

In response to these findings, MDEQ listed Kent 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 in the subwatershed. 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 Kent Lake because of the increased developmental pressures in the subwatershed that threaten to increase the contribution of NPS and result in an expected violation of the State's narrative water quality standards. As a result of extensive field studies, MDEQ established a TMDL target concentration of 30 micrograms per liter (µg/L) of phosphorus so as to assure satisfactory water quality for Kent Lake (Alexander, 1999a).

1.3 Purpose of the Kent Lake Subwatershed Plan

The Kent Lake Subwatershed Management Plan represents a broad effort to restore and protect the water quality integrity of Kent Lake and the upstream waterbodies that drain into the lake. The purpose of this plan is to establish a state-approved methodology to diminish the adverse effects of nonpoint source phosphorus pollution to the lake and meet the established TMDL. This plan outlines both quantitative and qualitative steps considered necessary to meet water quality goals for Kent Lake and its subwatershed.

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 Commerce, Highland, Milford, Springfield, Waterford, West Bloomfield, and White Lake, the Villages of Orchard Lake and Wolverine Lake, and the Cities of Walled Lake and Wixom 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 plans 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 between the Spring and 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 Kent 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.

1.5 Relation with Rouge River Subwatershed Plans

As part of the Great Lakes Water Quality Agreement between governments of the United States and Canada, a Rouge River Remedial Action Plan (RAP) was developed in 1989. The intent of the RAP was to set forth a 20-year plan to restore the water quality of the Rouge River, and subsequently, the Great Lakes Region. The focus of the plan was the reduction of the most easily addressed pollution sources and of large industrial and municipal wastewater treatment discharges into the river. Although improvements have been made, pollution still exists and is impairing our water quality.

The Michigan Department of Environmental Quality (MDEQ) established a voluntary watershed-based approach, called the Michigan General Storm Water Permit, to address the forthcoming requirement that numerous southeast Michigan communities obtain a federal National Pollutant Discharge Elimination System (NPDES) Phase II stormwater permit. This program initiated the Rouge River Wet Weather Demonstration Program with a unique watershed-based voluntary permit. Several of the communities within the Rouge River Watershed also have land area within the Kent Lake Subwatershed, and have already taken actions to meet permit requirements. These communities include the Townships of Commerce, West Bloomfield, and Lyon, the Cities of Walled Lake and Wixom, and the Village of Orchard Lake.

Unlike the Rouge River Subwatershed Plans that focused on meeting and obtaining a Michigan General Storm Water Permit, the Kent Lake Subwatershed planning process concentrates on meeting and sustaining a quantifiable water quality target for phosphorus loading to Kent Lake (i.e., TMDL). Hence, while many similarities exist amongst the planning processes and recommendations for the two plans, to demonstrate feasibility in meeting the Kent Lake phosphorus TMDL a thorough quantitative and qualitative procedure is required. Nonetheless, many of the communities and agencies that participated in the Rouge River Subwatershed Plans are already committed to many of the actions in this plan.

CHAPTER 2. MAJOR CHARACTERISTICS OF THE HURON RIVER WATERSHED AND KENT 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 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 Kent Lake Subwatershed

The drainage area that provides water to Kent Lake is located in the upper Huron River Watershed and is designated the Kent Lake Subwatershed (Figure 1). This 556 square-mile (100,000 acres) area, which extends from the headwaters of the Huron River downstream to the Kent Lake impoundment in the Kensington Metropark, contains nearly 700 individual lakes comprising approximately 9,000 acres, and innumerable acres of wetlands providing water quality and aesthetic value. The vast majority of the subwatershed lies within Oakland County and comprises all or portions of eight municipalities and five cities or villages which make up approximately 37,000 acres of built land. Included in the Subwatershed are two Metroparks and four state recreation areas, along with numerous county, city, and village parks, totaling roughly 22,000 acres of publicly owned land.

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

2.2.1 History and Demographics

Oakland County began as a settlement in the year 1818 where the Saginaw Trail crossed the Clinton River. A year later on January 12, 1819, Oakland County was officially organized and was named for its abundance of large oak trees. However, the area was not heavily wooded enough to attract many lumbermen, and settlement was slow at first. But agriculture was productive, and when roads and railroads to the north were built, the county grew as trade with the lumber areas expanded.

According to the U.S. Census Bureau, today the county is the second most populated of Michigan's 83 counties and is part of the Detroit Metropolitan Area. In 1999, the county had a per capita personal income of $44,146. This number ranked first in the state, was 157% of the state average of $28,104, and was 155% of the national average of $28,546. Earnings by persons employed in the area increased from $38.93M in 1998 to $41.41M in 1999—an increase of 6.4%. The largest industries in 1999 were services (35.2% of earnings), durable goods manufacturing, (19.7%) and wholesale trade (9.6%). Of the industries that accounted for at least 5% of earnings in 1999, the slowest growing from 1998 to 1999 was durable goods manufacturing, which increased 0.7%, and the fastest was services, which increased 9.3%.

2.2.2 Political Structure

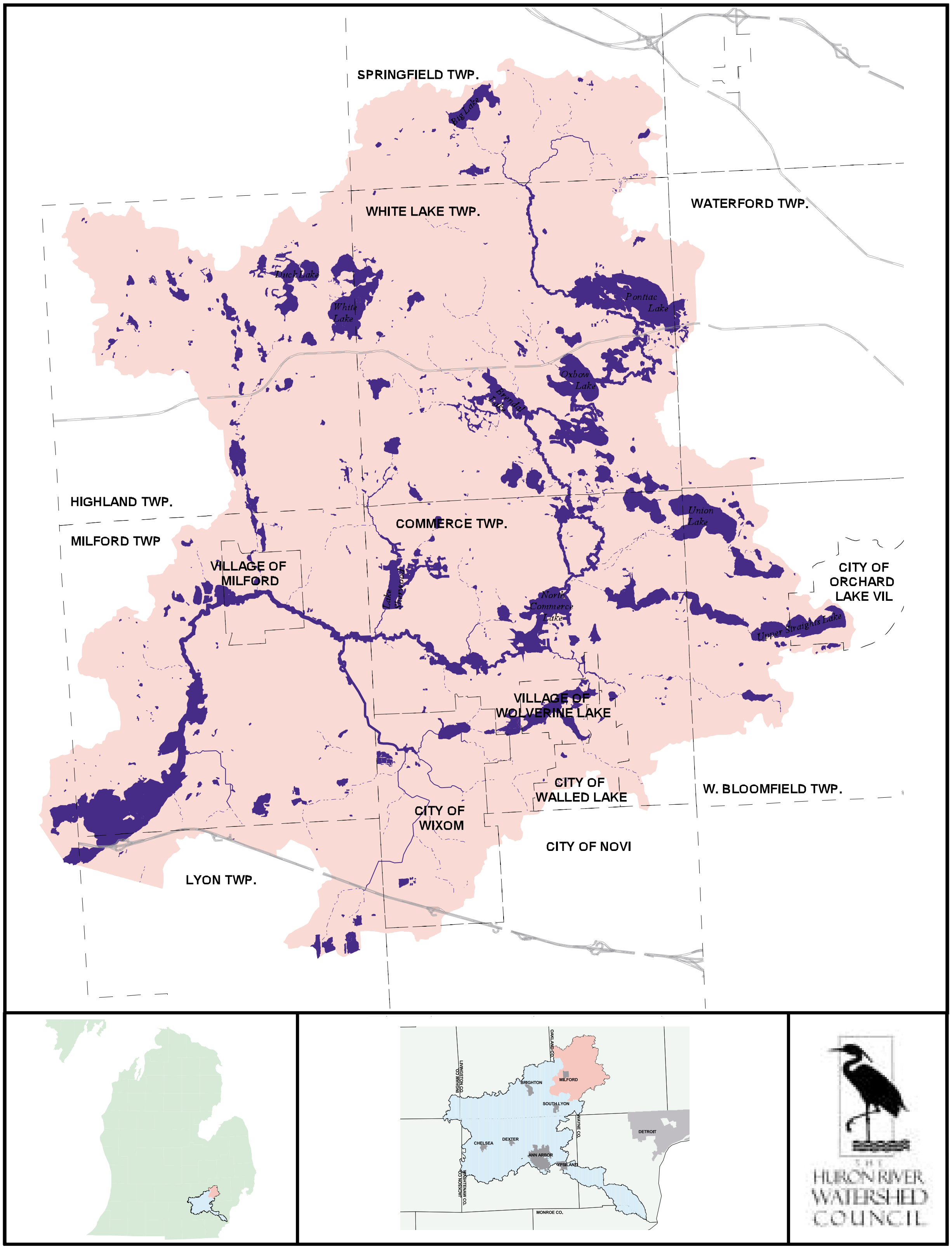
The subwatershed is located in the southwest portion of Oakland County and comprises all or portions of eight municipalities and five cities or villages (Figure 1). This includes the townships of Commerce, Highland, Lyon, Milford, Springfield, Waterford, West Bloomfield, and White Lake. Also included in the subwatershed are the Villages of Milford, Orchard Lake, and Wolverine Lake and the Cities of Walled Lake and Wixom.

Each jurisdiction is zoned and holds regularly scheduled meetings of township governmental 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 power over land use and development policy, among other important activities. Public road maintenance and road drainage in each township, however, is the responsibility of the Road Commission of Oakland County.

Land and water regulation, management, and protection within the Kent Lake Subwatershed are 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 Oakland County Drain Commissioner's Office (OCDC) 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, although local governments may also administer this program. Communities in the Kent Lake

Figure 1. Location of the Kent Lake Subwatershed.



Subwatershed that currently administer their own program are the townships of Commerce and West Bloomfield, the Villages of Milford and Wolverine Lake, and the Cities of Walled Lake and Wixom.

While 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 capacity in land and water management by passing and enforcing safeguards which 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 Kent 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 the landscape of the subwatershed had changed significantly (Figure 3). Permanent mixed density residential, agriculture, and grass and shrublands dominated the landscape. 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 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 “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.

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.

Figure 2. Kent Lake Subwatershed Pre-settlement Land Use

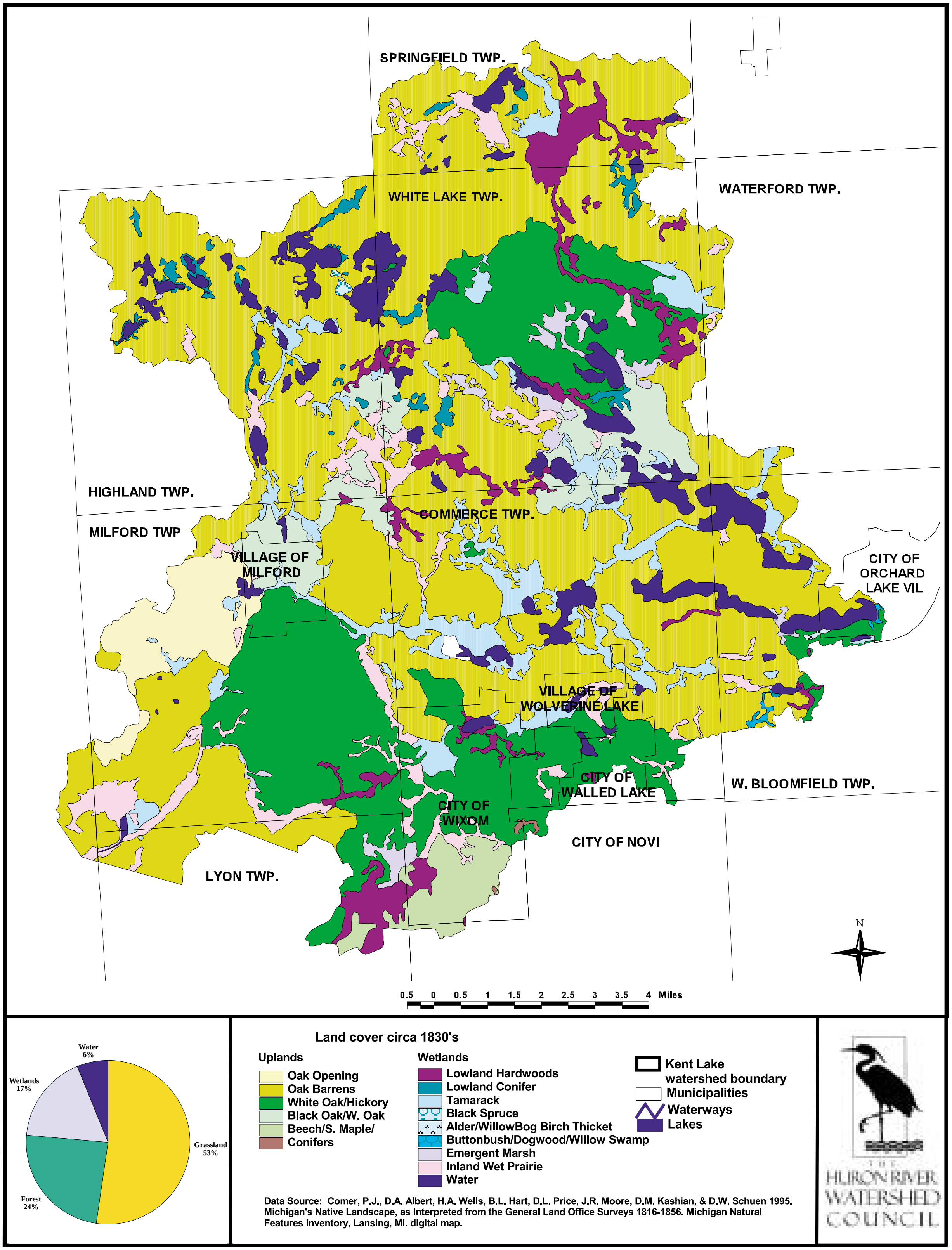
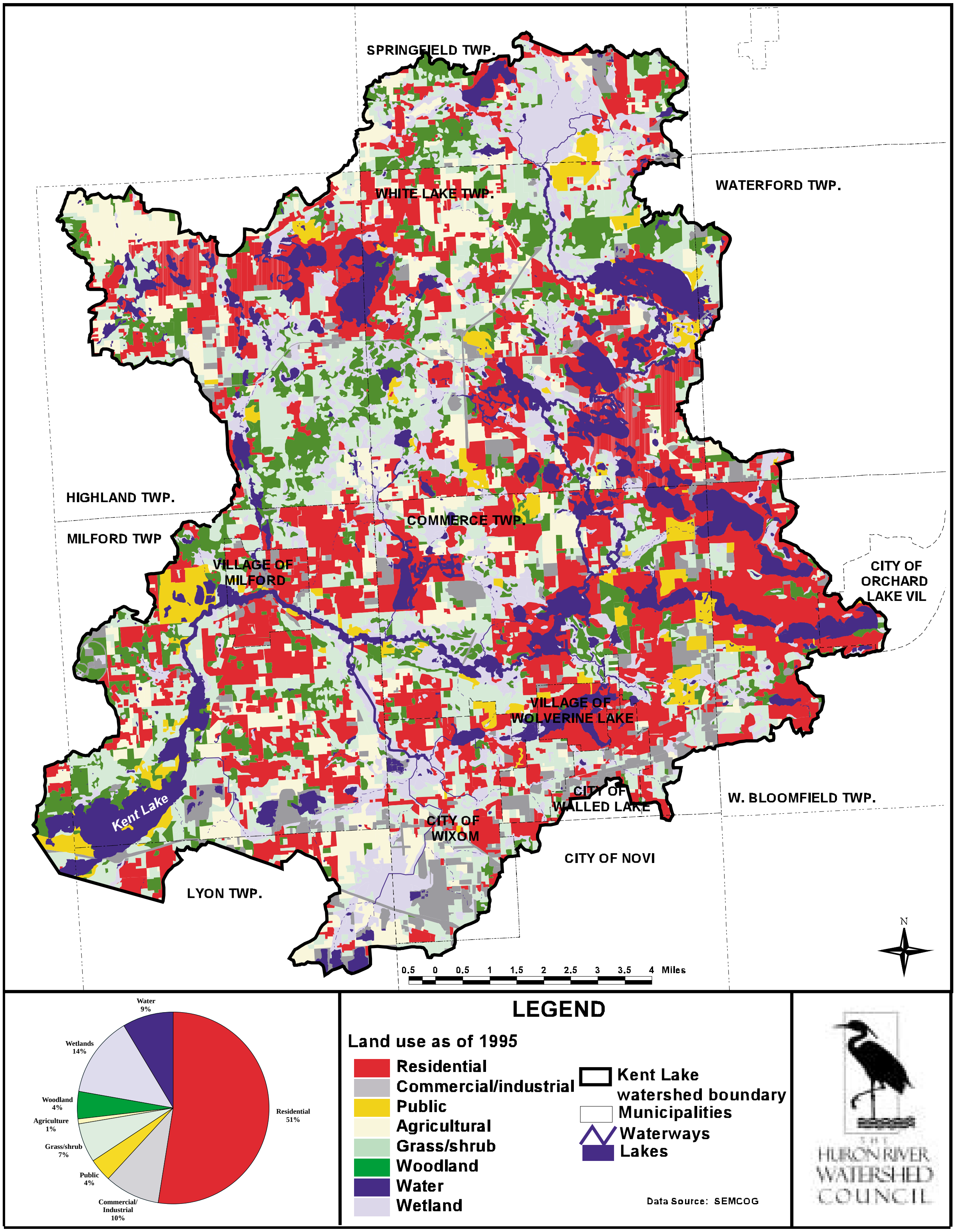


Figure 3. Kent Lake Subwatershed 1995 Land Use



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 (Schueler, 1994). 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, aerial photographic SEMCOG data indicate a Kent Lake Subwatershed imperviousness rate of approximately 9.6% (Figure 4). Research reveals that water quality degradation is first notable as impervious surfaces in a subwatershed achieve 10% of the total landscape (Schueler, 1994). Our area, however, starts to exhibit such water quality degradation at an imperviousness rate 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 and fish populations and subsequently the recreational value of waterbodies.

Using SEMCOG zoning ordinance 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 Kent Lake Subwatershed imperviousness rate may double. However given the uncertainty of such analyses, future economic and population trends can significantly alter this prediction.

Since these predicted increases in impervious rates threaten to have a critical impact on the quality of Norton Creek, Pettibone Creek, and the Huron River, significant efforts to mitigate these effects should be a priority for applicable communities (Figure 5).

2.2.5 Current Sewer Service and Privately Owned Septic System Areas

The Kent Lake Subwatershed has a diverse mix of households whose waste discharges are treated by publicly owned wastewater treatment plants or on-site decentralized wastewater systems (privately-owned septic systems). Sanitary sewers 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 on-site 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 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 divisions regulate the design, installation, and repair of private septic systems. However, only a relatively small portion requires regular maintenance and inspection to assure proper functioning of these systems (e.g., Washtenaw County, Michigan).

Figure 4. Kent Lake Subwatershed 1995 Imperviousness

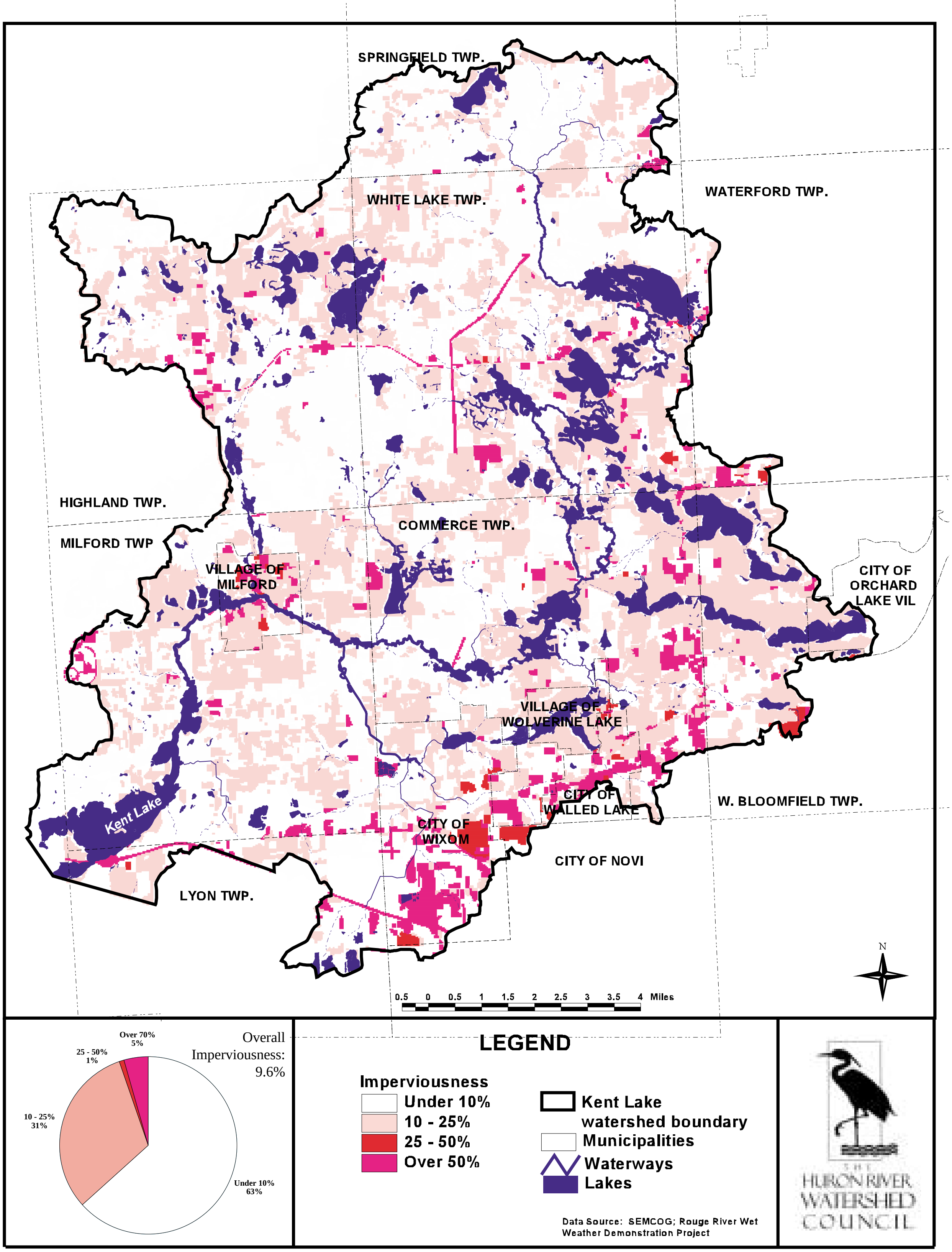
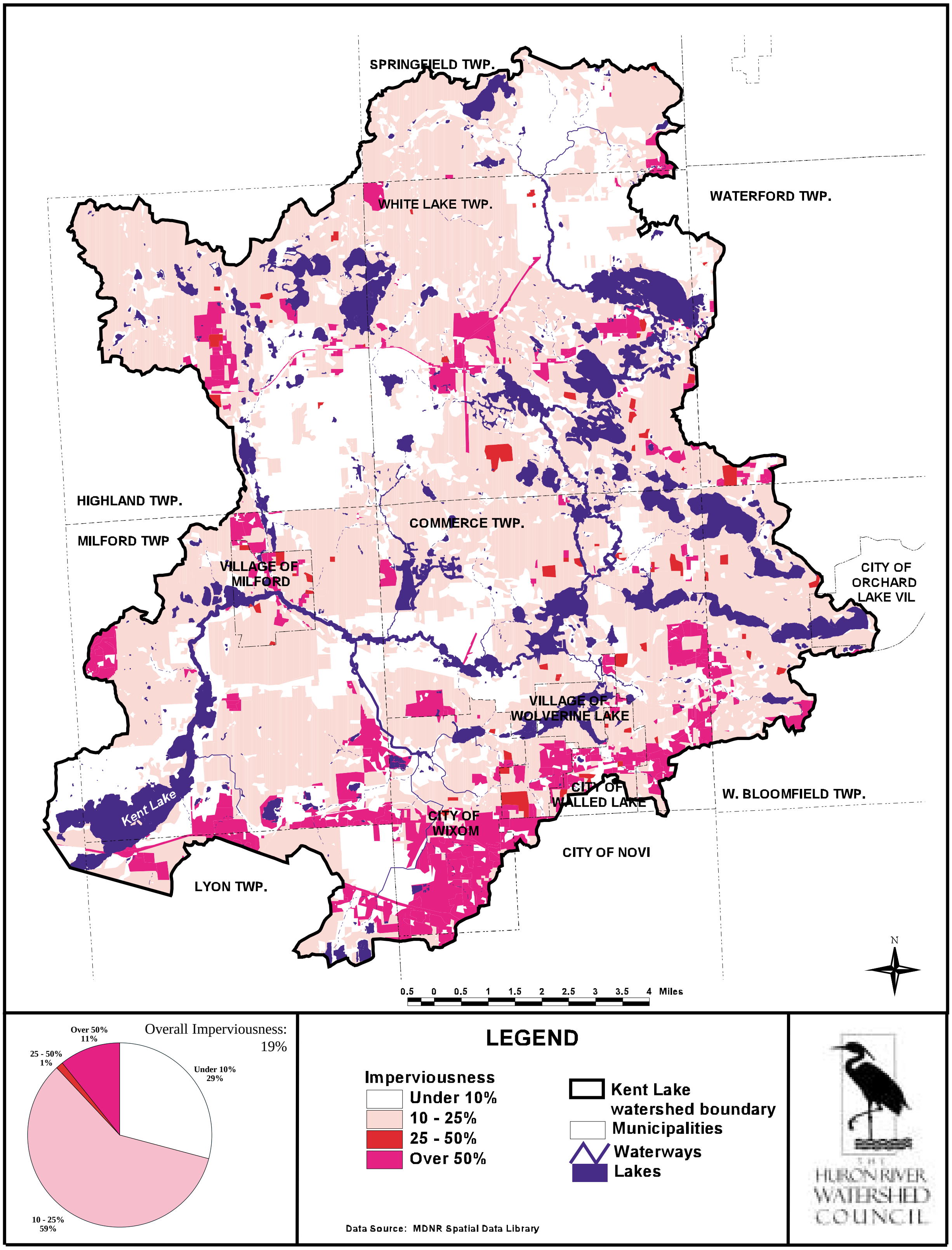


Figure 5. Kent Lake Subwatershed Build-Out Imperviousness



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 Oakland County Drain Commissioner's Office's Illicit Discharge and Elimination Program (IDEP). This program is currently concentrated in the Rouge River Watershed, however plans for expansion of the program to other areas of the County are being formalized.

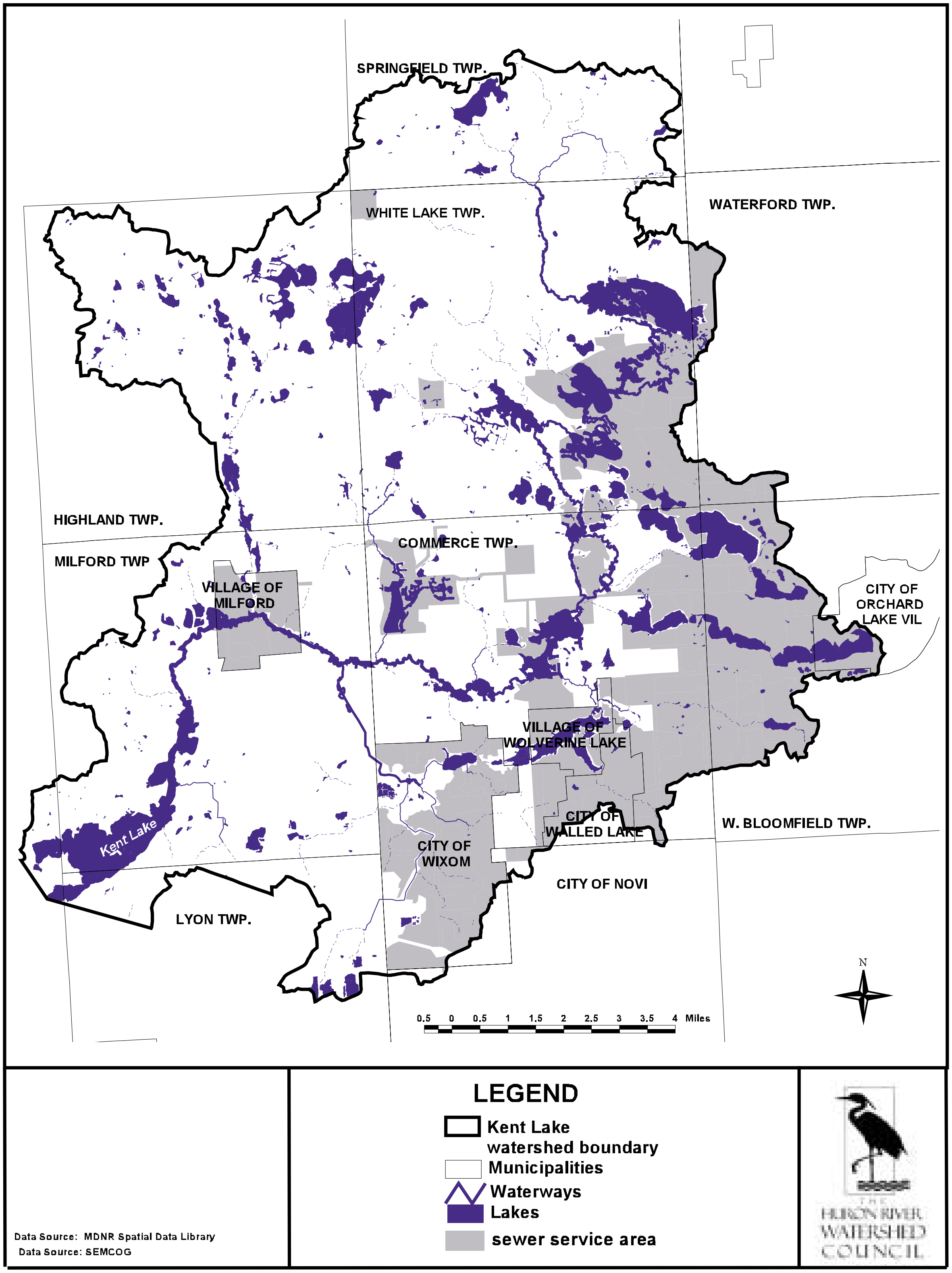
In general, in 2001 households served by sewers are located in the eastern and urbanized areas of the subwatershed while the less developed western portions are typically served by on-site septic systems (Figure 6).

The Oakland County Health Division (OCHD) estimates approximately 57,400 (51%) of the total subwatershed population of 118,000 individuals rely on sewer systems for waste treatment. The remaining residents use approximately 32,200 on-site septic systems for wastewater treatment. On average 1,548 new on-site septic systems are installed annually in the county. And a review of reported system failures from 1956 to 1999 indicates that on average 252 failures occur per year in the county. For Kent Lake Subwatershed communities, from 1956 to 1999 a total of 5,551 septic system failures were reported. However, this can not be considered a complete representation of on-site septic system failures as current law limits the Health Division's ability to investigate system functioning on private property. For absence of property owner permission or a court authorized warrant, Health Division staff is prohibited from investigating such systems on private property.

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 resulting unhealthful conditions to humans (i.e., bacterial contamination) that result.

The OCHD is responsible for licensing the properties for installation and for enforcement of privately owned septic systems determined to be discharging bacteria to the environment (whether surface water or ground water). While educational materials are available from a wide variety of organizations, most local governments and the County do not have a formal maintenance and inspection program in place. Such a program is expected to be introduced and implemented around May 2003.

Figure 6. Current Sewer Service Areas of the Kent Lake Subwatershed



The Oakland County Drain Commissioner's office and municipalities operate and maintain the municipal systems to insure that they do not impact water quality. When any discharges occur, the OCDC provides proper public notice and corrective action to eliminate the discharge.

2.2.6 Existing Point Sources

Within the Kent Lake Subwatershed, there are two point sources present which discharge measurable concentrations of phosphorus. These sources are the Wixom Wastewater Treatment Plant (WWTP) and the Milford WWTP. Based on MDEQ water quality monitoring data of discharges, between April 1998 to March 1999, the Wixom WWTP discharged a total of 1,112 pounds of phosphorus, or 16% of the total phosphorus load, to the subwatershed. During the same period of study, the Milford WWTP discharged 261 pounds of phosphorus or 4% of the subwatershed total phosphorus load. Both facilities are in compliance with the NPDES I program (Alexander, 1999b).

2.2.7 Hydrological Conditions

This region of the Huron River Watershed is one of the most densely concentrated areas 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 7. The information presented represents the monthly mean streamflow for three typical rainfall years of 1949, 1985, and 1998. The data represent a drainage area of 132 square miles or one-fifth of the Kent Lake Subwatershed. As illustrated by Figure 7 flow conditions of the subwatershed have remained relatively similar over the last 60 years although specific year flow conditions may vary. One possible reason for this observation is the large number of lakes, wetlands, and impoundments in the subwatershed that act as stormwater and flood control storage.

In general, as land is developed, flows in the rivers become "flashy", with increased volume and velocity of flow, which impact water quality in numerous ways (Table 1). Groundwater hydrology is also impacted with development and can impact flow within rivers and lake levels as the systems interconnect. In Kent Lake, the groundwater is connected at numerous points with the wetlands and lakes.

Figure 7. Mean Monthly Streamflow for Three Typical Hydrologic Years for the USGS Gage Station # 04170000 (Huron River at Milford).

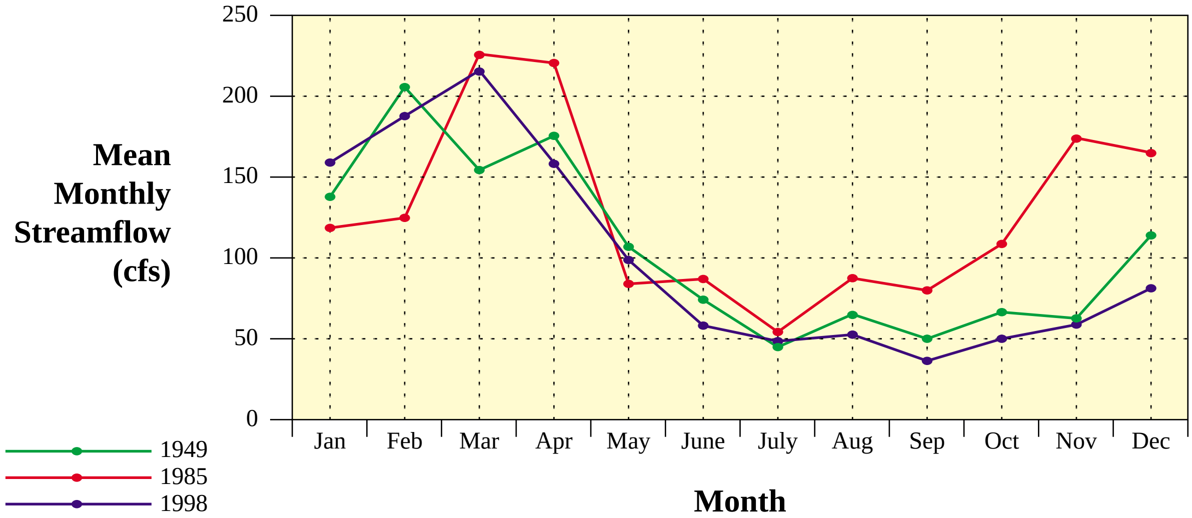


Table 1. Impacts of Development on Hydrological Conditions (source: MOSAG, 2001)

	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 factors important in reviewing and understanding the hydrology of the subwatershed are the direct drainage, Darcy's Law, the depth to groundwater, and soil permeability maps that reflect either the potential passage or infiltration potential of groundwater in the subwatershed (Figures 8, 9, 10, and 11).

The Darcy's Law map utilizes its namesake's hypothesis to predict the probability of groundwater recharge areas in subwatersheds. As illustrated in Figure 9, the Darcy's Law predicts that, in general, areas adjacent to the river and tributary streams hold the greatest probability of having groundwater recharge. Figures 10 and 11 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 require added water quality precautions within the subwatershed (i.e., gas stations, chemical storage facilities, etc.).

Figure 8. Direct Drainage Area of the Kent Lake Subwatershed

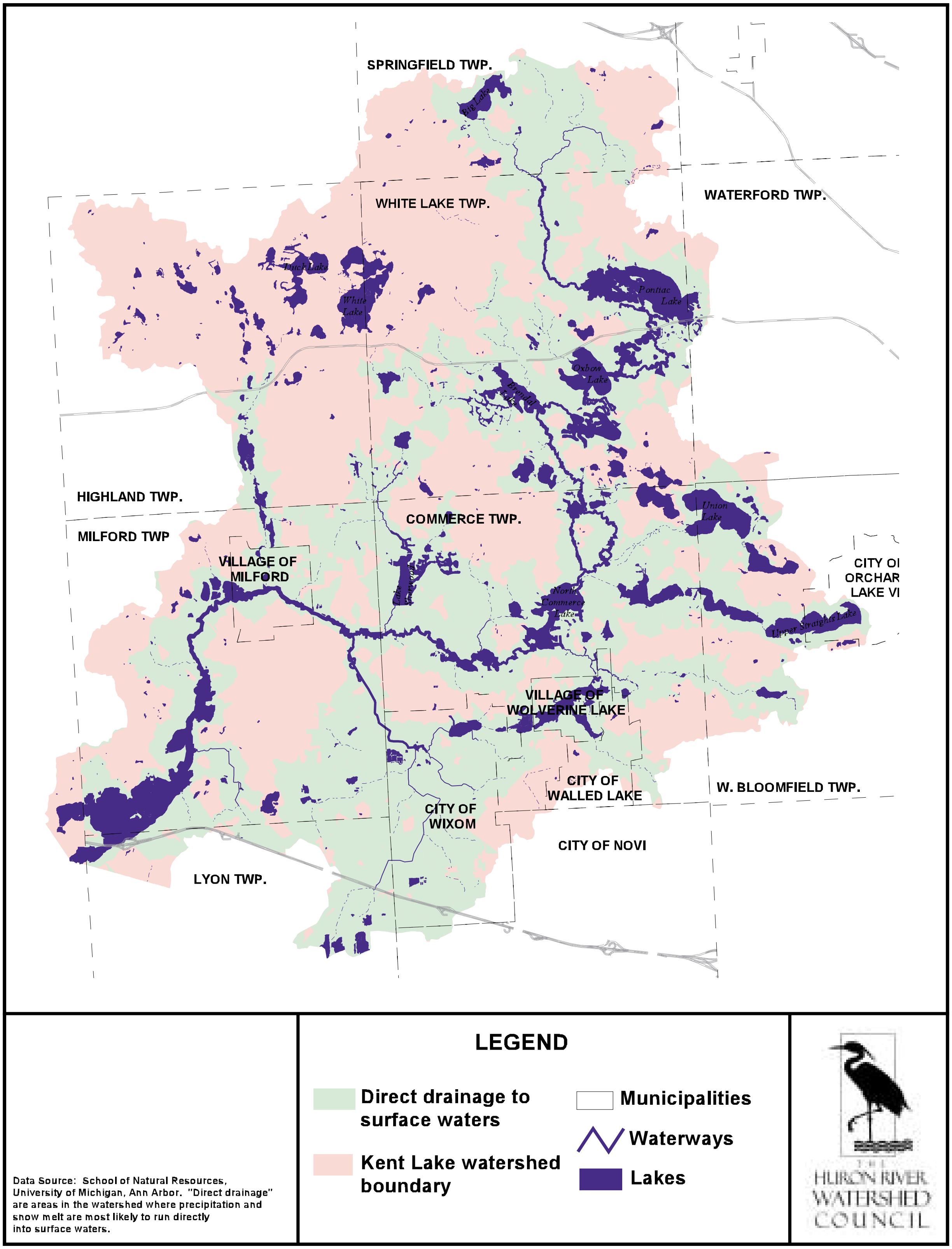


Figure 9. Probability of Groundwater Recharge Areas for the Kent Lake Subwatershed

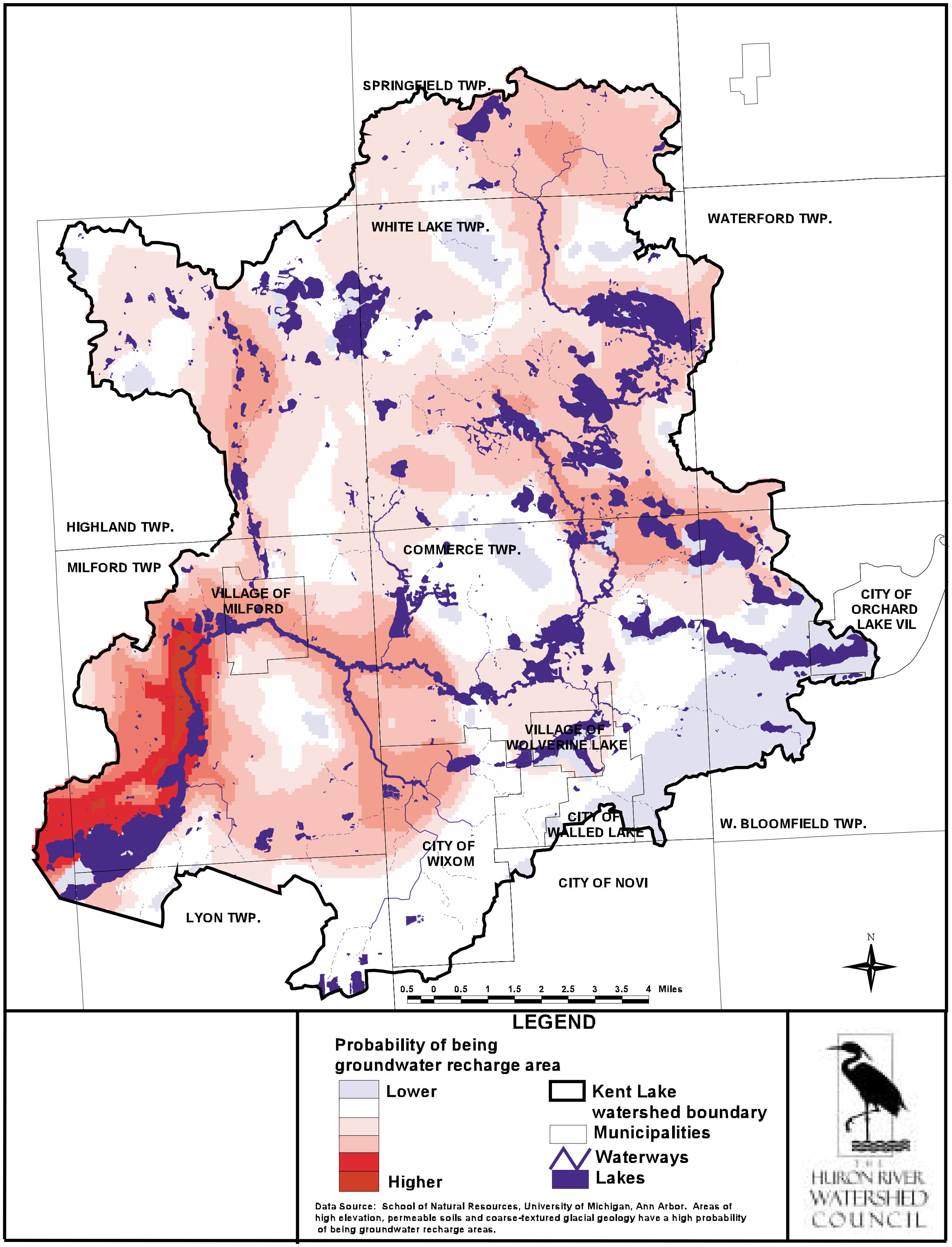


Figure 10. Depth to Water Table for the Kent Lake Subwatershed

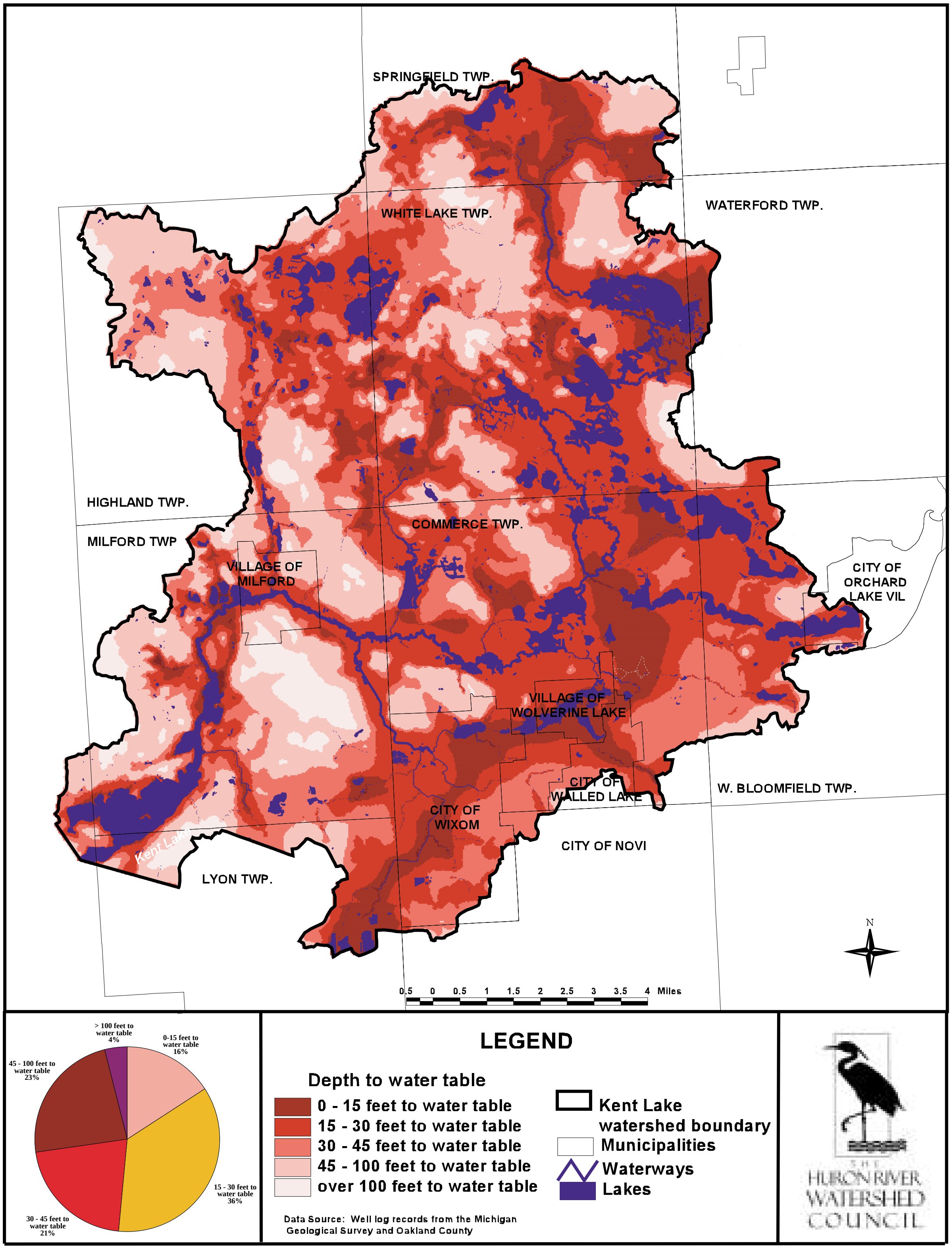
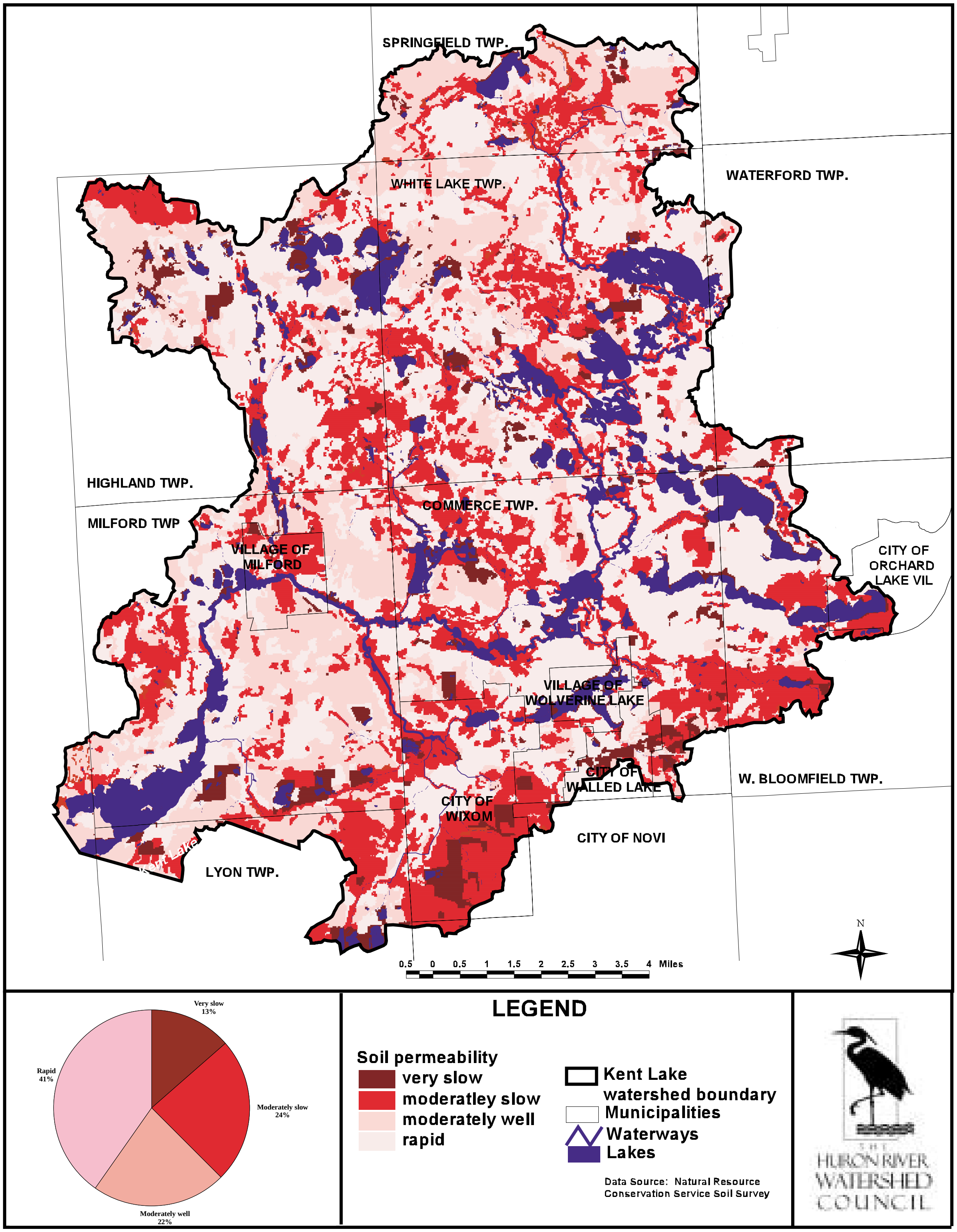


Figure 11. Soil Permeability Properties of the Kent Lake Subwatershed



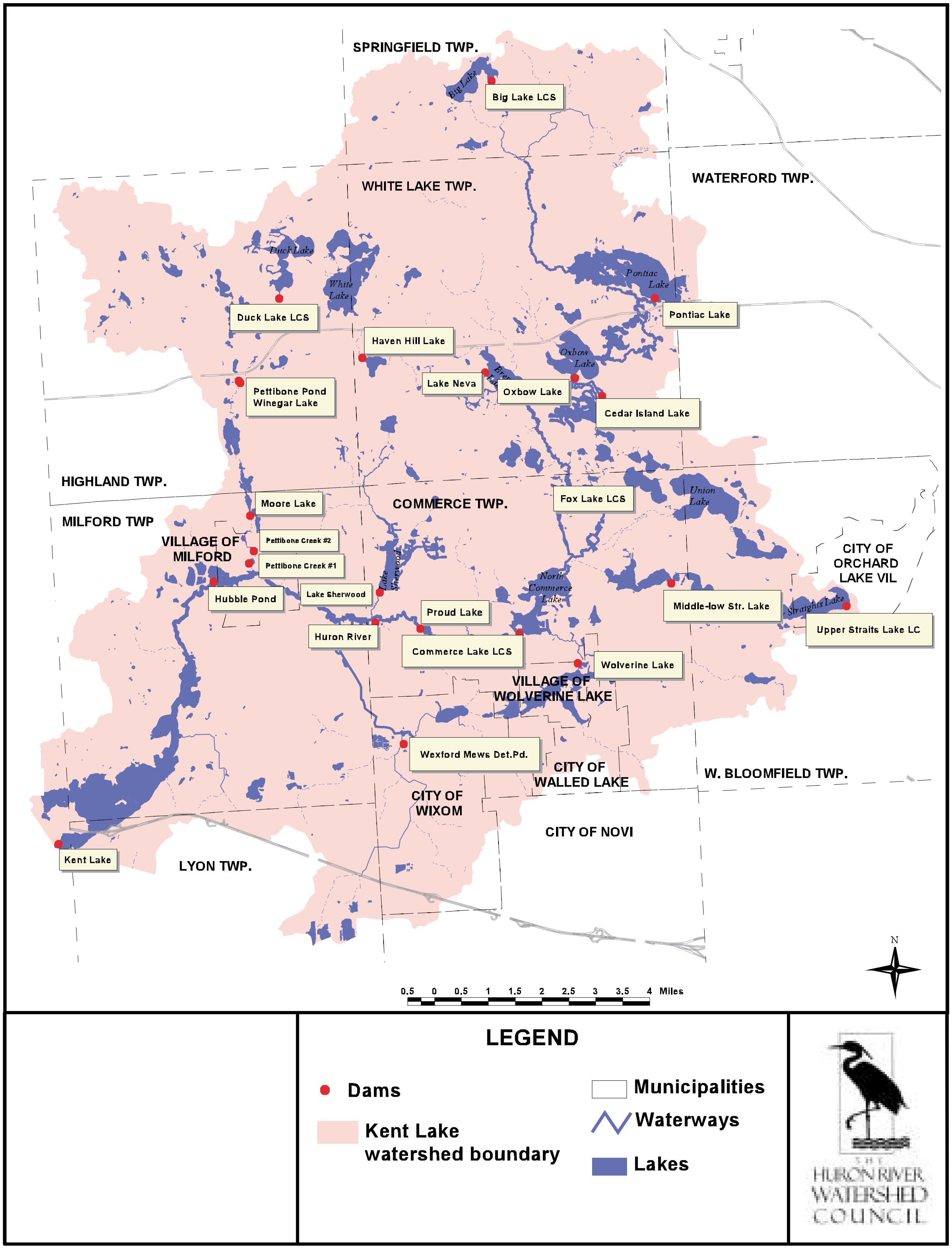
Two major tributary creeks discharge to the Kent Lake Subwatershed—Pettibone Creek and the Norton Creek/Drain. Pettibone Creek is located in the north-central portion of the subwatershed north of the Village of Milford. Norton Creek is located in the south-central portion with its outfall a few miles east of the Village of Milford. See Chapter 3 for more information regarding these tributaries.

Another attribute contributing to the overall hydrological condition of the Kent Lake Subwatershed is the presence of dams or impoundments. According to the U.S. Environmental Protection Agency (EPA) BASINS program, 22 of the 96 identifiable dams or impoundments in the Huron River Watershed are located in the Kent Lake Subwatershed (Figure 12 and Table 2).

Table 2. Name, location, and Waterway of the Dams of the Kent Lake Sub-watershed (—, not available).

Dam Name	Human Hazard	Community	Waterway
Kent Lake	*Significant*	*Milford*	*Huron River*
Ford #3	*Significant*	*Lakeland*	*Huron River*
Oxbow Lake	*High*	*White Lake*	*Huron River*
Pontiac Lake	*High*	*White Lake*	*Huron River*
Lake Neva	*High*	*Union Lake*	*Unnamed tributary to the Huron River*
Pettibone Pond #1	--	*V. of Milford*	*Pettibone Creek*
Pettibone Pond #2	*Low*	*V. of Milford*	*Pettibone Creek*
Moore Lake	*Low*	*Milford*	*Pettibone Creek*
Haven Hill Lake	*Low*	*Union Lake*	*Unnamed tributary to the Huron River*
Fox Lake Level Control Structure	*Low*	*Commerce*	*Huron River*
Lake Sherwood	*Significant*	*Milford*	*Unnamed tributary to the Huron River*
Cedar Island Lake	--	*White Lake*	*Huron River*
Middle Lower Straits Lake	--	*Commerce*	*Unnamed tributary to the Huron River*
Upper Straits Lake	--	*West Bloomfield*	*Unnamed tributary to the Huron River*
Wolverine Lake	--	*Wolverine Lake*	*Unnamed tributary to the Huron River*
Commerce Lake	--	*Commerce*	*Huron River*
Proud Lake	--	*Commerce*	*Huron River*
Wexford Mews Detention Pond	--	*Wixom*	*Norton Creek*
Winegar Lake	--	*Highland*	*Pettibone Creek*
Humble Pond	--	*Milford*	*Huron River*
Big Lake	--	*Springfield*	*Huron River*
Duck Lake	--	*Highland*	*Unnamed tributary to the Huron River*

Figure 12. Dams in the Kent Lake Subwatershed



County established Drains are common in the subwatershed. The Oakland County Drain Commissioner's Office has established over 25 Chapter 4 agricultural drains, all open ditch, covering 50 miles of watercourse. There are also some Chapter 20 enclosed drains that cover about 3 miles of the drainage area. In addition, within West Bloomfield Township, there are over 20 additional subdivisions that have their drainage systems managed by OCDC through Chapter 18.

2.2.8 Geomorphology and Soils

From its headwaters to Commerce Lake, the river is narrow and the channel exhibits evidence of past dredging activities. Substrate consists mostly of gravel and detritus with small amounts of rubble. Fish cover is sparse and the stream is dominated by run habitat with very few pools or riffles. Downstream from Commerce Lake to Kent Lake, the river channel varies in configuration. Portions of the river in this locale exhibit the narrowing effects of dredging while other areas show widening effects due to fluctuating water flow or sedimentation. The substrate in the river between Commerce Lake and Kent Lake varies among silt, gravel, and sand. Marl is also found in some locations (Hay-Chmielewski, et al., 1993).

The majority of the soils in the subwatershed are sandy loams or friable sand-clay mixtures. Near the river and its tributaries, Fox-Oshtemo-Plainfield associations are predominant. Areas farther away from the river and its tributaries mostly consist of soils in the Bellefontain-Hillsdale-Conover association. The properties of these soils are favorable for consistent groundwater input to surface waters, leading to overall stabilized flows in the river (Hay-Chmielewski, et al., 1993). This is evidenced in soil permeability rates for the subwatershed (Figure 11).

2.3 Kent Lake and the Kensington Metropark

Numerous dams, or impoundments, in the subwatershed serve as recreational and waterfront housing enhancement structures. The Kent Lake impoundment, which forms Kent Lake, is an example of such a recreational enhancement structure.

Built in 1946 and owned by the Huron Clinton Metropark Authority (HCMA), the Kent Lake impoundment has a head of 14 feet that forms the 1,200-acre Kent Lake. Surrounding the lake is the 4,357-acre Kensington Metropark that opened in 1948. Currently, 2.5 to 2.7 million people visit the Metropark annually to enjoy the abundant opportunities for biking, picnicking, hiking, observing nature, swimming, and horseback riding, as well as numerous winter activities. Fishing is also a popular activity, with nearly 200,000 anglers per year visiting Kent Lake and the Kensington Metropark (Hay-Chmielewski, et al., 1993). Another popular activity on the lake is boating, as the HCMA has sold nearly 3,000 daily and 730 annual boating passes for the past several years. In addition, 80 rowboats, 15 paddleboats, and a large tour boat are available for rental on the lake (Schafer, personal communication). The park is also home to a 6,378-yard 18-hole golf course that is open to the public.

2.4 Key Natural Areas Protection Opportunities

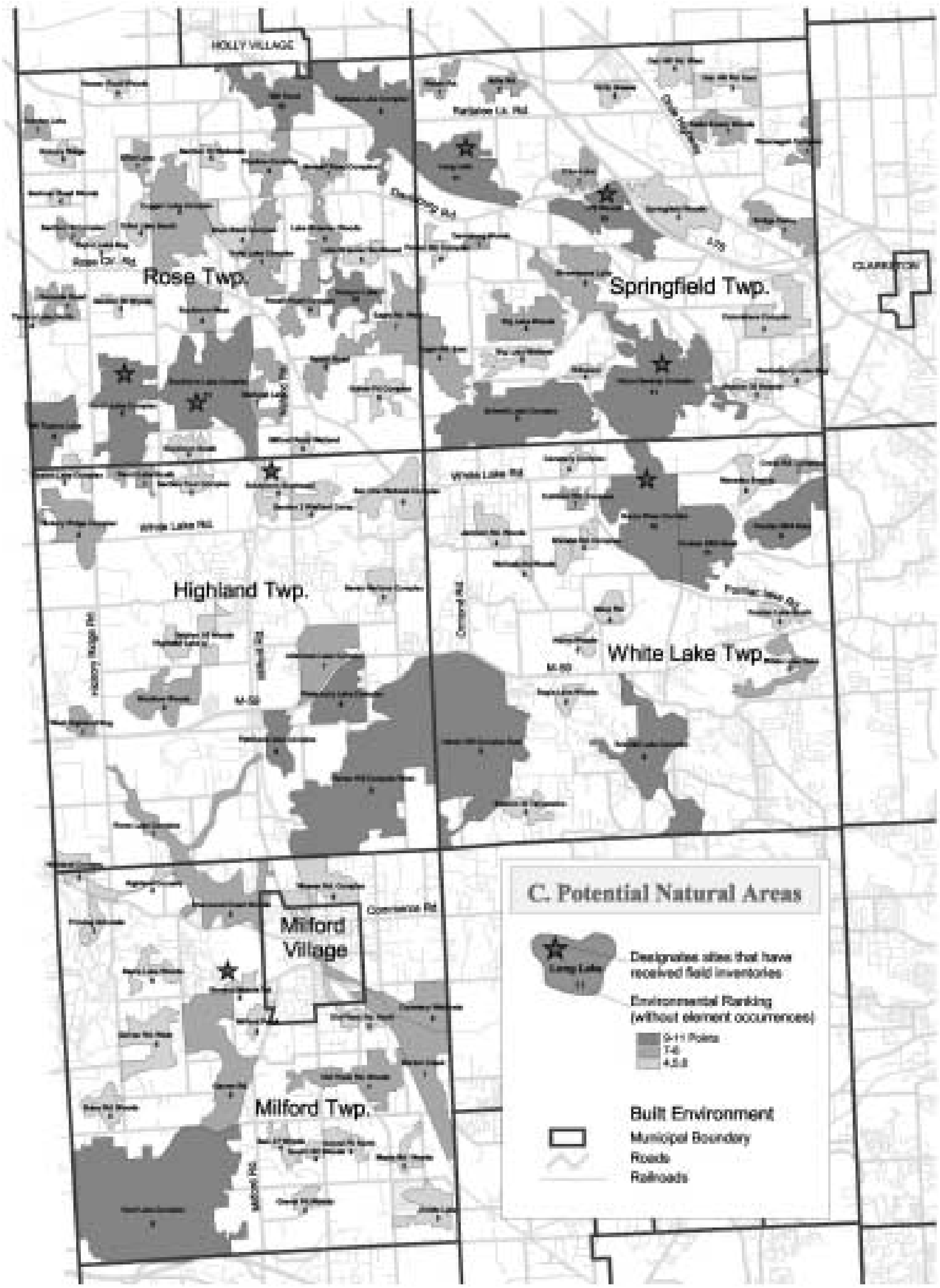
The extent of stewardship of sensitive open spaces and native habitats can directly impact the quality of life and quality of water in a subwatershed. To this end, the Shiawassee & Huron Headwaters Resource Preservation Project (S&H) with the assistance of the Michigan Natural Features Inventory (MNFI) conducted a natural resources inventory of portions of the Kent Lake Subwatershed project. Within the subwatershed, the townships of Springfield, White Lake, Highland, and Milford and the Village of Milford participated in the process. The MNFI located 114 key habitats and evaluated them for intactness, upland and wetland complexes, riparian corridors, significant forested tracts, and potential for restoration.

Based on MNFI analysis eighteen (18) habitats considered vital (scoring a 7 or better out of 10) within the subwatershed were identified for targeted protection practices (Table 3 and Figure 13).

Table 3. Key Habitats for Protection and Restoration within the Kent Lake Subwatershed. (Source S&H Project, 2000)

Site Name	Community
Huron Swamp Complex	*Springfield*
Schmitt Lake Complex	*Springfield*
Pontiac SRA East & West	*White Lake*
Huron River Corridor	*White Lake*
Cuthbert Road Complex	*White Lake*
Haven Hill Complex East & West	*White Lake & Highland*
Brendel Lake Complex	*White Lake*
Pettibone Lake Complex	*Highland*
Alderman Lake Complex	*Highland*
Waterbury Lake Complaex	*Highland*
Old Plank Road Woods	*Milford*
Norton Creek Complex	*Milford & Village of Milford*
Cemetary Wetlands	*Milford & Village of Milford*
Sherwood Creek Woods	*Milford & Village of Milford*
Garner Road Complex	*Milford*
Kent Lake Complex	*Milford*

Figure 13. Key Habitats for Protection and Restoration Identified in the Shiawassee & Huron Headwaters Resource Preservation Project



Source:Oakland County Planning and Economic Development

THE HURON RIVER WATERSHED COUNCIL

2.5 State and Federal 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 Kent Lake Subwatershed, the Townships of Commerce, Highland, Lyon, Milford, Springfield, Waterford, West Bloomfield, and White Lake and the Cities of Walled Lake and Wixom and the Villages of Orchard Lake and Wolverine Lake either have or will need to obtain a permit. Some of these communities already have coverage for the adjoining Rouge River drainage area under the watershed-based permit and will likely simply increase their efforts in a similar fashion as the Phase II requirements fall into place in March of 2003. However, MDEQ has received consent from the USEPA under the Regulatory Innovation Program, to offer a Michigan General Storm Water Permit as equivalent to the Federal Phase II Storm Water Regulations.

The MDEQ is offering two distinct permit coverage options—Traditional and Watershed-based General Permit Coverage. The Traditional permit covers the standard EPA six minimum measures. The Watershed-based permit covers the six minimum measures through cooperative watershed planning, and 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.

It is intended that this planning process to improve and protect the water quality of Kent Lake will sufficiently address many of 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 Kent Lake
As previously discussed, 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.

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.

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. 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 drainage area. This list is available to the public from MDEQ.

Table 4. 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 Phosphorus Total Maximum Daily Load for Kent Lake

In April of 1998, a 12-month phosphorus loading analysis was initiated by the MDEQ to investigate the water quality of Kent Lake and its upstream sources. The analysis showed that Kent Lake 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 Kent 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 Walker methodology of lake trophic assessment, the TMDL estimates that the current annual phosphorus load is 7,000 pounds/year. Approximately 1,300 pounds/year of this total is from point sources, and 5,700 pounds/year is from nonpoint sources. Therefore, MDEQ prescribes a 16% reduction (approximately 1000 pounds/year) of nonpoint source phosphorus loading to the lake in order to meet the TMDL.

The phosphorus TMDL for Kent Lake was approved by the USEPA on March 10, 2000. See Appendix A for the federally approved Kent Lake TMDL.

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 the presentation and analysis of readily available and relevant data, a general review of the study of lake water quality and typical variables of concern is warranted.

3.1 Variables of Concern

In order to provide a perspective on the general water quality conditions of Kent Lake and the Kent Lake Subwatershed, readily available and relevant water quality data were complied and summarized. Not surprisingly, but disappointingly, spatial and temporal data for the subwatershed were 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 variables 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 regarding 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 secondary 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 and septic systems, as well as 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 to support aquatic life (Sawyer, et al., 1994).

Table 5 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 5. Pollutant Concentrations per Land Use in Runoff from a Typical Rain Event. (Cave, K., et al., 1994)

Land Use	Pollutant (mg/L)				
	Total Phosphorus	Total Nitrogen	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 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 stream macroinvertebrate or fish population community assessments, organic contamination studies, and bacteriological surveys.

3.2 Water Quality Review per Drainage Area

In order to gain a better perspective on the past and present water quality conditions in the subwatershed, efforts were made to obtain and review all readily available and relevant water quality data.

Because of the large size of the area (100,000 acres) and its impact on efficient review of water quality data, an effort was made to categorize the analysis based on drainage areas in the subwatershed. Four (4) distinct drainage areas—Upper Kent, Norton Creek/Drain, Pettibone Creek, and Lower Kent—were established and are reviewed below. In addition, summarization of water quality studies and data found during the review and pertaining to Kent Lake are also presented.

Note that not all the lakes within the subwatershed are reviewed either because these lakes have not been studied, or data requests and review did not produce such studies. Hence, the following narrative may not be considered a comprehensive review of water quality in the subwatershed but rather a snapshot.

3.2.1 Upper Kent Drainage Area

The Upper Kent River drainage area begins at the headwaters of the Huron River and extends in a southeasterly direction to approximately the eastern boundary of the Village of Milford (Figure 1). The drainage area of the Upper Kent is roughly 5,023 acres.

According to USGS data reported in the USEPA STORET database, the mean total phosphorus concentration for the Huron River in the upper drainage area between 1977-78 was 23 µg/L (n = 84). This concentration represents the mean of several Huron River sites in the Huron Direct drainage area. The average flow for this period was not reported for the 1977-78 period; therefore, the 1966-71 flow of 11 cubic feet/second (cfs) was utilized. Considering the reported concentration and flow, a load of 41lbs/month or approximately 492 pounds per year (lbs/yr) can be calculated. Unfortunately, no distinction between nonpoint source and point source phosphorus loading can be made utilizing the USGS data.

In 1979, the Michigan Department of Natural Resources (MDNR) calculated a phosphorus loading for the Huron River at Commerce Lake of approximately 946 lbs/yr (MDNR, 1979). In a more recent MDEQ loading study for the watershed, Alexander (1999) determined the monthly phosphorus load for the same site to be approximately 1,670 lbs/yr between April 1998 and March 1999. No point source loads were established in either the 1979 or 1999 investigations.

During the 1999 study, Alexander determined a total phosphorus load of 5,556 lbs/yr at the Huron River at Milford. Eliminating the 1997-98 load from the Wixom Wastewater Treatment Plant (WWTP), a nonpoint source phosphorus loading of 370 lbs/month (approximately 4,440 lbs/yr) is established. Although MDNR in 1979 established a load of 6,785 lbs/yr, this value includes loads from the Norton Creek/Drain that then included the Ford Motor Company and Wixom Wastewater Treatment Plant (WWTP) point source discharges. Therefore, subtracting the 1979 load contributed by the Ford Motor Company and Wixom WWTP from the total load observed at the Milford site in 1979, a nonpoint source load of 2,724 lbs/yr can be established for 1979.

The loading values determined by MDNR (1979) and Alexander (1999) greatly exceed those determined using STORET data and are considered more reliable in describing past and current water quality conditions due to study lengths and sampling frequencies. Therefore taking these observations into consideration, a measurable increase in nonpoint source phosphorus loading in the drainage area between 1979 and 1999 appears to have occurred.

Readily identifiable and available total nitrogen measurements were limited in scale for the Upper Kent. For the period of record between 1977-78 reported by the USGS, total nitrogen averaged 847 mg/L (n = 83). Using 11 cfs as the average flow identified in the study, an annual nitrogen load of 1.8 lbs/day can be determined.

STORET data for the Upper Kent indicate dissolved oxygen levels averaged 8.8 mg/L 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 not collected, not reported, or not readily available.

In addition to data regarding the variables of concern, the Huron River Watershed Council's (HRWC) Adopt-A-Stream program has been monitoring benthic macroinvertebrates on two Huron River sites located in the Upper Huron River drainage area. The first site, for which monitoring began in 1994, is located at the outlet of Big Lake, headwater to the Huron River. The second site, for which monitoring began in 1997, is slightly upstream of the impoundment at Commerce Lake.

Bioassessment results for the headwaters site were better than expected for the Huron River. The number of sensitive macroinvertebrate families, indicators of those families vulnerable to human-influenced or created (anthropogenic) pollution, ranged from 1 to 7. The number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) families, which are particularly sensitive to reduced dissolved oxygen, flow, and/or increased temperature, ranged from 7 to 13. On three occasions, collecting teams found Odontoceridae caddisflies, which are rare in Michigan's Lower Peninsula. Macroinvertebrate monitoring of the second site in the Upper Huron River drainage area upstream of Commerce Lake indicated good overall ecological health, although not as impressive as the upstream site of the Huron River at White Lake Road. Overall, EPT families have ranged between 4 and 6 and between 0 and 1 for sensitive families at both sites.

In addition to HRWC Adopt-a-Stream summer sampling, HRWC volunteers have monitored the two sites for winter stoneflies. Winter stoneflies are of interest because they have unique life cycles which enable them to be relatively immune to perturbations that often occur during summer months, such as increased water temperature fluctuations common in stormwater runoff. However, when little or no winter stoneflies are present, it indicates the site may be or may receiving toxic contamination. At the Huron River at White Lake Road site, sampling events in 1995, 1996, and 2000 found at least one winter stonefly family for each sampling event. However, 1998 and 2000 sampling at the Commerce Township site found 0 and 1 winter stonefly family, respectively, indicating possible impairment.

As a supplement to macroinvertebrate sampling, habitat assessments were performed in 1998 at the Big Lake site and the Commerce site. The Big Lake site was rated as having good habitat with stable bank conditions. Conversely, the Commerce site was deemed poor in both habitat conditions and bank stability as erosion and bare banks were prevalent.

3.2.2 Norton Creek/Drain Drainage Area

Norton Creek is located in the south-central portion of the Subwatershed and discharges into the river a few miles east of the Village of Milford (Figure 1). The drainage area is located in the southern portion of the Sub-watershed and encompasses approximately 1,548 acres.

Relatively little STORET data are available pertaining to the drainage area and the variables of concern. Little other pertinent or readily available data were found. Based on this information, an accurate assessment of the water quality condition of Norton Creek/Drain cannot be made, however, general observations can be derived.

Three sampling events reported by the USEPA in September of 1980 on Norton Creek averaged a phosphorus concentration of 39 µg/L. Based on the reported flow of 1.9 cfs at the time of sampling, this value corresponds to a load of 146 lbs/yr.

Alexander (1998) determined current non-point source phosphorus loading for the Norton Creek drainage area to be 288 lbs/month (approximately 3,456 lbs/yr). As discussed previously, this value is deemed most representative of current loading conditions because of the study's sampling methodology and consistency. This indicates a slight increase in nonpoint source phosphorus loads when compared to the 1979 MDNR estimate of 3,206 lbs/yr.

Phosphorus loading from the Ford Motor Company, Wixom Assembly Plant, were determined to be 2,153 lbs/yr between May 1977 and April 1978 (MDNR, 1979). However, since that time, the plant has connected to the Wixom WWTP and no longer discharges into Norton Creek.

While no total nitrogen samples were reported in STORET, nitrate-nitrogen values were available from a 1980 USEPA study. Based on the same flow of 1.9 cfs that was used to determine phosphorus loads, an average nitrate-nitrogen concentration of 163 µg/L corresponds to a load of 602 lbs/day.

Dissolved oxygen was observed to have an average concentration of 7.8 mg/L during the 1980 USEPA study, indicating sufficient levels of oxygen in the waters to sustain aquatic life.

STORET records for suspended sediment, macroinvertebrate, and other water quality indicator data were not collected, not reported, or not readily available for the Norton Creek/Drain drainage area.

3.2.3 Pettibone Creek Drainage area

The Pettibone Creek drainage area begins north of the Village of Milford and extends south to its outfall at Milford (Figure 1). The drainage area of Pettibone Creek is roughly 15,710 acres.

Little data concerning the variables of concern appear available for the Pettibone Creek drainage area. However, a review of STORET files yielded a USEPA and a MDEQ study for Pettibone Creek. According to a 1972-73 USEPA study, the mean total phosphorus concentration for Pettibone Creek was 17 µg/L (n = 13). At a different sampling site, MDEQ determined the mean total phosphorus concentration of Pettibone Creek to be 26 µg/L (n = 12) between 1977-78. No flow data were reported in STORET for either study, thus making load determination for the studies impossible.

Alexander (1999) determined a phosphorus loading rate of 34 lbs/month (approximately 408 lbs/yr) for the Pettibone Creek drainage area between April 1998 and March 1999. This estimate is slightly lower than that determined by MDNR in 1979 of 424 lbs/yr. No point sources are currently in the Pettibone Creek drainage area, and none were reported in the 1979 MDNR study.

While total nitrogen data were unavailable, nitrate-nitrogen values as reported in the 1972-73 USEPA study indicate a concentration of 45 mg/L. As mentioned previously, flow data were not reported, making load determination unachievable.

A 1977-78 study reported in STORET determined a mean dissolved oxygen level at the Pettibone Creek sampling location of 10.6 mg/L, indicating ample levels of dissolved oxygen. No recent dissolved oxygen data were available.

3.2.4 Lower Kent Drainage Area

The Lower Kent Drainage Area begins east of the Village of Milford boundary and extends southeast until reaching Kent Lake (Figure 1). This drainage area is approximately 9,488 acres (14.8 square miles).

Little data concerning phosphorus were available specifically for the Lower Kent Drainage Area. However, a review of STORET files yielded one USGS sampling point. According to the USGS, at the Huron River near New Hudson, Michigan, the mean total phosphorus concentration between 1984-86 was 57 µg/L (n = 29). Flow during this period of record averaged 120 cfs. Considering the mean phosphorus concentration and flow, the phosphorus load between 1984-86 at the Huron River near New Hudson was approximately 13,505 lbs/yr. No distinction can be made between nonpoint source and point source contributions to total phosphorus loads from the reported data.

Between April 1998 and March 1999, the MDEQ determined that a nonpoint source phosphorus loading of 376 lbs/month into the Huron River existed at General Motors Road (Alexander, 1999). This equates to approximately 4,512 lbs/yr nonpoint source phosphorus loading. These results indicate a marked decrease in loading compared to the 1979 MDNR observation of 11,558 lbs/yr for the same sampling location. However, the MDNR observation includes point source loads from the Milford WWTP of 3,311 lbs/yr and 2,153 lbs/yr from the Ford Motor Company plant. Subtracting these loads, one can estimate a 1979 nonpoint source phosphorus load of 2,888 lbs/yr for the drainage area. This result indicates a marked increase in nonpoint source phosphorus loading from 1979 to 1998-99.

The MDNR (1979) study also determined a nonpoint source phosphorus load at the Huron River on Main Street, Milford, of 1,321 lbs/yr. Alexander in 1998-99 estimated a total non-point source load of 4,444 lbs/yr for this location. Comparison of these results also indicates an approximate increase in nonpoint source phosphorus loading of 70% between the 1979 and 1998-99 studies.

Total nitrogen measurements were of more limited availability. For the period of record from 1985-86, total nitrogen averaged 967 µg/L (n = 3). Using 120 cfs as the average flow, an annual nitrogen load of 618 lbs/yr can be calculated. As a result, it appears that phosphorus is the limiting nutrient for this portion of the Sub-watershed.

Dissolved oxygen levels for the 1984-86 Huron River site averaged 10 mg/L for the 1985-86 record, indicating sufficient levels of oxygen to support aquatic life for this portion of the river.

The 1984-86 record indicates widely varying suspended sediment readings. The mean suspended sediment concentration for this period was 9.7 milligrams/liter (mg/L) with a range of 1 to 47 mg/l. The variability of the data cannot be explained due to the limited dataset and reporting. However, it is possible that soil disturbance events upstream or adjacent to sampling stations or a period of unusually high flow could have caused the reported variability.

Of particular note was the reporting to STORET of 12 detections of 2,4-Dichlorophenoxyacetic acid [CAS 94-75-7], commonly referred to as 2,4-D, by the USGS in a 1984-86 study. Most often used in commercial lawn applications, 2,4-D is a pesticide that can have negative impacts to aquatic organisms and other non-target species if misapplied or misused. Based on the reported data, the mean 2,4-D concentration from 1984-86 was 0.25 mg/L. The Michigan final acute value for 2,4-D is 2.9 mg/L, the final chronic value is 0.22 mg/L, and the aquatic maximum value is 1.4 mg/L.

3.2.5 Kent Lake

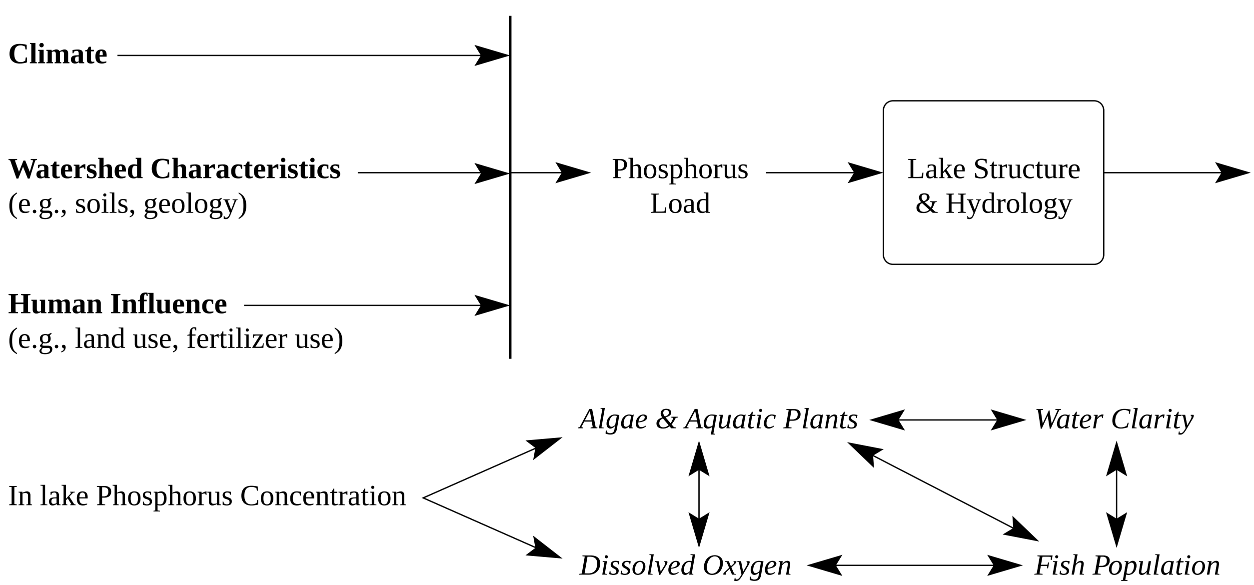
Prior to exploring reported water quality data and studies for Kent Lake, a general review of lake behavior—the study of lake conditions—is warranted.

Limnology, in essence, is the physical, chemical, and biological science of freshwater systems, including lakes. While numerous water quality parameters are studied to determine the trophic status and water quality status of lakes, in-lake phosphorus concentrations are often the determining factor. Trophic status is a useful means of assessing the water quality of a lake since it affects the productivity or growth of the system. While many factors influence the overall trophic status of a lake, the interaction of climate, watershed characteristics (e.g., soils), and human influences is the most dominant (Figure 14).

Ordinarily, a lake with concentrations of phosphorus less then 10 micrograms/liter (µg/L) is considered oligotrophic. A lake is considered mesotrophic at concentrations of, 10 to 20 µg/L and eutrophic to hypereutrophic at or greater than 20 to 30 µg/L (USEPA, 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 have limited recreational value compared to oligotrophic or mestrophic lakes because of periodic nuisance algal blooms. Hypereutrophic lakes, which experience frequent and intense nuisance algal blooms, do not ordinarily support cold or warm water fisheries and offer little or no recreational value. In addition, these lakes often exhibit decrease in open water surface areas because of layers of algal and aquatic plant masses.

As with all temperate zone lakes, Kent Lake experiences changes in water chemistry and biology throughout the year. During the winter months, lake water temperature, dissolved oxygen, and other variables are essentially equal at all depths. As ice thaws when spring approaches, winds and temperature changes in surface waters cause a mixing within the water column. This event is often referred to as a spring turnover. Into the summer months, warm air temperatures interacting 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. Lakes that receive increased pollutant loading can exhibit quantifiable reductions in water quality at this time because of the lack of water mixing. As the season enters fall, cooler air temperatures increase surface water density and mixing establishes uniformity within the water column in what is termed as fall turnover.

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



As previously discussed, the Kent Lake Subwatershed is approximately 100,000 acres in size. The immediate drainage area of the lake is estimated at 16.9 square miles (10,900 acres). The lake has an average depth of 2 meters and a hydraulic residence time of 33 days (0.09 year). Investigation into readily available and obtainable data concerning the lake indicated that a few pertinent historical water quality and fish community assessment studies of the lake exist in addition to the recent water quality study by Alexander (1999b).

J.L. Hulbert (1966) performed a biological survey of Kent Lake and the Huron River inlet to the lake. Of the six stations selected for the study, one was located at the inlet and three were located directly in the lake. the author utilized the Beck Biotic Index methodology of assessment in order to determine the biological health of the sampling stations,. The Beck Biotic Index is defined as the index value based on biological findings and is indicative of the cleanliness of a stream or lake with regard to organic pollution. An index value of 0 indicates severe pollution, 1 to 6 moderate pollution, and 7 to 10 greater a clean system. Results from the investigation indicated excellent biological communities at the inlet sampling station with a Beck Biotic Index score of 20. The three sampling stations in Kent Lake did not rate as well, yet were still quite good. Going progressively downstream towards the outlet, biological indexes range from 8 to 11, with the lowest index score of 8 at the deepest lake sampling point.

In addition to the biological survey, Hulbert (1966) performed a bacteriological and a dissolved oxygen survey of Kent Lake. However, results varied widely, and no conclusions were drawn because of the limited dataset. Beach closings due to excessive bacterial concentrations have occurred in the past and recently during the summer months.

In 1975, the USEPA, as part of the National Eutrophication Survey in cooperation with the Michigan DNR and the Michigan National Guard, performed a water quality assessment of Kent Lake. The study determined that the trophic status of Kent Lake was eutrophic. The authors noted that algae blooms were reported to have been frequent and intense for the lake and that dissolved oxygen levels appeared to be depleted. Interestingly, results indicated that nitrogen was the limiting nutrient in June and September 1975 while phosphorus was limiting in November of 1975.

Determination of load source from this study indicated that 53.9% of the phosphorus load to Kent Lake was from the Milford and Wixom wastewater treatment plants. Nonpoint source loads from the Huron River and its tributaries comprised 42.7% of the total phosphorus load, while the immediate drainage area and precipitation contributed 2.3% and 1.1%, respectively (USEPA, 1975).

In conclusion, the report suggests that increased regulation and improvement to the two wastewater treatment plants would reduce nitrogen loading to Kent Lake. The magnitude of this reduction, the authors contended, would allow phosphorus to become the limiting nutrient and reduce algae bloom frequency. As noted earlier, point source controls have been set in place since the late 1970s and the water quality of Kent Lake has improved.

A 1979 report by the MDNR concluded that, at the time of the investigation, Kent Lake had a phosphorus concentration ranging from 27 to 90 µg/L with a mean of 44 µg/L. The report states that these concentrations indicate eutrophic to hypereutrophic conditions. Total phosphorus loading to the lake was estimated at 12,355 lbs/yr, of which 60% was from point sources. The remaining 40% represented nonpoint source loads. These results are similar to those determined by the USEPA (1975) and Alexander's (1999) nonpoint source loads.

In addition, the MDNR (1979) report noted that Kent Lake was nearly devoid of macroinvertebrates and that the organisms observed to be present were indicative of prolonged anaerobic (low or no dissolved oxygen) conditions. The study also found moderately polluted levels of copper, zinc, and chromium in the lake sediments along with heavily polluted concentrations of arsenic, cadmium, nickel, and lead.

The Kent Lake fish community was assessed by the MDNR in June of 1997 and again in 1998. Eight sites were sampled using a trap net that yielded a total of 790 fish, representing 15 different species. The majority of the fish identified were common carp and black crappie. The 1998 study yielded similar species but fewer numbers of individual fish; however, methodologies differed between the two sampling surveys as an electroshocker was employed in 1998 (Allmen, 1999).

Finally, in addition to the Kent Lake TMDL for phosphorus, a TMDL for polychlorinated biphenyls (PCBs) is scheduled for the lake in 2010 (MDEQ, 2000). PCBs have been banned since the 1970s but are persistent in the environment. Sources of PCBs include industrial activity use in degreasing and cleansing products and insulation for electrical conductors. MDEQ determined Kent Lake to be contaminated with PCBs via the State's Fish Contaminant Monitoring Program.

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

4.1 Identification and Prioritization of Subwatershed Concerns

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 group identified several uses of water and other resources needing protection and restoration through the planning effort. They include:

- Open space preservation/greenway corridors for habitat,
- Groundwater recharge and groundwater quality protection,
- Water conservation or irrigation for recreational use (e.g. golf courses),
- Agriculture (e.g. horse farms),
- Navigation,
- Industrial use of groundwater,
- Habitat protection,
- Biodiversity,
- Sustainable development,
- Preservation of rural character/scenery,
- Protection of cold & warm water fisheries,
- 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 Kent 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 6.

Table 6. Prioritized List of Subwatershed Concerns

Rank	Concern/Need	Total Votes
1	Excessive Impervious Surfaces	13
2	Wetland Loss	10
3	Impaired or Compromised Septic Systems	9
4	Need for Enhanced Watershed-Friendly Planning	8
5	Illicit Connections	7
6	Need for Enhanced Monitoring Data	6
7	Need for Open Space and Habitat Protection	5
8	Intensive Landscaping	4

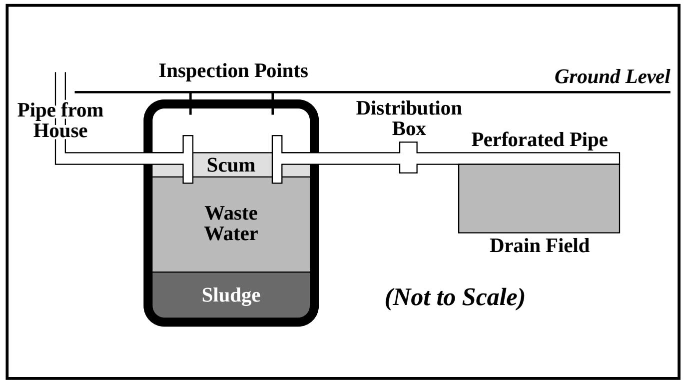
4.2.1 Concern #1: Impervious Surfaces

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.

4.2.2 Concern #2: Wetland Loss

Intimately related to planning and land use, the Workgroup cited the loss of wetlands via fill or non-fill stress from development within close proximity of boundaries as the second highest concern for the subwatershed. Studies indicate that half of the state's inland wetlands and 70% of the coastal wetlands no longer exist (MLUI, 1999). Permitted fills for commercial and industrial development, housing, roads, agriculture, and logging claim an estimated 500 acres of wetlands statewide each year. While wetland loss rates are currently unsubstantiated in the Kent Lake Subwatershed, the Huron River Watershed has lost approximately 66% of its wetlands to human activities (HRWC, unpublished). This massive change in the landscape has the potential to contribute to increased flooding, loss of property values, water pollution, and diminished and fragmented wildlife habitat. Wetlands smaller than 5 acres or not within 500 feet of another waterbody are not protected by the state. Such wetlands often serve as many or more important functions than do the larger wetlands (ADID, 1999). Therefore, local protection of these systems is imperative.

4.2.3 Concern #3: Impaired Septic Systems



In general, an impaired or compromised septic system is considered to be one that discharges effluent without the benefit of designed treatment. Impairment of on-site disposal systems can be caused by a number of circumstances, including unsuitable soil conditions, improper design and installation, and inadequate homeowner maintenance practices. Such systems are recognized as a significant contributor of pollutants and microbiological pathogens in the United States. These systems discharge more than one trillion gallons of waste each year to subsurface and surface waters (NSFC, 1995). Identifying and eliminating impaired septic systems can help address potential contamination of ground and surface water supplies from untreated wastewater discharges. Systems in deteriorated condition carry nutrients, such as phosphorus, bacteria, medicinal and chemical agents, and other pollutants to waterbodies with little or no treatment. While no specific studies on failure rates in the Kent Lake Subwatershed have been reported, Oakland County's recent survey of Onsite Sewage Disposal Systems in selected areas of Southfield and Farmington Hills found a substandard operation rate (undefined) of 50% (Johnson, et al., 2000). Given that there are approximately 60,600 individuals in the subwatershed that rely on septic systems for waste treatment, faltering septic systems in the subwatershed have the potential to affect water quality and health.

4.2.4 Concern #4: Community Land Use Planning

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 (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.

In essence, the impact of impervious surface generation, wetland loss, and the majority of all other concerns for the Kent 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.

4.2.5 Concern #5: Illicit Connections

The Workgroup expressed concern over the unknown rate and impact of illicit connections including sanitary sewer interconnections, discharge from floor drains, washing machines, swimming pool backwash, and other non-stormwater related discharges which may have significant impacts on the water quality of the subwatershed. Such connections can carry untreated pollutants, such as sewage from homes and businesses, to streams, lakes, wetlands, and the river. The Oakland County Drain Commissioner's Office has an active and successful detection and elimination program for such discharges. The program is currently concentrated in the Rouge River Watershed but there are plans to expand to throughout the county.

4.2.6 Concern #6: Monitoring Programs and Data

Integrated and coordinated water quality monitoring, as expressed by the Workgroup, needs to be more firmly established within the Kent Lake Subwatershed. Review of readily available and relevant data reveals a number of concerns. In some cases, studies and data significant to water quality decisions and knowledge was only minimally distributed or promoted throughout the subwatershed. In other cases, existing datasets are not complete enough to be used as a basis for subwatershed decisions. Other datasets are nearly non-existent, especially those dealing with sediment contamination, illicit connection and septic system failure rates, and emerging issues such as the presence or absence of endocrine disrupting chemicals in the water, sediments, and biota. In addition, the quality of some of the existing data causes concerns given that the quality assurance/quality control (QA/QC) protocols of sampling parties is unknown. The type of data that has been historically collected is often not useful for answering the key questions about the subwatershed; therefore, inference towards trend detection cannot comfortably be employed given the lack of time-series data.

4.2.7 Concern #7: Open Space and Habitat Fragmentation and Loss

The Workgroup agreed that upland terrestrial habitats will continue to be lost or fragmented into small uncoordinated pieces as suburban development in the Kent Lake Subwatershed converts more open space to lands for intensive human use. The issue is especially associated with loss and fragmentation of forests, wetlands and grasslands vital to water quality, wildlife populations, and community livability. For instance many postulated that as development encroaches upon remaining open space in the area, visually attractive and safe pedestrian walkways would be lost. In addition, many birds and other wildlife species require large blocks of forest for successful breeding or specialized habitat more likely to be found in a large natural area than in a small patch. Retaining existing and reconnecting large patches of natural landscape with green corridors, where feasible, can help to maintain the viability of populations otherwise rendered vulnerable because of small numbers and/or isolation.

4.2.8 Concern #8: Intensive Landscaping and Over-Fertilization

What we do in our own backyards has systemic impacts we many never conceive. The plants in our yards and businesses and the way we maintain them are a significant water quality and environmental pollution source (Swan, 1999). Nonetheless, surveys indicate that less than one-fourth of homeowners rated fertilizers as a water quality concern (Syferd, 1995 and Assing, 1994). The majority of lawn owners are not aware of the phosphorus or nitrogen content of the fertilizer they apply or that mulching grass clippings into lawns can reduce or eliminate the need to add fertilizer (Morris and Traxler, 1996). The Workgroup identified intensive landscape maintenance as a trend that is problematic for subwatershed health because of the reliance on chemical fertilizers and pesticides, irrigation, and other "life-support" measures necessary to maintain the artificial conditions that meet our standards. Air, noise, and water pollution, consumption of natural resources, increased stormwater runoff and flooding, and loss of beneficial insects and other species are some of the things that affect the subwatershed and have been linked with rigorous landscaping and over-fertilization.

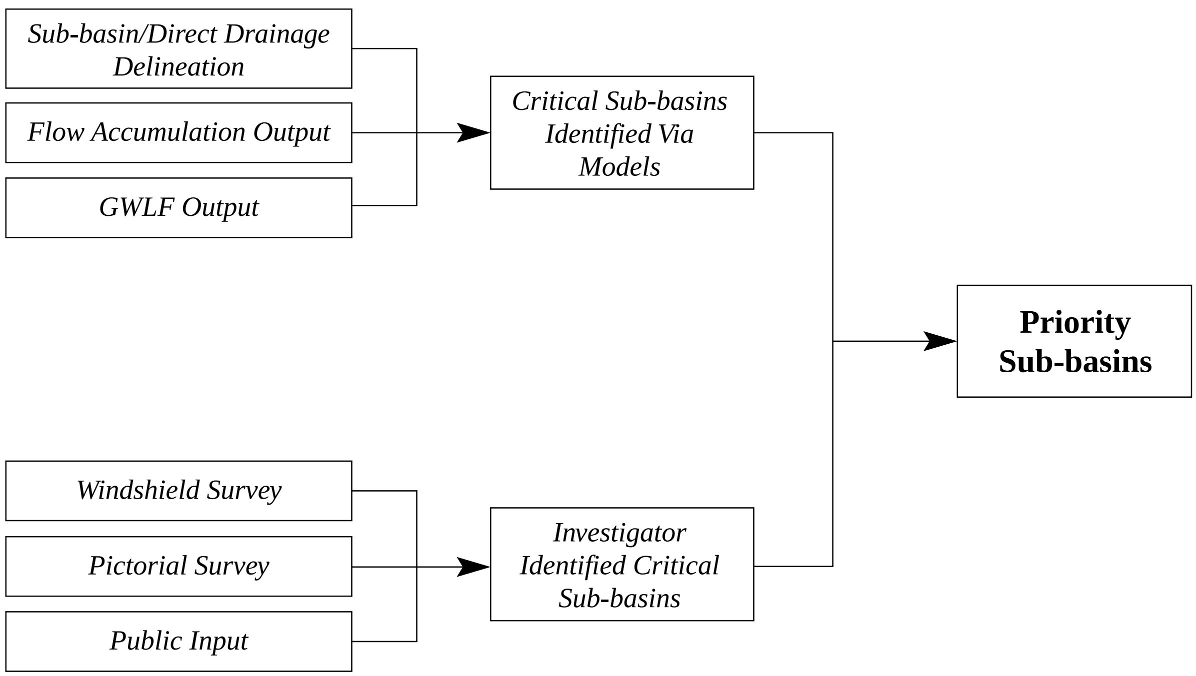
4.3 Critical Sub-basin Determination

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

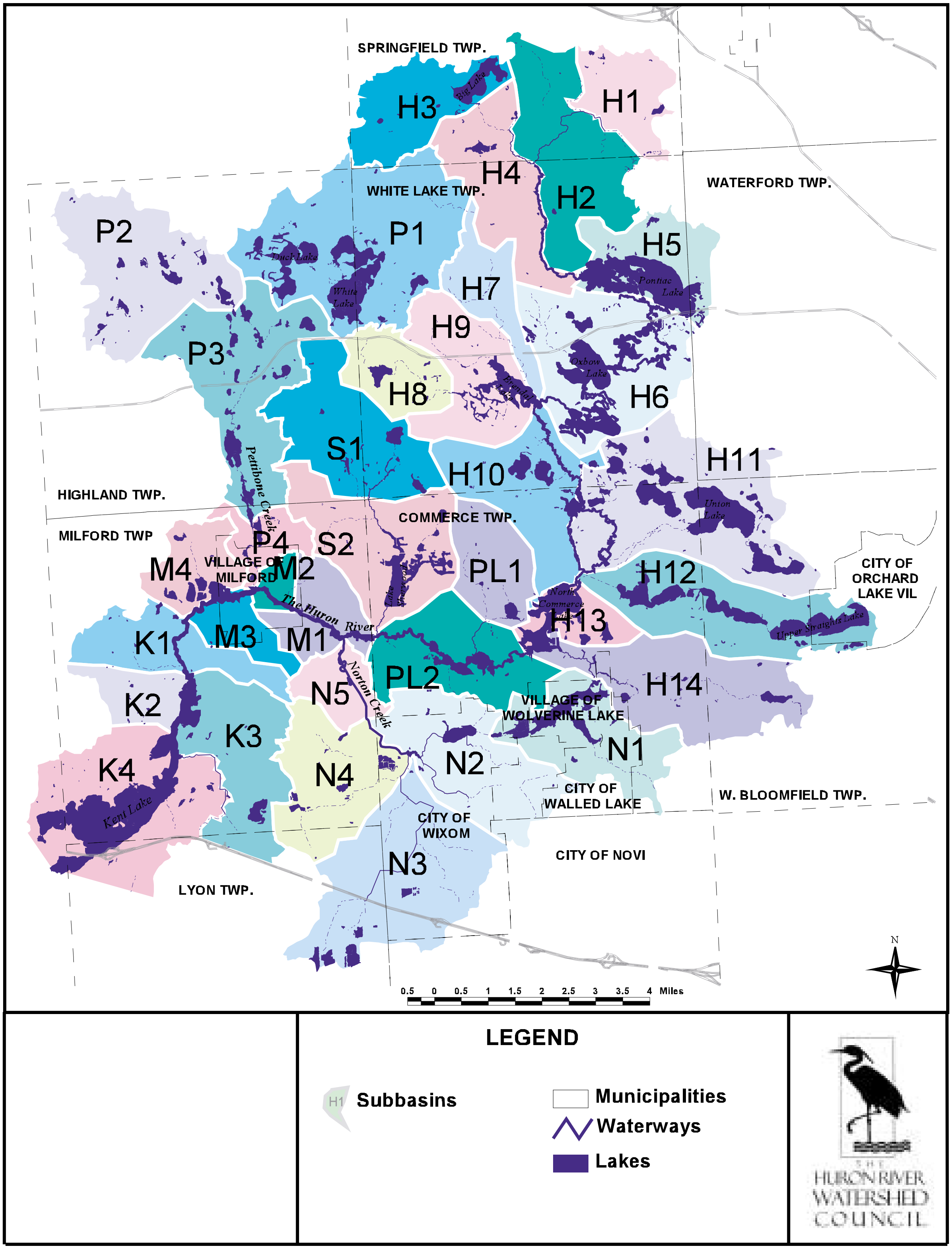
In order to focus investigations to specific areas of water quality concern and influence, the subwatershed is segmented into a series of sub-basins based on predominant land use, topography, and relation to direct surface water drainage to the river system (hydrological connectivity). This delineation process produced 33 sub-basins for the Kent Lake Subwatershed (Figure 16).

4.3.3 Mathematically Identified Critical Sub-basins

The method to identify these areas utilized subwatershed geographic and land use information as the premise for investigation. The hydrological direct drainage area and 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 watershed.

The Generalized Watershed Loading Function (GWLF) model was employed to establish yearly phosphorus loading rates on a sub-basin scale (Figure 16) to achieve a greater degree of

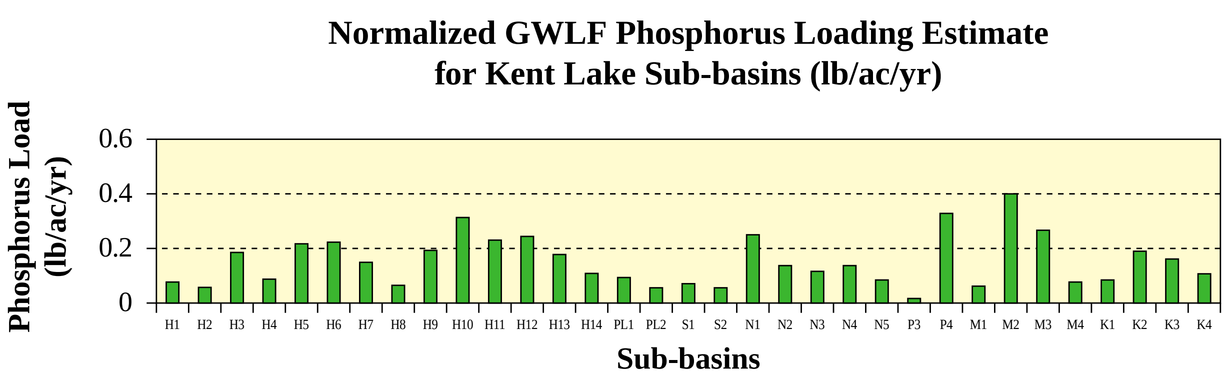
Figure 16. Sub-basins of the Kent Lake Subwatershed



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 10% error rate for this subwatershed. See Appendix B for more information regarding GWLF.

Normalized (for area) 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. Specifically, the GWLF indicates that those sub-basins are associated with the Village of Milford, Milford Township, Commerce Township, Village of Wolverine Lake, and the City of Wixom.

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



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 Kent Lake Subwatershed where topographic and land cover characteristics cause them to receive large quantities of total phosphate. The model was further used to establish critical areas within the subwatershed and indicate locations that intercept runoff flow paths from large areas, by virtue of their slope and aspect. Identified sites are potentially perfect locations 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 flow-paths 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 focus 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.

Utilizing the conclusions of the sub-basin and direct drainage delineation and the GWLF and Flow Accumulation model outputs, a set of mathematically identified critical sub-basins was established. These sites were hypothesized to be the sub-basins of H4-14, S1-2, PL2, N1-N5, M1-5, P3-4, and K3- 4 (Figures 19 and 20).

4.3.4 Investigator Identified Critical Sub-basins

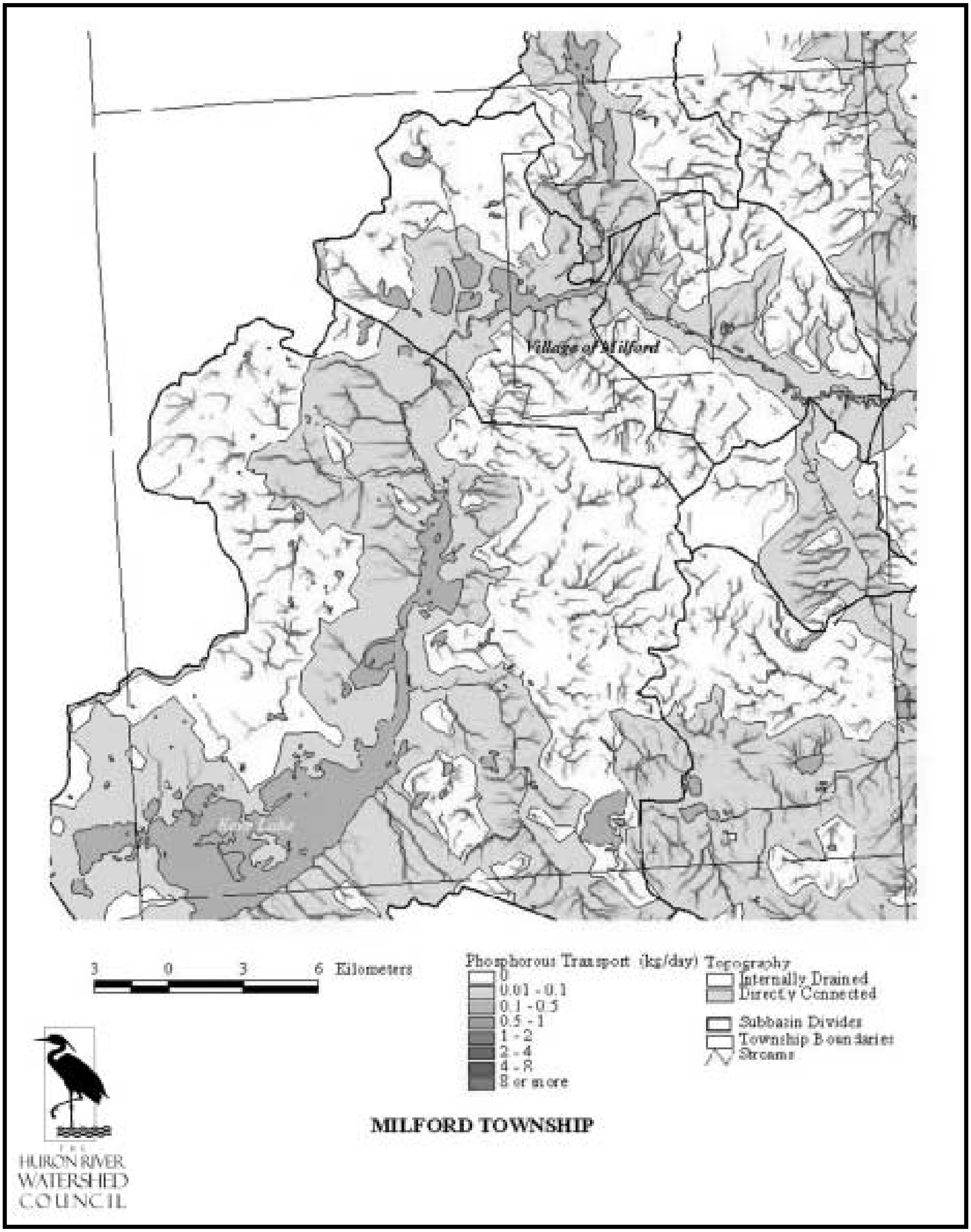
In addition to the model-based approach, study coordinators embarked upon a method which relied heavily on expert theorizing, field observations, and public input to determine a set of sub-basins identified from field observations (Figure 15).

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. Utilizing results from the analysis of existing water quality data and review of current and future land use information, a photographic inventory of the subwatershed was performed in June and July 2000 by Huron River Watershed Council (HRWC) staff. The purpose of this review was to identify and document the general condition of the subwatershed, in addition to discovery of source areas of water quality degradation, and to document 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 highlighted from modeling efforts. TTMPS staff visited older pre-existing 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 BMP types for recommendation.

The results of the survey indicated that many subdivisions and other developments had stormwater systems that were either (a) non-existent, or consisted of (b) grassed ditch systems, (c) pipes or gutters leading directly to wetlands, streams, lakes, and the Huron River, and (d)

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



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. Many 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 and behavior (geomorphology) and habitat of the Huron River and its tributaries appeared somewhat stable in most cases. However, evidence of increased flows, undercut and eroding streambanks, or sedimentation was observed in Norton Creek, Hays Creek, the Huron River upstream of Oxbow Lake, and the Huron River upstream of North Commerce Lake. See Appendix E for documentation of the photographic inventory.

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.

Public meeting attendees also noted degradation of the Huron River at the mouth with Oxbow Lake, of Hays Creek as it flows from Union Lake to North Commerce Lake, and of the Huron River between Pontiac Lake and North Commerce Lake. Many attendees noted that in recent years there had been noticeable degradation of streambanks along these waterways and increased sedimentation in areas of slow moving water, such as pools and mouths.

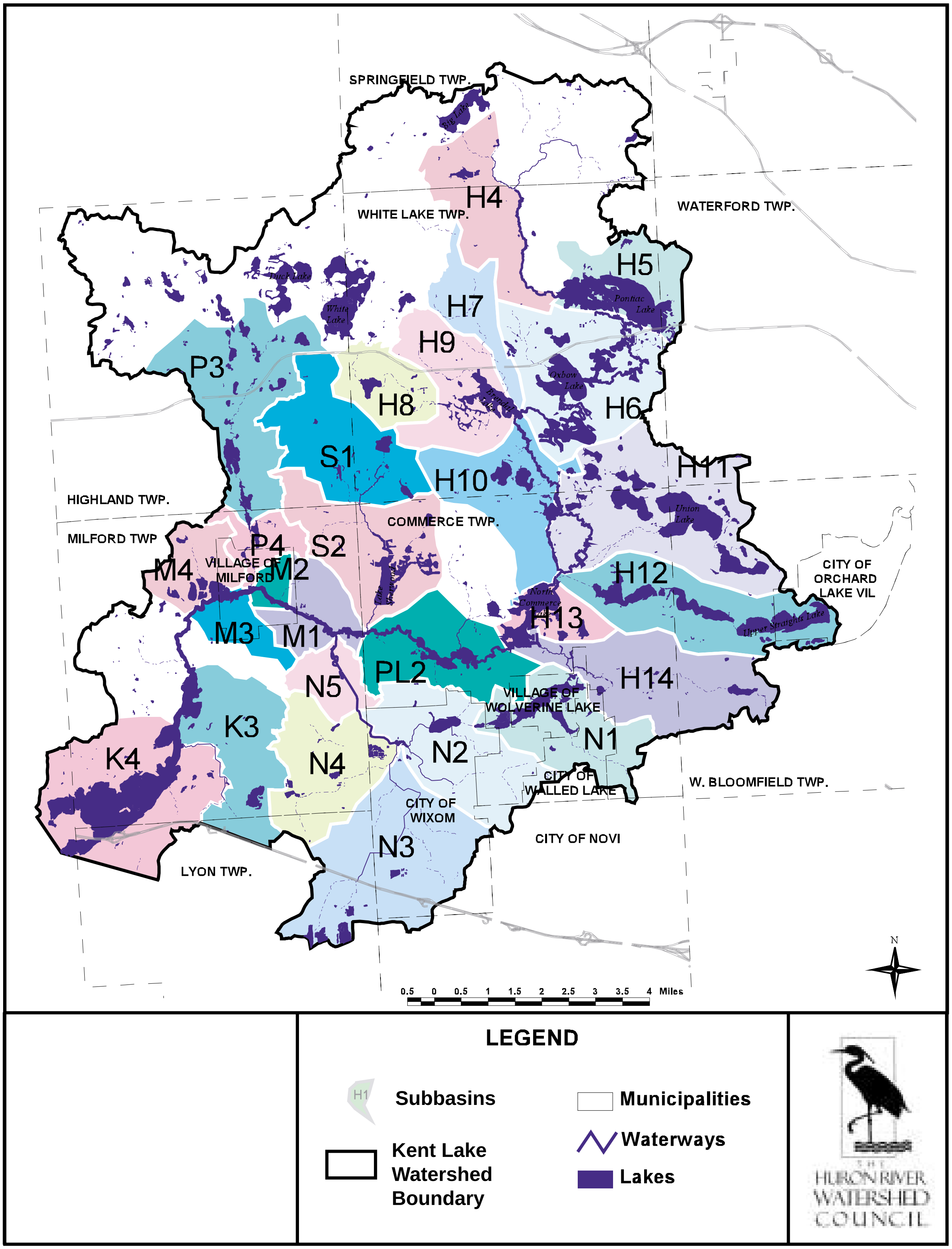
Attendees also noted several development sites that, in their opinion, had inadequate stormwater BMPs. In most cases, such situations were identified in older developments prior to the establishment of many stormwater standards. However, many attendees noted that existing stormwater facilities also appear 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 deduced critical sites was established. These sites were postulated to be the sub-basins of H5-14, S2, PL2, N1-N5, M1-5, P3-4, and K1-4 (Figures 19 and 20).

4.3.5 Priority Sub-basins

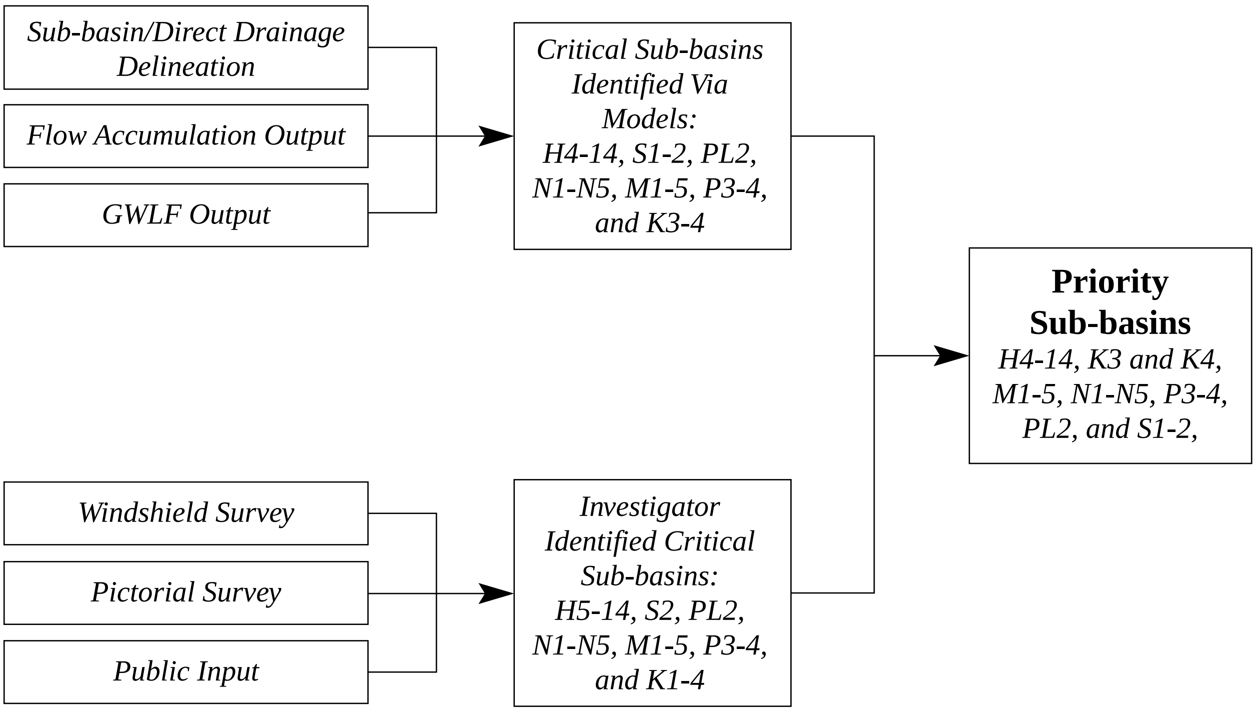
Researchers developed the following Priority Sub-basins: H4-14, K3 and K4, M1-4, N1-N5, P3-4, PL2, and S1-2 (Figures 19 and 20) by combining the results from the mathematically identified critical areas and investigator identified critical area methodologies. These areas represent sites of significant pollutant load or sites where observations indicate such and where employment of restoration and protection techniques will theoretically achieve maximum benefits.

Figure 19. Kent Lake Critical Area Sub-basins



For this planning effort, the employment of retrofitted and new stormwater BMPs to meet the TMDL target of a 16% reduction in current nonpoint source phosphorus loading will focus on these priority sub-basins.

Figure 20. Components of the Watershed Critical Area Prioritization Methodology and Kent 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 Kent 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.

- ***Habitat Loss and Fragmentation:*** 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 (hydraulic) 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 #3, 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 in 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 16% 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 Kent 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 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 Kent Lake and the Huron River, its floodplains, lakes, tributary waterways, and associated wetlands so that 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 7.

Table 7. Categorization of Probable Pollutant Sources and Subwatershed Concerns.

Pollutant	Subwater Concern (#)	Consolidated Concern (if applicable)
Nonpoint Source Pollution	• Impervious Surfaces (1) • Community Land Use Planning (4) • Intensive Landscaping and Over-fertilization (8)	• Community Land Use Planning and Design Standards • Intensive Landscaping and Over-fertilization
Habitat Loss and Fragmentation	• Wetland Loss (2) • Open Space and Habitat Fragmentation and Loss (7)	• Open Space Protection
Impaired Decentralized Onsite Disposal Systems (Septic Systems) and Illicit Connections	• Impaired Septic Systems (3) • Illicit Connections (5)	• Decentralized Wastewater Treatment and Illicit Connections
Other	• Monitoring Programs and Data (6)	• Monitoring Programs and Data (1)

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. Chapters 6, 7, 8, and 9 present the recommendations (actions) to meet subwatershed goals.

Nonpoint Source Pollution
Community Land Use Planning and Design Standards

Goal 1: *Promote local site planning standards that foster stewardship, open space and 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 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.*

Intensive Landscaping and Over-fertilization

Goal 5: *Encourage local standards, strategies, and programs that promote reduced reliance on fertilizers, water-efficient landscaping, and the use of native plants.*

Goal 6: *Conduct on-going programs to raise the public and practitioners' awareness of the impacts of over-fertilization, benefits of native plants, watershed protection, and nonpoint pollution issues.*

Habitat Loss and Fragmentation

Open Space Protection

Goal 7: *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.*

Goal 8: *Establish a mechanism towards greater coordinated protection and identification of wetlands and other natural features throughout the subwatershed.*

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

Decentralized Wastewater Treatment and Illicit Connections

Goal 9: *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 10: *Establish a mechanism towards identification and correction of illicit connections within critical areas of the subwatershed.*

Other

Monitoring Programs and Data

Goal 11: *Establish a mechanism towards greater dissemination of data and coordination and promotion of water quality monitoring and assessment throughout the subwatershed.*

Goal 12: *Conduct on-going programs to raise the public and practitioners' awareness of volunteer monitoring activities, watershed protection, and nonpoint pollution issues.*

4.6 Designated Uses of Waterbodies in the Kent Lake Subwatershed

As reviewed in Section 2.5, the MDEQ considers whether the waterbody in question meets 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 reviewed in Section 2.5 may be attainable, they do provide significant direction towards 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 SUBWATERSHD CONCERNS AND GOALS

5.1 Management Alternatives

The approach to address the threatened water quality status of Kent 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 Kent 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 Kent 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 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 Chapter 7.

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 only as a guide for communities and other participants, and as such, can be altered as opportunities arise.

- **Phase I.** 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 8 for the assigned phase for each recommendation in this plan, whether structural or nonstructural.

Table 8. Matrix of Actions for the Kent Lake Subwatershed Plan.

Table 8. Matrix of Actions for the Kent Lake Subwatershed Plan.

Potential Action	Primary Goals Addressed	Phase* I	Phase* II	Phase* III	Intended Participants: Local Governments	HHSC**	Oakland County: Drain Commission	Oakland County: Health Department	Oakland County: Road Commission	State: MDOT	State: MDEQ	State: MDNR
PART I. ACTION PLAN TO ATTAIN TOTAL MAXIMUM DAILY LOAD STRUCTURAL BEST MANAGEMENT PRACTICES (BMPS)												
__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												
__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, 12	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	X					
Enhanced Site Plan Review Requirements	2	X			X	X						
Enhanced Site Plan Review Tallysheet	2	X			X	X						
Impervious Surface Limitations	3, 4		X		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						
Promotion of Conservation or Cluster Subdivisions	3, 4	X			X	X	X	X	X			
Intensive Landscaping and Over-Fertilization												
Water Efficiency Policies for Commercial Landscaping	5		X		X	X						
Fertilizer Application Standards or Resolution	5		X		X	X						
Native Landscaping in Public Locals Initiative	5. 6		X		X	X			X	X		X
Golf Course Nutrient Management Initiative	5		X		X	X						X
Education Plan and Program Implementation	1, 6, 7, 9, 12	X			X	X	X	X	X	X	X	X
Native Landscaping in Public Localities Initiative	6			X	X	X			X	X		X
__Habitat Loss and Fragmentation Actions__												
Open Space Fragmentation												
Education Plan and Program Implementation	1, 6, 7, 9, 12	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, 12	X			X	X	X	X	X	X	X	X
Promotion/Coordination of Oakland County Drain Commission Periodic and Time of Sale Septic System Inspection Program	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, 12	X			X	X	X	X	X	X	X	X
PART III. STRATEGIES FOR WATERBODY SPECIFIC RESTORATION												
Waterbody Specific Restoration	--			X	X	X	X				X	X
PART IV. STRATEGIES TO INFORM AND EDUCATE THE PUBLIC												
Education Plan and Program Implementation	1, 6, 7, 9, 12	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 Kent 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 Kent 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 variables,
- Required maintenance activities,
- Construction and maintenance costs,
- Safety concerns and mitigation measures, and
- 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 Kent 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:

City of Walled Lake

- Central city development - Farmer Jack supermarket and adjacent strip of commercial development along Pontiac Trail and Maple Road

Commerce Township

- Dawn Hill Road and Meadow Ridge Subdivision
- Summit and Spruce Drives and Spruce Park Subdivision
- Governors Lane
- Palomino Drive and other portions of the Golf Manor Subdivision
- New housing off South Commerce/Carroll Lake Roads, abutting Mud and North Commerce Lakes

Village of Milford

- Municipal complex on Atlantic Street
- Milford Road - areas of large-lot residential housing and commercial uses
- Older, high-density, residential housing off Atlantic Street
- Central village commercial development on South Main Street

Village of Wolverine Lake

- Wolverine Road
- Nifty's Restaurant
- Helmsford Road and adjacent subdivisions

West Bloomfield Township

- Commercial development along Union Lake and Commerce Roads
- West Acres Subdivision
- Residential housing areas off Commerce and Willow Roads

White Lake Township

- Commercial development along M-59
- Residential housing areas off Oxbow and Union Lake Roads, surrounding Cedar Island and Round Lakes

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 the Huron River 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.

Some commercial properties built prior to the 1960s, such as the area behind the Farmer Jack grocery store and adjacent stores and restaurants at the intersection of Maple Road and Pontiac Trail in downtown Walled Lake, do include areas of existing stormwater retrofits. In this particular example, end-of-pipe stormwater detention has been added since its initial construction.

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 4.3 and sub-basin use/land cover composition was summarized and reviewed. SEMCOG 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 and village and city centers (e.g., the Villages of Milford and Wolverine Lake) were identified as urban, whereas sub-basins dominated by residential and/or commercial and industrial land uses, without such village or city centers, were labeled as urbanizing.

Table 9. Kent Lake Sub-basin Land Use/Land Cover Composition.

	Residential		Commercial/Industrial		Agriculture		Open/Forest		***Total***
Sub-basin	***Acres***	***Percent***	***Acres***	***Percent***	***Acres***	***Percent***	***Acres***	***Percent***	***Acres***
H1	52.0	18.6	20.4	7.3	16.3	5.8	191.6	68.4	**280.3**
H2	191.5	6.8	3.5	0.1	262.5	9.3	2,351.7	83.7	**2,809.3**
H3	183.6	26.2	24.9	3.6	24.9	3.6	466.9	66.7	**700.1**
H4	221.4	17.0	19.0	1.5	46.9	3.6	1,017.0	78.0	**1,304.4**
H5	264.7	16.5	59.6	3.7	51.0	3.2	1,228.2	76.6	**1,603.4**
H6	1,377.1	38.6	133.4	3.7	135.8	3.8	1,921.9	53.9	**3,568.2**
H7	179.5	28.3	23.2	3.6	109.1	17.2	323.1	50.9	**634.9**
H8	54.0	6.9	29.9	3.8	27.1	3.5	673.9	85.9	**784.8**
H9	586.7	33.0	139.7	7.9	162.5	9.1	888.0	50.0	**1,776.9**
H10	269.5	51.9	30.6	5.9	124.0	23.9	95.6	18.4	**519.8**
H11	1,200.9	39.7	154.0	5.1	33.0	1.1	1,638.9	54.1	**3,026.8**
H12	1,462.2	49.8	99.5	3.4	0.9	0.0	1,374.3	46.8	**2,936.9**
H13	327.5	33.5	0.0	0.0	0.0	0.0	650.7	66.5	**978.2**
H14	503.9	29.3	82.9	4.8	27.9	1.6	1,105.8	64.3	**1,720.6**
K1	178.6	22.1	9.6	1.2	21.0	2.6	598.1	74.1	**807.3**
K2	106.0	22.0	1.7	0.4	27.0	5.6	348.0	72.1	**482.8**
K3	284.4	31.0	104.9	11.4	270.5	29.4	258.9	28.2	**916.6**
K4	194.0	7.1	171.8	6.3	104.1	3.8	2,256.6	82.8	**2,726.5**
M1	105.6	21.6	1.1	0.2	0.3	0.1	381.2	78.1	**488.2**
M2	149.1	55.3	37.6	14.0	0.0	0.0	82.8	30.7	**269.4**
M3	110.5	34.9	43.5	13.7	0.0	0.0	162.6	51.4	**316.6**
M4	55.8	11.5	9.3	1.9	5.5	1.1	413.5	85.4	**484.0**
N1	827.7	42.4	185.5	9.5	22.9	1.2	914.7	46.9	**1,950.8**
N2	768.3	40.2	77.4	4.0	65.7	3.4	1,001.6	52.4	**1,913.0**
N3	303.2	8.4	710.6	19.7	808.9	22.5	1,778.2	49.4	**3,600.9**
N4	417.4	25.0	222.5	13.3	189.6	11.4	839.8	50.3	**1,669.3**
N5	115.2	20.7	18.6	3.4	48.1	8.7	374.3	67.3	**556.3**
P3	136.1	1.7	30.2	0.4	11.0	0.1	7.761.2	97.8	**7,938.5**
P4	135.0	33.9	67.4	16.9	0.0	0.0	196.3	49.2	**398.6**
PL1	137.8	15.2	98.1	10.9	25.0	2.8	643.0	71.1	**903.8**
PL2	197.5	9.8	57.7	2.9	128.7	6.4	1,633.4	81.0	**2,017.3**
S1	84.1	9.2	0.0	0.0	250.0	27.5	575.5	63.3	**909.6**

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). BMP-specific phosphorus removal efficiencies are also presented in 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 Kent 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 10. 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 10. 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	19750	$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 Kent 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 Kent Lake Subwatershed, the use of extended wet detention basins, grassed channels, constructed wetlands, and the combinations of catch-basin inserts discharging to wet pond, and grassed channels discharging to ponds, allow communities to reach phosphorus reduction targets at the lowest construction cost.

B. The relative ranking of costs differed slightly. Both residential and commercial applications in the subwatershed followed the ranking described in A, in order of increasing construction cost.

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. For example, as shown in the spreadsheet model output in Appendix D, the Kent Lake TMDL phosphorus reduction target of 16% can be met with the construction of wet detention basins in each of the 25 priority sub-basins in residential settings at an estimated construction cost of $15.75M. However, to meet this target reduction requires 12 replications of the basic treatment unit across all 25 sub-basins, or the construction of approximately 295 wet detention basins or wet detention capturing the equivalent drainage area (approximately 7,375 acres). In contrast, at an estimated cost of $22.135M the combination of grassed channels and constructed wetlands could also be employed. This would require nine replications of the basic treatment unit across all 25 sub-basins, or the construction of approximately 218 wet detention basins or wet detention systems capturing the equivalent drainage area. This treatment would reduce the amount of land necessary to meet TMDL targets by approximately 1,937 acres. Both the financial cost and the availability of opportunities for such retrofits must be considered in designing a final strategy to meet these targets. Other considerations such as design constraints of the various BMPs and secondary benefits such as the aesthetic and habitat values provided by constructed wetlands should also be factored into the decision process for applying retrofit solutions to each individual location.

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, 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 of identifying locations planned for redevelopment. The following table is excerpted from retrofit suggestions from the Center for Watershed Protection (CWP, 1995):

Table 11. 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 Kent Lake Subwatershed, with involvement of the Huron Headwaters Steering Committee (see Chapter 10):

1. *Identify Specific Locations per Sub-basin.* Communities should explore 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. For example, a review of the phosphorus reduction values for each sub-basin in the Kent Lake Subwatershed shows that BMP applications in the sub-basins of P4-commercial, M2-residential, H7-commercial, H5-residential, and P4-resi-

dential yield the greatest pollutant removal, in pounds, for any given treatment technology. Local investigations to identify specific retrofit opportunities in each of these 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 uses within the directly connected drainages in the subwatershed. 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. Strategizing BMP placement in these locations, where feasible, will not only help achieve the phosphorus reduction target for Kent 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 Milford, Walled Lake, and Union Lake 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-construction 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 of the upper Huron Watershed (e.g., the City of Wixom, Villages of Milord and Wolverine Lake, etc.), but it 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 is currently no policy, 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, and 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 (Chapter 9 of Education Plan) be implemented throughout the subwatershed to reduce the influence 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 of the City of Wixom, Villages of Milford and Wolverine Lake, and the Townships of Commerce, Milford, and West Bloomfield.

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

This section of the subwatershed plan for Kent 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 appendixes 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.

Each of the below actions are assigned a sequence-of-implementation phase (Table 8). While phase assignment should not be considered final, 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 I).* A community's master plan sets forth the overall vision of the community leaders for the next 10 to 20 years. Unlike zoning ordinances, master plans are not legal documents. 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." Major policies are to include 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 subsequent establishment of Conservation Overlay District.

Appendix G contains relevant portions of the Shiawassee & Huron Headwaters Resource Preservation Project.

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 and 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. Plan includes programs in addition to personal communication and passive media outlets. Task Force charged with implementation and refinement of the subwatershed education plan and programs as described in Section 7.5.

Goal 2: Adopt local site design principles that consider the impact on both water quantity and quality 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).* Consider 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 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. 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 that provides a general guidance on the potential impact of proposed developments on water quality. Appendix K presents the High Point, North Carolina, approach which can be altered to community specific situations prior to incorporation.

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.

H. *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 L).

I. *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 M for specific considerations.

J. *Private Roads Ordinance (Phase I).* Consider enacting or revising private road ordinance that promotes narrow road widths while enhancing rural character. Hamburg Township, Livingston County, Michigan, and Ann Arbor Township, Washtenaw County, Michigan have these ordinances (Appendix N).

K. *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 O for model language.

L. *Promotion of Conservation or Open Space Subdivisions (Phase I).* Recent state law now requires that communities include 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 that is presented in Appendix P.

7.1.2 Intensive Landscaping and Over-Fertilization

Goal 5: Encourage local standards, strategies, and programs that promote reduced reliance on fertilizers, water-efficient landscaping, and the use of native plants.

M. *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 Q contains sample standard).

N. *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. Encourages 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 R for illustrative policy.

O. *Native Landscaping in Public Localities Initiative (Phase II).* A program to study, locate, coordinate, and implement native landscaping techniques and demonstration projects in key public locations throughout the subwatershed. Particular emphasis will be placed on reestablishing native habitats in key locations along the shoreline of Kent Lake.

P. *Golf Course Nutrient Management Initiative (Phase II).* The subwatershed contains many public and private golf courses. These areas are probable sources of high nutrient loading because of the intensive turf grass management used. 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.

Goal 6: Conduct on-going programs to raise the public and practitioners' awareness of the impact of over-fertilization, benefits of native plants, watershed protection, and nonpoint pollution issues.

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

R. *Native Landscaping in Public Localities Initiative (Phase III).* See above.

7.2 Habitat Loss and Fragmentation Actions

7.2.1 Open Space Protection

Goal 7: 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.

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

Goal 8: Establish a mechanism towards greater coordinated protection and identification of wetlands and other natural features throughout the subwatershed.

T. *Natural Features Mapping Initiative (Phase II).* Expansion of Shiawassee & Huron Headwaters Resource Preservation Project (S&H) methodology to subwatershed communities who did not participate in the initial program. Initiative develops important natural features maps, such as wetlands, lakes, streams, floodplains, steep slopes, woodlands, remnant prairies, etc., for incorporation into community Master Plans. See Section 3.2.6 and S&H (2000) publication for currently identified key natural areas protection opportunities.

U. *Natural Features Setback Standard (Phase 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.

V. *Review 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.

W. *Wetland Stewardship Standard (Phase II).* Policy designed to protect human property and water quality and wildlife support properties of non-state regulated wetlands by establishing local oversight standards for non-state regulated wetlands. Many townships throughout the area have wetland standards, such as the townships of West Bloomfield, Milford, White Lake, and the City of Wixom. See Appendix U for a model standard.

X. *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 identify natural resource corridors in the community, opportunities for preservation and restoration, and tools for implementation. Task Force will consider, promote, coordinate, and facilitate open space and natural features protection. Specific task force actions will 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. *Native Plant Restoration in Public Localities Initiative*—Restoration is important to establish the connections between protected areas and to provide buffers between natural areas and development. This initiative will focus on replacing turf grass with native plantings in appropriate publicly owned locations. Various organizations are available to assist with native landscaping such as the Oakland Conservation District, Wild Ones, and National Wildlife Federation.

iv. Investigation into *Open Space Acquisition Referenda*—Many communities throughout 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 9: Conduct on-going programs to raise the public and practitioners' awareness of the impacts of impaired septic systems on water quality and human health.

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

Z. *Promotion/Coordination of Oakland County Drain Commissioner's Office Proposal for Periodic and Time of Sale Septic System Inspection Program (Phase II).* Proposal is based on the Washtenaw and Wayne County Time of Title Transfer Program but improves upon them by establishing periodic inspections for all known septic systems within the County.

Goal 10: Establish a mechanism towards identification and correction of illicit connections within critical areas of the subwatershed.

AA. Illicit Connection Detection and Elimination Initiative (Phase III). Initiative will focus on establishing areas of concerns for such connections via Water Quality Task Force facilitation. Based on the existing Oakland County Drain Commissioner's Office 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 11: Establish a mechanism towards greater coordination and promotion of water quality monitoring and assessment throughout the subwatershed.

BB. *Development of a Coordinated Subwatershed-wide Volunteer Monitoring Program (Phase II).* Based potentially 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 and to include sampling stations upstream of Kent 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.

CC. *Creation of a lake and creek drainage area specific planning and protection service (e.g., lake wide and creekshed management plan development) (Phase II).* Guidelines and service 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.

DD. *Establishment of a Water Quality Task Force (Phase I).* Populated by Huron Headwaters Steering Committee members, concerned citizens, and scientists charged 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 12: Conduct on-going programs to raise the public and practitioners' awareness of volunteer monitoring activities, watershed protection, and nonpoint pollution issues.

EE. *Expansion of the Huron River Watershed Council's Stewardship Network (Phase II).* Currently limited to Washtenaw County, 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.

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

7.5 Summary of Potential Task Forces and Intended Actions

The Kent Lake Subwatershed comprises 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 three 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 Brighton Lake Subwatershed.

7.5.1 Environmental Advisory Team Task Force
The task force is primarily a conglomeration of community-based environmental advisory team members 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 for 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 commissioner's office and health division 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 of employment, 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, academia, 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 12. Sites of Potential Restoration in the Kent Lake Subwatershed.

Waterbody	*Location of Concern*	*Designated or Desired Use Threatened/ Impaired*	*Pollutant*	*Potential Cause/Source*	*Potential Action*
Greenaway Drain	Entire Drain	Aquatic life/wildlife; Property value protection	Sediment; Erosive flow	Incremental degradation via nonpoint source runoff	Stormwater BMP retrofitting and construction; streambank and stream restoration techniques
Green Lake	W. Bloomfield Township	Partial body contact recreation; property value protection	Nutrients	Suburban nonpoint source runoff; BMP failure	Stormwater BMP retrofitting and construction; lake treatment technologies
Hays Creek	Commerce Township	Aquatic life/wildlife; Property value protection	Sediment; Erosive flow	Incremental degradation via nonpoint source runoff	Stormwater BMP retrofitting and construction; streambank and stream restoration techniques
Huron River	Mouth with North Commerce Lake; Commerce Township	Aquatic life/wildlife; Property value protection	Sediment; Erosive flow	Incremental degradation via nonpoint source runoff	Stormwater BMP retrofitting and construction; streambank and stream restoration techniques
Huron River	Mouth with Oxbow Lake; White Lake Township	Warmwater fishery; Aquatic life/wildlife; Partial body contact recreation, Property value protection	Sediment; Erosive flow	Improper construction methods; Uncoordinated lake level control	Streambank and stream restoration techniques
Norton Creek*	From Pontiac Trail downstream to Huron River	Aquatic life/wildlife; Recreation	Sediment; Erosive flow	Incremental degradation via nonpoint source runoff	Stormwater BMP retrofitting and construction; streambank and stream restoration techniques

*Segment identified on the Michigan 303(d) List of Impaired Waterbodies requiring the establishment of a Total Maximum Daily Load (TMDL).

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 and by reviewing the vision and goals for the subwatershed 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 throughout households, businesses, and communities in the subwatershed, on water quality and watershed issues so ultimately to reduce nonpoint source pollution (NPS) through changes in daily actions.

9.2 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 storm water drainage. *

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 of pollutants from storm water drainage systems serving their place of residence. For example, promote awareness of stormwater runoff, simple mitigation activities, and the importance of imperviousness to water quality. *

H) Increase knowledge of the impact on water quality of impaired septic systems and promote knowledge of 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.

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 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 & disposal
3. Innovative stormwater management
4. Participation in a Community Clean Streams Program
5. Storm drain use and awareness

9.3.3 Agriculture

1. Advantages/Opportunities for partnerships & land conservation
2. Importance of soil erosion & sedimentation control practices
3. Less intensive fertilizer/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. Importance of and enhanced principles of erosion control
5. Awareness of water cycle and how we impact it

9.3.5 Governmental Organizations/Local Decision-Makers

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

9.3.6 Educators/School Systems/Partner Organizations

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 and the responsibility of boaters
2. Watershed tidbits (e.g., "you are here" signage, historical uses, etc.)
3. Boat discharge
4. Curtailing accidental spills
5. Importance of not feeding waterfowl

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 to 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 overtime, the prioritized audiences may change with a corresponding level of effort.

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 Prioritized Audiences—How do we reach them?

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 13. Prioritized Audiences per Preferred 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.

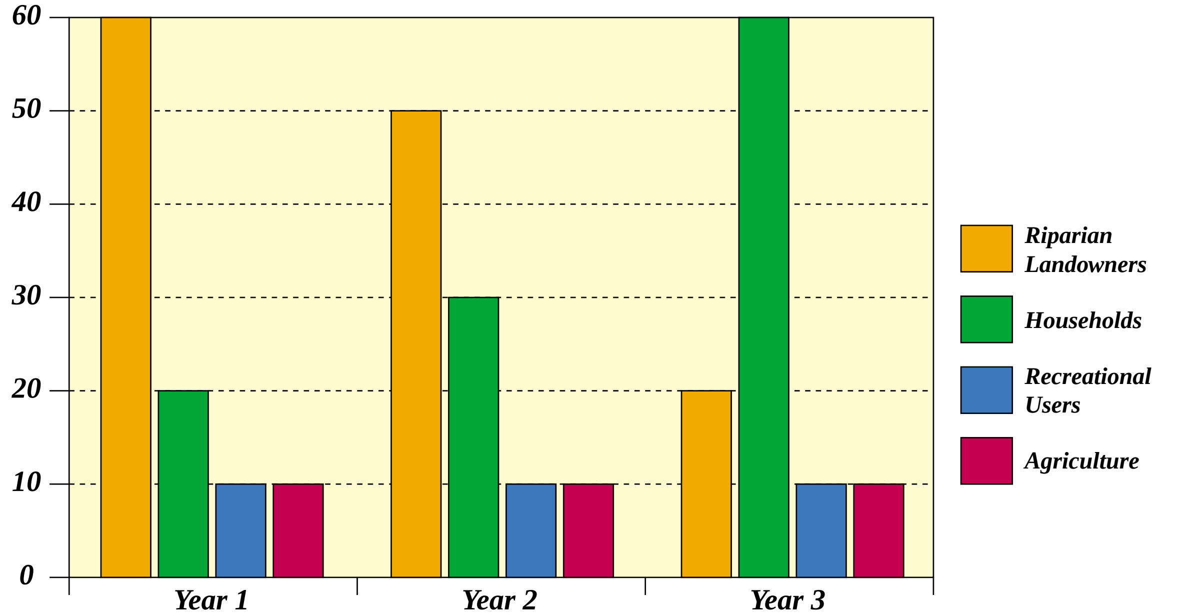
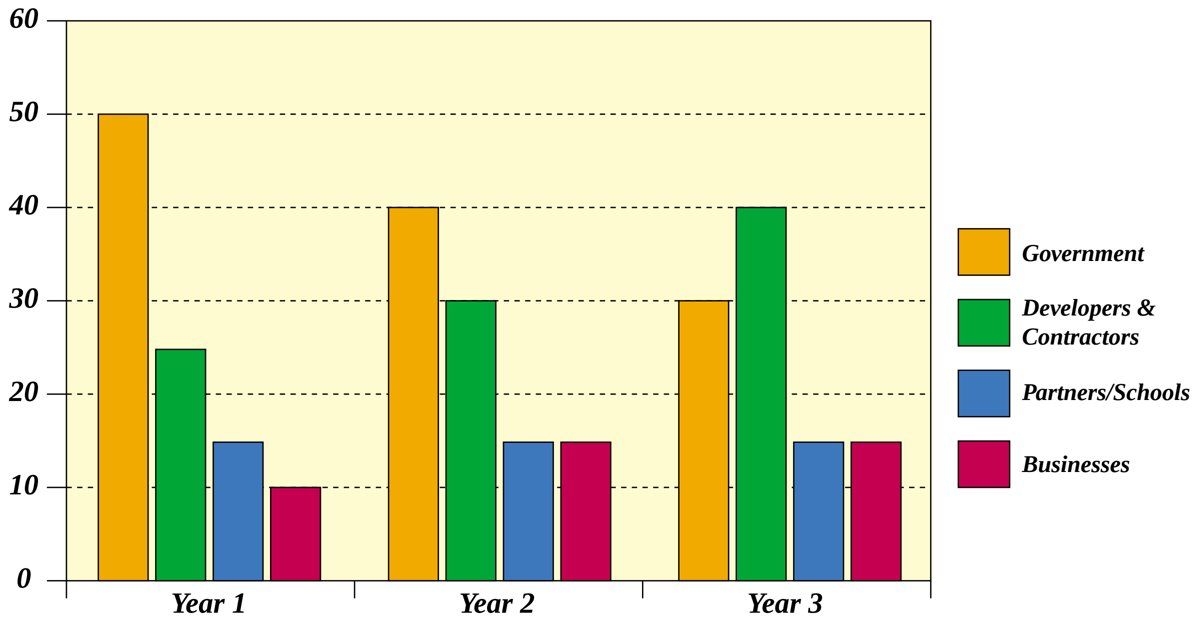


Figure 22. Percentage of Educational Effort via Personal Communication/Interaction.



It is important to note that the Workgroup intends that the Education Task Force 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 that 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 Commissioner's 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.

- *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 Oakland County Drain Commissioner's Office and the Road Commission of Oakland County 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.

- *Greenaway Drain Education and Monitoring Initiative.* With the goal to establish high school-based educational and water quality monitoring initiative for the Greenaway Drain, this initiative begun in winter 2001. It is spearheaded by the Village of Wolverine Lake Water Management Board and includes the Huron River Watershed Council, Oakland County Drain Commissioner's Office, Walled Lake School District, and potentially, Commerce Township and the City of Walled Lake.

CHAPTER 10. FRAMEWORK FOR IMPLEMENTATION AND PROGRESS APPRAISAL

10.1 Huron Headwaters Steering Committee Formation and Purpose

The success of the Kent 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 that 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 Kent Lake Subwatershed, yet considered part of the upper Huron (e.g., Novi Township and others), may need to initiate their own discussions on ways to reduce current, and limit future, nonpoint phosphorus loads as additional TMDLs in the upper Huron are established. Additional concerns about 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, and 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 Kent Lake Subwatershed plan proposes use of this framework to assure to the state and federal government that progress and appraisal of water quality improvement is 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 a significant source of phosphorus within the Kent 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 Kent Lake from upstream nonpoint sources have 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; and*
>
> *THEREFORE BE IT RESOLVED, that (community) shall implement, where feasible, the recommendations in the Kent 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 Kent Lake Subwatershed, for use and enjoyment by current and future generations. The undersigned recognize that the subwatersheds 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 states 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 Kent 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 Kent 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 Kent Lake by meeting the federally approved Total Maximum Daily Load.

Signatory Beliefs

We, the undersigned, acknowledge the importance of Kent 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 the Michigan Department of Environmental Quality (MDEQ) developed and U.S. Environmental Protection Agency approved document entitled "Total Maximum Daily Load for Phosphorus in Kent Lake" (TMDL document), published January of 1999, by the MDEQ, nonpoint source phosphorus loading to Kent Lake account 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 Kent 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
KENT LAKE SUBWATERSHED MANAGEMENT PLAN

This addendum was prepared to bring the 2002 Kent 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 Kent 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 4.2.1 to 4.2.8 (on pages 45-48 in the original WMP). Used to better describe and quantify sources and causes listed on pp. 56-57.

4.2.1 Concern #1: Impervious Surfaces

Addressed as an issue of both nonpoint source pollution and land use, the Workgroup concluded that 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.[1]

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.[2]

As shown in Figure 4 on p. 14, the overall imperviousness of the Kent Lake Subwatershed is estimated at 9.6%. 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. Sixty-three percent of the subwatershed has an imperviousness of less than 10%; 31% of the watershed has an imperviousness rate between 10% and 25%; 1% of the subwatershed area is between 25% and 50% impervious; and 5 % 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 Kent Lake subwatershed rises to 13.0%, 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: Kent 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	793	0.8%	51.4%	408
Single Family	26,774	26.8%	19.0%	5,087
Mobile Home	820	0.8%	60.0%	492
Mixed Use	28	0.0%	76.3%	22
Shopping Center / Mall	47	0.0%	80.0%	38
Secondary / Neighborhood Service	765	0.8%	88.0%	673
Institutional	974	1.0%	28.0%	273
Office	118	0.1%	65.9%	78
Industrial	1,578	1.6%	75.9%	1,198
Industrial Park	287	0.3%	65.9%	189
Air Transportation	29	0.0%	16.8%	5
Rail Transportation	38	0.0%	52.9%	20
Road Transportation	285	0.3%	52.9%	151
Communications	22	0.0%	53.0%	11
Utilities	366	0.4%	65.9%	241
Open Pit Sand/Gravel	1,115	1.1%	2.0%	22
Outdoor Recreation	3,280	3.3%	10.9%	358
Cemetary	77	0.1%	12.8%	10
Cropland / Agricultural	9,558	9.6%	2.0%	191
Rural Residential	32	0.0%	11.0%	3
Nonforested Open	19,482	19.5%	2.0%	389
Woodland	11,203	11.2%	2.0%	224
TOTALS	**77,671**	**100.0%**	**13.0%**	**10,083**

Table 9 on page 69 shows the same land use/land cover composition data (consolidated into four broad land use categories) for each sub-basin in the watershed.

4.2.2 Concern #2: Wetland Loss

Intimately related to planning and land use, the Workgroup cited the loss of wetlands via fill or non-fill stress from development within close proximity of boundaries as the second highest concern for the subwatershed. Studies indicate that half of the state's inland wetlands and 70% of the coastal wetlands no longer exist (MLUI, 1999). Permitted fills for commercial and industrial development, housing, roads, agriculture, and logging claim an estimated 500 acres of wetlands statewide each year. While wetland loss rates are currently unsubstantiated in the Kent Lake Subwatershed, the Huron River Watershed has lost approximately 66% of its wetlands to human activities (HRWC, unpublished). Comparing land use composition between presettlement conditions (Figure 2) and 1995 land use (figure 3), wetlands have declined from 17% of the subwatershed to 14%. A 1996 MDEQ report comparing pre-settlement values with modern development found that as of the early 1980s, 46% of all wetlands in Oakland County had been filled for human use. According to SEMCOG land use data, a total of 185 acres of wetlands were lost between 1990 and 2000 in Highland, Milford, Commerce, and White Lake townships combined[3].

This massive change in the landscape has the potential to contribute to increased flooding, loss of property values, water pollution, and diminished and fragmented wildlife habitat. Wetlands smaller than 5 acres or not within 500 feet of another waterbody are not protected by the state. Such wetlands often serve as many or more important functions than do the larger wetlands (ADID, 1999). Therefore, local protection of these systems is imperative.

4.2.3 Concern #3: Impaired Septic Systems

In general, an impaired or compromised septic system is considered to be one that discharges effluent without the benefit of designed treatment. Impairment of on-site disposal systems can be caused by a number of circumstances, including unsuitable soil conditions, improper design and installation, and inadequate homeowner maintenance practices. Such systems are recognized as a significant contributor of pollutants and microbiological pathogens in the United States. These systems discharge more than one trillion gallons of waste each year to subsurface and surface waters (NSFC, 1995). Identifying and eliminating impaired septic systems can help address potential contamination of ground and surface water supplies from untreated wastewater discharges. Systems in deteriorated condition carry nutrients, such as phosphorus, bacteria, medicinal and chemical agents, and other pollutants to waterbodies with little or no treatment.

According to estimates of the Oakland County Health Division (OCHD), approximately 51% of the subwatershed's 118,000 residents rely on approximately 32,200 on-site septic systems for wastewater treatment. An average of 1,548 new on-site septic systems are installed annually in Oakland County. While no specific studies of OSDS failure rates for the Kent Lake Subwatershed have been conducted, studies have been conduced in other areas of southeast Michigan. 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%.[4] 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 there are approximately 60,600 individuals in the subwatershed that rely on septic systems for waste treatment, faltering septic systems in the subwatershed have the potential to affect water quality and health. Based on these studies of failure rates in surrounding areas, a 20% failure rate of 32,200 OSDS units equates to 6,440 failing OSDS units in the subwatershed

4.2.4 Concern #4: Community Land Use Planning

In essence, the impact of impervious surface generation, wetland loss, and the majority of all other concerns for the Kent 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 Oakland County increased by 18% as over 48,000 acres was converted from undeveloped to developed land; the area is now 54% developed. During the same time period, active agricultural land decreased by over 35% from 66,603 acres to 42,920 for a loss of 23,683 acres. Grassland and shrub decreased 26% from 95,460 acres to 70,779 for a loss of 24,681 acres. A majority of the undeveloped land was converted to single family residential land use, which increased by 33,212 acres (18%). In 1990, the average density of single family land use was 1.71 units per acre. In 2000, the average density decreased to 1.65 units per acre. [5] Furthermore, SEMCOG predicts that the population of portions of the Huron River Watershed in Oakland County (which closely corresponds to the Kent Lake subwatershed) will increase from 161,000 in 2000 to 242,000 in 2030, an increase of 50%. During this same time period, the number of households will increase from 60,000 to 97,000 – an increase of 61%.[6]

4.2.5 Concern #5: Illicit Connections

The Workgroup expressed concern over the unknown rate and impact of illicit connections including sanitary sewer interconnections, discharge from floor drains, washing machines, swimming pool backwash, and other non-stormwater related discharges which may have significant impacts on the water quality of the subwatershed. Such connections can carry untreated pollutants, such as sewage from homes and businesses, to streams, lakes, wetlands, and the river.

Little data exists for illicit connections in the Kent lake subwatershed, but the Wayne County Department of Environment has an active and successful Illicit Discharge Elimination Program. From the time of the program's inception in 1987 to the end of 2004, field staff have inspected 6,317 facilities and have found 1,483 violations at 493 of the sites. In 2004, 353 facilities in Wayne County in the Rouge River Watershed were dye-tested. 97 illicit connections were identified, 82 of which were discharges related to floor drains. Wayne County also projected the amounts of various pollutants that will be prevented from entering the Rouge River based upon removal of all illicit discharges. The County calculates that 11,505 lbs/year of total pollutants (including 79 lbs/year of phosphorus) will be prevented from entering the Rouge River if all the sites detected so far in the program are corrected.[7]

4.2.6 Concern #6: Monitoring Programs and Data

Integrated and coordinated water quality monitoring, as expressed by the Workgroup, needs to be more firmly established within the Kent Lake Subwatershed. Review of readily available and relevant data reveals a number of concerns. In some cases, studies and data significant to water quality decisions and knowledge was only minimally distributed or promoted throughout the subwatershed. In other cases, existing datasets are not complete enough to be used as a basis for subwatershed decisions. Other datasets are nearly non-existent, especially those dealing with sediment contamination, illicit connection and septic system failure rates, and emerging issues such as the presence or absence of endocrine disrupting chemicals in the water, sediments, and biota. In addition, the quality of some of the existing data causes concerns given that the quality assurance/quality control (QA/QC) protocols of sampling parties is unknown. The type of data that has been historically collected is often not useful for answering the key questions about the subwatershed; therefore, inference towards trend detection cannot comfortably be employed given the lack of time-series data.

4.2.7 Concern #7: Open Space and Habitat Fragmentation and Loss

The Workgroup agreed that upland terrestrial habitats will continue to be lost or fragmented into small uncoordinated pieces as suburban development in the Kent Lake Subwatershed converts more open space to lands for intensive human use. The issue is especially associated with loss and fragmentation of forests, wetlands and grasslands vital to water quality, wildlife populations, and community livability. For instance many postulated that as development encroaches upon remaining open space in the area, visually attractive and safe pedestrian walkways would be lost. In addition, many birds and other wildlife species require large blocks of forest for successful breeding or specialized habitat more likely to be found in a large natural area than in a small patch. Retaining existing and reconnecting large patches of natural landscape with green corridors, where feasible, can help to maintain the viability of populations otherwise rendered vulnerable because of small numbers and/or isolation.

As discussed on pages 27-28, opportunities for protection of key natural areas in much of the Kent Lake subwatershed were identified through the Shiawassee & Huron Headwaters Resource Preservation Project (S&H) with the help of the Michigan Natural Features Inventory (MNFI). S&H identified 14 key habitats, including 18 "vital" habitats, based on intactness, upland and wetland riparian corridors, significant forested tracts, and potential for restoration. In 2002, Oakland County Planning and Economic Development Services (OCPED)worked with MNFI to make comparable data available throughout Oakland County by expanding and refining the S&H project, which identified and ranked the least disturbed natural areas in the County.

In 2004, the project was updated to exclude natural areas that had been converted to development or agriculture and additional criteria for prioritization were added. In addition to MNFI data on vegetation quality and rare species/quality natural communities, the criteria included total size, size of core area, presence of stream corridors, landscape connectivity, restorability of surrounding lands, and parcel fragmentation. Natural areas less than 40 acres were not given any points, while areas larger than 240 acres were given the maximum number of points. The reason for this criterion is that size is recognized as an important factor for viability of species and ecosystems. Core areas were defined as the total area minus a 300 ft. buffer from the edge of the area. Greater Core area limits negative impacts on "edge sensitive" animal species. Points were assigned to core areas starting at 60 acres and larger. Points for landscape connectivity were based on the percentage of potential natural areas with ¼ mile of the site and the number of other potential natural areas within 100 feet of a site. Landscape connectivity between habitat patches is considered a critical factor for wildlife health. Restorability of surrounding lands was measured by the percentage of agricultural lands and old fields within a ¼ mile buffer of land surrounding a natural area. Restorability is important for increasing size of existing natural communities, providing linkages to other habitat patches, and providing a natural buffer from development. Priority was given to areas that were surrounded by more than 35% restorable lands. Finally, parcel fragmentation was measured according to the number and size of land parcels in each natural area. The associated consequences of subdividing (fragmenting) land adversely affects habitat. Points based on the ratio of the size of the largest parcel in the area to the mean size of parcels in the site. Points were given to parcel fragmentation ratios starting at 2.6 acres, up to greater than 43 acres. Throughout Oakland County, 93,521 acres were identified as priority conservation areas. 59% was considered "priority two" or "priority three" land and the remaining 41% was considered "priority one".[8]

A similar project was completed by HRWC in 2002 for the Huron River Watershed. Like the 2002 Oakland County Natural Areas Report, "Conservation Planning in the Huron River Watershed" (also known as the Bioreserve Project) was also based on the methodology used for the S & H Project. While the boundaries of the natural areas were not identical, the results of the Bioreserve Project and the Oakland County Natural Areas Report were comparable.[9] A total of 5,597 acres were identified in the Kent Lake subwatershed as "medium" priority natural areas for protection, while 21,810 acres were identified as "high" priority natural areas.[10]

4.2.8 Concern #8: Intensive Landscaping and Over-Fertilization

The Workgroup identified intensive landscape maintenance as a trend that is problematic for subwatershed health because of the reliance on chemical fertilizers and pesticides, irrigation, and other "life-support" measures necessary to maintain the artificial conditions that meet our standards. Consequences of intensive landscaping and over-fertilization include air, noise, and water pollution, consumption of natural resources, increased stormwater runoff and flooding, and loss of beneficial insects and other species.

What we do in our own backyards has systemic impacts many never conceive. The plants in our yards and businesses and the way we maintain them are a significant water quality and environmental pollution source (Swan, 1999). The majority of lawn owners are not aware of the phosphorus or nitrogen content of the fertilizer they apply or that mulching grass clippings into lawns can reduce or eliminate the need to add fertilizer (Morris and Traxler, 1996). In a survey of Kent Lake subwatershed residents conducted by SEMCOG in summer 2004, 31% indicated that they use fertilizer on their land at least once a year. 34% of those surveyed indicated that their household uses a lawn service for fertilizer and/or pesticide applications. The most common reason residents gave for selecting the type of fertilizer or pesticide they use was how safe the product is for the environment. When asked about their willingness to perform various actions to help reduce pollution in lakes and streams, 85% said they would sweep excess fertilizer/grass clippings into their lawn and 66% were willing to change lawn watering practices.[11]

Data is wide-ranging on how much residential landscaping and fertilizing contribute to phosphorus loading, and no local studies were readily available. However, one study in Minnesota compared phosphorus runoff from three urban residential drainage areas in a municipality (Maple Grove, MN) that has no restrictions on phosphorus applications with three similar urban residential drainage areas in an adjacent municipality (Plymouth) that has a phosphorus-free fertilizer ordinance. Over a 4-month period between July and November, Maple Grove (no phosphorus restrictions) showed an average of .23 lbs/acre of phosphorus runoff, while Plymouth (phosphorus-free ordinance) showed an average of .10 lbs/acre of phosphorus runoff.[12]

Another study in Wisconsin on the effects of lawn fertilizer on nutrient concentration in runoff from 70% developed lakeshore lawns concluded that while the lakeshore drainage area contributed only 4% of the inflow to the lake, it contributed 51% of the phosphorus input. Median total phosphorus concentrations were 1.81 mg/L from lawn areas that didn't use fertilizer. Lawns using "regular" fertilizer (not characterized) at a rate of 3-3.5 lbs/ft^2 2-4 times a year had runoff concentrations of 2.85 mg/L.[13]

One more study sampled runoff volume and total phosphorus concentrations in two urban basins in Madison, WI. In one basin, lawns accounted for 23% of the runoff volume and 70% of the total phosphorus loading. In the other basin, lawns accounted for 24% of the runoff volume and 56% of the total phosphorus loading.[14]

For Element B: additional text for Section 6.5 (to be inserted after second paragraph on page 72 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 Kent 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 9.5. 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]	50	154.9	40	150.0	305.0
Constructed Wetlands[a]	45	148.2	35	139.5	287.7
Grassed Channels[a]	25	46.8	45	102.0	148.8
Catch Basin Inserts[b]	160	0.5	25	0.0	0.5
Bioretention Islands[c]	35	34.3	0	0.0	34.3
Engineered Dry Swales[a]	20	83.9	25	135.1	219.0
Street Sweeping[d]	1	9.9	1	41.4	51.4
TOTALS	-	**479**	-	**568**	**1047**

[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 Kent Lake calls for an average phosphorus reduction of 16 percent (1000 pounds/year) in nonpoint source contributions. The estimates in Table 9.5 provide demonstrate how a minimum reduction of 1000 pounds/year can be met through applications of the selected structural stormwater BMPs in commercial/industrial and residential areas.

FOR ELEMENT D: see attached Excel file for corrected version of Table 8: Matrix of Actions on page 64 of the Plan.   This table in the original Plan was not printed correctly, cutting off the far-right column that showed the range of cost estimates for implementation by category. The attached table 8 provides the original cost estimates for implementation.

Note: the high-end estimate for stormwater BMP ($2 billion) 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 Kent 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 $68,253,000 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 Kent Lake Subwatershed Management Plan. Additional Information on Costs and Resources.

Task	Recommended BMP	Primary Goals Addressed	Phase I	II	III	Responsible Parties	Costs	Measurable Milestone	Resources
Structural Best Management Practices	Wet Detention Basin	2, 4			X	Private Landowners, Local Governments, Oakland County	*$\$24.5V^{.705}$ ($45,700 for 1 acre facility) Maintenance: 5% construction cost	Pilot retrofit demonstration (at Wildwood subdivision) complete by 2006; 3 additional retrofits completed by 2010	CMI, 319 grants, other private/ public grants
	Constructed wetlands	2, 4			X	Private Landowners, Local Governments, Oakland Co.	*$\$30.6V^{.705}$ ($57,100 for 1 acre facility) Maintenance: 5% construction cost	Pilot retrofit demonstration (at Banks middle school) complete by 2006; 3 additional retrofits underway by 2010	CMI, 319 grants, other private/ public grants
	Grassed Channels	2, 4			X	Private Landowners, Local Governments, Oakland Co.	$\$.65/f^2$	Pilot retrofit demonstration (25 acres of treatment) complete by 2008. 4 Additional retrofits completed by 2010	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 all 5 applicable communities by 2010	CMI, 319 grants, other private/ public grants
	Catch-basin Inserts	2, 4			X	Private Landowners, Local Governments, Oakland County	$800 each + $150,000 vac truck Maintenance: $300[b]	Install 30 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, Oakland Co.	$\$7.30V^{.99}$ Maintenance: 20% construction cost	Pilot retrofit demonstration (5 acres of treatment) completed by 2008	CMI, 319 grants, other private/ public grants
	Infiltration Trenches	2, 4			X	Private Landowners, Local Governments, Oakland Co.	$\$5/f^3$ Maintenance: 20% construction cost	Pilot retrofit demonstration (as part of a treatment train) complete by 2010	CMI, 319 grants, other private/ public grants
	Engineered Dry Swales	2, 4			X	Private Landowners, Local Governments, Oakland County	$\$5.50/f^3$	Pilot retrofit demonstration site complete by 2010	CMI, 319 grants, other private/ public grants
Land Use Planning and	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

* 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	II	III	Responsible Parties	Costs	Measurable Milestone	Resources
Design Standards	Low Impact Design Principles in Community Development Design Standards	2		X		Local Governments,	$5k – 10k	Implemented by 4 local governments by 2008	County Planning, Drain , RoadCommissions; Sample Master Plans; SEMCOG; HRWC;
	Stormwater Management Ordinance	2		X		Local Governments	$5k – 10k + Enforcement[a]	Implemented by 4 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	Used by 50% of 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)	Used by 50% of local governments by 2008	
	Impervious Surface Limitations	3,4		X		Local Governments	$3000[b]	Standards adopted by 4 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 5 communities by 2008	County Planning Dept., Drain Comm.
	Private Roads Ordinance	3,4	X			Local Governments; Oakland County	$5k – 10k[d]	Adoption by all communities by 2010	HRWC; County Planning Dept., County Road Commission
	Promote Conservation or Cluster Subdivisions	3, 4	X			Local Governments	$5k – 10k[a]	Adoption by 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
Intensive Landscaping and Over-fertilization	Water Efficiency Policies for Commercial Landscaping	5		X		Local Governments;	$5k – 10k	Adoption by 7 communities by 2010;	MSU Extension
	Fertilizer Ordinance or Resolution	5		X		Local Governments	$10k[d]	Adoption by 7 communities by 2010	HRWC: MSU Extension; other local governments with existing ordinances

[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
	Native Landscaping/ Restoration in Public Areas	5, 6		X		Local Governments; Huron Clinton MetroParks	$600-800/ acre installation Maintenance: $500/acre[b]	Demonstration sites at all local government town halls and 5 parks/shorelines by 2008	MSU Extension; Conservation District; NRCS; CMI funding
	Golf Course Nutrient Management Improvements	5		X		Private Landowners; Oakland County	Little to no cost through information provided via 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	8		X		Local Governments; Oakland 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; HRWC
	Natural Features Setback Ordinance	8		X		Local Governments	$5k – 10k[c]	Adoption by 4 communities by 2010	HRWC
	Floodplain Mapping and Ordinance	8			X	Local Governments	$5k – 10k	Floodplain mapping complete. Standards/ordinance in place by 50% of communities by 2010	MDEQ, County Drain Commisioner
	Wetland Protection Ordinance	8		X		Local Governments	$5k – 10k[c]	Adoption by 6 communities by 2008	HRWC: model ordinance, policy assistance
	Conservation Task Force	8	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	9		X		Oakland County Local Governments Private Landowners	$5k – 10k + $300 per inspection[a]	Adpoption by 4 local governments or county-wide by 2008	County Health Dept. Drain Comm., Wayne Co. Dept. of Environment, and Washtenaw Co. Environ. Health Dept.
	Illicit Detection & Elimination Program	10			X	Local Governments, Oakland 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	Oakland Co. Drain Commission, Oakland 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	11	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	11		X		Local Governments; HRWC	$10,000 annually[c]	Training and monitoring begun by 2008	HRWC
	Expansion of Stewardship Network	12	X			Local Governments, Stewardship Network	$5000 start-up $3000/annually[b]	Headwaters Cluster of Stewardship Network program initiated in 2006	Stewardship Network
	Lake and Creek Drainage Area Planning and Protection Services	11		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	1, 6, 7, 9, 11, 12	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	1, 6, 7, 9, 11, 12		X		Oakland County Local Governments	$10K – 20k for start-up $10 – 15k annually	Program initiated by 2008. Minimum of 20 partners by 2009	Washtenaw Co. Drain Commissioner, HRWC] 319 grants, other grant sources
	Homeowner-based BMP Initiative	2, 3, 4, 6			X	Local Governments Oakland Co. Education Task force	$5K – 10K annually	Minimum of 2 Homeowner BMP workshops presented annually starting in 2008. Minimum of 10 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	6, 7	X			Local Governments with curb/gutter storm drains	$1.50 per lexon marker; $3.00 crystal-coated marker	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 Sign Program	7	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 2008	HRWC, Oakland Co. Road Commission, SEMCOG
	Greenaway Drain Education and Monitoring	11, 12	X			Wolverine Lake, Walled Lake School District; MDEQ	$500 - $2000K annually	Data collection started in 2003 and ongoing. Annual analysis and progress reports developed for distribution to responsible parties and Water Quality Task Force	Walled Lake School District; HRWC; teacher and student volunteers; Wolverine Lake Water Quality Board; grant funds
Plan Implementation	Establish Huron Headwaters Steering Committee	All goals	X			Local Governments, Oakland County,	$100/hr per municipal staff	Formation by 2007 with regular meetings, all communities represented on task force	In conjunction with downstream (Livingston 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 98-99 of the Kent Lake Subwatershed Plan.

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[15]

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 Kent 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.

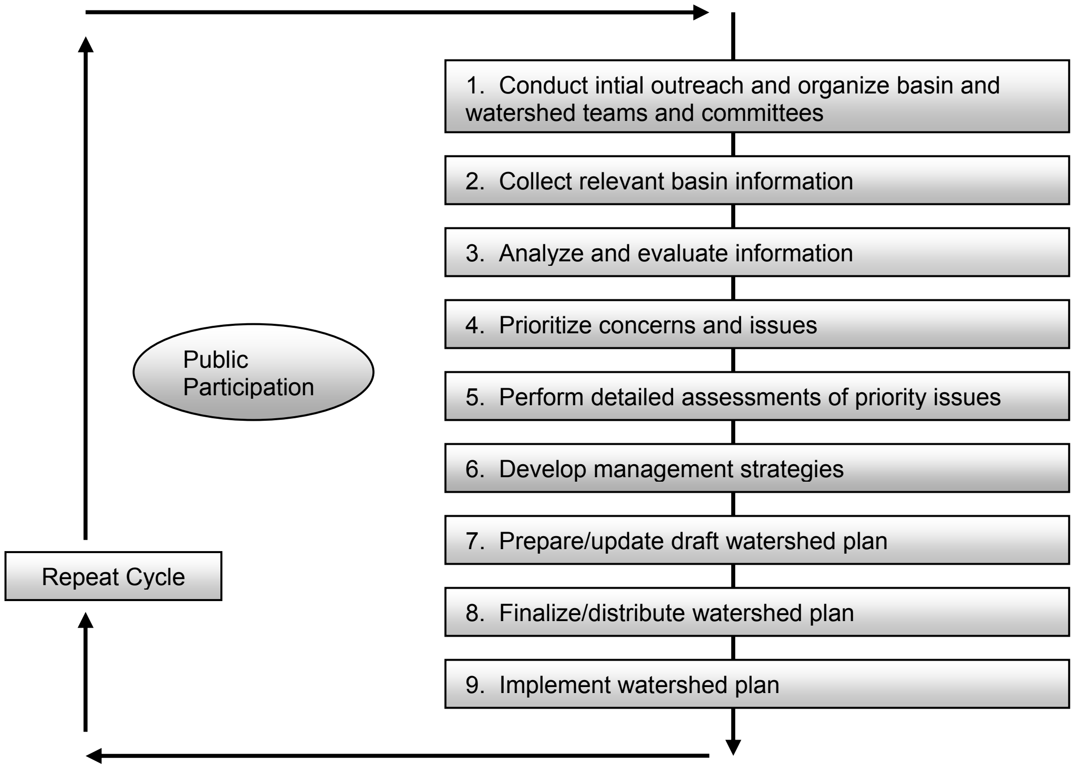
Watershed Plan Revision

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 Kent 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[16]



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 Kent 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.[17] 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 Kent 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 Kent Lake as part of the established phosphorus TMDL for the Lake. Regular MDEQ monitoring may also occur at other waterbodies for which TMDLs are scheduled to be established in the future. 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 Kent 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 Kent Lake Subwatershed.

Table 10.4: Selected Parameters, Indicators, and Key Milestones for the Kent 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 Kent Lake by 2010 Maintain acceptable N:P ratio (Redfield's ratio)
Physical: Sediment	Sedimentation and erosion	Bottom deposition: % of silt/sand fines	Maintain % fines at Huron R. @ White Lake and Commerce Rds, and 2 sites on Pettibone Cr. Decrease % fines at Huron R. @ Proud Lake and at 2 Norton Creek Sites by 20% 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 3 "fair" sites to "good" by 2010. (Huron R. @ Commerce Rd. and 2 Pettibone Cr. sites) Increase both Norton Cr. "poor" sites to "fair" by 2010. Maintain "excellent" rating at Huron R. @ White Lake Rd. site
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 overall macroinvertebrate ratings: Maintain "excellent" rating for Huron R. @ White Lake Rd. Maintain "good" rating for Huron R. @ Commerce Rd. and Proud Lake Rd. Increase two Norton Creek Sites from "fair" to "good" ratings by 2010 Increase two Pettibone Creek Sites from "poor" to "fair" ratings by 2010 Using Adopt-A-Stream data for # of EPT species: Maintain avg. EPT score of 9.5 for Huron R. @ White Lake Rd. Increase # of EPTs at 2 remaining Huron River sites to 8 by 2010 Increase # of EPTs at 4 creek sites to 5 by 2010 Using Adopt-A-Stream data for # of sensitive species: Maintain average of 5 sensitive species at Huron River @ White Lake Rd. Increase # of sensitive species at all 6 other sites to 1 by 2010
Programmatic: Impaired septic systems and illicit discharges	Nutrient loads E. Coli	Inspection of illicit discharges and failing septic systems Correction of illicit discharges and failing septic systems County-wide septic system inspection program	(Milestones for identification of illicit discharges and failing septic systems to be determined upon completion of Kent Lake Phase II Stormwater Management Plan IDEP goals) (Milestones for correction of illicit discharges and failing septic systems to be determined upon completion of Kent Lake Phase II Stormwater Management Plan IDEP goals) Septic inspection program initiated by 2008

Subwatershed-wide long-term monitoring related to priority pollutants will address many objectives established for the Kent Lake subwatershed, and Goals 11 and 12 that address establishment of a monitoring program and data collection. A monitoring program at the subwatershed level will require a regional perspective and county or state support. Communities and agencies in the subwatershed 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.

<u>Parameters and Establishing Targets for River Monitoring</u>

Upon reviewing the data collected for the Plan, the Steering Committee 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 Kent Lake calls for a 16% 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 river and its tributaries 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. A USGS stream gage is located on the Huron River at Milford (Gage Station #04170000) that provides continuous measurement of discharge. Data generated at the station can assist in establishing an appropriate flow target and assessing any progress made toward that goal.

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 seven sites in the Kent Lake Subwatershed 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.

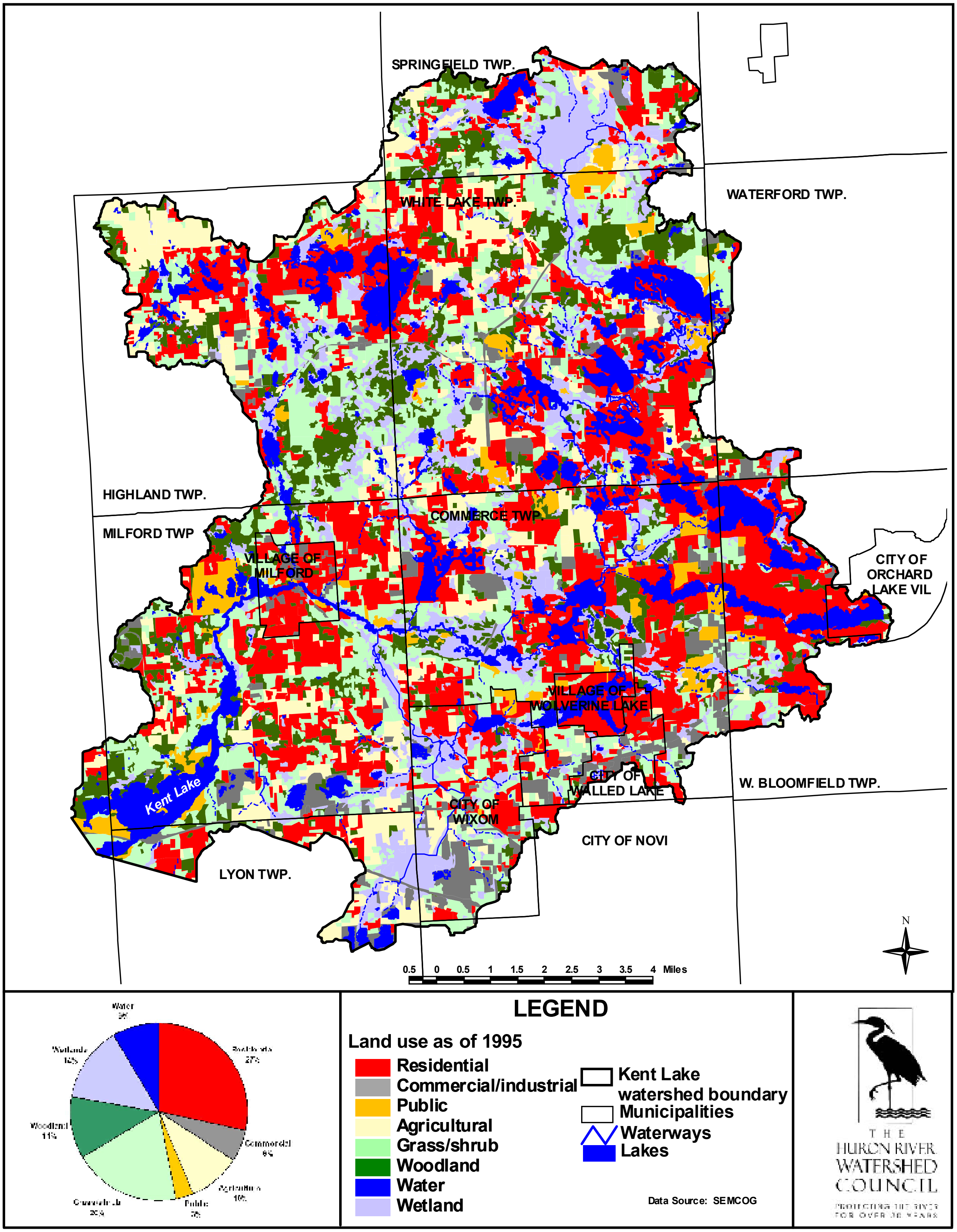
Temperature: The state standard lists temperature standards only for point source discharges and mixing zones – not ambient water temperatures in surface water. However, recommendations for water temperature can be generated by assessing fish species' tolerance to temperature change and these guidelines are found within the statute. Although some temperature data have been collected in Kent 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.

Map with corrected pie chart. (The original pie chart was found to be erroneous).

Figure 3: Kent Lake Subwatershed 1995 Land Use



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