Little Traverse Bay Watershed Protection Plan

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Tip of the Mitt Watershed Council
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Executive Summary

The Little Traverse Bay Watershed
At approximately 45 square miles, Little Traverse Bay is Lake Michigan's fourth largest bay. The land area of the Bay's watershed is approximately 174 square miles and contains a diversity of water resources, including Walloon Lake and its tributaries (Schoof's Creek and Fineout Creek), Bay Harbor Lake (a flooded quarry adjacent to Lake Michigan), Bear River, Hay Marsh Creek, Spring Brook, Tannery Creek, and Five-Mile Creek. The Little Traverse Bay shoreline is also diverse, containing a large recurve sand spit known as Harbor Point, miles of dune and sand beach ecosystems, miles of cobble beach, and exposed limestone bedrock.

French explorers traveling along the east coast of Lake Michigan found two large embayments along their way. During calm weather, they crossed the bays' mouths in their canoes to save time. The northernmost bay had a slightly narrower mouth and they called this *la petit travers-the little traverse*. Little Traverse Bay is about 3.5 miles wide between Petoskey and Harbor Springs and 8 miles wide at its outer end (between Nine Mile Point on the south and Seven Mile Point on the north). The Bay has a surface area of approximately 45 square miles or 19,840 acres. Between Petoskey and Harbor Springs it reaches a depth of about 170 feet. The outer bay drops to depths of more than 200 feet.

Water resources in the Little Traverse Bay region have always been essential to the regional economy and quality of life. In the 1800s, the rapid flow of the Bear River generated power to run lumber mills and factories. The limestone and shale along the south shore of the Bay were the basis for cement manufacturing, and deepwater ports in Petoskey and Harbor Springs provided excellent transportation opportunities. These activities impacted the resources of Little Traverse Bay and its tributaries, particularly the Bear River and Tannery Creek. Both experienced damage from erosion, dam construction, pollution, and sedimentation from logging and early industry.

The beauty of Little Traverse Bay has attracted visitors for more than a century. Ironically, development pressure that results from the area's beauty poses a serious threat to the quality of the water resources that make the region attractive. As more and more land is converted to residential or commercial uses, the potential for water quality degradation is increased. Other pollutants that threaten the Bay's health today are nutrients and sediments from different human activities such as shoreline development, polluted runoff, streambank erosion, and agricultural activities.

Project Goals
The overarching goal of the Little Traverse Bay Watershed Protection Plan is to protect and enhance the water quality and ecosystem integrity of Little Traverse Bay and its tributaries in a way that ensures all designated uses are restored and protected. The Little Traverse Bay Watershed Protection Plan will provide a framework to accomplish the following goals (related to the designated uses for public surface waters):

1) Manage nonpoint source pollution to ensure that the status of the following designated uses remain supported--agriculture, industrial water supply, and public water supply at intake point.

2) Improve and maintain navigation in the Bear River and other tributaries by reducing sediment inputs and maintain navigation in Mud Lake by reducing nutrient inputs to avoid excessive weed growth.
3) Improve the warm water fishery by reducing inputs of toxic substances, sediments, and nutrients; controlling aquatic nuisance species; and protecting and restoring wetlands.

4) Improve the cold water fishery by reducing inputs of toxic substances, sediments, and nutrients; restoring ground water recharge; protecting and restoring wetlands; controlling aquatic nuisance species; and restoring vegetation along rivers and streams to provide shade and wildlife cover.

5) Improve other indigenous aquatic life and wildlife by reducing inputs of toxic substances, sediments, and nutrients; restoring ground water recharge; protecting and restoring wetlands; controlling aquatic nuisance species; and restoring vegetation along rivers and streams to provide shade and wildlife cover.

6) Assure that recreation (partial and total body contact between May 1 and October 31) is safe by improving quality of water discharged from urban runoff/stormwater sewers; discouraging waterfowl in swimming areas; addressing possible failing septic systems; and researching and implementing control of swimmer's itch.

Nonpoint Source Pollution Inventories
A variety of assessments were conducted to document nonpoint source pollution in the Little Traverse Bay Watershed. The goal of the inventories was to document current sources and causes of pollution as well as potential sources. Nonpoint source pollution inventories focused on all areas within 1,000 feet of lakes, streams, wetlands, urban areas, and steep slopes (25% or greater). Nonpoint source pollution inventories conducted include: Stormwater; Lakeshore and Streambank; Road/Stream Crossing; Agricultural; Priority Sensitive Lands; Forestry; and Zoning.

Priority Pollutants
After the completion of the nonpoint source pollution inventories, pollutant and impact sources were prioritized based on how they most affect the designated uses. Two pollutants were given top priority ranking across the Watershed: nutrients and sediment. Nutrients are the priority pollutant for Little Traverse Bay and Walloon Lake and sediment is the priority pollutant for the tributaries. Habitat loss was ranked second across the Watershed, followed by toxics, changes in hydrology, pesticides, bacteria, and aquatic nuisance species.

Recommendations
More than 100 recommendations set the stage for work that is needed to enhance the health of the Little Traverse Bay Watershed. The action steps represent an integrated approach. From restoration to education the actions are designed to reduce or prevent nonpoint source pollution. For each action step, the organization(s) best suited to implement the task was identified along with estimated costs to implement each item. A measurable milestone is also listed for each action step to ensure that recommendations are progressing and being complete. A timeframe of 10 years was used to determine the scope of activities and the estimated costs.

In Closing
Little Traverse Bay Watershed is at an important crossroads. On one road lies the degraded water quality that will result if past abuses are left uncorrected and the development predicted for this region occurs without attention to reducing polluted runoff and protecting shorelines. On the other road lies the opportunity to unite the community in an effort to implement a results-oriented plan that recommends tangible actions to ensure healthy waters. We hope that the Little Traverse Bay Watershed Protection Plan provides the map to ensure that the waters of the Little Traverse Bay Watershed will be enhanced, restored, and protected for generations to come.

chapter
ONE

Getting to Know the Little Traverse Bay Watershed

1. Introduction

Healthy natural resources, including high quality water resources, provide the background for healthy communities. A community survey conducted in Emmet County (Emmet County Comprehensive Land Use Plan, Attitude Survey, 1990) identified that having clean surface and drinking waters is extremely important to the county's citizens (95.9% ranked as extremely important). A highly-valued resource, however, requires preservation and protection. Protecting our surface and drinking waters requires looking at the land area surrounding associated water bodies, also known as the watershed, and developing a long-term strategy, or management plan, to safeguard its water resources.

A watershed is the area of the land's surface that drains to a particular water body. Boundaries are generally based on high elevations. The Continental Divide is North America's most famous watershed boundary. On the east side of the Continental Divide the rivers and other water bodies all drain to the Atlantic Ocean. On the west side of the Continental Divide all of the waters drain to the Pacific Ocean. Interestingly, the watershed divide between Lakes Huron and Michigan comes quite close to the Bay, following along the tops of the dunes in the Petoskey State Park.

Watersheds may also be characterized by their size. Large watersheds may encompass thousands of square miles; small watersheds may include only several square miles. The Little Traverse Bay Watershed (Figure 1) receives water from both precipitation and Lake Michigan via dynamic mixing currents. Tributaries are the primary conduits for water from throughout the Watershed. They carry natural dissolved and suspended materials, as well as pollutants. Little Traverse Bay's main tributaries are the Bear River (which includes Hay Marsh Creek and Spring Brook), and Tannery and Five-Mile Creeks. There are also many small, unnamed tributaries that discharge to Little Traverse Bay.

The features of a watershed influence the characteristics of its receiving water body. These features include things like soils, vegetation, climate, topography, geology, and human land use. Because each watershed has different conditions, each lake and stream is unique. For instance, because of the limestone which is prevalent throughout much of the Lake Michigan basin, the water has high levels of calcium and magnesium (termed hardness), and carbonates (which create alkaline conditions), and as such is well buffered against acid precipitation.

The activities occurring in a watershed are often reflected in a lake's water quality. Watersheds that are predominantly forested and have little human activity generally are less polluted than heavily urbanized and more populated watersheds. The pollution that human activities generate fits into two major types: point source and nonpoint source. Point source pollution comes from an easily identifiable source, such as a discharge pipe from a factory. Nonpoint source pollution is pollution which comes from more diverse and diffuse sources that are not usually so obvious. Examples include soils that are eroded as a result of human activities or substances which have been applied to land, such as fertilizers. Nonpoint source pollution reaches surface water primarily through runoff from rainfall or melting snow that picks up contaminants from the land. It can also include subsurface drainage such as leachate from septic systems, and airborne

pollutants, such as emissions from cars and power plants that produce acid rain. Atmospheric deposition is the leading source of mercury pollution in the Little Traverse Bay Watershed.

A. What is a Watershed Management Plan?
A watershed management plan identifies problems and threats to water resources and develops a framework to address these issues within a specific watershed. It is useful as both a process and a tool.

The process of developing a watershed management plan can vary, but generally it involves bringing together stakeholders, identifying a common goal, gathering information to identify problems and threats, and developing recommendations that address the problems and achieve the goal. A watershed management plan is also an important tool. It provides a compilation of information, background, and history for a geographic area. Perhaps one of the most valuable assets of a watershed management plan is that it provides a strategic approach to restoration and prevention actions. In addition, a watershed management plan provides a tangible tool for fundraising efforts.

Little Traverse Bay Watershed Protection Plan
The process for developing the Little Traverse Bay Watershed Protection Plan began in 2002 with funding from the Michigan Department of Environmental Quality. Led by the Tip of the Mitt Watershed Council, the process included the following activities:

1) Established the Advisory Committee and coordinated regular meetings,
2) Developed project goals,
3) Delineated priority areas in the watershed,
4) Conducted detailed nonpoint source pollution inventories in the priority area,
5) Developed tangible recommendations to address nonpoint source pollution problems,
6) Developed an information and education strategy, and
7) Completed a final protection plan.

The successful development of a watershed management plan depends upon the involvement of a diversity of community members. The Advisory Committee members represented a variety of interests including local government—cities, townships, and counties, farmers, lake and beach associations, local tribe, land conservancies, and citizen groups. The Committee provided input on the process and commented on all written materials produced through the project.

A public forum was hosted to obtain additional citizen input. The public forum was held on August 12, 2003 at the North Central Michigan College. A slide presentation that reviewed the process and the preliminary results from the nonpoint source pollution inventories was presented. The recommendations were also presented to the audience. Numerous public presentations were given throughout the duration of the project. All of the presentations included invitations to participate in the process and comment on the work product. In addition, meetings were held with local governments to review the stormwater inventory results and to begin developing a strategy to address the problems.

During the development of the Little Traverse Bay Watershed Protection Plan, the U.S. EPA developed a set of nine elements that a watershed management plan must include in order for it to be eligible for funding under the Clean Water Act (Section 319). The nine elements (Appendix G) require that the watershed management plan provide detailed information on impairments, estimated load reductions with the use of best management practices, detailed cost estimates for restoration and preventative actions, and a monitoring and evaluation

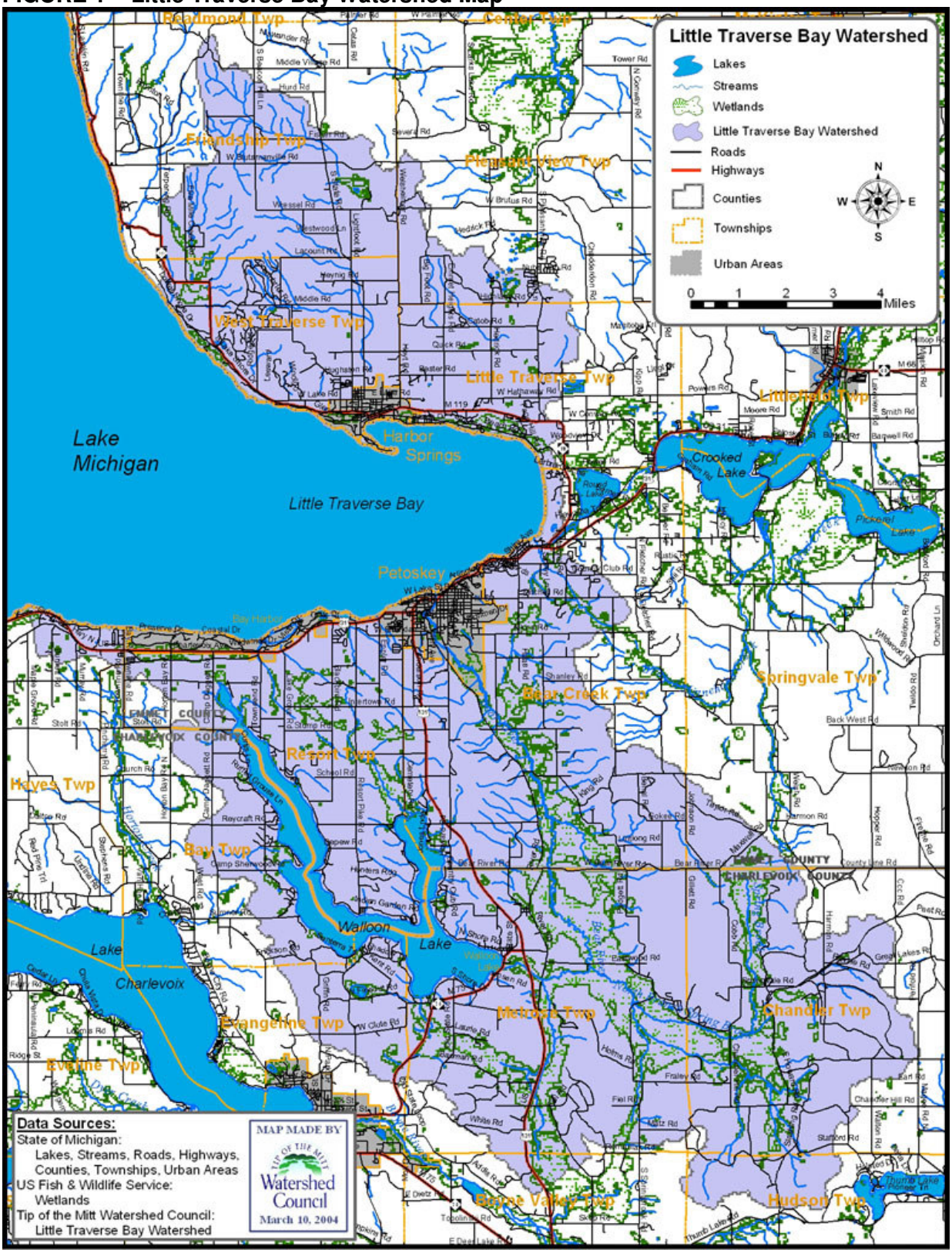
strategy.

Additional funding was provided to the Tip of the Mitt Watershed Council in August 2004 to modify the Little Traverse Bay Watershed Protection Plan to meet the nine elements. This document reflects the changes required by the nine elements and includes the most recent information available on the status and health of the Bay and the other water resources in its Watershed.

There are two important steps that follow the completion of a watershed management plan—1) implementing the plan, and 2) evaluating the success. The recommendations in the Little Traverse Bay Watershed Protection Plan reflect a timeline of ten years. All of the recommendations, whether it is educating riparian property owners or correcting severe erosion problems, require a certain amount of funding. Applications for grant funds through federal, state, and community programs will be submitted to support implementation activities.

Funding to develop and update the Little Traverse Bay Watershed Protection Plan came from the Michigan Department of Environmental Quality nonpoint source pollution program which receives funds from the Environmental Protection Agency (Section 319 of the Clean Water Act).

FIGURE 1 – Little Traverse Bay Watershed Map



B. Geologic History and Geographic Description

Geologic History

Lake Michigan and Little Traverse Bay's early formations started about 570 million years ago during the Devonian Period when shallow productive seas were located in what is now Michigan. Over the next 240 million years a succession of seas existed, and deposits of limestone were laid down on the bottom of each. These seas were full of worms, mollusks, corals, and other invertebrates. The fossil remains are common in the shoreline rocks, including fossils of an extinct species of coral unique to this area called Petoskey Stones.

Between 330 and 2 million years ago, the seas drained away and the land was uplifted. River valleys were eroded into the limestone. A large river flowed through a broad deep valley in what is now Lake Michigan and a smaller tributary carved a valley between different limestone deposits in what is now Little Traverse Bay.

Beginning about 2 million years ago and lasting to as recently as 10-12,000 years ago, a series of four continental glaciers descended from the north. The glaciers widened and deepened the river valleys and eventually left them filled with water.

After the glaciers left, the water went through a series of wide fluctuations. About 10,000 years ago, glaciers blocked the outlet to the north and held the water 160 feet higher than it is now. Geologists have named that water body Lake Algonquin. After the glaciers retreated further north, they uncovered a northern outlet, and the water fell to a level 350 feet below the present level (called Lake Chippewa). At that time (9,500 years ago) Little Traverse Bay was completely dry and probably forested. As the land, and the outlet's elevation, rebounded from the weight of the glacier, the lake level again rose, reaching a height of about 25 feet above the present level. This lake was called Lake Nipissing and existed about 4,000 years ago. About 2,400 years ago, the St. Clair River (the modern outlet of Lakes Michigan and Huron) eroded down to a stable layer, and the Lake has been relatively stable ever since (except for normal seasonal and yearly fluctuations) at the level we see today.

The Great Lakes

The Great Lakes are one of the world's most significant water resources. The series of five lakes (Superior, Michigan, Huron, Erie, and Ontario) are the most extensive freshwater system on earth and are easily spotted as an outstanding feature on a map of the world. They span more than 750 miles west to east and contain about 1/5 of the earth's surface freshwater. They have figured prominently in the history of the U.S. and Canada. They contain unique habitats for fish and wildlife; sustain a valuable fishery; and provide water for consumption, transportation, power, recreation, and a host of other uses.

Lake Michigan

Lake Michigan is the fourth largest freshwater lake in the world based on surface area. Only Lakes Superior, Victoria (in Africa), and Huron (but just slightly) are larger. Lake Michigan covers 22,278 square miles. It is 307 miles long and 118 miles wide at Petoskey (which is the widest point).

Another way to measure lake size is volume. Lake Michigan has the fifth largest volume of any freshwater lake. Only Lakes Baikal (Russia- it is the world's deepest at one mile, and by itself contains another fifth of the earth's freshwater), Tanganyika (Africa), Superior, and Nyassa (Africa) are bigger. Lake Michigan contains about 1,180 cubic miles of water.

Lake Michigan has a maximum depth of 924 feet, with an average depth of 279 feet.

Interestingly, this puts the deepest spot (which is located mid-lake near the Michigan coastal cities of Frankfort and Manistee) about 350 feet below sea level! This may seem quite deep, but actually Lake Michigan ranks far down on the list of the world's deepest lakes. Including islands, Lake Michigan's shoreline is 1,659 miles long.

Little Traverse Bay

At approximately 45 square miles, Little Traverse Bay is Lake Michigan's fourth largest bay. The Bay is about 10 miles long, and is about 3.5 miles wide between Petoskey and Harbor Springs, with a maximum width of 8 miles. It is 200 feet deep in the outer part of the Bay, and 170 feet deep at the inner part of the Bay located between Petoskey and Harbor Springs.

Little Traverse Bay Watershed Political Boundaries

The Little Traverse Bay Watershed is one of Northern Michigan's larger watersheds covering approximately 174 square miles or 111,207 acres in Emmet and Charlevoix Counties. Emmet County townships within the Watershed include Friendship, Pleasantview, West Traverse, Little Traverse, Resort, Bear Creek, and Springvale. Charlevoix County townships within the Watershed include Bay, Evangeline, Melrose, Chandler, Boyne Valley, and Hudson. The Little Traverse Bay Watershed includes the municipalities of Petoskey and Harbor Springs, and the unincorporated village of Walloon Lake. The approximate population of the Little Traverse Bay Watershed is 12,200 (2000 U.S. Census). See Figure 1 for the Watershed's political boundaries.

Walloon Lake

Walloon Lake is a large, picturesque inland lake located within the Little Traverse Bay Watershed and empties into Lake Michigan through the Bear River. The lake and its watershed are located in Bay, Evangeline, and Melrose townships of Charlevoix County; and Bear Creek and Resort Townships of Emmet County. It is considered an outstanding ecological, aesthetic, and recreational resource. Rolling glacial terrain surrounds its deep waters, including its four distinct depressions or basins. Three of these basins (the Foot, Main Basin, and West Arm) are deep (80', 81', and 100' respectively) and the fourth (the North Arm) is shallower (52').

Walloon Lake is primarily fed by ground water (53%) and only has a few small inlet creeks, Schoof's Creek and Fineout. The lake has a relatively small watershed (22,650 acres) compared to its lake surface area (4,270 acres). Walloon Lake is characterized as an oligotrophic lake, which includes low plant growth and algae, high water clarity, is generally cold and deep, and is well supplied with oxygen in most areas to support recreational pursuits, including its fine trout fishing. The lake supports healthy populations of walleye, small mouth bass, northern pike, rock bass, perch, and stocked rainbow and lake trout. Five percent of the Walloon Lake Watershed is classified as wetlands. Of particular importance are the North Arm wetlands where over 5,000 acres of land drains through the wetlands before reaching the waters of the North Arm.

Since the turn of the century, Walloon Lake has attracted development. Its irregular shoreline results in a high (3.0) shoreline development factor (i.e., the ratio of shoreline length (27.5 miles) to lake surface area). This means the lake is more susceptible to pollution from shoreline activity (development, erosion, fertilizer use, etc.) than a lake that is rounder. The lake, however, has managed to maintain its excellent water quality despite the pressures and impacts from increasing shoreline development. While several features, including the lake's depth, the presence of marl (a type of soil that contains calcium carbonate and clay), and its small watershed size enhance the lake's ability to buffer its waters from the detrimental effects of development, the lake is not unaffected. The irregular shoreline of Walloon Lake and its long retention period (4.1 years) make it particularly sensitive to nutrient additions from development.

Bear River

The Bear River, the largest tributary to Little Traverse Bay, originates from Walloon Lake and flows 12 miles in a northerly direction to its confluence with the Bay in Petoskey. Two streams, Hay Marsh Creek and Spring Brook, flow into the Bear River as it passes through farmland and a cedar swamp. The last mile of its length contains the steepest drop of any river in Michigan's Lower Peninsula. The Lake Street Dam divides two valuable fisheries. Upstream of the dam, the River supports a native brook trout fishery, and a salmon and steelhead fishery lies downstream.

The Bear River has played an important role in the Little Traverse Bay Watershed's history. The river once generated local wealth by providing fish and game, as well as transportation for people and logs, and power to grind grain and turn saws. Unfortunately, the Bear River was also used as a dumping ground for waste and polluted stormwater.

Threats to the Bear River continue to impact its water quality as well as that of the Little Traverse Bay Watershed. Shoreline erosion due to increased runoff from development presents the greatest challenge to the river. As a result, sedimentation and polluted runoff are deposited directly into the Bay. Although efforts are underway to "Heal the Bear," the Little Traverse Bay Watershed Protection Plan will bring far-reaching benefits to the river as well.

C. Water Quality Monitoring in the Watershed

Water Quality Parameters

Water can contain literally thousands of different dissolved substances of both natural and human origin. As a result, there is no single test that can characterize water quality or reveal the presence of pollutants. The Watershed Council monitors a number of basic water quality parameters throughout the watershed to characterize the water and detect problems. Parameters tested were water clarity (abundance of suspended microscopic algae (termed phytoplankton) and sediment), pH (the acidity or alkalinity of the water), chloride (from road runoff, sewage, and industrial wastewater), nutrients (such as nitrogen and phosphorus), conductivity (a measure of total dissolved substances), dissolved oxygen (necessary for all aquatic life), and temperature.

Water Clarity

The more algae or sediment in water, the less clear it is. Clarity is also described by terms like turbid, cloudy, or muddy. Generally, the clearer the water the fewer the nutrients and the better the water quality. Waters which are not clear may be less productive, because sunlight cannot penetrate deeply. Muddy waters also clog fish gills, smother spawning beds, inhibit the sight and feeding of many fishes, and can reduce angling success. The clarity of water is a simple and valuable way to assess water quality.

Water clarity is often highest in winter and early spring when cold temperatures inhibit algae growth. However, "algae blooms" also occur in most lakes at some time during spring. As a result, clarity varies greatly, from several feet in small inland lakes, to about 50 feet in large inland lakes and Great Lakes bays.

pH

The acidity or alkalinity of water is expressed by a measurement called pH. The pH scale ranges from 0-14. A pH of 7 is neutral, with levels below 7 indicating acidity, and levels above 7 indicating alkalinity. When pH is outside the range of 5.5 to 8.5, most aquatic organisms become stressed and populations of some species can become depressed or disappear entirely.

Chloride
Chloride is a component of salt. Due to the marine origin of bedrock in Northern Michigan, chloride is present in the ground water, usually in concentrations less than 12 mg/l. Surface waters seem to have a typical background level of 4 mg/l. Even slight increases in chloride concentration can have a subtle impact on aquatic ecosystems, but most fish and other large aquatic organisms are not directly affected until concentrations reach 1,000 mg/l.

Chlorides are common in many products associated with human activities. Increasing chloride levels or levels above expected natural background amounts can indicate impacts from human activities.

Nitrogen and Phosphorus
Elements required for the growth of plants are called nutrients. Nitrogen, phosphorus, and carbon are the three nutrients most important for aquatic plants.

Nitrogen and phosphorus occur in many chemical forms. Only the inorganic forms are generally useable by rooted aquatic plants and algae for their growth. The organic forms are those that are, or have recently been, incorporated into the bodies of living organisms. Because these nutrients can undergo complex reactions and change form quickly, testing the total amount of all forms is considered the most reliable way to evaluate a lake or stream's nutrient status.

Phosphorus is the most important nutrient for productivity in surface waters because it is usually in shortest supply relative to nitrogen and carbon. Phosphorus is normally found at concentrations less than 10 micrograms per liter (ug/l, the same as parts per billion) in high quality surface waters. Nitrogen is a very abundant element throughout the earth's surface. Rainwater, for example, contains about 500 ug/l. It is a major component of all plant and animal matter.

Unfortunately, nitrogen and phosphorus are released into the environment as a result of many human activities. For instance, septic tank effluent contains about 15,000 and 50,000 ug/l of phosphorus and nitrogen respectively. Nutrient pollution is the most serious threat to the water quality of Northern Michigan's lakes and streams. The presence of filamentous green algae (*Cladophora, Oedogonium*) that washed up on the beaches in northern Lake Michigan and Walloon Lake the last few years indicates that nutrient pollution in the Watershed continues to be a threat and needs to be monitored and addressed.

Conductivity
The ability of water to conduct electricity is termed conductivity. The level of conductivity is directly related to the concentration of dissolved substances in the water. Because our lakes and streams contain a lot of soluble minerals (called hardness) and high alkalinity (from carbonate ions), the conductivity is fairly high. Conductivity is an easy and accurate way to measure the level of dissolved substances, but cannot indicate what the substances are. If conductivity levels show a steady increase over a period of years, it is an indication that pollution is occurring.

Dissolved Oxygen
Dissolved oxygen (D.O.) is necessary for most aquatic life. Oxygen dissolves into water from atmospheric exchange (especially wave turbulence) and through the photosynthesis of aquatic plants and algae. However, there is a maximum limit to the amount of D.O. water can hold, called a saturation limit. Cold water can hold more D.O. than warm water. The closer the D.O is to saturation at a particular temperature, the better the water quality.

Oxygen content can also vary within a lake, depending on depth and season. In stratified lakes during summer, oxygen in water near the bottom often drops to low levels or disappears entirely in all but lakes of the highest quality. Fish and other organisms can recover from short exposure to low D.O., but prolonged exposure to levels less than 2 milligrams per liter (mg/l, the same as parts per million) can permanently harm or kill fish. Generally, warm water fish need at least 5 mg/l of D.O., and cold water fish need at least 7 mg/l for good growth and survival. Larval and juvenile fish are more sensitive, and need even higher D.O. levels than adult fish. Excessive nutrients and the respiration and decay of the plant life they stimulate, as well as some other types of pollution, can consume oxygen faster than it is produced, robbing the water of dissolved oxygen.

Comprehensive Water Quality Monitoring in Little Traverse Bay

The Lake Michigan Watershed is home to more than 10 million people. The widespread urbanization and industrialization resulting from this population has caused a great deal of water pollution over the years in some areas, mostly in the Lake's southern portion. Types of pollution include inputs of toxins (poisons from industry which cannot generally be seen or tasted but which contaminate fish and other aquatic life, and affect the drinking water), sediments (from urban runoff, construction sites, and agriculture), disease-causing organisms (pathogens), nutrients that cause enrichment and growth of weeds and algae (from urban runoff, fertilizers, and sewage), and biological pollution from the introduction of aquatic nuisance species (primarily in conjunction with ballast water from international shipping).

However, northern Lake Michigan and Little Traverse Bay still have relatively low levels of sediments and nutrients, clearer water, and are freer of toxins than many other areas of Lake Michigan. This is because of the largely rural forested character, porous sandy soils, and small immediate area of the Watershed. Its water is in the category of best quality (called oligotrophic). The results of the 2004 Comprehensive Water Quality Monitoring Program conducted by the Tip of the Mitt Watershed Council are summarized in the table that follows. Seven water quality parameters were measured as a means to characterize the Bay and detect any problem conditions or water quality trends for Little Traverse Bay. Based upon these results, the water quality of Little Traverse Bay is very good. Each measured parameter falls within the range for high water quality.

TABLE 1: Little Traverse Bay 2004 Comprehensive Water Quality Monitoring Results

Clarity (feet)	46
pH	8.2
Chloride (mg/L):	10.4
Total Nitrogen (mg/L):	0.32
Nitrate Nitrogen (mg/L):	0.24
Total Phosphorus (µg/L):	3.1
Conductivity (µhmo/Cm^2):	260

Comprehensive Water Quality Monitoring in Walloon Lake

The majority of pollutants entering Walloon Lake are nutrients, primarily phosphorus, and sediment from nonpoint sources, such as runoff from fields and roads, and leachate from failing septic systems. With over 840 dwellings along its shoreline, many aging septic systems are contributing wastewater seepage directly into the lake. In addition, many of the shoreline soils do not adequately remove nutrients from septic system effluent. The results of the 2004 Comprehensive Water Quality Monitoring Program conducted by the Tip of the Mitt Watershed Council are summarized in Table 2. Seven water quality parameters were measured as a means to characterize the lake and detect any problem conditions or water quality trends for each of Walloon Lake's basins.

TABLE 2: Walloon Lake 2004 Comprehensive Water Quality Monitoring Results

	Foot Basin	Main Basin	West Arm	North Arm
Clarity (feet)	27	17.5	27	17
pH	8.29	8.41	8.36	8.37
Chloride (mg/L):	9.4	8.9	8.1	11.0
Total Nitrogen (mg/L):	0.39	0.46	0.39	0.50
Nitrate Nitrogen (mg/L):	0.12	0.12	0.19	0.27
Total Phosphorus (µg/L):	4.3	5.1	2.8	6.8
Conductivity (µhmo/Cm^2):	271	268	270	298

The clarity of Walloon Lake varies within the basins, from 17 to 27 feet, but overall clarity is considered very good. The average pH for Walloon Lake is 8.35, which indicates moderately high alkalinity from the limestone-rich geology of the area, and provides a natural protection against acid precipitation. Chloride levels for the Walloon Lake basins ranged from 8.1 to 11.0 mg/L. Measurements for each of Walloon Lake's basins indicate normal nitrogen and phosphorous levels. The conductivity results for Walloon Lake fall within the average for all water bodies included in the Tip of the Mitt Watershed Council's Comprehensive Water Quality Monitoring Program. Although dissolved oxygen is not included with the results of the Tip of the Mitt Watershed Council's Comprehensive Water Quality Monitoring Program for Walloon Lake (Table 2), it is worth noting its significance to Walloon Lake. The dissolved oxygen content of Walloon Lake indicates well oxygenated water. In addition to the Watershed Council's springtime monitoring program, the Walloon Lake Association monitors dissolved oxygen throughout the summer months.

D. Interesting Features Around the Bay

Features formed by those ancient lakes are still visible on the landscape today. Flat, level, sandy terraces deposited in the nearshore waters of Lakes Algonquin and Nipissing are visible across the water as parallel treelines on the Bay's north shore east of Harbor Springs. The Harbor Springs airport and M-119 on the north side of the Bay and the Petoskey business district are built on the Algonquin Terrace. The sand dunes at Petoskey State Park were created by the rising waters of Lake Nipissing and wind action. The high hills north of the Bay where the ski hills are located are glacial moraines which were an island (named Brutus Island) during Algonquin times.

The fossil-rich limestone bedrock from which Little Traverse Bay was carved is close to the surface on the south shore, and is visible in Petoskey's Bayfront Park and at Bay Harbor. The proximity of this limestone to the surface resulted in a cement industry developing in the area. The constant movement of sand from west to east along the north shore of the Bay by wave action and wind-generated currents has created a recurve sand spit known as Harbor Point. The Point continues to grow very slowly, and theoretically, in tens of thousands of years may grow completely across the harbor and form an inland lake.

E. Fish of Little Traverse Bay

Originally, the deep, cold, well-oxygenated waters of Lake Michigan were inhabited by lake trout, whitefish, chubs, cisco, burbot, and deep water sculpins. Smallmouth bass, yellow perch, lake sturgeon, as well as suckers, minnows, and other "nongame" fish species inhabited shallow waters, which get relatively warm during summer. This fish community existed in stability and abundance for thousands of years. Early records document the nearly unbelievable abundance and size of some of these species. Due to pollution, over fishing, habitat destruction, and competition and predation from aquatic nuisance species, the food chain and fish community have been greatly disrupted (U.S. EPA and Environment Canada, 1997). There are over 160 aquatic nuisance species, and the count rises higher every year. Some original species, like bass, perch, and whitefish, are still relatively abundant. However, many are severely diminished such as lake sturgeon, lake trout cannot sustain themselves through natural reproduction, and four species of chubs are extinct. Through artificial stocking of trout and salmon, good sport fishing opportunities exist in some areas (including Little Traverse Bay and the mouth of the Bear River), but overall the fish populations of Lake Michigan are very unstable and are but a shadow of what they once were.

F. Waves, Seiches, and Ice

Lake Michigan is a dynamic system. Winds blowing across a hundred or more miles of water can create large ocean-like waves, especially during fall or winter storms. Waves 20 or more feet in height on the open waters of the Lake have been recorded. These waves can create strong long-shore currents, stir up near shore bottom sediments, erode shorelines, and sink freighters! The Petoskey waterfront is a good place to watch huge storm waves overrun the break wall and light beacon.

Strong winds or sudden changes in barometric pressure over different sections of the Lake can cause the surface of the Lake to literally tilt, piling up water against one shore and causing a corresponding drop on the opposite shore. This storm-induced tilting can be up to three feet high on Lake Michigan. When the storm abates, the tilt oscillates back and forth across the Lake for a long time before it is dampened by friction. This back and forth oscillation, kind of like water sloshing in a bathtub, is called a seiche. The time for a seiche to complete one back and forth oscillation can be from 30 minutes to several hours. Usually there is some kind of seiche action happening on the Lake, although it is usually only about several inches in amplitude. Sometimes, people confuse seiche action with tides. Although lunar forces act on Lake Michigan's waters the same as they do on the oceans, because of its relatively small size, tides are almost imperceptible--only a fraction of an inch.

Little Traverse Bay usually freezes during winter, although it did not in several recent winters during the past decade, which may be a possible indicator of changes in the global climate. Typical "ice-up" is late January, although it has frozen as early as late December and as late as mid-March. Due to the Lake's dynamic nature, ice formation is highly variable, from smooth, black ice suitable for ice boating; to jagged, jumbled chunks of storm-driven floes frozen together

in a six-foot thick mass. Often times, spray from waves breaking on the shore creates interesting ice mountains, caves, and "volcanoes," especially on the Bay's northwest end, some up to 25-feet high.

2. Designated Uses and Water Quality Summary

The Michigan Environmental Protection Act (P.A. 451 of 1994, Part 31, Chapter 1) requires all waters of the State of Michigan to be of the quality to meet seven designated uses: 1) agriculture; 2) navigation; 3) industrial water supply; 4) public water supply; 5) warm water fishery; 6) habitat for indigenous aquatic life and wildlife; and 7) partial or total body contact recreation. An eighth designated use, cold water fishery, is applicable for many rivers and lakes in Michigan.

For the water resources in the Little Traverse Bay Watershed, the Watershed Council assessed whether the designated uses were supported, threatened, degraded or impaired. When a use is supported the water quality is good to excellent for that purpose. When a use is threatened the water quality may not be adequate to provide for that use during certain times of the year or in certain locations. For example, bacteria counts may be above levels for safe swimming at some locations in the Bay after a rain storm. When a use is degraded the water quality is known to not support the use during certain times of the year or in certain locations. For example, navigation is not possible in some locations of the Bear River due to excessive sedimentation. When a use is impaired, the water quality is known to not support the use for the majority of a year or habitat has been harmed to a degree that has negatively impacted aquatic populations and/or diversity. For example, at Bay Harbor near shore habitat for fisheries and other indigenous aquatic life and wildlife is negatively impacted due to contaminated leachate causing high pH levels and depositing persistent toxins.

In general the water quality of Little Traverse Bay and its tributaries is good. Degraded uses in the Watershed are the warm water fishery in Walloon Lake and total body contact recreational use primarily in Little Traverse Bay, Walloon Lake, and Bear River. The warm water fishery is degraded by increasing inputs of toxic substances, sediment, and nutrients, as well as aquatic nuisance species. Direct discharges of urban runoff containing high levels of bacteria near swimming beaches and recreation spots threaten the safety of swimming.

Little Traverse Bay's cold water fishery and habitat for aquatic life are also degraded. The exact reasons for the decline in fisheries and other aquatic life is not known but is likely due to a number of human activities. Potential impacts contributing to the impairment include toxic pollution, loss of spawning habitat, loss of shoreline wetlands, and ecosystem disruptions from aquatic nuisance species. Walloon Lake's cold water fishery is also degraded due to inadequate oxygen supplies in the deep waters during late summer and potential loss of spawning habitat.

Navigation in the Bear River is degraded by sedimentation. Navigation in Mud Lake (a small basin adjacent to the West Arm of Walloon Lake) is degraded by nutrient pollution which has generated excessive aquatic plant growth.

A. Watershed Concerns

In 2002, the first meeting of the Little Traverse Bay Watershed Protection Project Advisory Committee was held to discuss concerns about water quality. The group included state and local government officials, conservation groups, environmental organizations, regional planning

agencies, health departments, and other stakeholders within the Little Traverse Bay Watershed. The group identified many different issues and committed to working together in a partnership on developing this watershed management plan. The group also discussed activities threatening or degrading the designated uses. The table below summarizes the identified concerns and threats to designated uses. The uses not threatened or degraded were not addressed (agricultural use, public water supply, and industrial use).

TABLE 3: Little Traverse Bay Watershed Concerns and Threats to Designated Uses

N=Navigation, O=Other indigenous aquatic life and wildlife R=Recreation (total and partial body contact), C=Cold water fishery, W=Warm water fishery	N	O	R	C	W
Stormwater discharges to lakes and rivers and increasing urbanization		♦	♦	♦	
Agricultural pollution from fertilizers, animal waste, livestock access		♦	♦	♦	
Golf courses/fertilizers and pesticides		♦	♦	♦	
Recreational use (ORV use in tributaries and on the shoreline)	♦	♦		♦	
Road/stream crossings	♦	♦		♦	
Local land use decision making and lack of zoning enforcement	♦	♦	♦	♦	
New construction/subdivision development without adequate regulations and oversight	♦	♦		♦	
Parcel splits/fragmentation	♦	♦		♦	
Wetland destruction/loss		♦		♦	♦
Forest management planning and logging activities	♦	♦		♦	
Need for land protection of sensitive areas		♦			
Chlorides/brine on roads		♦		♦	♦
Streambank erosion	♦	♦		♦	
Erosion in steep areas around lakeshore	♦	♦		♦	♦
Lawn care/fertilization and pesticide use		♦	♦	♦	♦
Increasing algae blooms/nuisance aquatic plants		♦		♦	♦
Pollution from septic systems		♦		♦	♦
Destruction of greenbelts and shoreline vegetation		♦		♦	♦
(continued)					
Loss of wildlife/aquatic habitat		♦		♦	♦
Warm water discharge		♦	♦	♦	♦
Water withdrawal		♦		♦	
Nuclear storage		♦			♦

TABLE 3: Little Traverse Bay Watershed Concerns and Threats to Designated Uses N=Navigation, O=Other indigenous aquatic life and wildlife R=Recreation (total and partial body contact), C=Cold water fishery, W=Warm water fishery	N	O	R	C	W
Waterfowl impacts/nutrients, swimmer's itch		♦	♦		
Mercury contamination		♦		♦	♦
pH problems, acid rain		♦		♦	♦
Dams (hydrologic impacts, fish movement, and potential failure)			♦	♦	
Boats/wave runners		♦	♦		♦
Industrial discharges		♦	♦	♦	
Loss of threatened and endangered species		♦			
Beaver activity (water temperature increase and sediment loading)	♦	♦	♦	♦	
Historic nutrients in sediments		♦		♦	
Aquatic nuisance species (e.g., zebra mussels, Eurasian water milfoil)		♦		♦	♦
Overharvesting fish		♦		♦	
Underground storage tanks/ground water contamination		♦	♦	♦	♦
Improper dumping including household hazardous waste		♦			
Long-term air quality		♦		♦	♦
Mining/gravel pits		♦			

B. Known and Suspected Pollutants in the Little Traverse Bay Watershed

The health of the warm and cold water fisheries, habitat for aquatic life, recreation, and to some extent navigation are the primary uses that are being degraded, impaired or threatened by pollution in the Little Traverse Bay Watershed. The key pollutants or impacts of concern are sediment, nutrients, toxics, hydrology, habitat loss, aquatic nuisance species, and bacteria. The table below provides a list of the known and suspected pollutants.

TABLE 4: Little Traverse Bay Watershed Known and Suspected Pollutants		
Designated Use	**Threatened (T) Degraded (D) or Impaired (I)**	**Pollutant Impacts Known (k) or suspected (s)**
Navigation	D	Sediment (k)
	D	Nutrients (k)

TABLE 4: Little Traverse Bay Watershed Known and Suspected Pollutants		
Cold water fishery	D	Sediment (k)
	T	Nutrients (k)
	T	Hydrology (s)
	D	Toxics (k)
	D	Aquatic nuisance species (k)
	D	Thermal (k)
	D	Habitat loss (k)
Other indigenous aquatic life and wildlife	D	Sediment (k)
	T	Nutrients (k)
	D	Hydrology (s)
	I*	Toxics (k)
	D	Habitat loss (s)
	D	Aquatic nuisance species (k)
	T	Pesticides (s)
Warm water fishery	I*	Toxics (k)
	T	Pesticides (s)
	T	Nutrients (s)
	D	Aquatic nuisance species (k)
	D	Habitat loss (s)
Recreation (partial and total body contact)	T	Bacteria (k)
	I*	Toxics (k)

* Designated use is partially impaired at Bay Harbor due to contamination from toxic cement kiln dust leachate (US EPA, 2005).

C. Sources of Pollutants in the Little Traverse Bay Watershed

There are numerous sources of pollutants to the water resources in the Little Traverse Bay Watershed. Land uses range from the urban environment of the Cities of Petoskey and Harbor Springs to the forested wetlands along stretches of the Bear River. Diverse land use equals a diverse amount of activities and many potential sources of nonpoint source pollution. The main activities, or sources, contributing nonpoint source pollution for each primary pollutant of concern in the Little Traverse Bay Watershed are described below.

TABLE 5: Little Traverse Bay Watershed Pollutant Sources	
Pollutant	***Sources*** **k = known s = suspected**
Sediment (k)	Road/stream crossings (k) Lakeshore/streambank erosion (k) Lakeshore development/construction (k) Urban runoff (k) Livestock access to streams (s) Forestry practices (s) Construction in priority areas (s)
Nutrients (k)	Failing septic systems (s) Residential lawns (s) Urban runoff (k) Livestock access to streams (s) Golf courses (s)
Changes in hydrology (k)	Urban runoff (k) Dams (k) Decreased ground water recharge (s) Water withdrawals (k)
Toxics (s)	Air deposition (k) Urban runoff (k) Improper disposal of household hazardous waste (s)
Pesticides (s)	Agricultural fields (s) Residential lawns (s) Golf courses (s)
Bacteria (k)	Livestock waste (s) Pet waste (s) Wildlife (s) Urban runoff (k)
Thermal (s)	Removal of shoreline vegetation (k) Industrial discharge (k)
Aquatic Nuisance Species (k)	Boat trailers (k) Wildlife (s) Ballast water (k)
Habitat Loss (k)	Streambank and lakeshore development (k) Wetland destruction (k) Fragmentation of forest lands (k)

D. Pollutant Sources and Causes for the Little Traverse Bay Watershed

Understanding the potential causes of the pollution is essential in developing goals and action

strategies. For the Little Traverse Bay Watershed, the following causes connected to each pollutant source were identified.

TABLE 6: Little Traverse Bay Watershed Pollutant Sources and Causes	
Source	**Cause** (known = k; suspected = s)
Road/stream crossing (k)	Undersized culverts (k); improperly placed culverts (k); lack of runoff diversions (k); inadequate fill on road surface (k); lack of vegetation (k); blockage of fish movement (k)
Streambank erosion (k)	Recreation access (k); changes in hydrology (s); vegetation removal (k)
Lakeshore erosion (k)	Vegetation removal (k); boat waves (k); changes in runoff due to shoreline development (k)
Urban runoff (k)	Impervious surfaces(k); inadequate treatment of stormwater (k)
Livestock waste and access to streams (s)	Unrestricted access (s); no alternative water source (s)
Forestry (s)	Inadequate buffer strips near streams (s); temporary road construction (s)
Failing septic systems (s)	Outdated or improperly maintained systems (s)
Decreased ground water recharge (s)	Increased development and impervious surfaces in recharge areas (s)
Air deposition (k)	Burning of waste (k); industrial air discharge (s)
Agricultural fields (s)	Overapplication of fertilizers, manure, and pesticides (s)
Residential lawns (s)	Overapplication of fertilizers and pesticides (s)
Golf courses (s)	Overapplication of fertilizers and pesticides (s)
Pet and wildlife waste (s)	Inadequate disposal of pet waste (s); runoff of wildlife waste (s)
Construction in priority areas (s)	Inadequate treatment of stormwater (s); lack of erosion control (s); shoreline development (k)
Removal of shoreline vegetation (k)	Development along the shorelines (k)
Boat trailers (k)	Transferring a boat from one body of water to another without washing (k)
Ballast water (k)	Discharge of ballast water introduces aquatic nuisance species (k)
Industrial discharge (k)	Warm water (thermal) discharges (k); malfunctions with waste water treatment plants (k); toxic pollution from former cement industry (k)
Shoreline development (k)	Earth moving for construction (k); increased impervious surfaces (k); hardened shorelines (k)
Household hazardous wastes (s)	Improper disposal of household hazardous wastes (s)
Wetland destruction (k)	Shoreline development (k)

TABLE 6: Little Traverse Bay Watershed Pollutant Sources and Causes	
Source	**Cause** (known = k; suspected = s)
Access sites (boat launches, road ends) (s)	Lack of runoff diversions (s); lack of erosion control (s)
Varied zoning (k)	Lack of consistent standards and provisions to require shoreline protection strips (k)
Dams (k)	Restrict natural flow (k)
Beaver dams (s)	Unnatural warming of water in dammed area (s)

E. Watershed Goals

The overarching goal of the Little Traverse Bay Watershed Protection Plan is to protect and enhance the water quality and ecosystem integrity of Little Traverse Bay and its tributaries in a way that ensures all designated uses and attributes are restored, enhanced, and protected. This includes considerations for Little Traverse Bay, Walloon Lake, Bear River, and Schoof's, Fineout, Tannery, Hay Marsh, Spring Brook, and Five-mile Creeks. The Advisory Committee developed a list of attributes that describe a healthy Little Traverse Bay Watershed, which includes:

- Adequate public access to lakes and streams
- Educated public regarding benefits of clean water to economy & quality of life
- Healthy wildlife populations and corridors
- Ample public lands for recreation
- Awareness of ecologically-sound recreation to prevent streambank erosion, habitat loss, etc.
- Preserve "Up North" character
- Expanded network of protected private lands
- Ecologically wise industry
- Celebrated human history of region
- Dark skies
- Thriving populations of fish that are healthy for consumption
- Sustainable alternative modes of transportation
- Increased involvement in alternative energy
- Managed residential growth
- Maintained scenic views
- Well-coordinated collaborative efforts by local government
- Safe ground water for drinking water
- Preserved agricultural lands
- Protection of steep slopes along Lake Michigan
- Promote tourism that protects and enhances "Up North" atmosphere
- Protected native flora and fauna and the ecosystems upon which they depend

The Watershed Goals to Address Designated Uses, which appear in the table that follows, were developed with these attributes in mind. The goals focus on how best to maintain the uses that are supported, and improve those uses that are threatened or degraded.

TABLE 7: Little Traverse Bay Watershed Goals to Address Designated Uses

Designated Use	***Status***	***Watershed Goal***
Agriculture	Supported	Manage nonpoint source pollution to ensure that the status of this use does not decline.
Industrial water supply	Supported	Manage nonpoint source pollution to ensure that the status of this use does not decline.
Public water supply at intake point	Supported	Manage nonpoint source pollution to ensure that the status of this use does not decline.

TABLE 7: Little Traverse Bay Watershed Goals to Address Designated Uses (continued)

Designated Use	*Status*	*Watershed Goal*
Navigation	Degraded	Improve and maintain navigation in the Bear River and other tributaries by reducing sediment inputs; maintain navigation in Mud Lake by reducing nutrient inputs to avoid excessive weed growth.
Warm water fishery	Degraded	Improve warm water fishery by reducing inputs of toxic substances, sediments, and nutrients; controlling aquatic nuisance species; protecting and restoring wetlands.*
Cold water fishery	Degraded	Improve cold water fishery by reducing inputs of toxic substances, sediments, and nutrients; restoring ground water recharge; protecting and restoring wetlands; controlling aquatic nuisance species; restoring vegetation along rivers and streams to provide shade and wildlife cover.*
Other indigenous aquatic life and wildlife	Degraded	Improve habitat for other indigenous aquatic life and wildlife by reducing inputs of toxic substances, sediments, and nutrients; restoring ground water recharge; protecting and restoring wetlands; controlling aquatic nuisance species; restoring vegetation along rivers and streams to provide shade and wildlife cover.**
Recreation (Partial body contact, e.g., boating and fishing; total body contact between 5/1 and 10/31, e.g., swimming)	Degraded	Improve quality of water discharged from urban runoff (stormwater sewers); discourage waterfowl in swimming areas; address possible failing septic systems; research and implement control of swimmer's itch; clean-up contaminated near-shore areas at Bay Harbor.**

* Designated use is partially impaired due to toxins present from atmospheric deposition.
** Designated use is partially impaired at Bay Harbor due to contamination from toxic cement kiln dust leachate (US EPA, 2005).

F. Water Quality Summary

The Little Traverse Bay Watershed has five designated uses that are degraded: 1) navigation; 2) warm water fishery; 3) cold water fishery; 4) habitat for other indigenous aquatic life and wildlife and 5) recreation (partial and total body contact).

Navigation

Navigation is degraded in the Bear River from sediment. Streambank and lakeshore erosion, road/stream crossings, and urban runoff are known sources of sediment pollution. Suspected sources of sediment include livestock access to streams and forestry activities.

Lakeshore and streambank erosion is often a result of the removal of shoreline vegetation. Angler and canoeing access points are another source of erosion on the Bear River. Improperly sized culverts and lack of runoff diversions are the main reason for erosion and sedimentation associated with road/stream crossings.

In some of the small tributaries to the Bear River, livestock access to streams for a watering source can destroy the bank and cause erosion and sedimentation. New construction in the shoreline area can also contribute sediment, particularly if inadequate erosion controls are used. Not maintaining buffer strips during logging is also suspected of contributing to erosion and sedimentation.

Navigation in Mud Lake is degraded by excessive weed growth caused by nutrient inputs.

Warm Water Fishery

The warm water fisheries in the Little Traverse Bay Watershed occur in the shallow areas of Little Traverse Bay and Walloon Lake. Angler reports in Little Traverse Bay have shown a decline in the populations of smallmouth bass, rock bass, and perch. This is likely due to food chain impacts from the introduction and colonization of zebra mussels in the shallow waters of the Bay (US EPA and Environment Canada, 1997). In Walloon Lake, the fishery is degraded by shoreline development and hardening (large rock riprap and seawalls) that cause direct loss of habitat and can increase sediment, nutrient, and toxic pollutant loadings. In addition, pollutants from stormwater impact the health of fisheries in both waters. Throughout the Watershed, the warm water fishery is impaired primarily due to the occurrence of mercury, and consumption advisories for fish exist. The primary source of mercury is atmospheric fallout.

Cold Water Fishery

Like Lake Michigan, Little Traverse Bay and most of the rivers and streams within the Little Traverse Bay Watershed support cold water fisheries. Many factors, however, have compromised this regional resource and as a result the cold water fisheries of the Little Traverse Bay Watershed are degraded. Although it is difficult to determine the exact causes behind the fisheries' decline, sedimentation, nutrient loading, changes in hydrology, and toxic pollution (oils, grease, heavy metals, and pesticides) are all harmful to cold water fisheries and are all present in the Little Traverse Bay Watershed. Potential impacts contributing to the degradation include toxic pollution, destruction of spawning habitat, loss of shoreline habitat, and ecosystem disruption from aquatic nuisance species.

In Walloon Lake, nutrients are potentially the most harmful. A known source of nutrients is urban stormwater runoff caused by increased impervious surfaces and inadequate treatment of stormwater. Other known or suspected sources of nutrients are septic systems that are outdated or improperly maintained, overapplication of lawn fertilizers and pesticides, and unrestricted access of livestock. Excessive aquatic plant growth as a result of nutrient pollution can decrease the oxygen available in the bottom of the lake (hypolimnion) during the summer months.

The cold water fishery in the Bay is impacted by the overall health of Lake Michigan. In the Bear River and other tributaries (Tannery and Five Mile Creeks), sediment may be the most harmful pollutant to the cold water fishery. Sediment impacts fish by covering spawning areas, making feeding difficult, and clogging gills.

The cold water fishery is also impacted by changes to the hydrology. Decreased ground water recharge results from increased development and impervious surfaces in the recharge area.

Other Indigenous Aquatic Life and Wildlife

Habitat for indigenous aquatic life and wildlife is degraded throughout the Watershed from sediment, nutrients, habitat loss, and aquatic nuisance species and is suspected to be impacted

by hydrology and toxics. Nutrients harm wildlife by encouraging excessive aquatic plant growth that can deplete oxygen supplies when it decomposes. Toxic chemicals harm aquatic life by weakening immune systems and making organisms more susceptible to disease. They can also harm reproduction, and if concentrations of the toxic materials are high enough, they can kill aquatic life.

Sources of sediment pollution are the same as mentioned above under threats to navigation. Known sources of nutrient pollution include lakeshore and streambank erosion, road/stream crossings, and lawn care on residential properties. Suspected sources of nutrient pollution include failing septic systems, livestock in streams, stormwater discharges in urban areas, manure application and management, golf courses, and new construction. Oils, grease, and heavy metals are known to be contributed from stormwater discharges in urban areas and road/stream crossings. Pesticides may be contributed from agricultural fields and lawns.

The contaminated cement kiln dust leachate seeping into near shore areas at Bay Harbor is an impairment to aquatic organisms and water quality in this part of the Bay (US EPA, 2005). High pH levels and toxins, such as mercury and arsenic, in contaminated areas are harmful to aquatic organisms. While dilution nullifies the pH effect in the short-term, the long-term effects of persistent toxins may contribute to mortality or habitat degradation for these organisms.

Recreation (Partial and Total Body Contact)

Although not a huge problem sources that contribute bacteria to the Bay can make it unsafe for swimming. Suspected sources of bacteria include stormwater discharges in urban areas, manure application and storage, and livestock access to streams. Stormwater discharge in urban areas can collect and deposit pet and wildlife waste into the Little Traverse Bay. Excessive application of manure, runoff from manure piles, or livestock access to streams can all be causes of bacterial pollution from agricultural sites. In addition, nutrient pollution can stimulate nuisance levels of aquatic plant and algae growth that disrupt recreational activities and make swimming and boating undesirable or difficult.

Recreation is also impaired in the near shore leachate contaminated areas of the Bay at Bay Harbor. High pH levels can make boating undesirable. High pH levels coupled with the presence of persistent toxins also makes swimming harmful to humans in the short and long-term.

3. Defining the Priority Area

The priority area is that portion of the watershed which is most sensitive to environmental impacts and which has the greatest likelihood to affect water quality and aquatic habitat. The geoprocessing tools in the ESRI software package, ArcView 3.2, were used to delineate priority areas. Supplemental information was used to identify sensitive areas, including USDA Soil Surveys, USGS Topographic Maps, Groundwater Education in Michigan (GEM) ground water studies, and the Tip of the Mitt Watershed Council survey of shoreline wetlands.

The priority area for the Little Traverse Bay Watershed includes the following areas:

1. Areas within 1,000 feet of the following features:
    A. Little Traverse Bay,
    B. Walloon Lake,
    C. Tributary rivers and streams (including intermittent drainages),

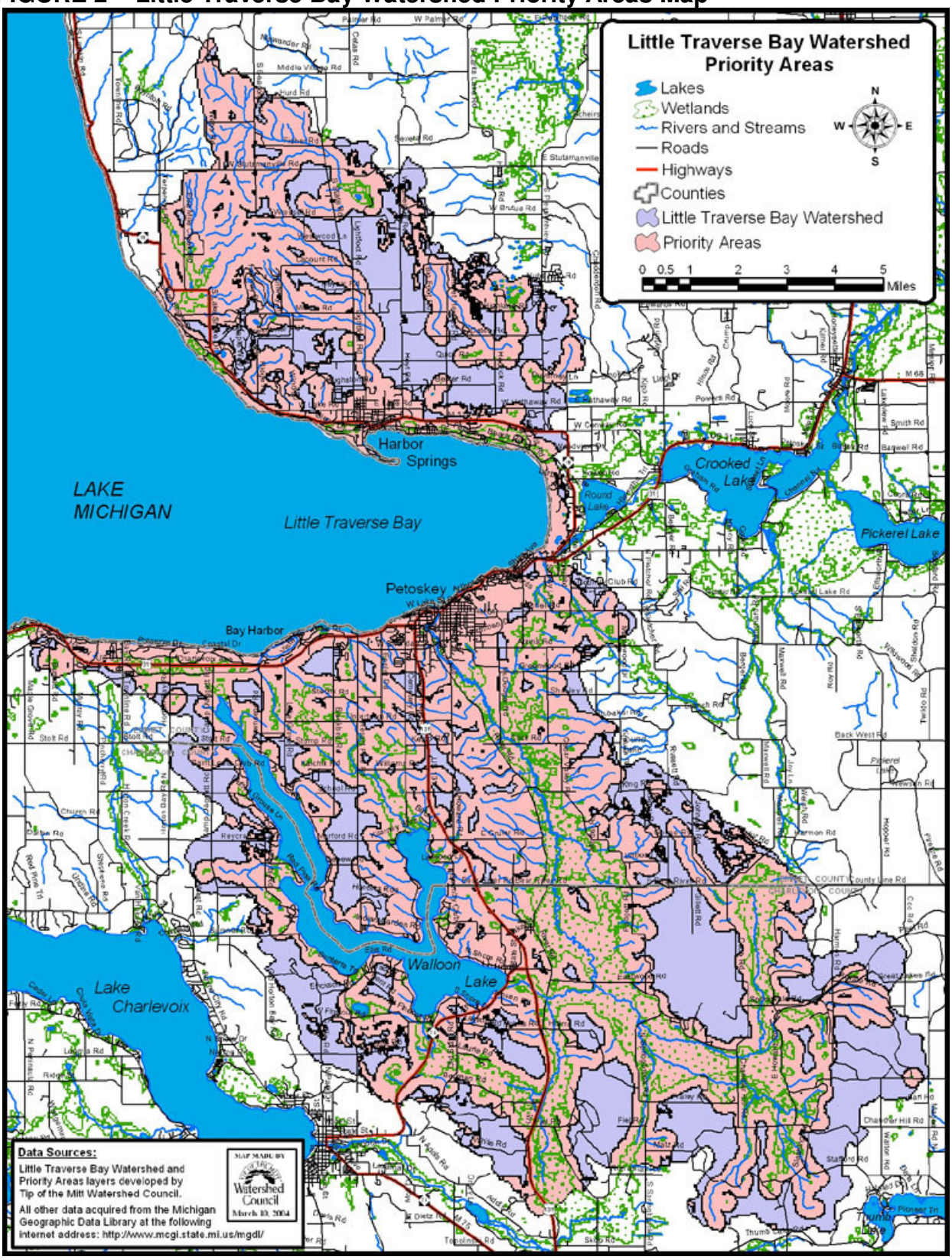
D. Wetlands in the watershed, and
E. Urban areas that drain to surface waters via storm sewers.

2. Areas of steep slopes (25% and greater slope)

3. High value wetlands and ground water recharge areas.

Nonpoint source pollution inventories conducted in the Little Traverse Bay watershed focused on the priority area (Figure 2).

FIGURE 2 – Little Traverse Bay Watershed Priority Areas Map



chapter
TWO

Review of Nonpoint Source Pollution Inventories

Numerous inventories were conducted to assess and document the current level of nonpoint valuable information for determining causes and potential sources of pollution. The following section includes summaries and results for all inventories conducted in the Watershed.

1. Stormwater Inventory

Stormwater is excess water that accumulates on the surface after the ground has become saturated from precipitation (rain, snow, or snowmelt) and begins to flow overland. Stormwater runoff occurs naturally, but increases as a result of landscape development and urbanization. As forests, grasslands, wetlands, and pastures are replaced by constructed (impervious) surfaces such as streets, roofs, sidewalks, and parking lots, the amount of stormwater runoff generated by a storm event increases dramatically. The negative effects of stormwater runoff on aquatic ecosystems have been well documented (Metropolitan Washington Council of Governments, 1987). Increased stormwater runoff alters the natural flow regime of streams, scouring stream banks and stream beds, increasing sedimentation, and reducing water quality and aquatic habitat for fish, aquatic insects and other aquatic organisms. In addition, stormwater carries many harmful substances found in urban areas, such as bacteria from pet and animal wastes, fertilizers, oil, grease, deicing road salts, sediments, heavy metals and pesticides, which wash into receiving water bodies.

The Little Traverse Bay Watershed contains four urban areas where stormwater runoff potentially degrades the water quality and aquatic habitat of receiving water bodies. The City of Petoskey, Harbor Springs, and Bay Harbor are located on the Little Traverse Bay shoreline and Walloon Lake Village lies adjacent to Walloon Lake and the Bear River. All of these urban areas possess paved streets with curbs, gutters, and subsurface drainage pipes called storm sewers. These storm sewers prevent flooding and water damage within the urban areas, but also have negative impacts on local surface water resources such as Little Traverse Bay, Walloon Lake, the Bear River and other streams (e.g., Tannery Creek).

As part of the Little Traverse Bay Watershed Protection Plan, Watershed Council staff conducted inventories in 2002 and 2003 of storm sewer systems in each of the four urban areas in the Watershed. The inventories consisted of identifying land uses (e.g., commercial, residential, natural) within the city/village boundaries, reviewing maps of storm sewers provided by each city, delineating different drainage catchment areas, and identifying locations of stormwater inlets and outlets. No water sampling or testing was conducted. However, results from a previous study by the Watershed Council documenting pollution and water quality impacts of storm sewer effluent in Harbor Springs were similar to those of the predictive model (Tip of the Mitt Watershed Council, 1989). Inventory data were inputted into an empirical model to predict pollutant loadings in each urban area for four major pollutants: sediment, phosphorus, copper, and zinc (Appendix A).

The survey found that 3,213 acres of land is serviced by stormwater systems, with a total of 70 stormwater outfalls. Together (based on a standardized method of estimating pollutant loadings), each year these outfalls discharge a total of 1,967 pounds of phosphorus, 412,203 pounds of sediment, 976 pounds of zinc, and 84 pounds of copper (Table 8). In more graphic terms, this equals 393 50-pound bags of 10-10-10 fertilizer (which could stimulate the growth of

nearly 1 million pounds of algae) and 17 dump truck loads of soil.

TABLE 8: Little Traverse Bay Watershed Storm Sewer Survey Summary				
	Bay Harbor	**Harbor Springs**	**Petoskey**	**Walloon Lake Village**
Area of Direct Stormwater Drainage (acres)	308	348	2,230	327
Land Use (% of acreage)				
Undeveloped/natural	25	19	39	67
Commercial/industrial	28	17	22	2
Residential	47	64	38	31
Overall Impervious Cover (%)	32.5	33.7	30.7	14.2
Number of Storm Sewer Outfalls	22	18	25	5
Estimated Annual Pollutant Export (lbs/year)				
Phosphorus	179	451	1,234	101
Sediment	37,554	94,694	258,771	21,184
Zinc	89	224	613	50
Copper	8	19	53	4
Comparative Pollutant Export				
10-10-10 Fertilizer (50 lb bags)	36	90	247	20
Aquatic plant growth (lbs)	89,600	225,900	617,250	50,550
Soil (dump truck loads)	1.6	3.9	10.8	0.9

The results indicate that the amount of pollutants in each urban area is probably a function of stormwater drainage area and predominant landuse. Estimates clearly show that annual pollutant exports are greater in Petoskey than other urban areas, but this is expected as the City of Petoskey has a much larger stormwater drainage area. Although stormwater drainage areas for Harbor Springs and Walloon Lake Village are roughly equivalent, pollutant loadings for Walloon Lake Village are substantially lower. The low level of pollutant export in Walloon Lake Village (even lower than Bay Harbor, which has a smaller drainage area) is attributed to the high percentage (67%) of natural/open area landuse in the stormwater basin. Overall, estimates reveal a large amount of pollution flowing into Little Traverse Bay and tributary waters in the watershed via stormwater systems in Bay Harbor, Harbor Springs, Petoskey, and Walloon Lake Village.

The Watershed Council coordinated meetings with appropriate government officials from all four urban areas to present findings, obtain feedback, and offer recommendations for mediating stormwater impacts (Appendix B). Comments provided by local governments will be used to modify stormwater system maps (Figures 3, 4, 5 and 6) and make necessary adjustments in pollutant loading calculations.

FIGURE 3 – City of Petoskey Stormwater Basin

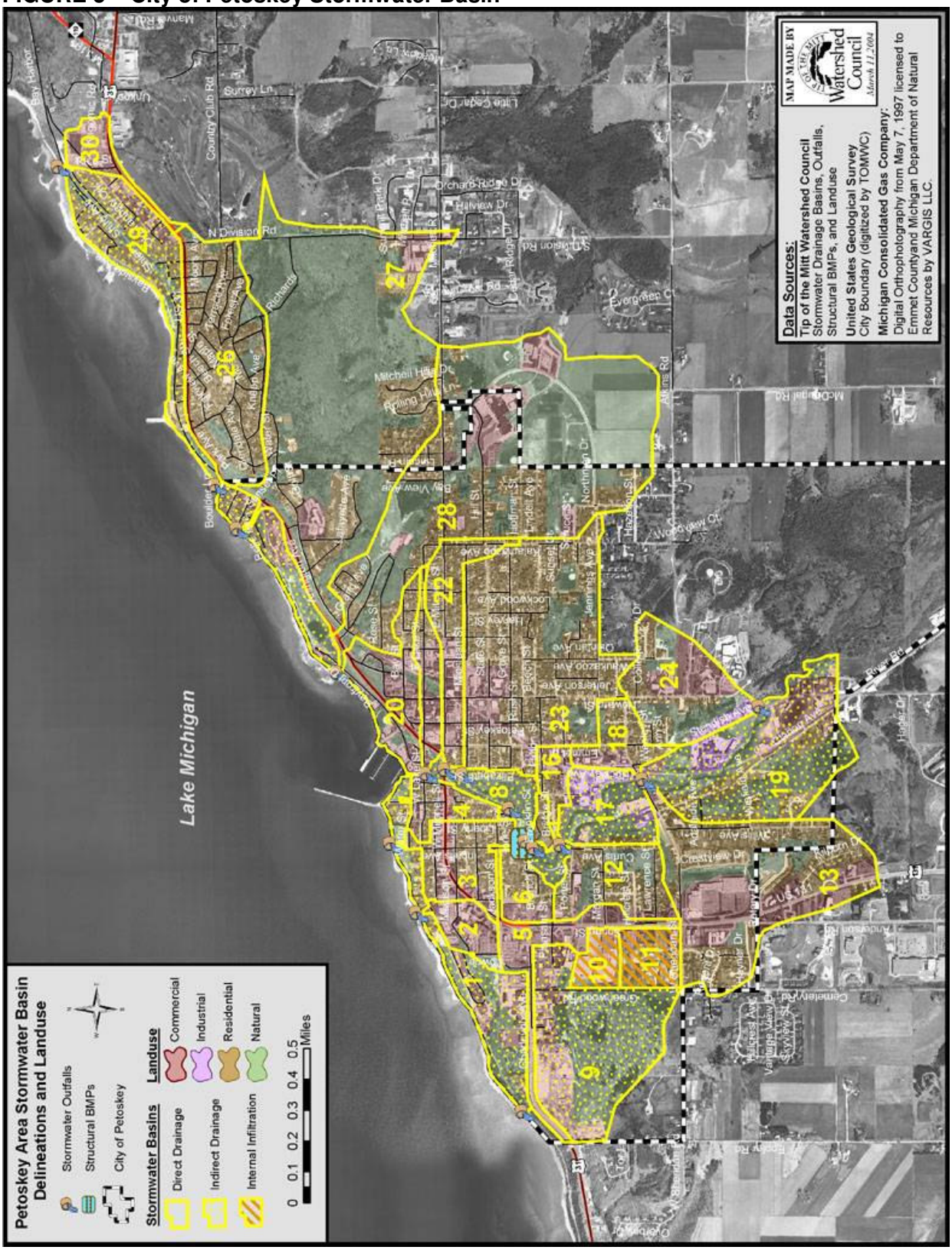


FIGURE 4 – Harbor Springs Stormwater Basin Map

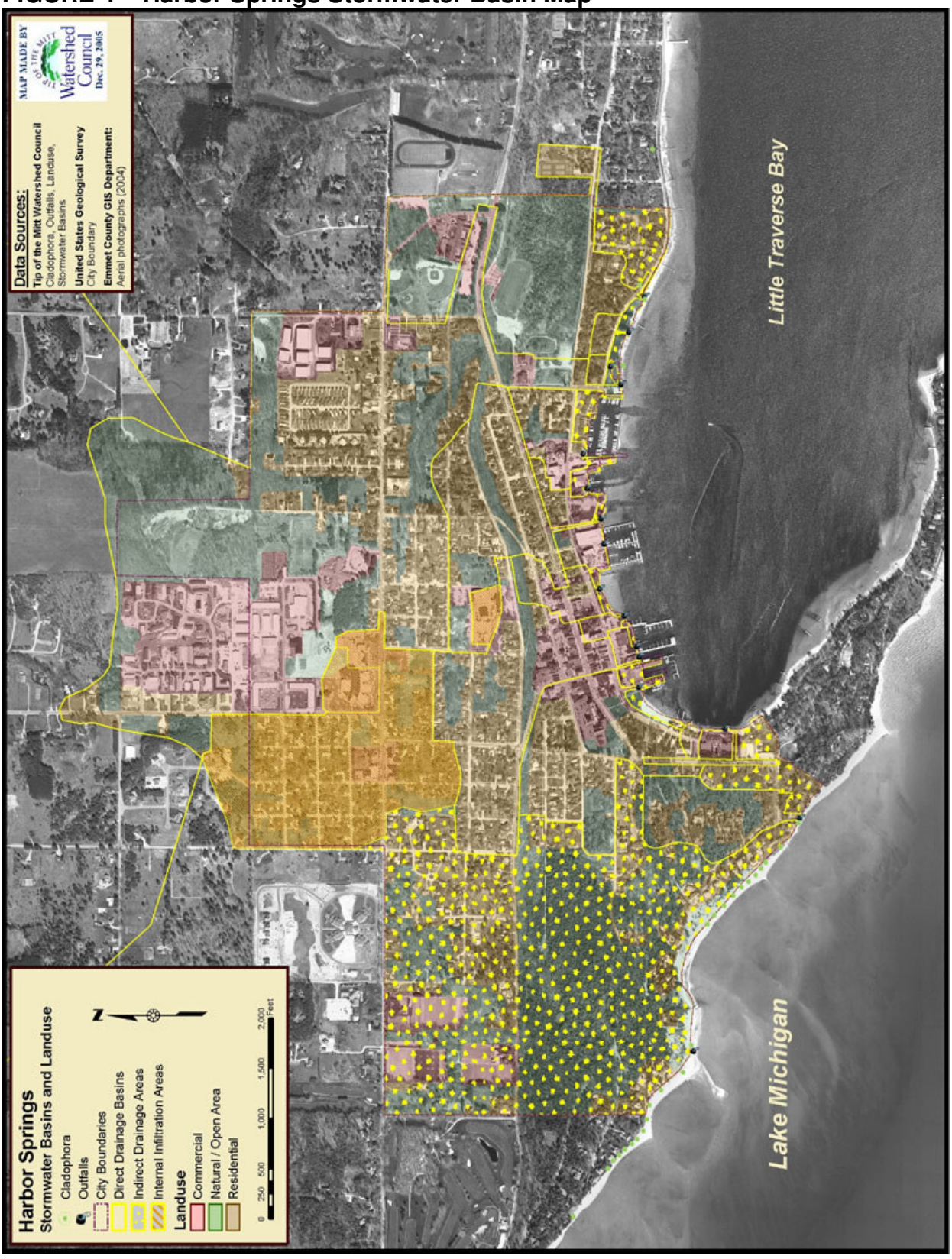


FIGURE 5 – Bay Harbor Stormwater Basin Map

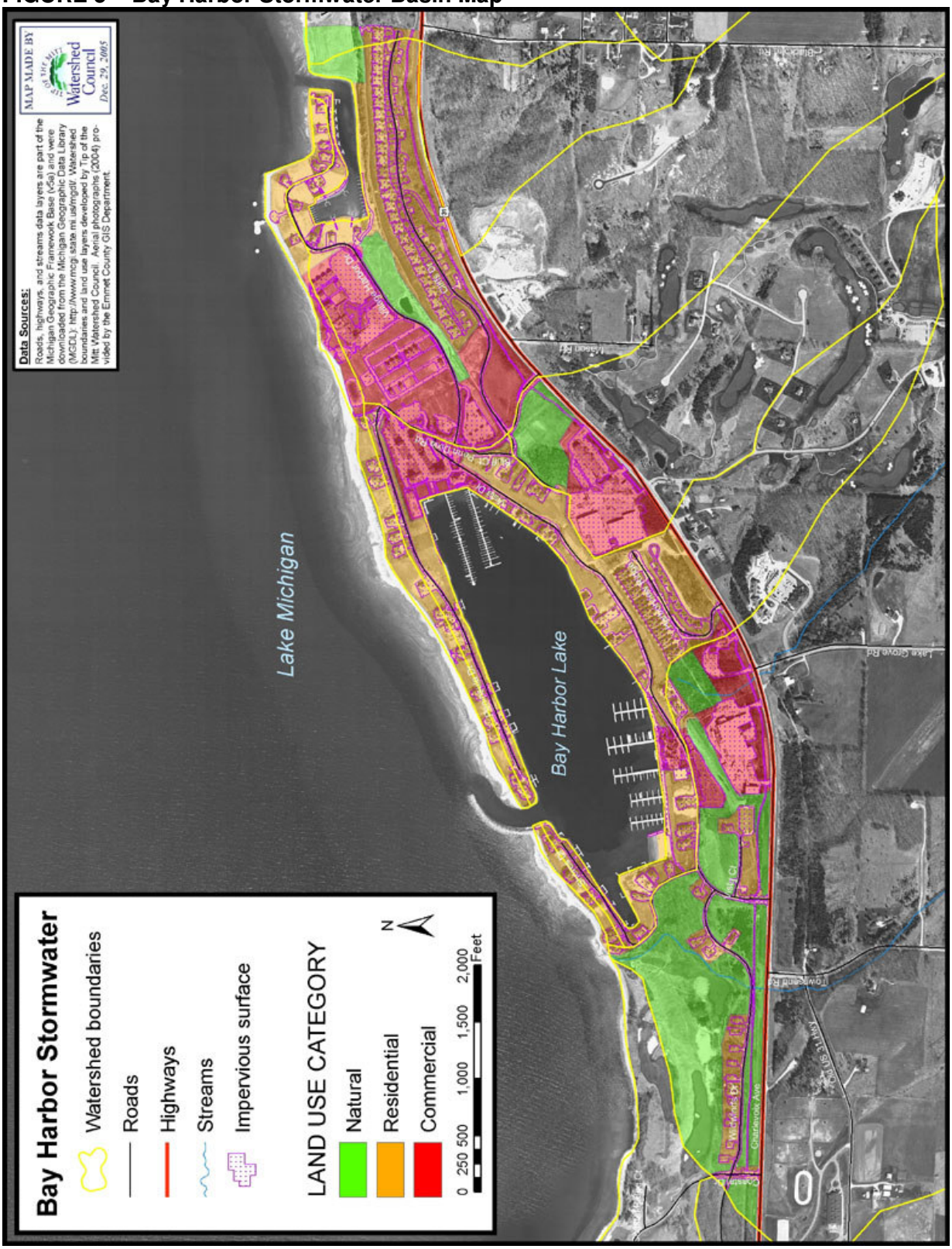
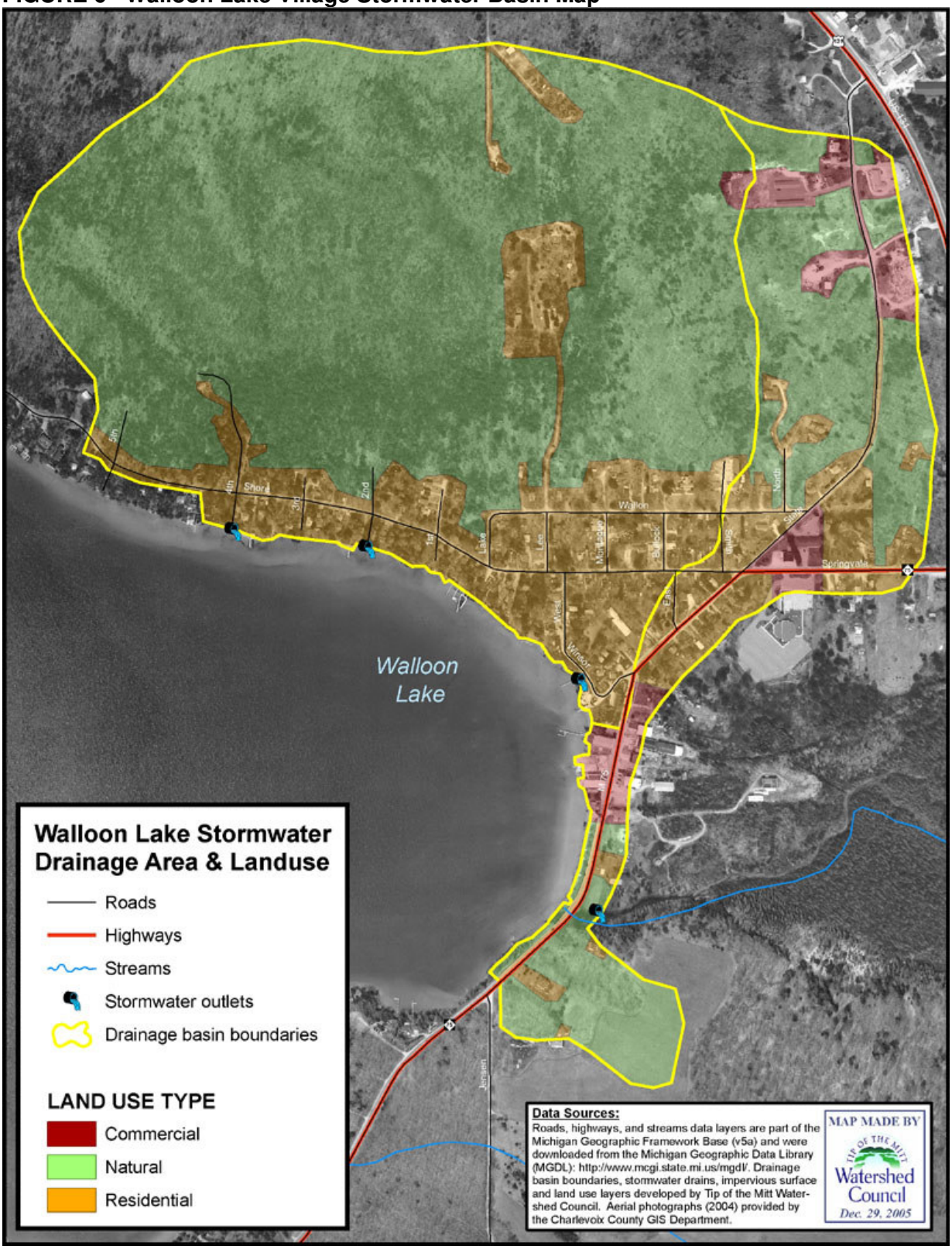


FIGURE 6– Walloon Lake Village Stormwater Basin Map



2. Walloon Lake Shoreline Inventory

A shoreline survey was performed on Walloon Lake by the Tip of the Mitt Watershed Council and the Walloon Lake Association during the summer of 2005 to document Cladophora growth and identify areas of nutrient contamination. Another survey was conducted by Watershed Council staff in the summer of 2003 to document areas of shoreline erosion. A third shoreline survey was conducted in the summer/fall of 2005 to document and assess the condition of shoreline vegetation, or greenbelts.

Cladophora is branched, filamentous, green algae that occur naturally in low densities in Northern Michigan lakes, mostly on rocky shorelines. However, dense growths typically form in areas where nutrient levels, particularly phosphorous, are high. Thus, in large, pristine water bodies such as Walloon Lake, Cladophora provides an exemplary, natural tool for performing nutrient pollution assessments.

The Tip of the Mitt Watershed Council used this tool or 'bio-indicator' during the shoreline survey to determine the extent and source of excessive nutrient input into the lake ecosystem. High nutrient levels do occur naturally, but most nutrient pollution is traceable to cultural sources such as lawn fertilization, malfunctioning septic systems, poor agricultural practices, soil erosion, and wetland destruction. Over time, excessive nutrient input can lead to a marked decline in lake water quality. Furthermore, malfunctioning septic systems pose a potential health risk due to bacterial and viral contamination.

TABLE 9: Walloon Lake Cladophora Survey Summary

	1998	*2001/2002*	*2005*
Shoreline property parcels	**977**	**992**	**1002**
Developed properties	**816**	**832**	**841**
Properties with habitat suitable for Cladophora	**784**	**818**	**832**
Cladophora growths	**200**	**391**	**304**

Results of the 2005 survey indicate that 304 of the approximately 1002 property parcels surveyed possessed noticeable Cladophora growth (Table 9). Approximately 841 parcels were developed (83%). The number of parcels is approximate because observations were made from the shoreline and exact property boundaries and recent lot splits were not always evident. Additionally, the parcel numbering system used in the 1998 survey differs from surveys performed after 1998, when Watershed Council staff switched to using the more accurate county parcel ID system.

Of the 304 noticeable Cladophora growths identified in the 2005 survey, 58% were in the light category, 27% were moderate, and 15% were classified as heavy growths. The total number of noticeable Cladophora growths almost doubled between 1998 and 2001 (96% increase: 200 to 391), but decreased between 2001 and 2005 (22% decrease: 391 to 304). The number of light growths decreased between 2001 and 2005 (37% decrease: 280 to 177). However, the number

of heavy growths increased 105%, from 22 in 2001 to 45 in 2005.

While differing methods (or subjectivity) can exist between field survey crews, the marked increase in number of heavy growths indicates that Cladophora growth is still severe in several areas and Walloon Lake could benefit from improved management.

Walloon Lake Shoreline Erosion Inventory
A shoreline survey was performed on Walloon Lake by the Tip of the Mitt Watershed Council during the summer of 2003 to document shoreline erosion and identify areas of accelerated sediment contribution. This survey was conducted as a supplement to a shoreline Cladophora survey that was completed in 2002.

Shoreline erosion occurs naturally on every lakeshore in response to seasonal water level fluctuations and storm and ice damage. While slight erosion is typically found on most lakeshores in Michigan, moderate or severe shoreline erosion is usually an indicator of an increase in impervious surfaces, extensive recreational use, greater powerboat traffic, and/or a lack of appropriate measures to control sediment contribution to the lake ecosystem. Sediment contribution in coastal environments damages aquatic plant growth, destroys fish spawning habitat, and leads to the degradation of lake water quality. Identification of severely accelerated erosion sites on Walloon Lake indicates locations of sediment pollution.

TABLE 10: Walloon Lake Erosion Survey Summary

	Total Count (2003)	% of Total
Shoreline Property Parcels	992	100
Accelerated Erosion Classification		
None	602	61
Slight	268	27
Moderate	98	10
Severe	24	2

Results of the 2003 survey indicate that 390 of approximately 992 property parcels are experiencing accelerated erosion. The number of parcels is approximate because survey observations were made from watercraft and exact property boundaries along with recent lot splits were not always evident.

Of the 390 accelerated erosion sites, 27% were described as slight, 10% were moderate, and only 2% were in the severe category. The severe sites are located in concentrated clusters around the lake, which allows for the identification of several erosion-prone shoreline areas (see Figure 8). Although relatively few sites are currently facing serious erosion problems, many are nearing the critical point at which they will begin to contribute large amounts of sediment to Walloon Lake. Therefore, it is recommended that the most severe sites be restored and that other, less-severe sites be examined more closely.

Resort Township Greenbelt Survey
A shoreline survey was performed on Walloon Lake shoreline properties within Resort Township by the Tip of the Mitt Watershed Council during the summer/fall of 2005 to assess and

document the current condition of shoreline vegetation (greenbelts). A greenbelt provides a natural strip of vegetation between the shoreline and lawn or structures to help prevent erosion and remove pollution from runoff.

The survey was conducted for Resort Township in response to the greenbelt ordinance that limits the amount of shoreline vegetation property owners can remove. Greenbelt documentation was requested by township officials as a basis for ordinance enforcement.

Greenbelt status was documented for 394 property parcels in Resort Township. The number of parcels is approximate because survey observations were made from watercraft and exact property boundaries along with recent lot splits were not always evident. 343 property parcels are developed lots and 51 are considered undeveloped.

Table 11: Resort Township Greenbelt Survey Summary

	Total count (2005)	% of Total
Shoreline Property Parcels	394	100
Greenbelt length (>75% length of shoreline)	202	51
Greenbelt width (>40 ft wide)	134	38
Turf (>75% of shore mowed to edge)	102	26

Of all 394 parcels surveyed, 202 parcels (51%) had a greenbelt that extended 75% or greater of the length of the shoreline (Table 11). 19% (76 parcels) had a greenbelt 25-75% the length of the shoreline. 8% (32 parcels) had a greenbelt 10-25% the length of the shoreline, and 11% (44 parcels) had a greenbelt less than 10% of the shoreline. 40 of the 394 parcels (10%) were documented as having no shoreline greenbelt. All parcels documented as having no shoreline greenbelt were developed property parcels.

Greenbelt depth (or width) was also documented, with 38% having greenbelts that are 40 feet wide or more. 40 feet is the desired greenbelt width as stated in the Resort Township ordinance. 35% (125 parcels) had greenbelt widths of 10-40 feet, and 27% (94 parcels) had greenbelts less than 10 feet wide. Additionally, 26% of property parcels surveyed had turf mowed to the water's edge on greater than 75% of their shoreline.

While half of the shoreline property parcels in Resort Township do have a greenbelt on along most of the shoreline, it is evident that more education is needed of residents of Walloon Lake shoreline property owners about the importance of greenbelts in protecting the shoreline and water quality.

FIGURE 7– Walloon Lake Cladophora Growth Map

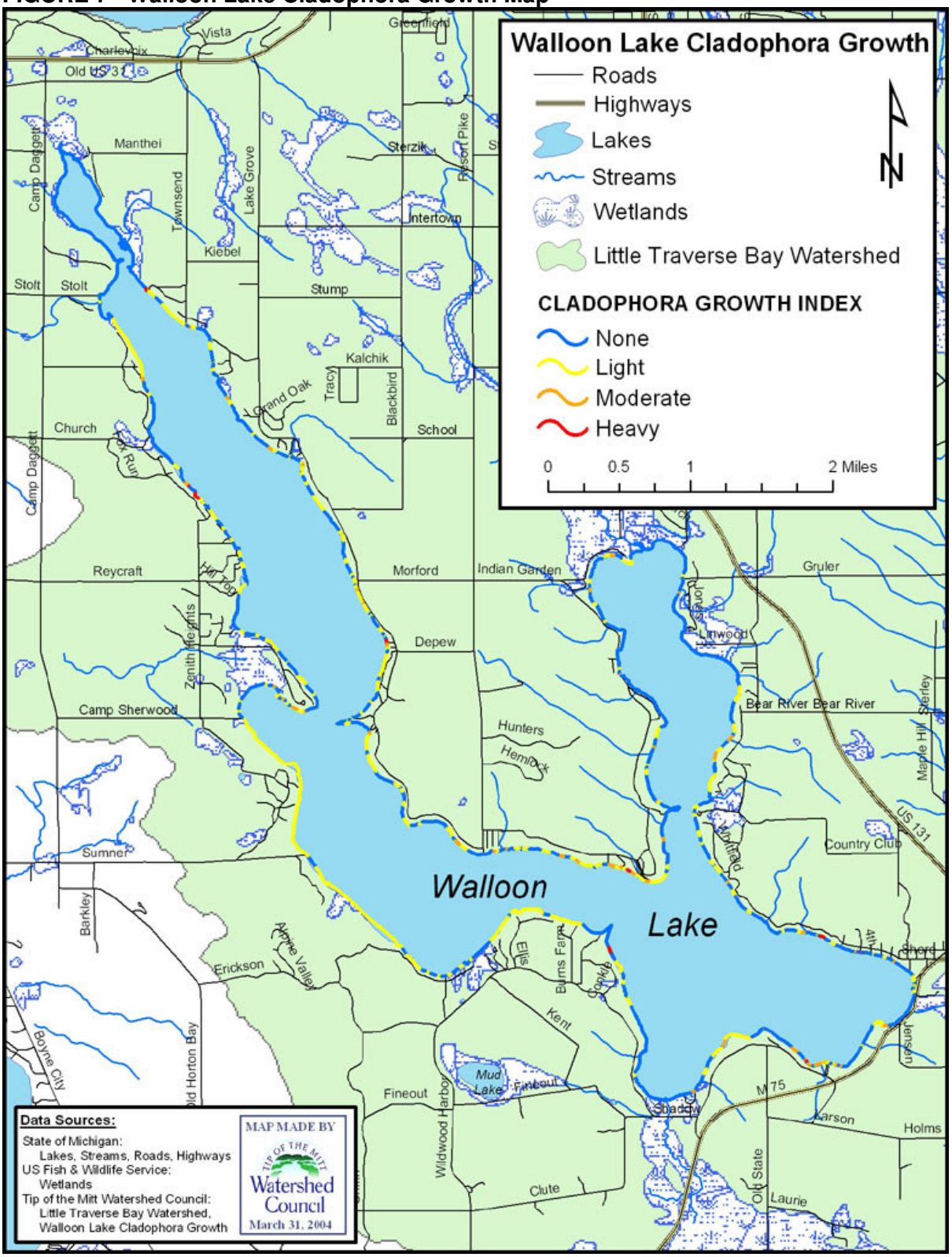
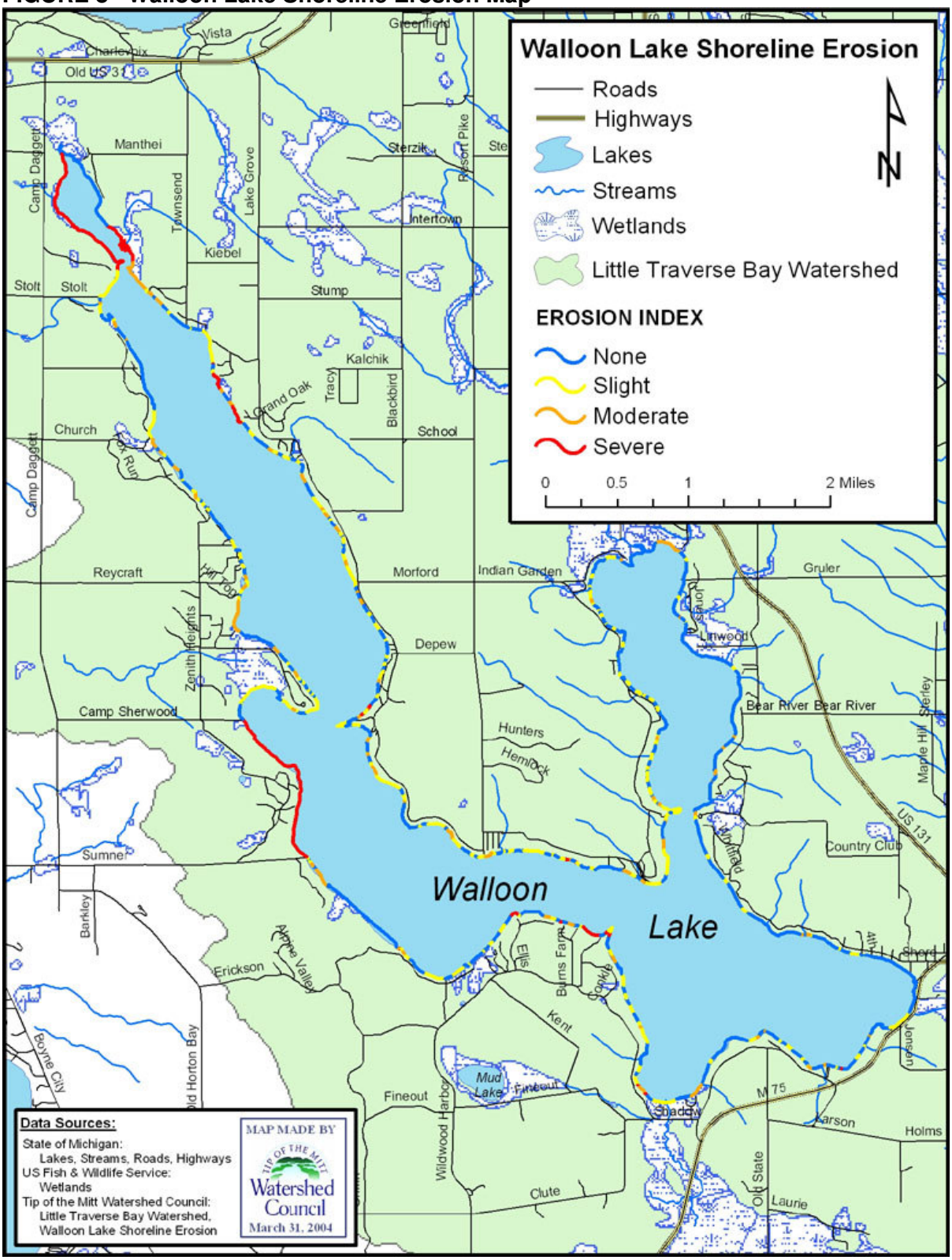


FIGURE 8– Walloon Lake Shoreline Erosion Map



3. Little Traverse Bay Shoreline Inventory

The entire length of the of the Little Traverse Bay shoreline, from Five Mile Creek at the northern boundary to Nine Mile Point on the southern boundary, was surveyed by Watershed Council staff in 2002. The survey documented 11 different shoreline features including physical and natural resource descriptions, as well as identified environmental problems and impacts (see Figure 9).

Physical characteristics documented include development status, shoreline property descriptions, and location of public access sites. Developed parcels had permanent structures such as houses, roadways, boat launching sites, and recreational properties (parks with pavilions and parking lots). Shoreline property descriptions noted features such as buildings, decks, boardwalks, culverts, drains, beaches, parks, marinas, and golf courses.

Public access sites include any properties that are considered open to some level of public use and grant access to the shore. This includes boat launches, parks, and undeveloped land owned by the State or local governments; road right-of-ways or other public easements; and property owned by land conservancies. Some of the public access sites on Little Traverse Bay include: East and West Resort Parks, Magnus Park, the Petoskey waterfront, various road ends in East Bay View, Petoskey State Park, Zoll Street Park, the Harbor Springs waterfront, Washington St. road end, and Thorne Swift Nature Preserve.

Natural resource characteristics documented in the shoreline survey included location of tributary streams, presence of beach vegetation, nearshore and beach substrate description, uplands description, and presence of wetlands.

Streams can contribute large quantities of nonpoint source pollution and have a significant impact on water quality. A total of 18 tributary streams were identified as draining directly to Little Traverse Bay. Beach vegetation is valuable for filtering runoff and preventing shoreline erosion. The survey found that 55% of the parcels had beach vegetation. Both nearshore and beach substrate can provide valuable habitat, as well as erosion-related information for fisheries management and shoreline erosion control. Eighteen different substrate types, such as rock, gravel, sand, muck, silt, and clay were noted for the beach and nearshore areas. The nearshore area included the first 20 feet from the shore.

Visual assessments using three major criteria typically used in wetland delineation: vegetation, soil, and hydrology were used to determine the presence of uplands or wetlands. Adjacent uplands in the Bay were categorized as being natural, developed, paved, or bluffs. Wetlands were noted as being present on 22 of the 552 parcels included in the survey, though many consisted of a relatively narrow fringe along the shore. The presence or absence of wetlands indicated by this survey does not replace the need for detailed onsite delineation for regulatory purposes.

The Little Traverse Bay shoreline survey also assessed problems and impacts; specifically, the presence of shoreline algae (Cladophora), shoreline erosion, and other human influences.

The presence of the filamentous green algae, Cladophora, was noted because it serves as a bio-indicator of areas of possible nutrient contamination along the shoreline. Although nutrient contamination can be natural in origin, it is usually attributable to human activities such as excessive fertilization, stormwater runoff, or septic system malfunction. Cladophora was found to

be present on 24% of shoreline properties.

Erosion is oftentimes accelerated by human activities and typically results in environmental problems and property damage. This survey noted only areas of visible, accelerated erosion such as gullies or rills on the land surface, undercut, slumping, or receding banks on shorelines, and barren areas on slopes or steep banks. Only seven properties were identified to have erosion. This low number may be due to the low lake levels in recent years.

Stormwater system installation, water withdrawal for consumption or industrial use, and human alteration of the shoreline can increase nonpoint source pollution, alter the natural hydrology, degrade aquatic habitat, and increase sedimentation. This component of the survey inventoried areas of shoreline hardening (e.g. placement of bulkheads, large rock riprap), beach alteration (e.g., landscaping, dredging, raking), stormwater discharge, water withdrawal, and private permanent piers. Shoreline hardening was identified at 56% of the properties.

The field survey covered a distance of approximately 24.7 miles of the Little Traverse Bay shoreline. Although certain sections of shoreline were surveyed using a small boat, the majority was accomplished by walking along the shoreline. Survey data were compiled in a Microsoft Access database and shoreline property parcel descriptions and aerial photographs were used in a GIS (Geographical Information System) to link surveys to parcel maps obtained from county equalization departments. Thereafter, accurate maps depicting locations of observed resource features were generated with relative ease and efficiency.

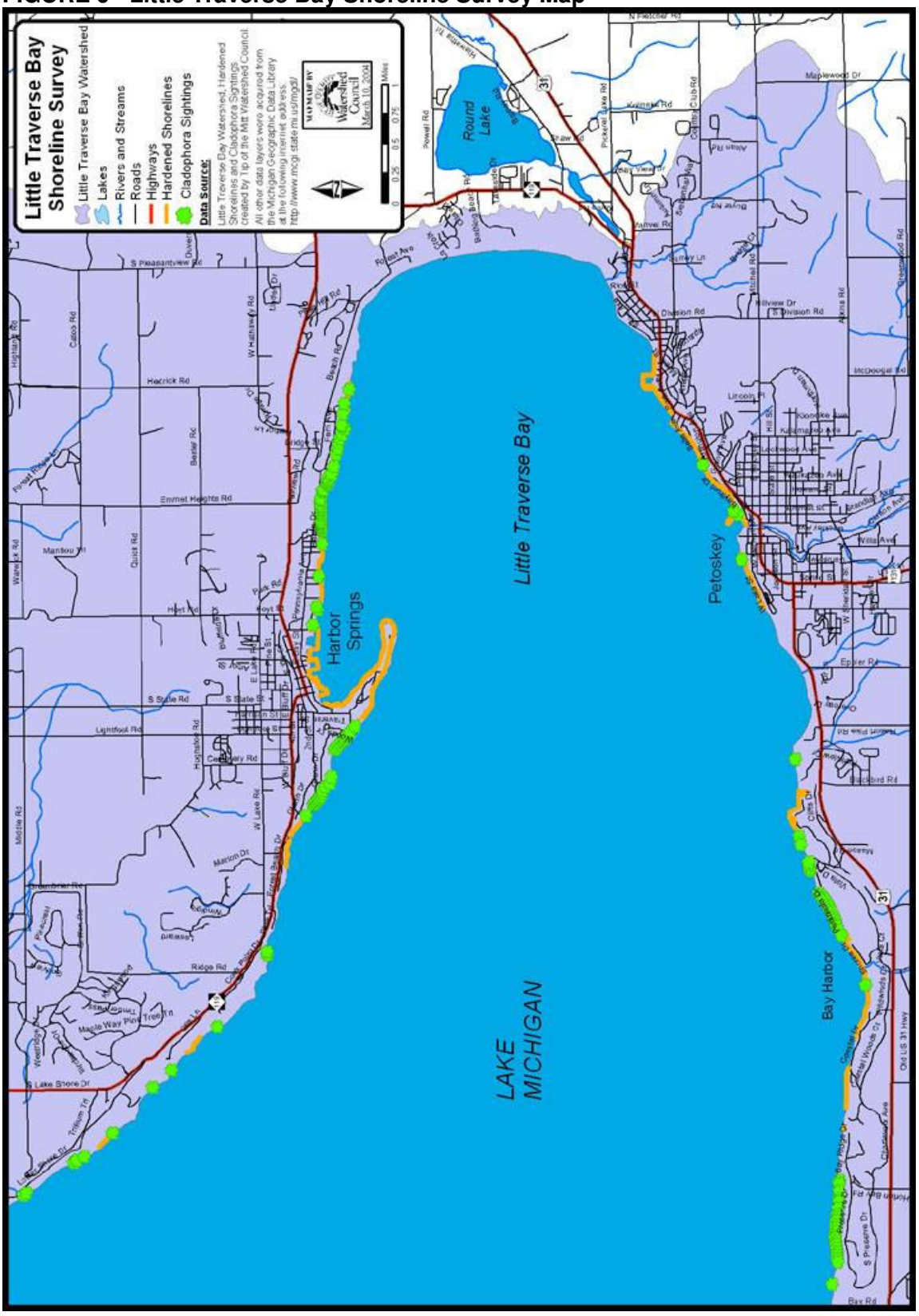
Additional surveys should be conducted in the future to track changes in these 11 variables. A summary of some of the features inventoried is in the following table.

TABLE 12: Summary of Little Traverse Bay Watershed Survey Results

Shoreline Survey Category	Number of Properties*
Developed Shoreline	413
Public Access Sites	31
Possessing Wetlands	22
Cladophora Present	132
Erosion Problems	7
Hardened Shorelines (large bulkheads or large rock riprap)	307
Beach Vegetation	304

**Total number of properties = 552 included in survey.*

FIGURE 9– Little Traverse Bay Shoreline Survey Map



4. Road/Stream Crossing Inventory

At locations where roads cross over streams, road-surface runoff from rainstorms or snowmelt washes sediments and pollutants associated with automobiles into the waterway. Increased sedimentation degrades habitat, reduces fish cover, changes stream velocity, and alters water temperatures (Alexander and Hansen, 1975). Roads also result in changes to the natural stream hydrology as new surface paths are formed and cause surface runoff to wash directly into the stream (Wemple et al. 1996). Increased surface runoff results in greater peak discharges, which scour the stream channel, destroy habitat, and displace or expose smaller aquatic organisms. Furthermore, culverts, commonly installed to route the stream under the road, have been shown to reduce trout standing stocks (Eaglin and Hubert, 1993). Due to nonpoint source pollution concerns at road/stream crossings, an inventory was developed to comprehensively identify and document all road/stream crossing sites within the Little Traverse Bay Watershed.

The Tip of the Mitt Watershed Council coordinated field data collection efforts for the inventory in 2002. Potential road/stream crossings locations were identified using a mix of map sources and field exploration (Figure 10). Each crossing that appeared to have regular flow connected to Little Traverse Bay or one of its tributaries was inventoried. With the exception of private drives, all vehicle access roads were included. All potential sites were investigated in the field. Some sites with negligible or intermittent stream flow were not included in the inventory as they were considered insignificant as sources of nonpoint source pollution.

Site investigation consisted of an assessment of potential impacts and problems. Data collected at the crossings included detailed information about the location, road characteristics (width, shoulder, drainage, surface); culvert condition; and erosion and runoff problems. Basic stream characteristics such as width, depth, current, and substrate were also recorded. Field data was collected by both resource professionals and trained volunteers.

A severity ranking index for road/stream crossings sites was used to prioritize future improvement projects (Appendix C). The severity ranking system used is identical to that used on a number of previous road/stream inventories conducted by other agencies throughout Michigan. Three classifications are used in the severity ranking: severe (30 points or more); moderate (15-29 points); and minor (under 15 points).

Data from the road/stream crossing inventory are summarized by in the following table. A total of 100 sites were inventoried, of which six were classified severe, 76 moderate, and 18 minor (Table 13).

TABLE 13: Severity Ranking of Road/Stream Crossings in the Little Traverse Bay Watershed

Severe	*Moderate*	*Minor*
6	76	18

Results of the inventory indicate that Hay Marsh Creek, the South Branch of Spring Brook, and the North Branch of Spring Brook are severely impacted by inadequate or poorly functioning road/stream crossings. The fact that these sub-basins are situated in the headwaters of the Bear River emphasizes the pressing need for improvements. Headwater streams such as these provide important habitat for native brook trout, which can be rapidly degraded by sedimentation and turbidity originating from eroding road/stream crossings. Hay Marsh Creek does not provide as valuable brook trout habitat as the Spring Brook branches due to warmer water temperatures and slower flow, but is in dire need of road/stream crossing reparation as three sites were rated as severe. The high costs of road/stream crossing repair on the main stem of the Bear River is attributable to recommendations of replacing culverts with bridges in four locations.

Sediment pollutant load reductions were calculated for the severe sites. Sediment reduction refers to the annual amount of sediment that would be saved if these sites were repaired. Estimates were calculated using the Channel Erosion Equation (MDEQ, 1999). More information can be found in Appendix F.

TABLE 14: Pollutant Load Reductions for Severe Road/Stream Crossings

Site	Sediment Reduction (tons/year)
Bear River	378
Haymarsh Creek	216
Haymarsh Creek	108
Haymarsh Creek	101
North Branch of Spring Brook	216
South Branch of Spring Brook	29

5. Rivers and Tributaries Erosion Inventory

It is evident that sedimentation is a problem throughout the state as the Michigan Natural Resources and Environmental Protection Act, 451 of 1994 includes a substantial section (Part 91) on soil erosion and sedimentation control. According to the 2002 Michigan Department of Environmental Quality's Section 305b water quality report, nearly 500 miles of rivers in Michigan do not support designated uses due to sedimentation (MDEQ, 2002). Shoreline and streambank soil erosion is a considerable source of sediment pollution to the lakes and streams in Northern Michigan and an issue that needs to be addressed in the Little Traverse Bay Watershed. Although streambank erosion is a natural physical process, erosion rates are often accelerated by human activity, resulting in unnatural quantities of sediment entering the stream ecosystem. The diversity of fish and aquatic invertebrate species is reduced in streams experiencing increased silt and sediment loads (Allan, 1997). Habitat for many species of invertebrates and spawning beds of salmonid species such as brook trout are lost as gravel streambeds are filled in with finer sediments (Phillips et al. 1975).

To address erosion and sedimentation concerns the Watershed Council staff conducted a streambank erosion inventory on Little Traverse Bay's largest tributary, the Bear River. This

inventory was completed during the 2001 and 2002 field seasons. The main stem and principle tributaries of the river were surveyed by canoe to document and photograph existing and potential erosion sites. The severity and cause of erosion at each site was evaluated. In 2005, a follow-up survey inventoried a segment of the Bear River where the most significant erosion sites are concentrated.

Severity Ranking

To prioritize the streambank erosion sites, information collected during the field evaluation was reviewed and scored. The scoring method, developed by Conservation Resource Alliance, was used to assign a severity ranking of minor, moderate, or severe to each site. Slope, vegetative cover, size of the site, water depth, current, and bank stability (whether the problem area was increasing or not) were features documented using this method. In addition to severity rankings, other variables such as cost, funding availability, access, and downstream benefits to habitat (achieved by site restoration) should be considered when prioritizing streambank erosion control projects.

Erosion sites were assigned severity ratings based on a point-score system. A score of less than 30 was considered minor, ranging from 30 to 36 was listed as moderate, and severe sites were those that received a score greater than 36. Results of the Bear River shoreline erosion survey are presented in the following table.

TABLE 15: Bear River Erosion Severity Ranking

Subwatershed	*Severe*	*Moderate*	*Minor*
Bear River – Main Stem	1	2	5

A total of eight priority sites (in addition to the problem areas associated with road/stream crossings) were identified along the main stem of the Bear River. All of the sites were found between the Springvale Road crossing in Melrose Township and Bridge Road within the city limits of Petoskey (see Figure 11). Of the eight sites, one was ranked as severe, two were ranked as moderate and five were ranked as minor. In addition, it is important to note that four additional priority erosion sites have been corrected during the inventory period. In 2005, an abbreviated follow-up survey (sites found between McDougal Rd. and Sheridan Rd.) of previously identified erosion sites' documented their locations and conditions and confirmed their 2001-02 rankings.

Rough cost estimates were calculated for restoration of each erosion site. The cost of repair for all sites totals approximately $24,400 and $17,000 to repair only the moderate sites. Cost and plans should be refined for each site prior to implementing the recommended improvements. In some situations where the erosion may be minor, the access to the site may be exceedingly challenging and thereby add substantial project costs.

FIGURE 10– Little Traverse Bay Watershed Road/Stream Crossing Map

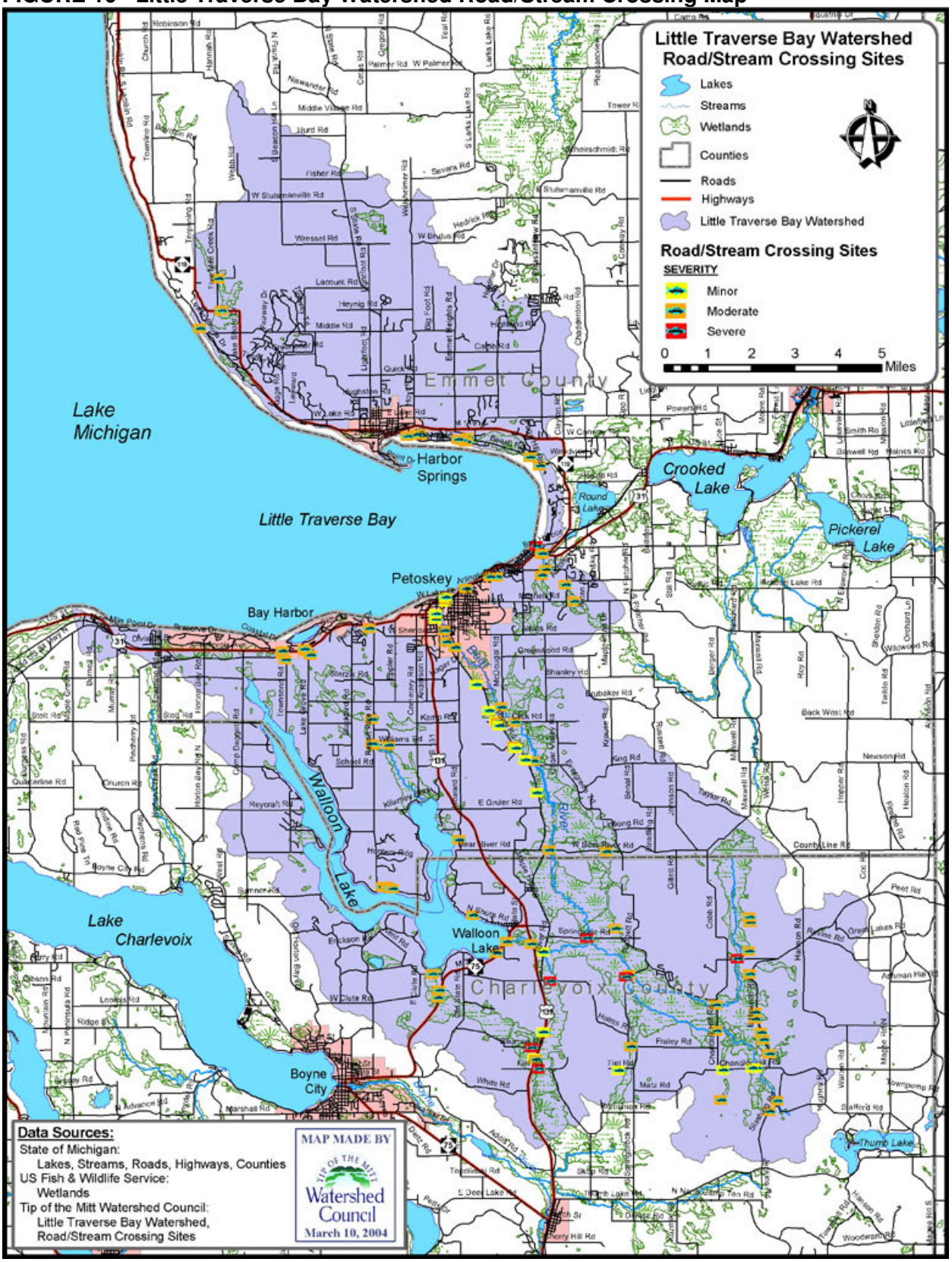
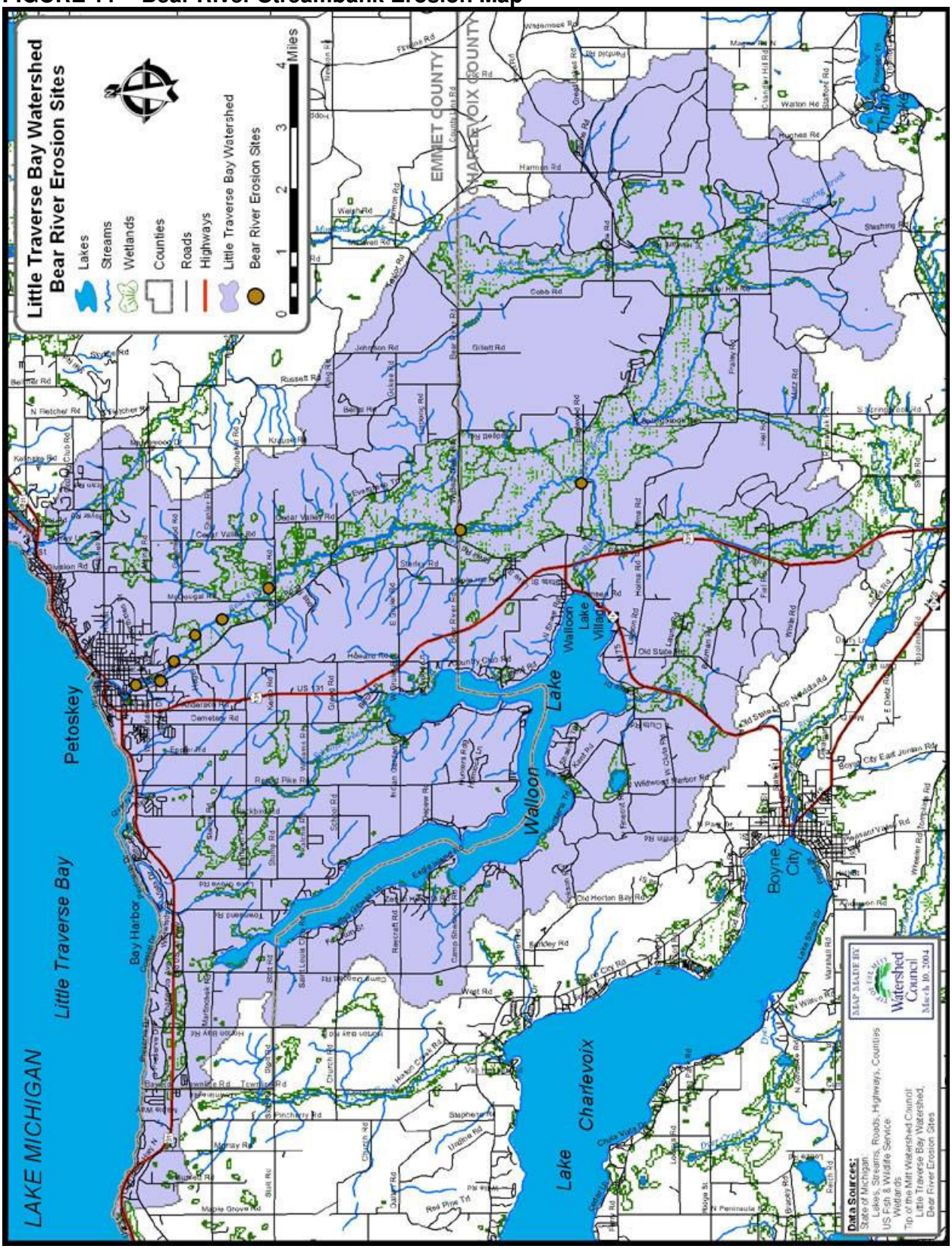


FIGURE 11 – Bear River Streambank Erosion Map



In the summer of 2004, two important projects were implemented on Tannery Creek, the third largest tributary of Little Traverse Bay. The Watershed Council along with a range of partners including the Petoskey Bay View country Club, the Michigan Department of Natural Resources, the Michigan Department of Environmental Quality, the U.S. Fish and Wildlife Service, the Petoskey-Harbor Springs Community Foundation, Greenwell Machine Shop, and H & D Roadbuilding Plus, Inc. worked to remove a low-head spillover dam located on the Country Club's golf course. The removal of the dam allowed the creek to be restored to its original configuration, matching the slope and width of the streambed up and downstream of the impoundment. Prior to the dam's removal, however, an innovative and cost-effective sea lamprey barrier was designed, fabricated and installed specifically for the Creek's location on Little Traverse Bay. The barrier will serve to block the migration of the lamprey, an aquatic nuisance species, from entering Tannery Creek and spawning upstream.

In October 2005, a small stream restoration project was completed in Bay View Woods, a publicly-owned nature preserve located within the Bay View Association, located in Emmet County on the easternmost shoreline of the Little Traverse Bay. The project included the installation of over 160' lineal feet of coir (coconut) bundles, riprap and dogwood shrubs in an effort to stabilize the unnamed stream's severely eroding banks. Localized accelerated erosion of the streambank is due to the increased volume of runoff generated from expanding development within the stream's drainage area.

Erosion from streambanks and shorelines can vary widely. The amount of sediment and nutrients (phosphorus and nitrogen) that enter a water body can be reduced by improving or eliminating the erosion source. Annual average sediment and nutrient load reductions for the Bear River streambank erosion sites were estimated using the Channel Erosion Equation (MDEQ, 1999). Also see Appendix F for more information.

Table 16: Bear River Streambank Pollutant Load Reductions

	Severe	Minor
Cumulative length of bank	75 feet	135 feet
Sediment Reduction	16 tons/year	3 tons/year
Reduction in P	13 lbs/year	3 lbs/year
Reduction in N	3 lbs/year	0.5 lb/year

6. Agriculture Inventory

Agricultural operations in Charlevoix and Emmet Counties consist of predominantly small farms (under 160 acres) that are quite diverse. Agricultural land use has been declining in both counties due to various social and economic factors. Family farms are not being continued by the younger generation and many farms are being sold for development as the demand for scenic lands for home sites increases. Runoff from agricultural areas has been identified as a major source of nonpoint source pollution in the U.S., contributing large amounts of sediment, phosphorous, and nitrogen to aquatic ecosystems (Allan, 1995). For the Little Traverse Bay Watershed Protection Plan, the location and any associated nonpoint source pollution problems were documented for all agricultural producers in the Watershed.

In 2003, the Charlevoix and Emmet Conservation Districts with assistance from Natural Resource Conservation Service conducted an inventory of agricultural activities within the Little Traverse Bay Watershed. Plat books, topographic maps, and aerial photos were used to identify area farms. Local knowledge from professionals working with the agricultural community coupled with a windshield survey (data gathered from roadside) of agricultural areas provided the necessary data to complete the inventory. Data sheets were filled out for each farm site and include the following information: type of farm, location, distance to nearest tributary, obvious nonpoint source pollution problems, recommended best management practices, and estimated cost of repairs. Nonpoint source pollution at each site was ranked as severe, moderate, or minor. A map showing the agricultural sites was produced but will not be included in the plan for confidential purposes.

TABLE 17: Severity Ranking and Potential Pollutants for Agricultural Sites in the Little Traverse Bay Watershed

Severity Ranking	***Severe***	***Moderate***	***Minor***
Number of Sites	**1**	**8**	**39**
Potential Pollutant	***Nutrients***	***Sediments***	***Toxics***
Number of Sites*	**38**	**13**	**18**

*A site can have more than one potential pollutant.

A summary of the agricultural site severity rankings appears in the table above. A total of 48 agricultural sites were inventoried and ranked, resulting in 1 severe, 8 moderate, and 39 minor sites. Data was also categorized by potential pollutant, which was nutrients at 38 sites, sediments at 13 sites, and toxics (primarily pesticides) at 18 sites. Both severe and moderate sites appeared to be contributing excessive sediment and nutrients to the waterway.

Pollutant loadings from the agricultural land uses were estimated using the Export Coefficient Model spreadsheet developed by North Carolina State University (Osmond et al.1995). Table 18 shows the estimated pollutant loadings.

TABLE 18: Pollutant Loading Estimates for Agricultural Lands

Land Use	***Area (ha)***	***Total Nitrogen Load (kg/yr)***	***Percentage of Nitrogen Load***	***Total Phosphorus Load (kg/yr)***	***Percentage of Phosphorus Load***
Corn	138	1532	0.36	276	0.84
Small Grain	55	292	0.70	83	0.25
Pasture	930	2883	0.67	93	0.28
Feedlot or Dairy	147	426,300	98.91	32,340	98.90
Total	1270	431,006	100%	32,699	100%

To reduce nonpoint source pollution at these sites generally accepted agricultural practices (GAAMPs) should be incorporated into agricultural activities at the severe and moderate sites. The recommended practices were ranked in importance based on the frequency of the recommendation. Implementing all recommended GAAMPs on the 48 sites would cost approximately $650,150. To completely implement the GAAMPs on the nine sites listed as severe or moderate would cost approximately $320,500. A summary of the ranking appears in the table below.

TABLE 19: Recommended Agricultural GAAMPs and Frequency of Recommendation

Recommended GAAMP	Frequency
Nutrient Management Plans	20
Exclusionary Fencing	13
Animal Waste Utilization	11
Animal Waste System	10
Improved Watering Facility	9
Integrated Pest Management	7
Improved Use of Cover Crops	6
Chemical Storage Facility	3
Conservation Tillage	3
Crop Rotation	2
Prescribed Grazing	2

7. Priority (High Value) Parcels for Water Resource Protection Inventory

Properly managing the high-quality water resources in the Little Traverse Bay Watershed requires addressing known sources of pollution and reducing future sources. In particular, a watershed management plan should be designed to conserve and protect invaluable shoreline, wetland, and ground water recharge areas. Although proper stewardship is encouraged throughout the watershed and regulations attempt to manage activities that adversely impact water quality and aquatic habitat, one of the most effective tools for long-term water quality protection is permanent protection of sensitive lands. Permanent protection is best achieved through purchase, donation, or conservation easement. Permanent protection of high priority areas will help maintain the ecological integrity of the most sensitive areas.

There are three local land trusts that work to protect land in the Watershed: Little Traverse Conservancy, The Walloon Lake Trust and Conservancy, and the Charlevoix County Land Conservancy. Local governments, cities, townships, and counties also participate in land protection efforts. Through collaboration with these entities, private parcels of land in the Little

Traverse Bay Watershed were reviewed and ranked based upon potential contribution to protecting and improving the water quality of Little Traverse Bay. Descriptions of selection criteria and the scoring system used to determine priority parcels are described below. See Appendix D for further details.

Parcel Size: Larger blocks of contiguous land typically have higher ecological value due to their potential to harbor a greater diversity of habitat types and species. Larger parcels are also more time and cost effective to protect than smaller parcels. The selection threshold for parcel size criteria during this process was 10 acres. The larger the parcel, the more points it received.

Ground Water Recharge Potential: Ground water discharge is essential for the maintenance of the cold water fisheries that prevail in the Little Traverse Bay Watershed. Land with highly permeable soils allows precipitation to percolate through the soils and recharge ground water supplies. Predominant soil type and associated permeability were determined for each parcel using the physical properties found in county soil surveys (Natural Resource Conservation Service, Emmet and Charlevoix Counties). Parcels with ground water recharge potential were scored appropriately.

Presence of High Value Wetlands: Wetlands provide a variety of important functions that contribute to the health of the Little Traverse Bay, including fish and wildlife habitat, water quality protection, flood and erosion control, and recreational opportunities. In 1994 the Tip of the Mitt Watershed Council identified high value wetlands in the Little Traverse Bay Watershed. Lands containing wetlands identified in the High Value Wetland Inventory were given additional points in the priority parcel identification procedure.

Lake and River/Stream Shoreline/Riparian Ecosystems: Activities on land immediately adjacent to a waterbody are critically important to maintaining water quality and ecological health. Properties with lake or stream shorelines were given scores based on total shoreline distance contained within the parcel.

Protected Land Adjacency: Properties adjacent to protected lands such as State Forests or conservancy lands have a high ecological value because they provide a buffer to pre-existing protected lands and increase the contiguous protected area, which essentially expands the biological corridor for species migration and interaction. Parcels bordering local or state government land and conservancy properties were identified and scored based upon the number of sides on the parcel adjacent to protected lands.

Presence of State or Federally Listed Threatened or Endangered Species: Threatened and endangered species represent an important aspect of biodiversity. Parcels with known occurrences or within the habitat buffer of threatened and endangered species were identified and scored accordingly.

TABLE 20: Priority Lands for Protection

Order of Priority	***1st Tier***	***2nd Tier***	***3rd Tier***
Number of Sites	13	66	505

Land parcels throughout the Little Traverse Bay Watershed were analyzed and scored using the seven listed criteria. The scores for each criterion were summed to produce a total score for each land parcel. Parcels receiving a total score of 16 or greater were considered to be the most vital for water resource protection and were grouped into the first tier. Parcels with total scores ranging from 11 to 15 were grouped into a second tier of priority and those receiving total scores of six to 10 were included in a third tier of priority. Of the 584 properties identified as high priority, 13 were classified as 1st tier priority, 66 as 2nd tier priority, and 505 as 3rd tier priority.

Information from county equalization departments and criteria scores utilized in the prioritization process has been compiled in a database that will be used by local land conservancies to prioritize land protection activities. The priority parcel database has also been imported into a GIS to generate maps and perform spatial analyses. A map showing the priority parcels was produced but is not included in the plan for confidentiality reasons. However, in 2006 the priority parcel maps were distributed to township supervisors throughout the watershed for use by the local governments.

8. Forestry Inventory

Forestry practices have the potential to negatively impact water quality as a result of sedimentation, warming due to canopy loss, reduced surface water absorption and filtration due to soil compaction, and consequently, increased peak discharge. Logging activities have been shown to increase soil erosion (Ryan and Grant, 1991), increase runoff (Jones and Grant 1996), and degrade stream habitat (Chamberlin et al. 1991). Improved forestry management that accounts for water resource protection could greatly benefit water quality in the Little Traverse Bay Watershed. This is particularly true for areas where forestry practices are likely to have the greatest impact such as the headwater streams and wetlands in the sub-watersheds of Hay Marsh Creek, Spring Brook, and Bear River in the southern portion of the Watershed.

To prevent and reduce the impacts of forestry activity on aquatic ecosystems, an assessment of forested lands in the Little Traverse Bay Watershed was conducted through a forestry inventory in 2003. The inventory identified forested land parcels within the Watershed that have a high potential to influence water quality or aquatic habitat. Mackinaw Forest Council volunteers and Tip of the Mitt Watershed Council staff members conducted the inventory and identified areas with the following features:

1. Wetlands in riparian corridors
2. Ground water recharge areas
3. Parcels with acquisition potential
4. Riparian restoration and protection sites
5. Endangered, threatened, and rare species sites
6. Wildlife travel corridors
7. Old growth forests

Thirteen areas were identified as sensitive to forestry activities (see Figure 12). The areas included both private and public lands. Forestry operations in these areas are likely to have negative impacts on water quality if best management practices are not utilized. Primary concerns identified in the forestry inventory include:

- Erosion from old logging roads.

- Off-road vehicle use crossing streams, causing erosion, and disrupting aquatic ecosystems.
- Powerline management resulting in the removal of the forest canopy in stream corridors.
- Need for protection of forests in significant ground water recharge areas.
- Many forestlands in the watershed include wetlands or steep slopes and are more sensitive to erosion from logging activity.
- Protection of old growth forests in priority area.

9. Zoning Assessment

The water quality of a water body is a reflection of the land uses in its watershed. Water bodies in wilderness areas generally have little pollution other than air borne contaminants. Urban rivers or lakes that are surrounded by intense commercial and industrial uses generally have the most contaminants. How communities manage their land use has a direct impact on the community's water resources. Zoning, master plans, and special regulations are a few of the more commonly used land management tools.

Originally developed to minimize conflicts between incompatible land uses such as industrial and residential areas, zoning ordinances today do much more than prevent land use conflict. They establish the pattern of development, protect the environment and public health, and determine the character of communities. Since protecting water quality requires looking at what happens on land, zoning is an important watershed management tool.

Zoning's effectiveness depends on many factors. An ordinance is only as good as the standards, if the standards aren't strict enough it won't accomplish anything. An effective zoning ordinance also requires consistent enforcement and a base level of public support. Many people believe the law protects sensitive areas, only to find otherwise when development is proposed. Although zoning has its critics, it can be used very effectively for managing land uses in a way that is compatible with watershed management goals.

Michigan has six planning and zoning enabling acts that provide broad authority for the use of a wide range of local planning and zoning techniques. In addition, a community can sometimes draw authority from another state regulation, a charter, or a general police power statute (e.g., noise ordinance).

Local Planning and Zoning Review
The local planning and zoning review for the Little Traverse Bay Watershed focused on three main documents from each local government in the Watershed: master plans, zoning ordinances, and recreation plans.

A master plan is a community's vision for future land use. It contains background information on the natural, cultural, and physical characteristics of a community, including population. A master plan provides a framework and a basis for a zoning ordinance. Michigan law requires communities to review or update their master plans every five years.

As mentioned previously, zoning can be a very effective way to manage development and reduce the impacts to water quality. Every community in the Little Traverse Bay Watershed has zoning either by township or county. Planning and zoning must be viewed as a part of a broader strategy, which is understood and supported by the community. Zoning is never the total answer to land use and water resource protection but it provides a necessary framework for responsible

local action and can limit the negative impacts of development and change.

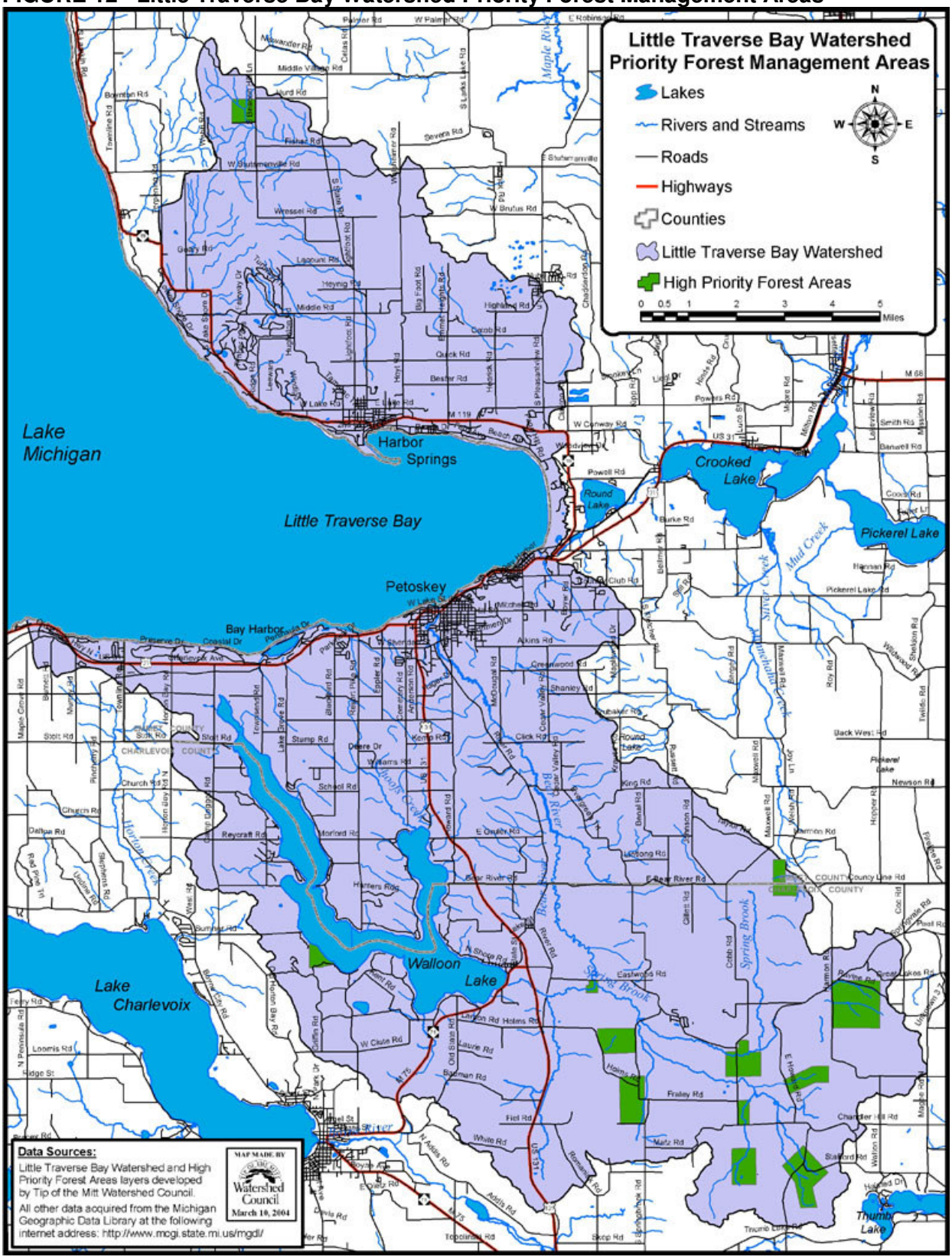
Recreation plans provide an assessment of existing recreation lands and programs and a community's goals for future recreation uses. Providing areas for year-round recreation is a main goal for most recreation plans. To accommodate residents, plans often include goals for expanding trails for snowmobiles and bikes, purchasing additional lands for parks, and maintaining existing recreation areas. Not all of the communities in the Little Traverse Bay Watershed have recreation plans.

Master plans, zoning ordinances, and recreation plans were reviewed for the municipalities in the Little Traverse Bay Watershed for provisions affecting water quality (Table 19). The Little Traverse Bay Bands of Odawa are in the process of developing a zoning ordinance for tribal lands, although they do have a site plan review statute as part of the LTBB Constitution. Since the ordinance is in the development phase, it is not included in Table 19. A brief description of what was found in the review is described below.

Special Districts: Adopting special standards or restrictions (often overlay districts) is an approach communities can take to protect specific natural resources. These districts generally have stricter provisions (e.g., Resort Township, High Risk Erosion Overlay Zone). The City of Petoskey is the only community in the Watershed that does not have any special districts. The most common special districts are for waterfront areas, farms, dunes, and steep slopes.

Shoreline Protection Strips: A shoreline protection strip (sometimes referred to as a greenbelt) is a strip of natural vegetation located between the shoreline and lawn or structures. Shoreline protection strips protect water quality in a number of ways. They reduce runoff by absorbing precipitation. This helps to prevent soil erosion. The plants act as filters removing sediment, nutrients, and other pollutants from entering a lake or stream. A shoreline protection strip can help prevent shoreline erosion. Shoreline protection strips along streambanks help to moderate stream temperature and provide food for aquatic organisms. In addition to protecting water quality, shoreline protection strips provide sound-breaks, attract birds and wildlife, and can enhance the view of shoreline development from the water.

FIGURE 12– Little Traverse Bay Watershed Priority Forest Management Areas



The effectiveness of a shoreline protection strip depends on the slope, width, soil permeability, size of contributing area, runoff velocity, type of groundcover and other vegetation, and management practices.

Zoning ordinances that require shoreline protection strips take two approaches: 1) establish a set width from the water's edge that must be maintained with natural vegetation; or 2) have a variable width of natural vegetation with the size being dependent upon the slope (greater the slope-greater the width of vegetation).

Ordinance provisions for shoreline protection strips sometimes prohibit application of fertilizers and pesticides in the strips and they often allow trimming and pruning of vegetation for a filtered view of the water and winding access paths to the water's edge.

The majority of the municipalities in the Little Traverse Bay Watershed have a shoreline protection strip section in their ordinance. The set width varies from 25 to 100 feet, with 35-40 feet being the most common. The Emmet County ordinance was the only one that had a different width for steep slopes (100-foot strip requirement). None of the ordinances address restoring shoreline protection strips for new construction on older developed properties.

Shoreline Setbacks: One of the simplest ways to protect water quality from land use activities is to ensure that those activities occur at an appropriate distance from the shoreline of a lake, stream, or wetland. The purpose of a setback is to reduce erosion, sedimentation, and nutrient input by reducing the quantity and improving the quality of runoff from the property. Setbacks vary greatly in the Little Traverse Bay Watershed. The typical shoreline setback is 50-60 feet. Evangeline Township has the most protective shoreline setback requirement based on the slope and steepness of a property. A property with a 12-18% slope has a setback of 100 feet, more than 18% requires a 150-foot setback.

Shoreline Density: Shoreline density is determined by the minimum width of a lot (e.g., 100 feet between parcels) or in certain circumstances the minimum lot size (e.g., 0.5 acre). Generally, the more dense the development, the more impervious surfaces (hard surfaces like roofs and pavement) there are to generate runoff to water bodies. Developed properties also are more likely to contribute nonpoint source pollution than undeveloped properties. In the Little Traverse Bay Watershed shoreline density ranged from 100 feet to 330 feet. Chandler Township requires a minimum lot width of 300-330 feet for properties adjacent to streams. The typical lakefront lot is 100 feet wide. Although this is standard from a zoning point of view it may not be wide enough to protect water quality.

Recent research from Wisconsin and Ontario has documented how shoreline development can decrease the quantity and diversity of birds, frogs, and other aquatic life. For example a study on Wisconsin lakes found that the number of frogs decreased as the density of shoreline development increased. On undeveloped lakes one frog was found for every 126 feet of shoreline. On developed lakes it dropped to one frog per every 220 feet, and one frog per 470 feet of shoreline on densely developed lakes.

Accessory Uses (docks, boats, and access): Zoning ordinances can limit lake activities by limiting accessory uses on land such as the number of docks and boats, and allowing access to off-shore properties (often called funnel developments). Bay, Evangeline, and Melrose Townships all limit one dock per lakefront lot and allow up to three moored boats. Melrose Township requires 30 feet of frontage for each off-lake lot for subdivision-owned lakefront parcels.

Site Plan Review: Standards for site plan review and vegetation screening can be helpful in reducing pollutant loads to surface water and also protecting ground water. A site plan consists of the documents and drawings that present information showing what an applicant for zoning approval wants to do on a parcel of land. Site plan review regulations provide an administrative review process to insure the standards contained in the zoning ordinance are complied with as a property is developed. If development does not proceed according to an approved site plan, legal means to require enforcement can be initiated.

The State zoning enabling acts require site plan review for all special land uses and planned unit developments. Communities may extend its application to other land uses. Site plan review is often applied to commercial and industrial uses, land uses requiring more than a specified number of parking spaces, land uses involving structures greater than a specified size, and development in sensitive environmental areas. It can be an effective tool in reducing stormwater runoff problems and protecting ground water.

Site plan review works by specifying the procedures for how special uses may be granted. It describes what information must be contained in an application, such as site description details, future use details, and environmental factors at the site. The advantage of having site plan review standards is that it provides an excellent tool for assessing the potential impacts of a project on neighbors, the environment, and the community. One disadvantage is that many planning commissioners are not trained to properly review the information submitted in this type of application, resulting in an inefficient process.

Site plan review standards are well used by the municipalities in the Little Traverse Bay Watershed. Emmet County and all of the townships have some provisions for site plan review. All the communities require site plan review for all uses other than single-family and two-family residential. Emmet County and Resort Township also exclude site plan review for multi-family residential.

Additionally, the Little Traverse Bay Bands of Odawa have a site plan review statute for tribal lands. The LTBB Planning Department requires a site plan review for all projects. Projects are evaluated against basic criteria for land use consistency, impacts to adjacent properties, traffic, etc. A site plan for development near a water body would be especially carefully reviewed with regard to impervious surfaces, changes to existing drainage patterns, soil erosion, and septic system requirements (if needed). The statute also allows the Planning Department to utilize other Tribal Departments for review, such as the Environmental Services Department and the Natural Resources Department.

Vegetation Screening: Vegetation screening is a strip of vegetation required between land uses to help avoid potential nuisance problems. In particular they are often required for industrial and commercial uses. They can also have an added benefit of helping to remove pollutants from any runoff that might leave the property. Slope, soils, the amount of impervious surface, as well as many other characteristics determine if these types of greenbelts are effective. Many zoning ordinances have set standards for landscaping plans and greenbelts. Evangeline Township is the only community in the Watershed that doesn't contain these provisions in their ordinance. In the Little Traverse Bay Watershed, these provisions would be most effective in areas where industrial or other intensive development is located in the priority area.

Land Cover: Land cover information is another tool used to develop community master plans. Remote sensing data (e.g. aerial photographs and satellite imagery) and field observations are used to categorize geographical areas according to land cover type. Primary land cover

categories are determined based upon natural physical features, dominant vegetation or ecosystem type, and human land use. Land in the Little Traverse Bay Watershed was divided into the following categories: forest, agricultural, wetlands, grasslands, open water, urban, and barren (Figure 13).

This information is extremely valuable during the planning process. Planners, government officials, developers and others are able to view current land use patterns, determine changes that have occurred in the landscape over time, and envision or predict future trends. Statistics for land cover change over time are also useful for correlating water quality with land use.

Degradation of aquatic ecosystems has been shown to be directly related to increased landscape development and urbanization (Klein 1979, Jones and Clark 1987, Steedman 1988). Land cover data for the Little Traverse Bay Watershed from 1992 shows that urban land use remains low (Table 18). However, this information is dated and does not account for the extensive development that has occurred in some areas of the Little Traverse Bay Watershed over the last decade. Updated land cover data should be acquired to view current land cover and compare with the 1992 data to determine change over time.

TABLE 21: Little Traverse Bay Watershed Land Cover Data (1992 USGS)

Land Cover Type	% Land
Forest	50
Agriculture	21
Wetlands	14
Grasslands	8
Open Water	4.5
Urban	2
Barren	0.5

FIGURE 13– Little Traverse Bay Watershed Landcover Map

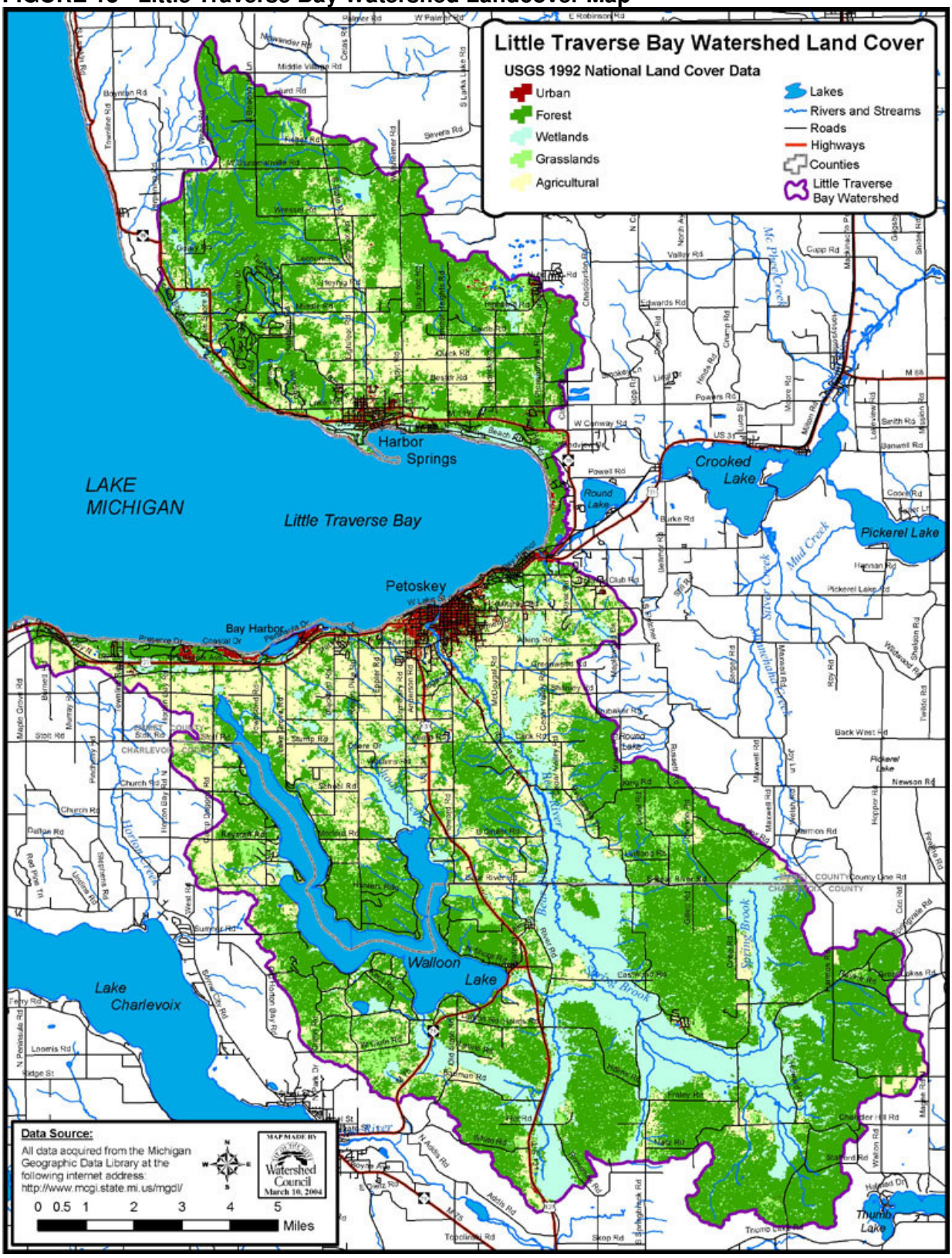


TABLE 22: SUMMARY: Zoning Provisions Affecting Water Quality in the Little Traverse Bay Watershed			
	Bay Township	**Chandler Township**	**City of Harbor Springs**
Water Quality Goals	Facilitate adequate transportation systems, sewage disposal, water, education, and recreation. Encourage the use of lands and natural resources in accordance with their traditional character.	Chandler Township contains a large wetland area which is environmentally sensitive and must be safe guarded. (Master Plan) To facilitate the development of adequate systems of ……sewage disposal, safe and adequate water supplies.	Because the waterfront of the City of Harbor Springs is a community resource, and the only means of access, both visually and physically, to the Harbor Springs harbor, ……..restrict the waterfront from over-development, but allow limited public, private and commercial uses.....which add to public enjoyment of the waterfront and public access to the water.
Special Districts	Wetlands overlay district and conservation reserves district.	Forest Recreation District	WF-Waterfront District WF-1 Waterfront Resort
Shoreline Protection Strips	40 feet width of natural vegetation, pruning allowed. No structures within 65 feet.	35 foot width strip of trees and shrubs maintained in natural state, pruning for view allowed. Planned Unit Development (PUD) : drainage streams shall be protected by 25' natural vegetation strip.	None required.
Shoreline Setbacks	No structures within 65 feet.	50 feet setback from all shorelines.	25 feet (R-1-A residential, WF waterfront, and WF-1 waterfront resort) ; 40 feet (R-1-E residential).
Shoreline Density	Minimum lot width along shoreline areas 100 feet.	Minimum lot width ranges from 300 to 330 feet.	Minimum lot width is 100 feet in R-1-A, WF, and WF-1, and 150 feet for R-1-E.
Accessory Uses (docks, boats, and access)	Each 150 foot lot is allowed: one dock, three moored boats, and one raft Docks must comply with side-yard building setbacks.	Docks and launch sites allowed in Forest Recreational district.	Boat slips and moorings allowed for personal use and temporary use of guests.
Site Plan Review	Planned Unit Development (PUD) includes site plan review requiring map with 2 foot contours, water courses flood plains, natural features, utilities, proposed storm sewer, and sanitary system	Extensive site plan review standards for all new uses except one- and two-family residential uses and agricultural buildings.	Site plans required for all activities except single-family and two-family building, and accessory buildings associated with residential properties.
Vegetation Screening	A ten-foot-wide buffer of trees and shrubs is required for commercial and industrial properties.	Required for PUD, 35 feet wide on exterior boundaries.	Screening with fences or vegetation is required on uses that abut another district, primarily applied to commercial and business uses. Ordinance details the number and type of plantings to be used.
Other	Lakefront parks developed as part of subdivisions require 30 feet of lake frontage for each off-lake lot. Discharge of subsoil footing drain systems to water bodies is not allowed.	PUD requires maximum allowable impervious coverage of 20% of the entire project area. PUD also requires 50% project area set aside as open space.	Residential estates (R-1-E), waterfront, and waterfront resort districts have a maximum lot coverage of 25%. Single-family (R-1-A) has a 40% maximum lot coverage.

TABLE 22: SUMMARY: Zoning Provisions Affecting Water Quality in the Little Traverse Bay Watershed			
	City of Petoskey	**Emmet County**	**Evangeline Township**
Water Quality Goals	"Providing adequate and economical provision of …..water, sewer….."	Proper use of natural resources, agriculture, wildlife, and floodplains. Avoid excessive structural encroachment of natural waters and waterways. Promote high water quality, undisturbed natural area to trap nutrients, and sediments from entering natural waters, prevent erosion.	Conservation of Natural Resources District--Protect water quality, minimize visual impact of water front development. Every building shall be provided with safe, sanitary water supply system, without risk of ground water contamination.
Special Districts	No special districts.	Scenic Resource District SR1&SR2 High Risk Erosion and Environmental Areas	Recreational District includes public lands . Waterfront Overlay Regulations regulate the development and redevelopment of waterfront properties within the township.
Shoreline Protection Strips	None required.	40 feet width strip maintained with natural trees and shrubs in Scenic Resources Districts. 100 feet in High Risk Erosion Areas, 35 feet in other districts.	35 feet minimum width required, maintain natural vegetation, pruning allowed for view. No lawn allowed between greenbelt zone and water and no application of supplemental plant nutrients allowed.
Shoreline Setbacks	Most shoreline property zoned single family residential and multiple family residential. Setbacks equal to yard setbacks, range from 25-50 feet. (Exception of an older subdivision, Rosedale that uses side yard setbacks.)	All structures 60 feet from waterfront. Decks and patios are allowed within 25 feet from waterfront.	Waterfront setback, all structures minimum of 50 feet: 0-12% slope = 50 feet; 12-18% =100 feet; 18-25% =150 feet.
Shoreline Density	Minimum lot width ranges from 50-150 feet. The majority of the shoreline has 70 feet minimum lot width.	Minimum lot width ranges from 100-200 feet.	100 feet minimum lot width on water bodies.
Accessory Uses (docks, boats, access)	No special standards.	No special standards.	One dock and swim raft per 150 feet of frontage. Maximum three motor boats allowed per 150 feet.
Site Plan Review	Site plan review required for all activities except single and two-family homes.	Required for uses other than single family, two-family, or multi-family dwellings.	Extensive site plan review standards required for most uses other than single family dwellings.
Vegetation Screening	No minimum width specified provides suggestions for materials.	Required for non-residential uses when adjacent to residential uses and other special uses. Spacing, plant materials, and maintenance standards are detailed.	Landscaping plans required for all activities requiring site plan review.
Other	Planned Unit Development (PUD) has open space provisions. Stormwater addressed in site plan review. Large amounts of publicly-owned land (as parks or undeveloped) adjacent to water bodies within the city limits.	Steep Slopes Ordinance amendment. Stormwater Ordinance, maximum lot coverage of 30-35% for some districts. Soil Erosion & Sedimentation Control Part 91. .	Lot coverage-maximum 20% lot coverage on parcels within 500 feet of waterbodies. Wetlands provision--no building envelope in hydric soils if upland alternative exists, site plan review required. Hazardous Substances--must meet state and federal standards, no direct or indirect discharges.

TABLE 22: SUMMARY: Zoning Provisions Affecting Water Quality in the Little Traverse Bay Watershed		
	Little Traverse Township	**Melrose Township**
Water Quality Goals	Adequate transportation systems for sewage and water supply.	Adequate transportation systems for sewage and water supply.
Special Districts	Farm and Forest Districts (larger lot requirements)	Single Family Residential District--Lake and Stream
Shoreline Protection Strips	None required.	35 foot strip of trees and shrubs maintained in natural state. Pruning for a view is allowed.
Shoreline Setbacks	Front yard setbacks range from 25 feet to 40 feet	50 feet
Shoreline Density	Minimum lot width is 100 feet for residential. A Local Tourist Business District does not have a minimum to allow for more dense development.	Minimum lot width is 100 feet for most lakeshore properties. Minimum lot width on stream properties ranges from 100-300 feet.
Accessory Uses (docks, boats, access)	No standards for docks, rafts, or access sites.	One boat dock and swim raft allowed for 150 feet of frontage. Three motor boats allowed per 150 feet. Subdivision lakefront parks must have a minimum of 30 feet frontage for each off-lake lot.
Site Plan Review	Site plan review required for all activities except for single family dwellings. Any use or development within 1,000 feet of Little Traverse Bay requires site plan review. Impact assessment must address how it will affect natural resources of the Township and Lake Michigan.	Detailed and thorough "Development Plan Review" required for commercial, industrial, and special uses.
Vegetation Screening	Ordinance requires greenbelts for industrial uses, and many other special uses (e.g., mobile home parks, resorts, race tracks). The "Plant Materials in Greenbelts" details requirements for greenbelts.	Required for commercial and industrial uses.
Other	Ordinance has a "Subdivision Open Space" section. For special uses ordinance assesses impact of the proposed use on the quality and quantity of water resources and water supplies.	Special section restricts grades so as to avoid discharge of surface runoff on abutting properties that will cause inconvenience or damage to adjacent properties. Multiple Family Residential District has density bonus for open space protection.

TABLE 22: SUMMARY: Zoning Provisions Affecting Water Quality in the Little Traverse Bay Watershed		
	Resort Township	**West Traverse Township**
Water Quality Goals	Avoid excessive structural encroachment of natural waterways. Protect natural environment of streams, lakes. Preserve image of landscape. Protection of sensitive features, wildlife habitat, wetlands, lakes, streams, steep slopes, wooded areas. Recognize importance of agriculture.	To meet need for natural resources. Retain natural character of the Township. Preserve open spaces, woodland streams ponds, similar natural assets. Preserve natural features of waterfront district.
Special Districts	Scenic Resource and Historical Resource District High Risk Erosion Overlay Zone (MDEQ)	S-1 Public District Shoreline Protection District W-1 Waterfront Overlay District
Shoreline Protection Strips	40 feet width, maintain natural tree, shrub condition. Pruning allowed for view and dock access.	A natural vegetation strip shall be maintained to the maximum extent possible between the ordinary high water mark and landscape predominated by forest vegetation.
Shoreline Setbacks	All structures and impervious surfaces 60 feet from waterfront. Decks and patios are allowed within 25 feet from waterfront.	60 feet from OHWM of 581.99 feet on Lake Michigan or 60 feet from other water features such as streams, lakes, and ponds.
Shoreline Density	Minimum lot width is 100 feet.	Minimum lot width is 150 feet.
Accessory Uses (docks, boats, access)	No special standards.	No special standards.
Site Plan Review	Site plan review required for all uses except single family, two-family, and multiple family residential uses.	Site plans required for all activities other than single family and two-family residential homes.
Vegetation Screening	Greenbelts required for certain uses. Ordinance contains standards for plant materials and landscaping.	Natural vegetation required.
Other	Planned Unite Development (PUD) has open space provisions. Waterfront setback requirement. High Risk Erosion and Environmental Areas standards.	

chapter
THREE

Priority Pollutants and Best Management Practices

1. Priority Pollutants and their Sources and Causes

The results of the nonpoint source pollution inventories provided data and a more thorough understanding of the problems and threats to Little Traverse Bay, Walloon Lake, the Bear River and other waterways in the Watershed. Using the results of the inventories, the pollutants and pollutant sources were prioritized based on their overall impact to waters in the Watershed (Table 20) and how they most affect the designated uses (Table 21). The priorities and rankings in the following tables were determined by Tip of the Mitt Watershed Council staff with Advisory Committee review.

Two pollutants were given top priority ranking: nutrients and sediment. Nutrients are the priority pollutant for Little Traverse Bay and Walloon Lake and sediment is the priority pollutant for their tributaries. Maintaining the low productivity (oligotrophic status) for Little Traverse Bay and Walloon Lake will require minimizing the amount of nutrient pollution that enters the lake from adjacent properties and the tributaries. Nutrients often attach to soil particles, thereby linking sediment and nutrient pollution. Habitat loss was ranked second, followed by toxics, changes in hydrology, aquatic nuisance species, bacteria, pesticides, and thermal pollution.

TABLE 23: Little Traverse Bay Watershed Priority Pollutants

Pollutants	*Priority Ranking*
Nutrients	1
Sediment	1
Habitat loss	2
Toxics	3
Changes in hydrology	4
Aquatic nuisance species	5
Bacteria	6
Pesticides	6
Thermal pollution	7

Different pollutants have different effects on water uses. For example, large amounts of bacteria in the water make the water unsafe for swimming, but bacteria has little if any effect on navigation. Nutrient and sediment pollution remain the two main pollutants that are resulting in degraded designated uses.

Sediment pollution covers gravel areas harming aquatic insects and spawning areas for fish. Sediments suspended in water make it difficult for fish to forage and the particles can harm fish gills.

Nutrients encourage algae and aquatic plant growth. When the aquatic plants die and decompose they use up large amounts of oxygen, potentially depleting sources for fish. The North Arm of Walloon Lake experiences oxygen depletion in the late summer months. Excess aquatic plants decrease the enjoyment of swimming and boating. Most people prefer to swim in areas with few aquatic plants. Nutrient pollution also can stimulate the growth of aquatic nuisance species such as Eurasian water milfoil. The table below provides a priority ranking of how the different pollutants impact the degraded designated uses.

TABLE 24: Pollutant Priorities for Threatened and Degraded Designated Uses

Designated Uses	*Pollutant*	*Priority Ranking*
Aquatic life/wildlife	Sediment	1
	Nutrients	2
	Habitat loss	2
	Toxics	3
	Changes in hydrology	4
	Aquatic nuisance species	4
	Pesticides	5
Cold water fishery	Sediment (streams)	1
	Nutrients (lake)	1
	Habitat loss	2
	Toxics	3
	Aquatic nuisance species	4
	Changes in hydrology	5
	Thermal	6
	Pesticides	7
Warm water fishery	Sediment (streams)	1
	Nutrients (lake)	1
	Habitat loss	2
	Toxics	3
	Changes in hydrology	4
	Aquatic nuisance species	5
	Pesticides	6
	Thermal	7
Recreation (partial and total body contact)	Bacteria	1
	Nutrients	2
	Sediment	3
	Aquatic nuisance species	4
	Changes in hydrology	5
	Toxics	6
Navigation	Sediment	1
	Nutrients	2

Evaluating and understanding the priority pollutants, pollutant sources, and causes provides a tool to identify what actions should be taken to protect or improve water quality. After completing the nonpoint source pollution inventories, the pollutant sources were ranked according to their impact on water quality. The following table describes the results for the ranking of the pollutants and the main sources. The priority activities or causes for each pollutant source are listed in priority order as well. The table helps to identify the shared pollutant sources and causes. For example, stormwater is a primary source of sediment, nutrient, and toxic pollution. Therefore addressing the causes of stormwater such as direct discharges of urban runoff and fertilizer applications in urban areas should be priority activities for implementation.

TABLE 25: Priority Pollutants and Sources in the Little Traverse Bay Watershed

Pollutant	*Ranking*	*Sources (Ranked in priority order)*	*Causes (Ranked in priority order)*
Sediment	1	Stormwater	Direct discharge of urban runoff. Varied street sweeping.
		Lakeshore development/construction	Lack of proper erosion control measures. Removal of native vegetation. Increase in runoff (causing erosion) from impervious surfaces.
		Lakeshore/streambank erosion	Lack of proper erosion control measures. Recreational access and use.
		Road/stream crossings	Undersized and short culverts. Lack of runoff diversions. Inadequate fill on road surface. Lack of vegetation.
		Livestock access to streams	Unrestricted access to tributaries.
		Forestry activities	Lack of use of best management practices.
		Access sites (boat launches, road ends)	Lack of runoff diversions and erosion control.
		Varied Zoning	Lack of consistent standards and provisions to require shoreline protection strips.
Nutrients	1	Stormwater	Fertilizer applications by businesses and residents in urban areas.
		Lawn care/shoreline property management	Fertilizer applications. Removal of native vegetation.
		Manure application on agricultural fields	Over application of manure on fields without testing soil needs.
		Road/stream crossings	Undersized and short culverts. Lack of runoff diversions. Inadequate fill on road surface. Lack of vegetation.
		Livestock access to streams	Unrestricted access to streams.
		Septic systems	Older systems in lakeshore areas with inadequate system design. Lack of septic system maintenance.
		Golf courses	Fertilizer applications. Lack of buffer strips between course and streams.
Habitat Loss	2	New shoreline construction	Removal of native vegetation. Human interference.
		Historic loss of shoreline habitats	Filling of wetlands before state and federal regulations.

TABLE 25: Priority Pollutants and Sources in the Little Traverse Bay Watershed

Pollutant	*Ranking*	*Sources (Ranked in priority order)*	*Causes (Ranked in priority order)*
		Wetland filling/draining	Cumulative filling of wetlands on a lot by lot basis (as allowed by permits)
Toxics	3	Stormwater	No treatment of urban runoff before discharge to rivers, lakes, and Bay.
		Road/stream crossings	Lack of runoff diversions. Inadequate fill on road surface. Lack of vegetation.
Changes in Hydrology	4	Large volumes of runoff from storms (due to impervious surfaces)	Increasing amounts of impervious surface.
		Dams	Restrict natural flow.
Aquatic nuisance species	5	Ballast water	Discharge of ballast water from Great Lakes shipping vessels from international ports.
		Boat trailers	Trailers spread aquatic nuisance species from one water body to another.
		Natural spread	Wildlife, birds, connected hydrology.
Bacteria	6	Stormwater	Pet and wildlife waste.
		Livestock	Manure piles and livestock in streams.
		Septic systems	Malfunctioning septic systems.
Pesticides	6	Lawn care	Pesticide use on lawns by businesses, residents in urban areas and shoreline homeowners.
		Agriculture fields	Pesticide use on fields.
		Golf courses	Pesticide use on courses.
Thermal pollution	7	Loss of shoreline vegetation	Removal of native vegetation along river corridors.
		Changes in hydrology	Increased flows and runoff from parking lots and impervious surfaces.
		Beaver dams	Unnatural warming of water in dammed area.

2. Proposed Best Management Practices (BMPs)

To address the sources and causes of priority pollutants in the Little Traverse Bay Watershed, a series of best management practices (BMPs) will be implemented. BMPs are techniques, measures, or structural controls designed to minimize or eliminate runoff and pollutants from entering surface and ground waters.

Types of BMPs

Non-structural BMPs are preventative actions that involve management and source controls. This includes policies and ordinances that provide requirements and standards to direct growth of identified areas, protection of sensitive areas such as wetlands and riparian areas, and

maintaining and/or increasing open space (including a dedicated funding source for open space acquisition). Other examples are providing buffers along sensitive water bodies, minimizing impervious surfaces, and minimizing disturbance of soils and vegetation. Additional non-structural BMPs can be education programs for homeowners, students, businesses, developers, and local officials about project designs and everyday actions that minimize water quality impacts.

Structural BMPs are physical systems that are constructed to reduce the impact of development and stormwater runoff on water quality. They can include storage practices such as wet ponds and extended-detention outlet structures; filtration practices such as grassed swales, sand filters, and filter strips; and infiltration practices such as infiltration basins and infiltration trenches.

Since priority pollutants and their sources and causes have been identified in the Little Traverse Bay Watershed, we can determine which BMPs can be used to address these water quality issues. Structural and non-structural BMPs will be used in combination in the Watershed to obtain the maximum reduction or elimination of a pollutant or pollutants. Recommendations for BMPs are located in the action steps outlined in Chapter Four of the Protection Plan. Additional specific stormwater BMP recommendations are located in Appendix A.

BMP Effectiveness

The actual effectiveness or efficiency of a BMP is determined by the size of the BMP implemented (e.g., feet of vegetated buffer or acres of stormwater detention ponds), and how much pollution was initially coming from the source. Table 23 (Huron River Watershed Council, 2003) lists estimates of pollutant removal efficiencies for stormwater BMPs that may be used in the Watershed.

Table 26: Pollutant Removal Efficiencies of Stormwater BMPs

	Pollutant Removal Efficiencies					
Management Practice	**Total Phosphorus**	**Total Nitrogen**	**TSS**	**Metals**	**Bacteria**	**Oil & Grease**
High-powered street sweeping	30-90%		45-90%			
Riparian buffers *Forested: 20-40 m width* *Grass: 4-9 m width*	Forested: 23-42%; Grass: 39-78%	Forested: 85%; Grass: 17-99%	Grass: 63-89%			
Vegetated roofs	70-100% runoff reduction, 40-50% of snow/rainfall. 60% temperature reduction. Structural addition of plants over a traditional roof system.					
Vegetated filter strips *7.5 m length* *45 m width*	40-80%	20-80%	40-90%			
Bioretention	65-98%	49%	81%	51-71%	90%	
Wet extended detention pond	48-90%	31-90%	50-99%	29-73%	38-100%	66%
Constructed wetland	39-83%	56%	69%	(-80)-63%	76%	

Table 26: Pollutant Removal Efficiencies of Stormwater BMPs						
	Pollutant Removal Efficiencies					
Management Practice	**Total Phosphorus**	**Total Nitrogen**	**TSS**	**Metals**	**Bacteria**	**Oil & Grease**
Infiltration trench	50-100%	42-100%	50-100%			
Infiltration basin	60-100%	50-100%	50-100%	85-90%	90%	
Grassed swales	15-77%	15-45%	65-95%	14-71%	(-50)-(-25)%	
Catch basin inlet devices		30-40% sand filter	30-90%			
Sand and organic filter	41-84%	22-54%	63-109%	26-100%	(-23)-98%	
Soil stabilization on construction sites			80-90%			
Sediment basins or traps at construction sites			65%			
Porous pavement	65%	80-85%	82-95%	98-99%		

Information regarding pollutant removal efficiency, designs of BMPs, and costs are constantly evolving and improving. The information contained in the table above is subject to change, and research to use the most current information will continue throughout the implementation phase.

Location of BMPs in the Watershed

The location of structural BMPs depends on the site and site conditions. Table 24 lists general guidelines for the placement of structural BMPs that have been adapted from the rapid assessment protocol of the Center for Watershed Protection (Huron River Watershed Council, 2003). Priority locations for BMP implementation in the Little Traverse Bay Watershed are documented on inventory maps within Chapter Two of the Protection Plan.

Table 27: General Guidelines for Locating Structural BMPs			
Amount of development	Undeveloped	Developing	Developed
Philosophy	Preserve	Protect	Retrofit
Amount of impervious surface	<10%	11-26%	>26%
Water quality	Good	Fair	Fair-Poor
Stream biodiversity	Good-Excellent	Fair-Good	Poor
Channel stability	Stable	Unstable	Highly unstable

Table 27: General Guidelines for Locating Structural BMPs			
Stream protection objectives	Preserve biodiversity and channel stability	Maintain key elements of stream quality	Minimize pollutant loads delivered to downstream waters
Water quality objectives	Sediment and temperature	Nutrients and metals	Bacteria
BMP selection and design criteria	Maintain pre-development hydrology		Maximize pollutant removal and quantity control
	Minimize stream warming and sediment	Maximize pollutant removal, remove nutrients	Remove nutrients, metals, and toxics
	Emphasize filtering systems		

chapter FOUR

Little Traverse Bay Watershed Project— Goals, Objectives, and Recommended Actions

1. Goals and Objectives

The goals and objectives for this project are based on the over-arching goal of ensuring that the designated uses described in Chapter One are maintained or improved. The goals, and their corresponding objectives, are summarized in the table below.

TABLE 28: Little Traverse Bay Watershed Project Goals and Objectives

Goal	Objectives
Improve and maintain navigation in the Bear River and other tributaries by reducing sediment inputs; maintain navigation in Mud Lake by reducing nutrient inputs to avoid excessive weed growth.	***Address sediment pollution by:*** -Stabilizing erosion at road/stream crossings. -Correcting most severe streambank and lakeshore erosion sites. -Reducing the pollutant load from stormwater in the urban areas. -Restricting livestock from streams. -Maintaining adequate recreational access. -Removing sediments from appropriate locations. ***Address nutrient pollution by:*** -Reducing the pollutant load from stormwater in the urban areas. -Reducing the amount of fertilizer used on residential lawns. -Educating about manure application rates and improving manure storage. -Stabilizing erosion at road/stream crossings. -Restricting livestock from streams. -Educating about good shoreline property management (e.g.; septic system maintenance).
Improve warm water fishery by reducing inputs of toxic substances, sediments, and nutrients; controlling aquatic nuisance species; protecting and restoring wetlands.	***Address nutrient pollution by:*** -Reducing the pollutant load from stormwater in the urban areas. -Reducing the amount of fertilizer used on residential lawns. -Educating about manure application rates and improving manure storage. -Stabilizing erosion at road/stream crossings. -Restricting livestock from streams. -Educating about septic system maintenance. ***Address sediment pollution by:*** -Stabilizing erosion at road/stream crossings. -Correcting most severe streambank and lakeshore erosion sites. -Reducing the pollutant load from stormwater in the urban areas. -Restricting livestock from streams. ***Address toxic pollution (oils, grease, heavy metals) by:*** -Reducing the pollutant load from stormwater in urban areas. -Stabilizing erosion and diverting runoff at road/stream crossings. - Encouraging proper disposal of household hazardous waste.

TABLE 28: Little Traverse Bay Watershed Project Goals and Objectives	
Goal	**Objectives**
	Control spread of aquatic nuisance species by: -Providing education to boaters on how to avoid spreading aquatic nuisance species. -Inventory lakes for aquatic nuisance species. ***Protect sensitive lands in the watershed by:*** -Contacting landowners of sensitive lands and educating about land stewardship and protection options. -Ensuring that state and federal wetland laws are properly administered and enforced. -Developing local ordinances to protect wetlands. -Educating landowners, developers, and citizens on the importance of wetland protection. ***Address pesticides pollution by:*** -Reducing the amount of pesticides used on residential lawns. -Improving pesticide application rates on agricultural land.
Improve cold water fishery by reducing inputs of toxic substances, sediments, and nutrients; restoring ground water recharge; protecting and restoring wetlands; controlling aquatic nuisance species; restoring vegetation along rivers and streams to provide shade and wildlife cover.	***Same objectives as warm water fishery, and…*** ***Maintain and restore ground water recharge where possible by:*** -Practicing BMPs for stormwater throughout watershed. -Replacing impervious surfaces with pervious surfaces. -Preventing thermal pollution by maintaining vegetated riparian corridors and managing dams. ***Restore vegetation along rivers and streams to provide shade and wildlife cover:*** -Educating shoreline property owners on the importance of shoreline vegetation. -Providing technical services and cost-share dollars to restore shoreline vegetation. ***Restoring fish passage so that cold water species can move freely within stream corridors by:*** -Identifying barriers to fish passage. -Studying impacts of barrier removal. -Removing barriers using BMPs to avoid downstream sediment transport and prohibit introduction of aquatic nuisance species.
Improve quality of water discharged from urban runoff (stormwater sewers); discourage waterfowl in swimming areas; address possible failing septic systems; research and implement control of swimmer's itch.	***Address bacteria pollution by:*** -Reducing the volume and pollutant load of stormwater in urban areas. -Restricting livestock from streams and improving manure storage and application. -Improving the maintenance of septic systems. ***Reduce problems with swimmer's itch by:*** - Educating landowners and swimmers about how to reduce chances of contracting swimmer's itch.

2. Recommended Actions to Protect the Little Traverse Bay Watershed

In an effort to successfully accomplish the goals and objectives listed above, specific and tangible recommendations were developed by the Tip of the Mitt Watershed Council and reviewed and modified by the Advisory Committee. The following recommendations are organized by the pollutant source or other main topic area (e.g., stormwater and general education). The action steps represent an integrative approach. From restoration to education, the actions are designed to reduce or prevent nonpoint source pollution. Priority recommendations as identified by the Advisory Committee are shown in boldface type.

For each action step, the responsible organization(s) and estimated costs to implement each item have been identified. A responsible organization is not committed to implementing the task, but it does identify the organization, agency, or group that is most appropriate for working on the specific task. The recommendations as listed below are based on a 10 year timeframe, and are organized from short-term to long-term. The goal for completing short-term tasks would be five years or less. Long-term tasks generally require more than five years to accomplish, or will result in an ongoing program. Estimated costs to implement the tasks takes into account materials, travel, etc., as well as the amount of personnel time needed to accomplish the task. The cost estimates takes into account what it would take to complete the task during the ten year time line for this project.

Outside funding is needed to implement these recommendations. Funding opportunities are available through a variety of private and governmental sources. Potential funding sources were identified for each of the recommendations.

Recommended actions to protect the Little Traverse Bay Watershed are listed below, and are also summarized in a table in Appendix G.

A. Stormwater Recommendations

1. Install a demonstration best management practice (BMP) at a residential site (e.g., water ponds, special gardens, rain barrels, etc.) and at a business site (e.g., runoff diversions, sand filter or other infiltration basins).

Responsible Organizations:	Tip of the Mitt Watershed Council, Emmet and Charlevoix County Drain Commissioners
Estimated Cost:	$75,000
Timeline:	Short term, 2006-2009
Task Milestone:	Install one demo site at one residence and one business by 2009
Potential Funding Source:	Private funding and government funding

2. Implement a media campaign to educate residents and businesses about nonpoint source pollution (including disposal of household hazardous waste) and how to reduce stormwater runoff.

Responsible Organizations:	Tip of the Mitt Watershed Council, Emmet and Charlevoix County Drain Commissioners, Emmet County Department of Public Works
Estimated Cost:	$20,000
Timeline:	Short term, 2008-2013
Task Milestone:	Educational materials developed and distributed to city residents (Harbor Springs, Petoskey, Walloon Lake Village).

Potential Funding Source: Private funding and government funding

3. Develop and implement education programs that highlight impacts of stormwater runoff on surface waters. Offer tours to local officials, business owners, and citizens to learn more about stormwater and how to minimize impacts.

Responsible Organizations: Tip of the Mitt Watershed Council, SEE-North, LTBB Odawa, Emmet and Charlevoix County Drain Commissioners
Estimated Cost: $25,000
Timeline: Long term, 2006-2013
Task Milestone: Initiate programs in 2008; conduct five tours by 2013
Potential Funding Source: Private funding and government funding

4. Develop and disseminate a stormwater systems design package with engineering plans and stormwater management information that local governments (and other appropriate entities) can provide to businesses to better manage stormwater.

Responsible Organizations: Tip of the Mitt Watershed Council, Emmet and Charlevoix County Drain Commissioners, Emmet and Charlevoix County Soil Erosion Control Officers
Estimated Cost: $20,000
Timeline: Long-term, 2006-2016
Task Milestone: 20% of developments incorporate appropriate BMPs in two years, and 50% at the end of the project time
Potential Funding Source: Private funding and government funding

5. Develop model stormwater ordinance language for the watershed and support the adoption and enforcement of stormwater ordinances for townships in Emmet and Charlevoix Counties by educating and informing developers, engineers, architects and others. Assess the effectiveness; identify shortcomings, and work to improve stormwater ordinances in Emmet and Charlevoix Counties.

Responsible Organizations: Tip of the Mitt Watershed Council, Emmet and Charlevoix County Planning Offices, Emmet and Charlevoix County Soil Erosion Control Officers, Walloon Lake Association, Emmet County Ordinance Enforcement Office, Townships
Estimated Cost: $20,000
Timeline: Long term, 2006-2016
Task Milestone: Develop model ordinance language by 2010
Potential Funding Source: Private funding and government funding

6. Provide programs and resources to Emmet and Charlevoix Counties' contractors about soil erosion and stormwater management techniques.

Responsible Organizations: Emmet and Charlevoix County Drain Commissioners, Emmet County Ordinance Enforcement Office, Charlevoix County Soil Erosion Control Office, Tip of the Mitt Watershed Council
Estimated Cost: $30,000
Timeline: Long term, 2006-2016
Task Milestone: Initiate in 2009; 50% of contractors attend events by the end of the project time
Potential Funding Source: Private funding and government funding

7. Work with businesses in the urban areas (particularly in locations adjacent to the Bear River, Tannery Creek, and the Bay) to reduce stormwater runoff from their sites.

Responsible Organizations: Tip of the Mitt Watershed Council, Emmet and Charlevoix County

Drain Commissioners
Estimated Cost: $300,000
Timeline: Long term, 2006-2016
Task Milestone: 2% in the first two years and 10% of the businesses install BMPs
Potential Funding Source: Private funding and government funding

8. Work cooperatively with local units of government to develop and implement stormwater management plans. Develop a basic outline of a stormwater management plan to provide as a template to communities.
Responsible Organizations: Tip of the Mitt Watershed Council, City of Petoskey, City of Harbor Springs, Bay Harbor, Walloon Lake Village-Melrose Township, Emmet and Charlevoix County Drain Commissioners, Local Emergency Planning Committee, LTBB Odawa
Estimated Cost: $2,000,000
Timeline: Long term, 2006-2016
Task Milestone: Complete plans and begin implementation in 2011
Potential Funding Source: Private funding and government funding

9. Implement priorities identified in stormwater management plans. Work cooperatively with local units of government to implement stormwater management using a variety of methods and tools (e.g., marking storm drains, mapping storm sewers, street sweeping).
Responsible Organizations: Tip of the Mitt Watershed Council, City of Petoskey, City of Harbor Springs, Bay Harbor, Walloon Lake Village-Melrose Township, Local Emergency Planning Committee, LTBB Odawa, Emmet and Charlevoix County Drain Commissioners
Estimated Cost: $2,000,000
Timeline: Long term, 2006-2016
Task Milestone: Communities are implementing tasks from the stormwater management plans by 2011
Potential Funding Source: Private funding and government funding

10. Conduct and update impervious surface studies on the tributaries and shoreline area.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $30,000
Timeline: Long term, 2006-2016
Task Milestone: 75% of the tributaries have completed inventories by 2011
Potential Funding Source: Private funding and government funding

B. Shoreline Protection, Restoration, and Management Recommendations

1. Develop a hand-out on riverfront living and distribute to river and stream riparians in the Watershed.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $20,000
Timeline: Short term, 2007
Task Milestone: Develop text and mailing list
Potential Funding Source: Private funding and government funding

2. Develop a plan with the City of Petoskey to improve the shoreline habitat and recreation

opportunities for the Bear River corridor.
Responsible Organizations: Tip of the Mitt Watershed Council, City of Petoskey
Estimated Cost: $15,000
Timeline: 2005
Task Milestone: TASK COMPLETED
Potential Funding Source: Private funding and government funding

3. Support the adoption of the National Aquatic Invasive Species Act (NAISA) and other policies that will regulate some sources and activities that spread invasives.
Responsible Organizations: Tip of the Mitt Watershed Council, Emmet County Lakeshore Association
Estimated Cost: $5,000
Timeline: Short term, 2009
Task Milestone: NAISA adopted
Potential Funding Source: Private funding

4. Work with marinas to reduce nonpoint source pollution from boaters and marina facilities and the spread of aquatic nuisance species by utilizing best management practices. Encourage marinas throughout the watershed to participate in Clean Marinas Program.
Responsible Organizations: Tip of the Mitt Watershed Council, City of Petoskey, City of Harbor Springs, private marinas
Estimated Cost: $50,000
Timeline: Short term, 2007-2011
Task Milestone: 25% of marinas participate in program by 2008
Potential Funding Source: Private funding and government funding

5. Conduct inventories to assess nonpoint source pollution problems at boat access locations.
Responsible Organizations: Tip of the Mitt Watershed Council, Michigan Department of Natural Resources, Walloon Lake Association
Estimated Cost: $15,000
Timeline: Short term, 2010-2014
Task Milestone: Identify access sites to inventory
Potential Funding Source: Private funding and government funding

6. Create and distribute educational packages to realtors for shoreline property clients.
Responsible Organizations: Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet County Lakeshore Association, Emmet and Charlevoix County Drain Commissioners
Estimated Cost: $10,000
Timeline: Short term, 2006-2010
Task Milestone: Develop a database of interested realtors
Potential Funding Source: Private funding and government funding

7. Develop and begin implementation of an education campaign to protect aquatic habitats in areas of new development and recreate habitats in developed shoreline areas.
Responsible Organizations: Tip of the Mitt Watershed Council, LTBB Odawa
Estimated Cost: $100,000
Timeline: Short term, 2011-2016
Task Milestone: Develop campaign by 2013
Potential Funding Source: Private funding and government funding

8. Conduct follow-up activities with property owners who have shoreline algae (provide a

questionnaire, information and specific guidance, and site visits) to reduce nutrient inputs.

Responsible Organizations: Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet County Lakeshore Association
Estimated Cost: $40,000
Timeline: Short term, 2006-2011
Task Milestone: Conduct follow-up activities every other year
Potential Funding Source: Private funding and government funding

9. Develop and implement a plan to reduce hardened shorelines in Little Traverse Bay.

Responsible Organizations: Tip of the Mitt Watershed Council, City of Petoskey, City of Harbor Springs, Lakeshore Associations, Emmet County Planning and Zoning
Estimated Cost: $300,000
Timeline: Long term, 2008-2014
Task Milestone: 50% of the hardened shorelines are softened by biotechnology
Potential Funding Source: Private funding and government funding

10. Educate shoreline residents on the importance of near shore habitat, impacts from beach sanding and grooming, living in mucky areas, aquatic vegetation, etc.

Responsible Organizations: Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet County Lakeshore Association, LTBB Odawa, Emmet and Charlevoix County Soil Erosion Officers
Estimated Cost: $75,000
Timeline: Long term, 2006-2016
Task Milestone: Publish a series of press releases, articles in association newsletters on these topics for five-years.
Potential Funding Source: Private funding and government funding

11. Inventory riparian corridors of the tributaries to assess health, diversity, and density of vegetation.

Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $20,000
Timeline: Long term, 2006-2016
Task Milestone: Complete inventories on 25% of the tributaries.
Potential Funding Source: Private funding and government funding

12. Develop a strategy to restore the moderate and minor shoreline erosion sites on a subwatershed basis.

Responsible Organizations: Tip of the Mitt Watershed Council, Emmet and Charlevoix Conservation Districts, Walloon Lake Association, LTBB Odawa, lakeshore associations, riparian property owners
Estimated Cost: $300,000
Timeline: Long term, 2006-2016
Task Milestone: Initiate an updated survey in five years
Potential Funding Source: Private funding and government funding

13. Restore the natural stream channel and aquatic habitat of Tannery Creek.

Responsible Organizations: Tip of the Mitt Watershed Council, US Fish and Wildlife Service, LTBB Odawa, Bay View Country Club
Estimated Cost: $200,000
Timeline: Long term, 2006-2016
Task Milestone: Begin shoreline restoration by 2010; Remove dam, install lamprey

weir, and restore 200 feet of shoreline
Potential Funding Source: Private funding and government funding

14. Repair most severe lakeshore and streambank erosion sites.
Responsible Organizations: Tip of the Mitt Watershed Council, Emmet and Charlevoix Conservation Districts, Walloon Lake Association, lakeshore associations, riparian property owners, LTBB Odawa, Emmet and Charlevoix County Drain Commissioners
Estimated Cost: $500,000
Timeline: Long term, 2006-2016
Task Milestone: 50% of the severe sites restored
Potential Funding Source: Private funding and government funding

15. Sponsor seminars for landscaping companies to learn more about water quality friendly practices.
Responsible Organizations: Tip of the Mitt Watershed Council, Emmet and Charlevoix Conservation Districts
Estimated Cost: $25,000
Timeline: Long term, 2006-2016
Task Milestone: Sponsor three seminars
Potential Funding Source: Private funding and government funding

16. Repeat the shoreline pollution inventories on Walloon Lake and Little Traverse Bay and associated follow-up actions at least every five years. Maintain an up-to-date database.
Responsible Organizations: Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet County Lakeshore Association
Estimated Cost: $60,000
Timeline: Long term, 2006-2016
Task Milestone: Initiate inventory updates every five years
Potential Funding Source: Private funding and government funding

17. Install demonstration natural vegetation strips on shoreline properties on the lakes, Bay, and tributaries.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $150,000
Timeline: Long term, 2006-2016
Task Milestone: Install ten sites
Potential Funding Source: Private funding and government funding

18. Promote the use of native plant species, particularly for shoreline properties, and work with local nurseries to stock local genotypes.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $20,000
Timeline: Long term, 2006-2016
Task Milestone: 50% of local nurseries carrying native genotypes
Potential Funding Source: Private funding and government funding

19. Monitor for the presence of invasive species and work to control purple loosestrife, Eurasian water milfoil, and other species that impair aquatic habitat.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $100,000
Timeline: Long term, 2006-2016

Task Milestone: Database initiated for existing presence of invasives by 2007
Potential Funding Source: Private funding and government funding

20. Restore shoreline wetlands that have been altered.
Responsible Organizations: Tip of the Mitt Watershed Council, Natural Resources Conservation Service, US Fish and Wildlife Service
Estimated Cost: $300,000
Timeline: Long term, 2006-2016
Task Milestone: 10 wetland restoration projects in 10 years
Potential Funding Source: Private funding and government funding

C. Zoning and Land Use Recommendations

1. Publish a handout/brochure (also available on websites) that lists information on permits needed and whom to contact when conducting construction or earth-change activities that could impact water quality.
Responsible Organizations: Charlevoix County Planning, Emmet County Planning, Tip of the Mitt Watershed Council, Emmet and Charlevoix County Soil Erosion Officers, Emmet and Charlevoix County Drain Commissioners, Citizens for Open Space, Tunnel of Trees Heritage Highway, City of Petoskey
Estimated Cost: $5,000
Timeline: Short term, 2006
Task Milestone: Print 5,000 copies of the brochure
Potential Funding Source: Private funding and government funding

2. Work with local governments to provide better zoning tools to help protect water quality (e.g., documenting greenbelt conditions, ordinance language).
Responsible Organizations: Walloon Lake Association, Charlevoix County Planning, Emmet County Planning, Tip of the Mitt Watershed Council, LTBB Odawa, Emmet and Charlevoix County Drain Commissioners, Citizens for Open Space, HARBOR Inc., City of Petoskey
Estimated Cost: $40,000
Timeline: Short term, 2007-2009
Task Milestone: Adoption of water quality protection provisions by 50% of local governments
Potential Funding Source: Private funding and government funding

3. Identify waterfront lots that are nonconforming to zoning ordinances and work with townships/cities/counties to discuss potential water quality impacts and solutions.
Responsible Organization: Tip of the Mitt Watershed Council
Estimated Cost: $8,000
Timeline: Short term, 2008-2011
Task Milestone: Identify lots in 2008
Potential Funding Source: Private funding and government funding

4. Assess the benefits and limitations of septic inspection programs, septic maintenance districts, and standards for alternative systems, and develop a strategy to utilize the tools that help protect water quality.
Responsible Organizations: Northwest Michigan Community Health Agency, Walloon Lake Association, Tip of the Mitt Watershed Council

Estimated Cost: $4,000
Timeline: Short term, 2006-2009
Task Milestone: TASK COMPLETED

5. Meet with local golf course managers and discuss management techniques to reduce nonpoint source pollution.
Responsible Organizations: MSU Extension, Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet and Charlevoix County Conservation Districts
Estimated Cost: $6,000
Timeline: Short term, 2006-2011
Task Milestone: 50% of golf courses members of MSU program by 2011
Potential Funding Source: Private funding and government funding

6. Develop a series of zoning guidelines and standards that are supported by science (e.g., setbacks for waterfront properties, the benefits of a 75 ft setback over a 40 ft setback).
Responsible Organizations: Citizens for Open Space, HARBOR Inc., government agencies, Tip of the Mitt Watershed Council
Estimated Cost: $75,000
Timeline: Long term, 2009-2016
Task Milestone: Zoning guidelines and standards are developed for two specific topics (priorities—vegetation strip, setbacks).
Potential Funding Source: Private funding and government funding

7. Use the "Harbor Plan" report as a model to acquire state clout to enforce local plans and ordinances.
Responsible Organizations: Citizens for Open Space, HARBOR Inc., government agencies, Tip of the Mitt Watershed Council, LTBB Odawa, City of Petoskey
Estimated Cost: $50,000
Timeline: Long term, 2006-2016
Task Milestone: Distribute copies of the "Harbor Plan" to the Advisory Committee.
Potential Funding Source: Private funding and government funding

8. Implement an ongoing education program for local governments on land use planning tools that can help protect water quality and encourage better coordination amongst neighboring townships (e.g., conservation planning and design and impact coordination rules, provide tools, examples, and model ordinances).
Responsible Organizations: Charlevoix County Planning, Emmet County Planning, Townships, HARBOR Inc., Citizens for Open Space, MSU Extension, Tip of the Mitt Watershed Council, LTBB Odawa, Emmet and Charlevoix County Drain Commissioners
Estimated Cost: $70,000
Timeline: Long term, 2006-2016
Task Milestone: Develop program by 2009; hold first program by 2010
Potential Funding Source: Private funding and government funding

9. Form a partnership of interested agencies and organizations to set standards for septic systems that protect water quality.
Responsible Organizations: Northwest Community Health Agency, HARBOR Inc., Emmet County Planning, Charlevoix County Planning, Tip of the Mitt Watershed Council, Walloon Lake Association
Estimated Cost: $20,000

Timeline: Long term, 2006-2016
Task Milestone: Set standards by 2010
Potential Funding Source: Private funding and government funding

10. Sponsor annual education program for lake and river realtors/developers/builders on special regulations and management for riparian properties.
Responsible Organizations: Charlevoix County Planning, Emmet County Planning, Walloon Lake Association, Tip of the Mitt Watershed Council, Little Traverse Conservancy, Charlevoix County Land Conservancy, Michigan Department of Natural Resources
Estimated Cost: $30,000
Timeline: Long term, 2006-2016
Task Milestone: 25% of realtors attend the first event
Potential Funding Source: Private funding and government funding

11. Annually sponsor a program for new planning commissioners, zoning board of appeals members, and township and county board members, to provide information about how their decision-making role influences water quality.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $30,000
Timeline: Long term, 2006-2016
Task Milestone: 25% of officials attend the first event
Potential Funding Source: Private funding and government funding

12. Organize a network of local planning units in the Watershed and work towards developing shared, high standards for provisions that protect water quality (e.g., setbacks).
Responsible Organizations: Charlevoix County Planning, Emmet County Planning, MSU Extension, Townships, Tip of the Mitt Watershed Council, LTBB Odawa, Emmet and Charlevoix County Drain Commissioners
Estimated Cost: $60,000
Timeline: Long term, 2006-2016
Task Milestone: 75% of local governments adopt similar high standards
Potential Funding Source: Private funding and government funding

13. Develop a yearly summary of variances of sanitary code/zoning to determine if there are water quality impacts.
Responsible Organizations: Northwest Michigan Community Health Agency, Tip of the Mitt Watershed Council
Estimated Cost: $10,000
Timeline: Long term, 2006-2016
Task Milestone: Summary reports produced
Potential Funding Source: Private funding and government funding

14. Increase awareness and promote the benefits of purchase of development rights (PDR) programs as a tool for water quality protection.
Responsible Organizations: Walloon Lake Association, Tip of the Mitt Watershed Council, Little Traverse Conservancy, Charlevoix County Land Conservancy, Citizens for Open Space, HARBOR Inc.
Estimated Cost: $40,000
Timeline: Long term, 2006-2016
Task Milestone: PDR program adopted by a local government

Potential Funding Source: Private funding and government funding

15. Encourage sound community planning and development to promote watershed protection (e.g., support the Citizens for Open Space, open space preservation, redevelopment).
Responsible Organizations: Citizens for Open Space, Charlevoix County Planning, Emmet County Planning, MSU Extension, Townships, Tip of the Mitt Watershed Council, LTBB Odawa, City of Petoskey
Estimated Cost: $50,000
Timeline: Long term, 2006-2016
Task Milestone: Adoption of open space provisions by 50% of local governments
Potential Funding Source: Private funding and government funding

16. Encourage more coordination of township planning efforts on a county-wide scale including efforts to review existing plans and studies.
Responsible Organizations: Citizens for Open Space, government agencies, HARBOR Inc., Tip of the Mitt Watershed Council
Estimated Cost: $100,000
Timeline: Long term, 2006-2016
Task Milestone: Develop inventory/list of existing plans
Potential Funding Source: Private funding and government funding

17. Educate watershed residents, including students, about land use issues and foster citizen involvement in local land use decision making.
Responsible Organizations: Charlevoix County Planning, Emmet County Planning, Walloon Lake Association, Tip of the Mitt Watershed Council, HARBOR, Inc., Citizens for Open Space, LTBB Odawa, Charlevoix County Land Conservancy, SEE-North
Estimated Cost: $50,000
Timeline: Long term, 2006-2016
Task Milestone: Conduct survey to document current status of knowledge and involvement
Potential Funding Source: Private funding and government funding

D. Road/Stream Crossing Recommendations

1. Develop strategy to update inventories on a regular basis and evaluate site severity taking into account locations identified as environmentally sensitive.
Responsible Organizations: Emmet County Road Commission, Charlevoix County Road Commission, Conservation Resource Alliance, Tip of the Mitt Watershed Council, LTBB Odawa
Estimated Cost: $15,000
Timeline: Short term, 2011
Task Milestone: Database is placed online.
Potential Funding Source: Private funding and government funding

2. Develop a method to keep track of repairs/records of culverts and problems.
Responsible Organizations: Emmet County Road Commission, Charlevoix County Road Commission, Conservation Resource Alliance, Tip of the Mitt Watershed Council
Estimated Cost: $20,000

Timeline: Short term, 2008
Task Milestone: Implement LIAA/CRA method by 2008
Potential Funding Source: Private funding and government funding

3. Develop and implement strategy to restore moderate and minor road/stream crossing sites on a subwatershed basis.
Responsible Organizations: Emmet County Road Commission, Charlevoix County Road Commission, Tip of the Mitt Watershed Council, Conservation Resource Alliance
Estimated Cost: $3,000,000
Timeline: Short term, 2006-2008
Task Milestone: Identify funding sources, timelines, and other potential partners for six sites.
Potential Funding Source: Private funding and government funding

4. Work closely with road commissions to utilize best management practices (BMPs) on road work within the priority area.
Responsible Organizations: Emmet County Road Commission, Charlevoix County Road Commission, Tip of the Mitt Watershed Council, Conservation Resource Alliance
Estimated Cost: $30,000
Timeline: Short term, 2010-2016
Task Milestone: Sponsor two better back road trainings for road commission staff.
Potential Funding Source: Private funding and government funding

5. Restore most severe road/stream crossings in cooperation with the Emmet and Charlevoix County Road Commissions.
Responsible Organizations: Emmet County Road Commission, Charlevoix County Road Commission, Conservation Resource Alliance
Estimated Cost: $5,000,000
Timeline: Long term, 2006-2016
Task Milestone: 25% are restored by 2010
Potential Funding Source: Private funding and government funding

E. Agriculture Recommendations

1. Work with farmers to implement GAAMPS (Generally Accepted Agricultural Management Practices) for severe and moderate agricultural sites and possibly use as demonstration sites.
Responsible Organizations: Emmet and Charlevoix Conservation Districts
Estimated Cost: $100,000
Timeline: Short term, 2006-2010
Task Milestone: 50% of the severe and moderate sites are improved
Potential Funding Source: Private funding and government funding

2. Work with Conservation Stewardship Program (CSP) to implement best management practices and GAAMPS.
Responsible Organizations: Emmet and Charlevoix Conservation Districts
Estimated Cost: $50,000
Timeline: Long term, 2006-2016

Task Milestone: Implement 25% more BMPs and GAAMPS
Potential Funding Source: Government funding

3. Promote sustainable agriculture (both financial and ecological) and value-added crops or products for agricultural producers (the water quality connection to this activity is to maintain low-impact agriculture, the open space associated with the farms, and minimal impervious surface).
Responsible Organizations: Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension
Estimated Cost: $100,000
Timeline: Long term, 2006-2016
Task Milestone: Fund sustainable agriculture conference registration for ten agricultural producers
Potential Funding Source: Private funding and government funding

4. Promote local agriculture and encourage residents to purchase locally grown products.
Responsible Organizations: Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension
Estimated Cost: $50,000
Timeline: Long term, 2006-2016
Task Milestone: Have two agricultural producers from Little Traverse Bay participating in local farmers' markets.
Potential Funding Source: Private funding and government funding

5. Investigate minor sites to determine extent of problems and implement GAAMPS where possible.
Responsible Organizations: Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension
Estimated Cost: $25,000
Timeline: Long term, 2006-2016
Task Milestone: 25% of the minor sites are improved
Potential Funding Source: Private funding and government funding

6. Cooperate with Groundwater Stewardship Program to encourage better nutrient management and other activities on farms that are both a surface water and ground water concern.
Responsible Organizations: Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension
Estimated Cost: $15,000
Timeline: Long term, 2006-2016
Task Milestone: 25% reduction in fertilizer use on agricultural fields
Potential Funding Source: Private funding and government funding

7. Distribute information to farmers on manure application, benefits of filter strips, and other topics using existing materials on agricultural best management practices.
Responsible Organizations: Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension
Estimated Cost: $4,000
Timeline: Long term, 2006-2016
Task Milestone: 20% increase in use of best management practices
Potential Funding Source: Private funding and government funding

8. Work to maximize funding available for GAAMPS by accessing federal programs (farm bill, EQIP, and others) and state programs.

Responsible Organizations: Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension
Estimated Cost: $25,000
Timeline: Long term, 2006-2016
Task Milestone: 50% of the projects benefit from these programs
Potential Funding Source: Private funding and government funding

F. Land Protection Recommendations

1. Share the selection criteria for identifying sensitive areas with local units of government for master plans and other land use decisions.

Responsible Organizations: Little Traverse Conservancy, Charlevoix County Land Conservancy, Walloon Lake Trust and Conservancy, LTBB Odawa
Estimated Cost: $15,000
Timeline: Short term, 2006
Task Milestone: TASK COMPLETED
Potential Funding Source: Private funding and government funding

2. Send follow-up letter to property owners identified with priority sensitive lands and make personal contacts with landowners.

Responsible Organizations: Little Traverse Conservancy, Charlevoix County Land Conservancy, Walloon Lake Trust and Conservancy
Estimated Cost: $30,000
Timeline: Long term, 2006-2016
Task Milestone: Letters sent bi-annually
Potential Funding Source: Private and government funding

3. Continue to work with Michigan Department of Natural Resources on potential assist and transfer projects on priority sensitive lands in the Little Traverse Bay Watershed.

Responsible Organizations: Little Traverse Conservancy, Charlevoix County Land Conservancy, Walloon Lake Trust and Conservancy
Estimated Cost: $6,000
Timeline: Long term, 2006-2016
Task Milestone: 200 acres protected through assist and transfer
Potential Funding Source: Private and government funding

4. Review the priority sensitive land parcel inventory annually to track land protection progress and identify additional priority parcels for protection.

Responsible Organizations: Little Traverse Conservancy, Charlevoix County Land Conservancy, Walloon Lake Trust and Conservancy, Tip of the Mitt Watershed Council
Estimated Cost: $5,000
Timeline: Long term, 2006-2016
Task Milestone: Identify parcels acquired annually; priority parcel list generated annually
Potential Funding Source: Private and government funding

G. Forestry and Mining Recommendations

1. Work with Michigan Department of Natural Resources to revise forest management plans to reduce impacts from forestry and recreation for sensitive parcels in the Watershed.

Responsible Organizations: Emmet and Charlevoix Conservation Districts, Tip of the Mitt Watershed Council, Michigan Department of Natural Resources, Mackinaw Forest Council, LTBB Odawa
Estimated Cost: $15,000
Timeline: Short term, 2008-2010
Task Milestone: Attend DNR Open Houses.
Potential Funding Source: Private funding and government funding

2. Send information packet on forestry best management practices to key property owners in the priority areas of the Watershed.

Responsible Organizations: Emmet and Charlevoix Conservation Districts
Estimated Cost: $5,000
Timeline: Short term, 2010-2016
Task Milestone: Gather newest materials on forest management for packets.
Potential Funding Source: Private funding and government funding

3. Develop guidelines to minimize impacts to water quality from mineral extraction and require adequate restoration.

Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $25,000
Timeline: Short term, 2011-2016
Task Milestone: Collect existing model standards, ordinances, or research on restoration.
Potential Funding Source: Private funding and government funding

4. Work with Michigan Department of Natural Resources to review forestry plans within the Watershed and ensure BMPs are required in all contracts, and management plans are consistent with Watershed project goals.

Responsible Organizations: Emmet and Charlevoix Conservation Districts, Michigan Department of Natural Resources, Mackinaw Forest Council
Estimated Cost: $25,000
Timeline: Long term, 2008-2016
Task Milestone: Review 25% of plans by 2010
Potential Funding Source: Private funding and government funding

5. Offer development of forest management plans for private landowners in the priority area that emphasize BMPs to protect water quality.

Responsible Organizations: Emmet and Charlevoix Conservation Districts
Estimated Cost: $10,000
Timeline: Long term, 2006-2016
Task Milestone: Provide 20 plans in five years
Potential Funding Source: Private and government funding

H. General Information and Education Recommendations

1. Produce a summary of the Watershed Plan and distribute to Watershed residents.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $12,000
Timeline: Short term, 2004-2005
Task Milestone: TASK COMPLETED
Potential Funding Source: Private funding and government funding

2. Develop a program to educate boaters at the marinas to reduce their impacts from invasives, boat washing, tank pumping, litter, and boating practices.
Responsible Organizations: Tip of the Mitt Watershed Council, Emmet County Lakeshore Association, Walloon Lake Association
Estimated Cost: $50,000
Timeline: Short term, 2006-2011
Task Milestone: Involve 75% of the marinas in five years
Potential Funding Source: Private funding and government funding

3. Create a long-term funding source to help fund the actions in this plan.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $100,000
Timeline: Long term, 2006-2016
Task Milestone: Begin fundraising in 2009
Potential Funding Source: Private funding and government funding

4. Develop a "place-based" water resource education program for elementary and secondary students.
Responsible Organizations: SEE-North
Estimated Cost: $100,000
Timeline: Long term, 2006-2016
Task Milestone: Develop program outline and obtain funding
Potential Funding Source: Private funding

5. Initiate Volunteer Purple Corp to manage and control purple loosestrife.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $15,000
Timeline: Long-term, 2006-2016
Task Milestone: Conduct inventory of purple loosestrife around Walloon Lake and the Bear River
Potential Funding Source: Private funding and government funding

6. Develop a portable display about the Watershed and actions needed to protect and improve its health and take it to local events (fairs, festivals, camps).
Responsible Organization: Tip of the Mitt Watershed Council
Estimated Cost: $20,000
Timeline: Long term, 2006-2016
Task Milestone: Develop display by 2009
Potential Funding Source: Private funding and government funding

7. Continue to educate the public about nonpoint source pollution using organizational newsletters of the Little Traverse Bay Watershed Plan partners and press releases.
Responsible Organizations: Tip of the Mitt Watershed Council, Project Partners

Estimated Cost: $5,000
Timeline: Long term, 2006-2016
Task Milestone: Print three articles annually
Potential Funding Source: Private funding and government funding

8. Give presentations to promote the project's goals and activities.
Responsible Organization: Tip of the Mitt Watershed Council
Estimated Cost: $20,000
Timeline: Long term, 2006-2016
Task Milestone: Conduct five presentations annually
Potential Funding Source: Private funding and government funding

9. Sponsor clean-ups of the Bear River and other tributaries to remove litter and increase civic pride and community connection to area water resources.
Responsible Organization: Tip of the Mitt Watershed Council
Estimated Cost: $30,000
Timeline: Long term, 2006-2016
Task Milestone: Sponsor clean-ups biannually
Potential Funding Source: Private funding and government funding

10. Sponsor Bear River Bio Blitz to build a data base of ecological health of the river and engage the community.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $50,000
Timeline: Long term, 2006-2016
Task Milestone: Collect ten data sets at four locations in ten years
Potential Funding Source: Private funding and government funding

I. Water Quality Monitoring Recommendations

1. Involve associations along the Bay in monitoring beaches for bacteria.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $10,000
Timeline: Long term, 2006-2016
Task Milestone: Three associations collect weekly bacteria samples
Potential Funding Source: Private funding and government funding

2. Work with volunteers to gather data on Little Traverse Bay algae and develop database.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $50,000
Timeline: Long term, 2006-2016
Task Milestone: Establish 10 monitoring sites in 2006
Potential Funding Source: Private funding and government funding

3. Monitor stormwater outlets around the Bay to document pollutant loadings and changes over time.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $100,000
Timeline: Long term, 2006-2016
Task Milestone: Collect two seasons of data for Harbor Springs

Potential Funding Source: Private funding and government funding

4. Monitor the physical, chemical, and biological characteristics of Little Traverse Bay.
Responsible Organizations: Tip of the Mitt Watershed Council, LTBB Odawa
Estimated Cost: $100,000
Timeline: Long term, 2006-2016
Task Milestone: Develop monitoring protocol by 2008
Potential Funding Source: Private funding and government funding

5. Advocate for stronger water quality standards for Little Traverse Bay, Walloon Lake, and its tributaries.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $75,000
Timeline: Long term, 2006-2016
Task Milestone: Research process for upgrading standards and outline strategy
Potential Funding Source: Private funding and government funding

6. Monitor physical, chemical, and biological characteristics of tributaries throughout the watershed.
Responsible Organizations: Tip of the Mitt Watershed Council, LTBB Odawa
Estimated Cost: $100,000
Timeline: Long term, 2006-2016
Task Milestone: Collect data on 50% of the tributaries
Potential Funding Source: Private funding and government funding

7. Establish air quality monitoring stations to detect trends in air quality.
Responsible Organizations: Tip of the Mitt Watershed Council, LTBB Odawa
Estimated Cost: $200,000
Timeline: Long term, 2006-2016
Task Milestone: Identify potential locations for stations
Potential Funding Source: Private funding and government funding

8. Research how to determine the "air shed" for Little Traverse Bay and identify potential pollution locations.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $100,000
Timeline: Long term, 2006-2016
Task Milestone: Gather existing information on Lake Michigan air shed
Potential Funding Source: Private funding and government funding

9. Recruit volunteer stream monitors for the tributaries in the watershed.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $50,000
Timeline: Long term, 2006-2016
Task Milestone: Monitor four of the larger tributaries in five years
Potential Funding Source: Private funding and government funding

10. Monitor reports from point source discharges to Little Traverse Bay.
Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $10,000
Timeline: Long term, 2006-2016
Task Milestone: Share annual updates with advisory committee

Potential Funding Source: Private funding and government funding

11. Establish an on-going program to monitor and study the shoreline along Bay Harbor to determine levels of contaminated leachate and assess the impact to the Bay's ecosystem.

Responsible Organizations: Tip of the Mitt Watershed Council, LTBB Odawa
Estimated Cost: $50,000
Timeline: Long term, 2006-2016
Task Milestone: Review clean up progress annually
Potential Funding Source: Private funding and government funding

J. Hydrology Recommendations

1. Develop a ground water recharge management plan in cooperation with the Michigan Department of Natural Resources and the District Health Department for identified sensitive locations in the Watershed.

Responsible Organizations: Tip of the Mitt Watershed Council, Michigan Department of Natural Resources
Estimated Cost: $7,000
Timeline: Short term, 2006-2010
Task Milestone: Develop plan by 2010
Potential Funding Source: Private funding and government funding

2. Develop guidelines and adopt policies to manage potential water extraction.

Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $150,000
Timeline: Long term, 2006-2016
Task Milestone: Establish guidelines by 2009
Potential Funding Source: Private funding and government funding

3. Assess the condition and impacts of dams in the Watershed and develop management options; prioritize dams for removal that are not providing economic or ecological benefits.

Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $600,000
Timeline: Long term, 2006-2016
Task Milestone: Conduct an inventory of existing dams
Potential Funding Source: Private funding and government funding

4. Develop maps to show ground water recharge, major aquifers, and general direction of ground water flow.

Responsible Organizations: Tip of the Mitt Watershed Council
Estimated Cost: $20,000
Timeline: Long term, 2006-2016
Task Milestone: Develop maps by 2011; update in 2016
Potential Funding Source: Private funding and government funding

K. Evaluation

1. Document the before status of all physical improvements with photographs.

Responsible Organizations: Tip of the Mitt Watershed Council, Conservation Resource Alliance, Charlevoix and Emmet Conservation Districts
Estimated Cost: $5,000
Timeline: Long term, 2006-2016
Task Milestone: Develop an online photo database of before and after photographs
Potential Funding Source: Private funding and government funding

2. Develop evaluation methods for the variety of information and education programs. Sponsor focus groups where most appropriate.

Responsible Organization: Tip of the Mitt Watershed Council
Estimated Cost: $10,000
Timeline: Long term, 2006-2016
Task Milestone: Compile list of information and education projects and outcomes and share with Advisory Committee
Potential Funding Source: Private funding and government funding

3. Conduct annual evaluation and overall evaluation of implemented activities.

Responsible Organizations: Tip of the Mitt Watershed Council, Advisory Committee members
Estimated Cost: $30,000
Timeline: Long term, 2006-2016
Task Milestone: Gather feedback from the Advisory Committee at the December meetings
Potential Funding Source: Private funding and government funding

3. Information and Education Strategy

The long-term protection of Little Traverse Bay's water quality will depend on the value and actions of future generations. Educating Little Traverse Bay Watershed residents about how their actions impact water quality is a priority. Increasing awareness and ultimately changing behaviors is the long-term antidote for water quality protection. Target audiences for education programs are identified in Table 26.

TABLE 29: Information and Education Strategy Target Audiences

Sources	*Target Audiences*	*Specific Target Audiences*	*Priority*
Urban stormwater	Homeowners Local government officials Chamber of Commerce Teachers/educators	Urban homeowners and residents, riparian property owners, and local government officials (townships bordering cities); business owners, chamber directors and boards, teachers, educators, and students	1
Lawn care	Homeowners	Riparian property owners, urban homeowners, and all Watershed residents in priority area	2
Shoreline development	Contractors, Realtors, Homeowners	Shoreline property builders/contractors, realtors, homeowners	2
Land Use Changes	Local government officials, Developers	Township and county planning officials, township and county board members, large landowners, realtors, and developers	3
Lakeshore erosion	Homeowners	Riparian property owners	4
Removal of shoreline vegetation	Riparian property owners	Riparian property owners, realtors, landscaping companies	4
Streambank erosion	Property owners	Riparian property owners	5
Failing septic systems	Homeowners	Riparian property owners	6
Road/stream crossings	Road Commissions	Road commission managers, crew workers	7
Forestry	Forestry consultants, landowners	Forestry business consultants, landowners, MDNR	8
Agricultural fields	Agricultural landowners	Agricultural producers (crop fields), farm bureau	9
Livestock in streams	Agricultural landowners	Agricultural landowners with livestock (cattle, horses, sheep, etc.)	9

TABLE 29: Information and Education Strategy Target Audiences

Sources	*Target Audiences*	*Specific Target Audiences*	*Priority*
Livestock waste	Agricultural landowners	Agricultural landowners with livestock (cattle, horses, sheep, etc.), farm bureau	9
Golf courses	Golf course managers	Golf course managers, turf management crew	10
Decreased ground water recharge	Local government officials, developers	Planning commission members, township and county board members, developers, large land owners	10
Recreation	Boaters, trail groups, hunters	Boaters who trailer their boats, vacation renters; Trail users, and organized recreation groups such as bicyclists, snowmobilers, etc ; Hunters, farmers, land owners	10

Water resources issues are often complex to communicate through mass media such as radio, newspapers, or television. In order for this information strategy to be effective, the following guidelines for content were recommended:

- Highlight the successes of this and other similar projects
- Match the message to the target audience
- Try to distill information into costs and benefits
- Utilize interesting ways to tell the story such as looking at the changes over time or tapping into positive visions for the future
- Use quality graphics and compelling images

The Information and Education Strategy was developed using our existing understanding of the target audiences. Consideration of the targeted audience's perspectives was used to create the message and identify delivery mechanisms. Additional review of the message will be done prior to the implementation of any education programs.

The information and education activities will use a variety of approaches including installing demonstration sites, building partnerships, sponsoring seminars, attending public events with displays, creating new informational materials, and distributing education materials. We believe this diversified approach will be the most effective in reaching our identified target audiences.

TABLE 30: Information and Education Strategy

Pollutant	*Source/Cause*	*Target Audience*	*Messages*	*Delivery Mechanism*	*Potential Evaluation*	*Reference Recommendation*
Sediment	Urban stormwater	Business owners	Clean water is good for tourism and business.	Provide short written information through the Chamber of Commerce on property management tips to reduce urban stormwater.	Conduct follow-up survey to see if any tips were implemented	Task A, 2,7
	Urban stormwater	Urban residents	I can make a difference to protect water quality.	Media campaign for urban residents and education programs for students.		Task A, 2
	Lakeshore erosion	Homeowners, riparian property owners, landscaping companies	Protect lake water quality for future generations and your investment.	Use model biotechnical erosion control site to demonstrate restoration, as well as newsletters and brochures.	Photographs and questionnaire to homeowners with erosion	Task B, 10, 12, 14
	Streambank erosion	Property owners	Protect the Bear River.	Use model biotechnical erosion control site to demonstrate restoration.	Interviews	Task B, 10, 12, 14
	Livestock in streams	Agricultural landowners, Farm Bureau	Help protect water quality and save money.	Conservation Districts and NRCS to meet with contacts and provide assistance.	Photographs and interviews	Task E, 1-8
	Road/stream crossings	Road Commissions	Help protect water quality and save money.	Meet with road commissions to discuss standard designs that reduce pollution and are cost effective.	Photographic and interviews	Task D, 1, 4
	Forestry	Forestry consultants, businesses, private landowners, MDNR	Good forestry practices means good fishing and hunting.	Develop a brief hand-out and information packet that can be mailed to forest businesses and give a presentation at a forestry workshop.	Interviews	Task G,2,5
	Lakeshore development-construction	Contractors, realtors, local government officials, homeowners	Protect water quality and property values.	Prepare stormwater systems design package, give presentation at contractors' workshop, work with local governments to standardize setback distances, and use	Focus groups Interviews	Task A, 4,7

TABLE 30: Information and Education Strategy

Pollutant	*Source/Cause*	*Target Audience*	*Messages*	*Delivery Mechanism*	*Potential Evaluation*	*Reference Recommendation*
				print media to educate riparians about the importance of setbacks.		
	Urban and rural development	Local government officials	Good land use decisions protect property values, quality of life, and water quality.	Develop ongoing education program for local planning officials that covers basics of water quality and tools that can help protect water quality.	Evaluation forms	Task C,2,6,8,9,11-16
Nutrients	Lawn maintenance	Landscaping and lawn care companies, homeowners, riparian property owners	Protect water quality and protect your investment.	Sponsor seminars for landscaping companies to learn more about water quality friendly yard maintenance. Sponsor workshops and use print media to reach riparians.	Interviews	Task B, 1,6,7,8,10, 15
	Urban stormwater	Urban residents	Healthy environment and clean water equals a great place to live.	Advertisements in newspapers, possible insert into tax bill.	Interviews	Task A, 2
	Failing septic systems	Riparian property owners	Protect water quality and keep the water safe for swimming.	Meet one-on-one with property owners who may have potential septic system problems. Provide assistance to address problems. Conduct follow-up activities for shoreline survey.	Interviews	Task B, 6,10
	Manure application management	Agricultural landowners with livestock	Protect water quality and save money.	Conservation Districts and NRCS to meet with contacts and provide assistance.	Photographic and interviews	Task E, 1-8
Habitat loss	Increased development	Developers, farmers, planning commissions, foresters, citizens	Don't' kill the goose that lays the golden eggs.	Develop a campaign to protect aquatic habitats in new development. The message will be light hearted but have practical, scientific based ideas on how to protect aquatic habitat.	Questionnaire/ evaluation form	Task B and Task C

TABLE 30: Information and Education Strategy

Pollutant	*Source/Cause*	*Target Audience*	*Messages*	*Delivery Mechanism*	*Potential Evaluation*	*Reference Recommendation*
	Increased development	Citizens, realtors, developers, contractors, builders	Permits required for healthy waters.	Brochure that provides descriptions of activities that require permits and contacts. Also a training session on environmental regulations for development community.	Evaluation forms	Task B, 1, 6, 9, 10
	Land fragmentation and development	Priority sensitive land owners	Protect wildlife.	Distribute brochure about land protection options and how land stewardship helps protect water quality.	Personal contacts	Task F, 2, 4
Changes in hydrology	Increased imperviousness	Contractors, builders, business owners	Save money and manage stormwater from your property.	Program at contractor's workshop, program at a chamber meeting, tour to demonstrate solutions.	Interview with participants to events	Task A, 1, 3,6,7,8,9
	Decreased ground water recharge areas	Local planning officials, developers	Protect your drinking water—manage ground water recharge areas	Offer technical service to local communities on identifying ground water recharge areas and how to protect them. Provide information to developers on how to limit imperviousness in these areas.	Interviews	Task C, 2,6,8,10,11
Toxics	Urban stormwater	Homeowners	We all live in the watershed—what we do on our property impacts the Lake.	Media campaign with local newspapers, radio, and TV. Mail residents information on reducing nonpoint source pollution.	Survey	Task A, 1,2
	Litter	Citizens	Litter is pollution.	Sponsor river clean-ups to engage the community and remove trash from the Bear River and other tributaries.	Evaluation forms	Task H, 9, 10
	Household hazardous waste	Residents (property owners and renters)	Protect your drinking water.	Promote household hazardous waste collections to residents in the watershed.	Survey	Task A, 1
Pesticides	Lawn maintenance	Homeowners, riparian property	Save money, protect lake	Sponsor seminars for landscaping	Focus group and survey	Task B, 6,10

TABLE 30: Information and Education Strategy

Pollutant	*Source/Cause*	*Target Audience*	*Messages*	*Delivery Mechanism*	*Potential Evaluation*	*Reference Recommendation*
		owners	water quality for future generations and your investment.	companies to learn more about water quality friendly yard maintenance. Sponsor workshops and use print media to reach riparians.		
	Agricultural fields	Agricultural landowners	Protect water quality and save money.	Conservation Districts and NRCS to meet with contacts and provide assistance.	Photographic and interview	Task E, 1-8
Bacteria	Stormwater	Urban pet owners	Keep the water safe for swimming and protect water quality.	Implement media campaign about proper disposal of pet waste.	Survey	Task A, 1
Thermal	Removal of shoreline vegetation	River and stream property owners	Connect the importance of keeping shoreline vegetation for good fishing.	Develop a hand-out on river front living and mail to identified property owners. Offer on-sites assessments to encourage shoreline plantings. Install demonstration greenbelts on public lands.	Interviews	Task B, 1
Aquatic nuisance species	Boat Trailers	Registered boat owners	Don't transport aliens!	Signs at boat launch sites, wash stations, articles in boating magazines, hand-out that accompanies boat registration fee.	Survey	Task B, 3, 19

4. Evaluation Strategy

To ensure that the recommended actions are meeting the goals of the watershed plan, an evaluation will be required to determine the progress and effectiveness of the proposed activities. The evaluation step is an important part of any watershed planning effort in that it provides feedback on the success of an activity or the project's goals. It also provides communities with important information about how to conduct future efforts, or how to change the approach to a specific problem to be more successful the next time. If activities are successful, this will gain more support for future activities amongst decision makers.

Evaluating the success of the Little Traverse Bay Protection Project will be evaluated on two levels—one level will assess specific activities or projects and the other level will evaluate the project overall.

Evaluation methods generally fall under two categories: qualitative and quantitative methods. Both types of evaluation techniques will be used based on the BMP or activity.

Qualitative Methods

Qualitative information includes words, phrases, stories, pictures that describe reactions or results of activities. Qualitative information can be subjective, but it can be a very effective way to evaluate certain components of a watershed management project. For example, it could measure whether or not people have learned new facts, changed their attitudes, or changed their behaviors about their own or others impact on water quality. Because protecting the quality of the resources is a focus of this project, information and education components are very important. A variety of techniques will be used. A written evaluation form will be used for workshops, seminars, or other events where people are gathered for a specific event. For riparian homeowners (both lake and river), interviews will be conducted after a certain number of the actions have been implemented to see what tools were most effective (personal visits, news articles, booklets, presentations).

Evaluating the effectiveness of programs directed towards improving land use management will require a different approach. Focus groups would be the most effective in learning how helpful the ordinances, programs, materials, maps, and other tools were for changing policy and protecting water resources. Interviews may also be used to assess the progress as the land use tasks are being implemented. A comparison study documenting the types of ordinance changes and standards adopted that have benefits to water quality could also be conducted.

The project will also utilize the *Seeking Signs of Success* (Beyer et al. 2001) publication to assist with evaluation tasks throughout the project for all components, physical improvements, information and education tasks, and land use/local government activities. This publication provides a structure to evaluate watershed management projects to measure success, document outcomes, and identify shortcomings and constraints. This method is very focused on identifying specific goals, defining success, gathering information, analyzing and then determining if success as previously defined was accomplished.

The Advisory Committee will be asked to assist with an annual evaluation of any implementation activities. Every three to five years the Committee will be asked to look over the entire list and reassess the recommendations.

Quantitative Methods

Quantitative methods show how certain water quality parameters have changed over time, and are often the result of a physical change within the Watershed. Some limited water quality monitoring of biological life in the tributaries may be done to document existing diversity and health as a baseline for future monitoring. This type of monitoring will be most valuable in evaluating the effectiveness of many of our actions on protecting the small tributaries within the Watershed.

We will also document changes with photographs to evaluate the effectiveness and improvements for any components of the project that modify physical features (road/stream crossings, lakeshore erosion, stormwater management improvements, streambank erosion, recreational access sites, etc.).

Evaluation Strategy for Determining Water Quality Improvement

A set of criteria were developed to attempt to determine if the proposed pollutant reductions in the watershed are being achieved and that water quality standards are being maintained or

improved. Since the water quality of Little Traverse Bay and its tributaries is good, the goal is to maintain this good quality. The Protection Plan identified many threats to water quality and reducing these threats will be critical to maintain the good water quality and ecological health of the Little Traverse Bay Watershed.

Water Quality Criteria:

1. Maintain low nutrient concentrations (no increases) in Little Traverse Bay and its tributaries.
2. Reduce nutrient concentrations in stormwater from urban areas.
3. Maintain or reduce sediment loads in tributaries and stormwater draining into Little Traverse Bay.
4. Maintain high dissolved oxygen levels (above 7 mg/l) in Little Traverse Bay and tributaries.
5. Maintain pH levels within range of 6.5 to 9.0 in Little Traverse Bay and tributaries.
6. Maintain or reduce present conductivity levels in Little Traverse Bay and tributaries.
7. Maintain low water temperatures in all water bodies in the Little Traverse Bay watershed that are designated or capable of sustaining cold-water fisheries.
8. Determine metal concentrations in Little Traverse Bay and tributaries and maintain or reduce.
9. Prevent beach closings in Little Traverse Bay and tributaries. *E. coli* levels should not exceed Michigan and US EPA water quality standards for single day (>300 *E. coli* per 100 ml of water) or 30-day geometric mean measurement (>130 *E. coli* per 100 ml of water in 5 samples over 30 days).
10. Maintain healthy diverse aquatic macroinvertebrate populations in streams where surveyed and expand survey program to document aquatic macroinvertebrates in streams throughout the watershed.
11. Reduce Cladophora growth on Walloon Lake's shoreline.

5. Monitoring Plan

Goals and objectives developed for the Little Traverse Bay Watershed Protection Plan focus on the reduction or elimination of nonpoint source pollution. To achieve goals set out in the Plan several projects have been initiated or completed and many more will be carried out in the future. A variety of monitoring activities will need to be implemented to gauge the effectiveness of the Protection Plan's recommendations at reducing nonpoint source pollution and documenting changes in the water resources for the Little Traverse Bay Watershed.

Protection Plan goals that require follow-up monitoring include:

1. Sediment and nutrient input reduction
2. Toxic substance reduction
3. Ground water recharge protection
4. Wetland restoration and protection
5. Aquatic nuisance species control
6. Riparian vegetation restoration
7. Stormwater pollutant reduction
8. Reduction of water quality contamination by waterfowl
9. Addressing septic system failure
10. Control of swimmer's itch

Priority monitoring for the Little Traverse Bay Watershed would be a comprehensive stormwater

pollutant monitoring program and stream monitoring program to document physicochemical and biological conditions. This monitoring would provide a baseline to document the amount of sediment, nutrients, bacteria, toxins from stormwater and the current ecological health based on macroinvertebrates. Future monitoring could be compared to the baseline to determine if pollutant loadings are being reduced through restoration and education efforts.

Surface Water Quality Monitoring
Surface water quality monitoring is one tool that will be used for measuring success of follow-up activities and assess changes in water quality. Water quality can be monitored over the short-term to gauge impacts of individual projects, and over the long-term to gauge the overall effectiveness of watershed protection measures. Additionally, data from existing or past water quality monitoring projects will be used for assessment. Potential water quality monitoring locations in the watershed are shown in Figure 14.

In addition to the Little Traverse Bay, surface water quality will need to be monitored on Walloon Lake, the Bear River and other tributaries that flow into the Bay. Water quality monitoring should be conducted throughout each aquatic ecosystem in terms of both areal/longitudinal extent and depth. Discharge data will also need to be collected in any lotic systems that are monitored.

Physicochemical parameters to be monitored include, but are not limited to: dissolved oxygen, pH, temperature, conductivity, chemical oxygen demand, biological oxygen demand, suspended solids, dissolved solids, water clarity, turbidity, light, carbon, phosphorus, nitrogen, chloride, zinc, copper, lead, cadmium, nickel, mercury, and arsenic. Biological monitoring will supplement physicochemical monitoring and includes monitoring of bacteria, algae, aquatic macrophytes, macroinvertebrates, fish, other aquatic organisms and organisms inhabiting riparian areas.

While some elements of physicochemical and biological monitoring will be used to gauge the effectiveness of erosion control and restoration projects, other monitoring activities will be required. Stream morphological characteristics such as bank stability, bank sheer, channel slope, water/channel depths, wetted perimeter, substrate particle size/shape, substrate embeddedness, and bank material will need to be monitored. To improve the efficiency of monitoring streams, more detailed mapping of the entirety of stream corridors and calculation of stream orders will be needed, whereas improved bathymetrical mapping will be needed for lakes.

Many of the same parameters listed thus far will be used to monitor wetlands restoration and protection. In addition, wetland mapping will need to be performed to document changes. Wetland mapping will be performed with the aid of GPS (Global Positioning System) and GIS (Geographical Information System), but will also require on-site examination and documentation of soils, hydrology and biology.

Physical habitat and biological community monitoring will be conducted in all aquatic ecosystem types. Examples of this type of monitoring include: mapping and changes in both depositional and erosional habitats in streams, changes in fish community composition, relative abundance of wetland subtypes, and macroinvertebrate community changes as a result of introduction of non-native species. Special attention will be given to monitoring invasive species; their spread and impacts on the ecosystem.

Ground Water Monitoring
Nonpoint source pollution also has the potential to contaminate ground water. Therefore, ground water will also need to be monitored throughout the watershed. Historical well records will be compiled and continual well water quality monitoring will be performed to examine trends

in deep (aquifer) groundwater quality. Physicochemical parameters to be measured include those listed for surface water quality monitoring, but others parameters such as VOCs (volatile organic compounds).

Septic system failure has the potential to contaminate ground water, specifically shallow ground water, and also contaminate adjacent surface waters. Thus, shallow ground water sampling, particularly along surface water shorelines, will be required to rate the success of the Protection Plan's objective of addressing septic system failure. Shallow ground water will be monitored for the same parameters listed for deep ground water.

Climate Monitoring
Climatic variables are important for determining all sources of nonpoint source pollution. Although sources of atmospheric deposition that contribute to nonpoint source pollution are largely outside the watershed and will probably not be affected by projects implemented as a result of the Protection Plan, some local sources may be addressed in the future and have a local impact. In addition, data about the climate, air quality and specific variables like evapotranspiration may be required for projects such as mass balance calculations and modeling, which would be used to monitor water quality changes due to nonpoint source pollution reductions. An atmospheric deposition study could provide useful information to understand the source of air deposition pollution.

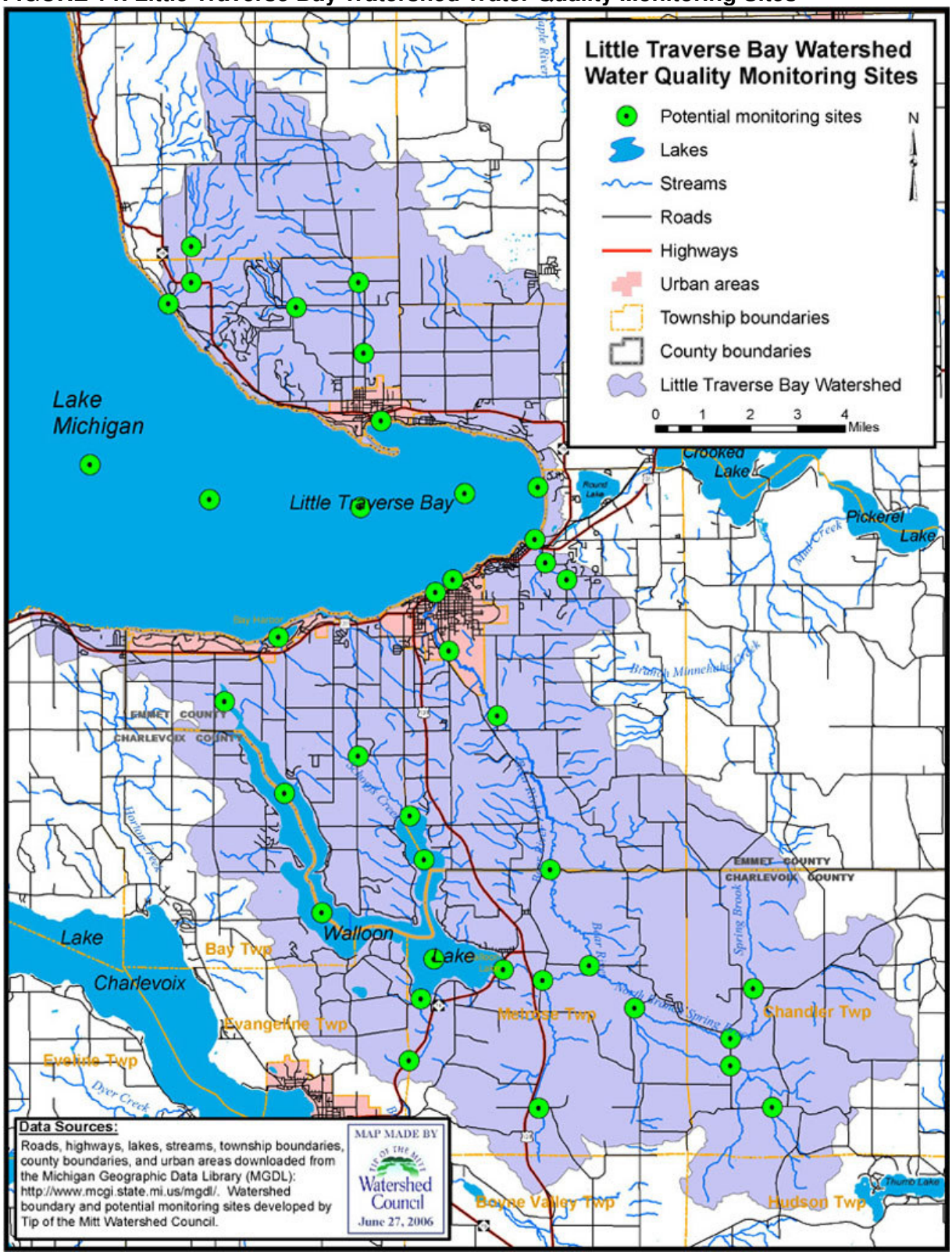
Landuse Monitoring
Landuse and landscape change due to human activity can have a large impact on nonpoint source pollution. To monitor this element of the Plan's effectiveness, changes in landuse will need to be monitored. Although primarily done using remotely sensed data in a GIS, field surveys may also be required. Specific attention will be given to monitoring areas where BMPs (best management practices) have been installed.

The priority parcel process is one landuse-specific project carried out as part of the Protection Plan to conserve land and reduce nonpoint source pollution impacts to water resources. As the landscape continually changes and more land is developed while other lands are restored to a natural state, the priority parcel process will have to be regularly updated every five years. Through regular updates of the process, we will be able to monitor the effectiveness of this tool in protecting critical lands and ameliorating nonpoint source pollution due to development.

Socio-economic Monitoring
Many projects carried out as a result of the Plan will have social and economic impacts. For example, nonpoint source education of watershed residents may affect behavior and result in a reduction of nonpoint source pollution or nonpoint source pollution reductions in surface waters may increase local tourism revenues and boost the economy. Therefore, monitoring activities must also include social and economic elements.

There are many methods for monitoring social and economic changes as a result of the Plan. Some of the primary tools for conducting this type of monitoring include surveys and demographic/economic change analyses. To establish relationships between socio-economic change and nonpoint source pollution change, data from other monitoring activities (e.g. surface water quality monitoring) will be incorporated into this monitoring effort.

FIGURE 14: Little Traverse Bay Watershed Water Quality Monitoring Sites



6. Conclusion

What will the water quality of Walloon Lake, Bear River, and Little Traverse Bay be like in ten years? Without the benefit of a crystal ball, we can only guess. Our goal is to protect and enhance the water quality and ecosystem integrity of Little Traverse Bay and its tributaries in a way that ensures all designated uses are restored and protected. The Little Traverse Bay Watershed Protection Plan will provide a framework to accomplish the following goals (related to the designated uses for public surface waters):

1) Manage nonpoint source pollution to ensure that the status of the following designated uses remain supported--agriculture, industrial water supply, and the public water supply at intake point.

2) Improve and maintain navigation in the Bear River and other tributaries by reducing sediment inputs and maintain navigation in Mud Lake by reducing nutrient inputs to avoid excessive weed growth.

3) Improve the warm water fishery by reducing inputs of toxic substances, sediments, and nutrients; controlling aquatic nuisance species; and protecting and restoring wetlands.

4) Improve the cold water fishery by reducing inputs of toxic substances, sediments, and nutrients; restoring ground water recharge; protecting and restoring wetlands; controlling aquatic nuisance species; and restoring vegetation along rivers and streams to provide shade and wildlife cover.

5) Improve other indigenous aquatic life and wildlife by reducing inputs of toxic substances, sediments, and nutrients; restoring ground water recharge; protecting and restoring wetlands; controlling aquatic nuisance species; and restoring vegetation along rivers and streams to provide shade and wildlife cover.

6) Assure that recreation (partial and total body contact between May 1 and October 31) is safe by improving quality of water discharged from urban runoff/stormwater sewers; discouraging waterfowl in swimming areas; addressing possible failing septic systems; researching and implementing control of swimmer's itch; and cleaning up the contaminated leachate in near shores areas at Bay Harbor.

Little Traverse Bay Watershed is at an important crossroads. On one road lies the degraded water quality that will result if past abuses are left uncorrected and the development predicted for this region occurs without attention to reducing polluted runoff and protecting shorelines. On the other road lies the opportunity to unite the community in an effort to implement a results-oriented plan that recommends tangible actions to ensure healthy waters. We hope that the Little Traverse Bay Watershed Protection Plan provides the map to ensure that the waters of the Little Traverse Bay Watershed will be enhanced, restored, and protected for generations to come.

Appendices

APPENDIX A

Estimating Stormwater Pollutant Export

A simple, empirical method developed by the Washington Metropolitan Water Resource Planning board in 1987 was used to estimate pollutant loadings for four important pollutants (sediment, phosphorus, copper, and zinc). Although very general in nature, this method is considered precise enough to make to make reasonable and reliable nonpoint source pollution management decisions at the site-planning level.

Stormwater export for an area can be estimated by using the equation:

$$L= [(P)(Pj)(Rv)/12](C)(A)(2.72)$$

where:

L = Pollutant export in pounds**.**

P = Rainfall amount in inches over the desired time interval. 32 was used for this study, which has been determined to be the average annual rainfall at Pellston, Michigan.

Pj = A factor that corrects P for storms that produce no runoff. A value of 0.90, determined from a study in the metropolitan Washington D.C area, was used for this study.

Rv = A runoff coefficient that expresses the fraction of rainfall that is converted to runoff, based on percent watershed imperviousness. This was determined from a figure depicting the relationship between watershed imperviousness and the runoff coefficient developed during a nationwide urban runoff study in the 1980's.

C = Flow-weighted mean concentration of the selected pollutant in urban runoff. Values for Total Suspended Sediments (54.500 mg/l), Total Phosphorus (0.260 mg/l), zinc (0.129 mg/l) and copper (0.011 mg/l) were taken from nation-wide averages (Smullen and Cave 1998) presented in the New York State Stormwater Management Design Manual.

A = Area of the study site in acres. Area determinations were determined using a geographic information system.

12 and **2.72** are unit conversion factors.

APPENDIX B

Specific Stormwater Management Recommendations

Stormwater Management Recommendations for Little Traverse Bay Urban Areas
The ultimate goal of the Little Traverse Bay Watershed Project is to reduce or prevent nonpoint source pollution to the Bay as well as the other waters throughout its watershed. The following list details a variety of options that, if put into effect by local governments, could result in a reduction of stormwater pollutants:

1. **Resident education**. There are numerous actions, which local residents can take to reduce nonpoint source pollution. Mass mailings to individual households within the four urban areas would provide critical information concerning non-point source pollution, urban property BMPs (Best Management Practices), and the extent of the drainage system (maps). Subjects that could be included in these mailings include:

    a. Identifying hazardous wastes, choosing least toxic products, proper storage of materials and waste, and proper disposal of waste.
    b. Spill response.
    c. Washing vehicles in designated areas (where water waste will be properly treated) or on lawns (where pollutants are absorbed).
    d. Use of tarps, clothes and other barricades when remodeling, painting, sand-blasting.
    e. Use of water-based paints whenever possible and proper disposal (never pour paints, solvents, etc, down storm drains or onto the ground)
    f. Regular vehicle maintenance to prevent leaks.
    g. Reducing/eliminating trash on ground that will eventually reach storm drains
    h. Using less fertilizer on lawns, choosing the proper amount of fertilizer, fertilizing at the right time of year (October), and eliminating fertilizing by converting lawns to low maintenance plantings.
    i. Pest management that doesn't require pesticides
    j. Natural area preservation & impervious surface reduction.
    k. Pond/stream bank improvements by planting native vegetation.
    l. Wetlands preservation (hydrologic nutrient buffer).
    m. Soil erosion / sediment transport control.
    n. Limiting use of deicing chemicals

2. **Commercial/Industry education.** Provide similar information as listed above, but slanted toward the commercial and industrial sector. In particular, target painting and drywall contractors, cement companies, and landscaping businesses to reduce pollutants associated with specific industries/activities from being washed into stormwater systems.

3. **Government official education.** Provide similar information as listed above, but slanted toward public officials. The information should focus on what can be done to manage the municipality's stormwater and include relevant examples from other areas.

4. **Improved storm sewer system mapping**. Help each local government produce better maps showing storm drainage sub-basins, storm sewer lines, catchment basins, and outfall locations. This may include investigative efforts to determine the extent of sub-surface drainage systems.

5. **Retrofit of selected BMPs, including:**
    a. Infiltration trenches or basins.
    b. Vegetate waterways and (re)direct stormwater to open lawns or swales to reduce storm event stream discharge and absorb pollutants.
    c. Install and maintain detention or retention basins. Identify potential sites, maintain appropriate native vegetation around ponds, regularly remove accumulated sediment and debris, and repair/remove damaged water control structures and other components.
    d. Street sweeping improvements (greater frequency and specific times of year that would substantially reduce nonpoint source pollution).
    e. Drain stenciling.
    f. Inlet structure treatment devices. Install additional catch basin sediment traps and maintain properly (vactor before half full). Install oil/water separators in storm drains near gas stations, car repair shops, & vehicle yards.
    g. Improved salt storage and usage.
    h. Better runoff, erosion, and sedimentation control at construction sites.

6. **Contaminant monitoring.** Monitor specific contaminants (particularly bacteria) at selected locations, primarily for educational purposes.

7. **Emergency response.** Develop plans to clean up and reduce impacts of pollutant spills within the stormwater drainage area.

8. **Conservation design.** Incorporate conservation design in new residential and commercial areas, above and beyond what current regulations require (e.g. avoid curb and gutter, build rain gardens, protect/enhance riparian areas, preserve wetlands and other sensitive natural areas).

9. **Coordinated planning with surrounding townships.**

10. **Installation of demonstration BMPs**. Install model BMPs at residential-type sites to demonstrate effective strategies for reducing nonpoint source pollution.

APPENDIX C

Road/Stream Crossing Severity Ranking Index

Site I.D. _____

FACTORS CONTRIBUTING TO SEVERITY	POINTS
ROAD SURFACE	Paved: 0 pt Gravel: 3 pt Sand and Gravel: 6 pt Sand: 9 pt
LENGTH OF APPROACHES	0 - 40 ft: 1 pt 41-1000 ft: 3 pt 1001- 2000 ft: 5 pt > 2000 ft: 7 pt
SLOPE OF APPROACHES	0%: 0 pt 1 - 5%: 3 pt 6-10%: 6 pt > 10%: 9 pt
WIDTH OF ROAD, SHOULDERS AND DITCHES	< 15 ft: 0 pt 16 - 20 ft: 1 pt > 20 ft: 2 pt
EXTENT OF EROSION	Minor: 1 pt Moderate: 3 pt Severe: 5 pt
EMBANKMENT SLOPE	Bridges: 0 pt > 2:1 slope: 1 pt 1.5 - 2:1 slope: 3 pt Vertical or 1:1 slope: 5 pt
STREAM DEPTH	0 - 2 ft: 1 pt > 2 ft: 2 pt
STREAM CURRENT	Slow: 1 pt Moderate: 2 pt Fast: 3 pt
VEGETATIVE COVER OF SHOULDERS AND DITCHES	Heavy: 1 pt Partial: 3 pt None: 5 pt
TOTAL: 0 - 15 Minor 16 - 29 Moderate > 30 Severe	

APPENDIX D

Priority Parcel Scoring System

Water Quality/Conservation Drivers and Scoring:

1. Parcel Acreage
   - 1 pt: ≥10 and <40
   - 2 pts: ≥40 and <80
   - 3 pts: ≥80 and <120
   - 4 pts: ≥120
2. Ground Water Recharge Acreage
   - 1 pt: ≥10 and <40
   - 2 pts: ≥40 and <80
   - 3 pts: ≥80 and <120
   - 4 pts: ≥120
3. Wetland Acreage
   - 1 pt: >0 and <10
   - 2 pts: ≥10 and <20
   - 3 pts: ≥20 and <40
   - 4 pts: ≥40
4. Lake Shoreline/Riparian Ecosystems (Lake Shore Distance)
   - 1 pt: ≥100 ft and <400 ft
   - 2 pts: ≥400 ft and <660 ft
   - 3 pts: ≥660 ft and <1320 ft
   - 4 pts: ≥1320 ft
5. River and Stream Shoreline/Riparian Ecosystems (Stream Distance)
   - 1 pt: ≥200 ft and <1320 ft
   - 2 pts: ≥1320 ft and <2640 ft
   - 3 pts: ≥2640 ft and <5280 ft
   - 4 pts: ≥5280 ft
6. Adjacency to Protected Lands
   - 1 pt: Adjacent to one protected parcel
   - 4 pts: Adjacent to two or more protected parcels
7. Threatened/Endangered Species
   - 1 pt: Within protected species habitat buffer
   - 4 pts: Species present on property

APPENDIX E

Inventory of Potential Wetland Conversion Sites

Wetlands provide valuable functions, including water quality protection, fish and wildlife habitat, floodwater storage, ground water recharge, recreational open space, and many commercially harvestable products. Many types of development projects result in unavoidable impacts to wetlands – and an important component of wetland regulation is the concept of mitigation of unavoidable impacts. Compensatory mitigation is increasingly required to offset the adverse impacts of wetland losses. It is theoretically possible, with proper planning, design, construction, and monitoring, to mitigate for wetland loss so that the wetland resource base in the Little Traverse Bay Watershed suffers no net loss of function and values.

Wetland restoration is the rehabilitation of a former wetland that was destroyed at some time in the past. Wetland enhancement is the improvement, maintenance, and management of existing wetlands. Wetland creation is the conversion of a historically upland area into a wetland. For the purposes of this inventory, these actions are collectively referred to as wetland conversion. Restoration and enhancement are the most successful methods for converting degraded wetlands back to healthy, functioning ecosystems.

The purpose of this inventory is to determine the location of potential conversion sites that may be used by property owners, developers, resource professionals, and regulatory agencies in their efforts to offset unavoidable impacts to wetlands within the Little Traverse Bay Watershed.

Gathering Offsite Information
Relevant information readily available was acquired at the outset of this project. Information used included: County Soil Surveys, County Plat Maps, U.S.G.S. Topographic Maps, National Wetlands inventory Maps, and Agricultural Stabilization and Conservation Service (ASCS) Highly Erodible Land and Prior Covered Determination Maps. Because the most successful type of wetland conversion is restoration, initial efforts were made to access all locally produced maps of county drains.

Compiling Offsite Information
The information from available resources was compiled to determine potential wetland conversion sites. Places where two or more of the information resources suggested the occurrence of former wetlands (such as areas of hydric soils and known agricultural lands, or ASCS “prior converted” wetlands and topographic maps) were designated as potential wetland conversion sites.

The ASCS Highly Erodible Land (HEL) determination maps proved to be quite useful. The use of this information deserves special note. Land designated by the ASCS as HEL has an erosion index of 8 or greater, based on the Universal Soil Loss Equation. This reflects a variety of characteristics of the soil, such as slope and erodibility, as well as the amount of rainfall. However, HEL may sometimes be associated with wetlands due to their inherent unsuitability for most agriculture activities. HEL determinations were limited for the purposes of this inventory by cross-referencing their location first with topographic maps and then with county soil surveys. Those areas that appeared to be located on steep slopes were removed. Those that were not associated with steep slopes were cross-referenced with the known water table based on the

county soil survey. Those areas in which a high water table (1-2 feet) was indicated were included in this inventory.

Field Checking Selected Sites
Due to respect for property rights, all field reviews were conducted from public roads or right-of-ways. It is important to note that some of the areas that are listed in this inventory may at this time meet the three criteria to be determined a wetland by the Michigan Department of Environmental Quality and the Army Corps of Engineers. As a result, the areas that may currently be determined to be a wetland would not qualify as "mitigation sites". However, most of the sites that would potentially qualify as wetlands have undergone some change, or are subject to ongoing impacts such as livestock grazing, which diminishes one or more of the functions and values typically attributed to wetlands (i.e., wildlife habitat). The decision was made to include these "degraded wetlands" in this inventory for several reasons:

(1) State and federal wetland mitigation policies may change in the future to allow compensation for unavoidable wetland loss in the form of restoration or enhancement of degraded wetlands.

(2) Wetland restoration, enhancement, or creation sites adjacent to existing functioning wetlands are often more successful simply because many of the necessary components are already present in the immediate locale (wetland vegetation seed source, hydric soils, wetland hydrology, and wetland fauna).

(3) Acquiring degraded wetland areas for the purpose of creating wetlands in the adjacent upland areas will also provide an opportunity to enhance that particular degraded wetland site.

Permission from the property owner and substantial field investigation on a site-by-site basis would be required to make a formal determination if a former wetland still possessed evidence that the three mandatory criteria were present.

No efforts were made to determine the functions or values of each potential wetland, or to determine the presence of state or federally-listed endangered, threatened, or special concern plants or animals. As successful restoration, enhancement, or restoration of a wetland requires information about a site that can only be gathered through onsite investigation, this inventory can serve to direct resource professionals to the most likely conversion sites, or regulatory agencies to potential mitigation sites.

APPENDIX F

Estimating Pollutant Load Reductions

Streambank erosion pollutant load reductions were estimated using the Channel Erosion Equation (CEE) as outlined in the Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual (MDEQ, 1999). Reduction in sediments and nutrients (phosphorus and nitrogen) were estimated using this method.

The CEE is used to calculate the annual average sediment reduction using the direct volume method:

CEE= Length (ft) x Height (ft) x LRR (ft/yr) x Soil weight (ton/ft^3)

where:

LRR= Lateral Recession Rate, or the thickness of the soil eroded from a bank surface (perpendicular to the face) in an average year. A LRR of 0.4 ft/yr was used for the severe site; 0.05 ft/yr was used for the minor sites.

Soil Weight = The dry density soil weight for a soil textural class. Dry density soil weights are given in Exhibit 1 (MDEQ, 1999). A soil weight of 0.045 tons/ft^3 was determined using the soil textural class of sandy clay.

A related equation was used to calculate annual average nutrient (P and N) reduction:

Nutrient reduced (lb/yr) =
Sediment reduced (T/yr) x Nutrient conc. (lb/lb soil) x 2000 lb/T x correction factor

where:

Sediment reduced: The value determined from previous CEE calculations.

Nutrient concentration: A concentration of 0.005 lbP/lb of soil was used for phosphorus; 0.001 lbN/lb of soil was used for nitrogen.

Correction factor: A correction factor is used to correct for soil texture. Sandy clay is categorized as Sand, with a correction factor of 0.85. Correction factors are presented in Exhibit 2 (MDEQ, 1999).

APPENDIX G

EPA Nine Required Elements

Beginning with FY03 grants, the United States Environmental Protection Agency (EPA) requires all implementation, demonstration, and outreach-education projects funded under Section 319 of the federal Clean Water Act to be supported by a watershed plan which includes the following nine listed elements. To be eligible for Section 319 funding watershed plans must address all nine elements. The nine EPA required elements, and the location of the plan component addressing these elements are listed below.

A. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (B) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g. X numbers of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

    - Tables showing the causes of pollution in the watershed that will need to be controlled are found in Chapter 3, section 1 of the Protection Plan.

B. An estimate of the load reductions expected for the management measures described under paragraph (C) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (A) above (e.g. the total load reduction expected for dairy cattle feedlots; row crops; or eroded streambanks).

    - Current annual stormwater pollutant export estimates are found in Chapter 2, section 1 of the Protection Plan.
    - Pollutant removal efficiencies of potential implemented BMPs can be found in Chapter 3, section 2 of the Protection Plan.
    - Pollutant load reduction estimates for road/stream crossings, streambank, and agricultural areas are found in Chapter 2, sections 4-6 of the Protection Plan

C. A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under paragraph (B) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using map or description) of the critical areas in which those measures will be needed to implement this plan.

    - A description of the recommended actions to achieve the estimated load reductions are found in Chapter 4, section 2 of the Protection Plan beginning on each of the following pages:

- Maps or descriptions displaying stormwater basin delineations and landuse, shoreline features and/or erosion sites, road/stream crossing sites, agricultural sites and forested areas in which load reduction measures will need to be implemented are found on each of the following pages:

- Measures recommended to achieve other watershed goals can be found in Chapter 4, section 2 of the Protection Plan on each of the following pages:

D. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

- Estimates of the amounts of technical and financial assistance needed and associated costs for implementation of this plan can be found in Chapter 4, section 2 and/or Appendix H of the Protection Plan.

E. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing NPS management measures.

- An information & education strategy can be found in Chapter 4, section 3 of the Protection Plan.

F. A schedule for implementing the NPS management measures identified in this plan that is reasonable expeditious.

    - A timeline is included within the recommendations in Chapter 4, section 2 and Appendix H in the Protection Plan.

G. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

    - Measurable milestones are included within the recommendations in Chapter 4, section 2 and Appendix H of the Protection Plan.

H. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

    - An evaluation strategy and water quality criteria can be found in Chapter 4, section 4 in the Protection Plan.

I. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (H) above.

    - A water quality monitoring plan can be found in Chapter 4, section 5 in the Protection Plan.

APPENDIX H

Summary table of recommendations for the Little Traverse Bay Protection Plan based on a timeline of 10 years (2006-2016). Recommendations are organized from short term (≤5 years) to long term (>5-10 years). **Priority recommendations are shown in bold.**

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
A. Stormwater Recommendations					
1. Install a demonstration best management practice (BMP) at a residential site and at a business site. Develop accompanying informational packet to be available via the internet, at the Freshwater Center, and other appropriate places.	Tip of the Mitt Watershed Council, Drain Commissioners	3 years	$75,000	PF, GOV	Install one demo site at one residence and one business by year 3
2. Implement media campaign to educate residents and businesses about nonpoint source pollution (including disposal of household hazardous waste) and how to reduce stormwater runoff.	Tip of the Mitt Watershed Council, Drain Commissioners, Emmet County DPW	5 years	$20,000	PF, GOV	Educational materials developed and distributed to city residents
3. Develop and implement education programs that highlight impacts of stormwater runoff on surface waters. Offer tours to local officials, business owners and citizens to learn more about stormwater and how to minimize impacts.	Tip of the Mitt Watershed Council, SEE-North, LTBB Odawa, Drain Commissioners	7 years	$25,000	PF, GOV	Initiate programs in year 2; conduct 5 tours in 7 years
4. Develop and disseminate a stormwater systems design package with engineering plans and stormwater management information that local governments (and other appropriate entities) can provide to businesses to better manage stormwater.	Tip of the Mitt Watershed Council, Drain Commissioners, Soil and Erosion Control Officers	10 years	$20,000	PF, GOV	20% of developments incorporate appropriate BMPs in two years

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
A. Stormwater Recommendations, continued					
5. Develop model stormwater ordinance language for the watershed, support the adoption and enforcement of stormwater ordinances in Emmet and Charlevoix Counties by educating and informing developers, engineers, architects and others. Assess the effectiveness, identify shortcomings and work to improve stormwater ordinances in Emmet and Charlevoix Counties.	Tip of the Mitt Watershed Council, County Planning Offices, County Soil Erosion Control Offices, Walloon Lake Association, Emmet County Enforcement Office	10 years	$20,000	PF	Develop model ordinance language by year 4
6. Provide programs and resources to Emmet and Charlevoix Counties' contractors about soil erosion and stormwater management techniques.	Drain Commissioners, Emmet County Ordinance Enforcement Office, Charlevoix County Soil Erosion Control Office, Tip of the Mitt Watershed Council	10 years	$30,000	PF, GOV	Initiate in year 3; 50% of contractors attend events by the end of project time
7. Work with businesses in urban areas to reduce nonpoint source pollution originating from their site. Offer an assessment service to businesses to rate water pollution impacts.	Tip of the Mitt Watershed Council, Drain Commissioners	10 years	$300,000	PF, GOV	2% of the businesses in the first two years install BMPs
8. Work cooperatively with local units of government to develop stormwater management plans. Develop basic outline of a stormwater management plan to provide as a template to communities.	Tip of the Mitt Watershed Council, City of Petoskey, City of Harbor Springs, Bay Harbor, Walloon Lake Village- Melrose Twp, Local Emergency Planning Committee, LTBB Odawa, Emmet and Charlevoix County Drain Commissioners	10 years	$2,000,000	PF, GOV	Complete plans and begin implementation in year 5

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
A. Stormwater Recommendations, continued					
9. Implement priorities identified in the stormwater plans. Work cooperatively with local units of government to implement stormwater managment plans using a variety of methods and tools (e.g. marking storm drains, mapping storm sewers, street sweeping).	Tip of the Mitt Watershed Council, City of Petoskey, City of Harbor Springs, Bay Harbor, Walloon Lake Village- Melrose Twp, Local Emergency Planning Committee, LTBB Odawa, Drain Commissioners	10 years	$2,000,000	PF, GOV	After 5 years communities are implementing tasks from the stormwater management plans
10. Conduct and update impervious surface studies on the tributaries and shoreline area.	Tip of the Mitt Watershed Council	10 years	$30,000	PF, GOV	75% of the tributaries have completed inventories in 5 years
B. Shoreline Protection, Restoration, and Management Recommendations					
1. Develop a hand-out on riverfront living and distribute to river and stream riparians in the Watershed.	Tip of the Mitt Watershed Council	1 year	$20,000	PF, GOV	Develop text and mailing list
2. Develop a plan with the City of Petoskey to improve the shoreline habitat and recreation opportunities for the Bear River corridor.	Tip of the Mitt Watershed Council, City of Petoskey	1 year	$15,000	GOV	TASK COMPLETED
3. Support the adoption of National Aquatic Invasive Species Act (NAISA) and other policies that will regulate some sources and activities that spread invasives.	Tip of the Mitt Watershed Council, Emmet County Lakeshore Association	1 year	$5,000	PF	NAISA adopted
4. Work with marinas to reduce nonpoint source pollution and the spread of aquatic nuisance species by using best management practices. Encourage marinas throughout watershed to participate in Clean Marinas Program.	Tip of the Mitt Watershed Council, City of Petoskey, City of Harbor Springs, Bay Harbor, private marinas	4 years	$50,000	PF, GOV	25% of marinas clean by year 2

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
B. Shoreline Protection, Restoration, and Management Recommendations, continued					
5. Conduct inventories to assess nonpoint source pollution problems at boat access locations.	Tip of the Mitt Watershed Council, Michigan Department of Natural Resources, Walloon Lake Association	4 years	$15,000	PF, GOV	Identify access sites to inventory
6. Create and distribute educational packages to realtors for shoreline property clients.	Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet County Lakeshore Association, Drain Commissioners	4 years	$10,000	PF, GOV	Develop a database of interested realtors
7. Develop an education campaign to protect aquatic habitats in areas of new development and recreate habitats in developed shoreline areas.	Tip of the Mitt Watershed Council, LTBB Odawa	5 years	$100,000	PF, GOV	Develop campaign
8. Conduct follow-up activities with property owners that have shoreline algae (provide a questionnaire, information, and specific guidance, and site visits) to reduce nutrient inputs.	Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet County Lakeshore Association	5 years	$40,000	PF, GOV	Conduct follow up activities every other year
9. Develop and implement a plan to prevent further hardening of shorelines (or reduce when feasible) in Little Traverse Bay.	Tip of the Mitt Watershed Council, City of Petoskey, City of Harbor Springs, lakeshore associations, Emmet County Planning and Zoning	6 years	$300,000	PF, GOV	50% of the hardened shorelines are softened using biotechnology
10. Educate shoreline residents on the importance of near shore habitat, impacts from beach sanding and grooming, living in mucky areas, aquatic vegetation, etc.	Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet County Lakeshore Association, Emmet and Charlelvoix County Soil Erosion Officers	10 years	$75,000	PF, GOV	Publish a series of press releases, articles in association newsletters on these topics
11. Inventory riparian corridors of the tributaries to assess health, diversity, and density of vegetation.	Tip of the Mitt Watershed Council	10 years	$20,000	PF, GOV	Complete inventories on 25% of the tributaries

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
B. Shoreline Protection, Restoration, and Management Recommendations, continued					
12. Develop a strategy to restore the moderate and minor shoreline erosion sites on a subwatershed basis.	Tip of the Mitt Watershed Council, Emmet and Charlevoix Conservation Districts, Walloon Lake Association, LTBB Odawa, lakeshore associations, riparian property owners	10 years	$300,000	PF, GOV	Initiate an updated survey in year 5
13. Restore the natural stream channel and habitat of Tannery Creek and install a weir to keep out aquatic nuisance species.	Tip of the Mitt Watershed Council, US Fish & Wildlife Service, LTTB Odawa, Bay View Country Club	10 years	$200,000	PF, GOV	Begin restoration by year 4
14. Repair most severe lakeshore and stream bank erosion sites.	Tip of the Mitt Watershed Council, Emmet and Charlevoix Conservation Districts, Walloon Lake Association, lakeshore associations, riparian property owners, LTBB Odawa, Drain Commissioners	10 years	$500,000	PF, GOV	50% of the severe sites are restored
15. Sponsor seminars for landscaping companies to learn more about water quality friendly practices.	Tip of the Mitt Watershed Council, Emmet and Charlevoix Conservation Districts	10 years	$25,000	PF, GOV	Sponsor three seminars
16. Repeat the shoreline pollution inventories on Walloon Lake and Little Traverse Bay and associated follow-up actions at least every five years. Maintain an up-to-date database. (Inventories to include shoreline algae, substrate, riparian vegetation, erosion, and others)	Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet County Lakeshore Association	10 years	$60,000	PF, GOV	Initiate survey updates every 5 years

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
B. Shoreline Protection, Restoration, and Management Recommendations, continued					
17. Install demonstration natural vegetation strips on shoreline properties on the lakes, Bay, and tributaries.	Tip of the Mitt Watershed Council	10 years	$150,000	PF, GOV	Install 10 sites
18. Promote the use of native plant species and work with local nurseries to stock local genotypes.	Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet County Lakeshore Association	10 years	$20,000	PF, GOV	50% of local nurseries carrying native genotypes
19. Monitor for the presence of invasives and work to control purple loosestrife, Eurasian water milfoil, and others species, that impair aquatic habitat.	Tip of the Mitt Watershed Council	10 years	$100,000	PF, GOV	Database established for existing presence of invasives in year 2
20. Restore shoreline wetlands that have been altered.	Tip of the Mitt Watershed Council, Natural Resources Conservation Service, US Fish & Wildlife Service	10 years	$300,000	PF, GOV	10 wetland restoration projects in 10 years
C. Zoning and Land Use Recommendations					
1. Publish a handout/brochure (also available on websites) that lists information on permits needed and whom to contact when conducting construction or earth-changing activities that could impact water quality.	Charlevoix County Planning, Emmet County Planning, Tip of the Mitt Watershed Council, Soil Erosion Officers, Drain Commissioners, Citizens for Open Space, Tunnel of Trees Heritage Highway, City of Petoskey	1 year	$5,000	PF, GOV	Print 5,000 copies of the brochure

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
C. Zoning and Land Use Recommendations, continued					
2. Work with local governments to provide better zoning tools to help protect water quality (e.g. documenting greenbelt conditions, ordinance language, water quality planning tools on website).	Walloon Lake Association, Charlevoix County Planning, Emmet County Planning, Tip of the Mitt Watershed Council, LTBB Odawa, Drain Commissioners, Citizens for Open Space, HARBOR Inc., City of Petoskey	2 years	$40,000	PF, GOV	Adoption of water quality protection provisions of 50% local governments
3. Identify waterfront lots that are nonconforming to zoning ordinances and work with townships/cities/county to discuss potential water quality impacts and solutions.	Tip of the Mitt Watershed Council	3 years	$8,000	PF	Identify lots in 2008
4. Implement and evaluate (time of sale) septic inspection programs and educate about the new requirements.	Northwest Community Health Agency, Tip of the Mitt Watershed Council, Walloon Lake Association	3 years	$4,000	GOV	TASK COMPLETED
5. Meet with local golf course managers and discuss management techniques to reduce nonpoint source pollution. Encourage enrollment in Golf Course Stewardship Program.	MSU Extension, Tip of the Mitt Watershed Council, Walloon Lake Association, Emmet and Charlevoix Conservation Districts	5 years	$6,000	PF, GOV	50% of golf courses members by 2011
6. Develop a series of zoning guidelines and standards that are supported by science (For example, setbacks for waterfront properties, the benefits of 75 feet setback over a 40 feet setback).	Citizens for Open Space, HARBOR Inc., Tip of the Mitt Watershed Council, Government Agencies	7 years	$75,000	PF, GOV	Zoning guidelines and standards developed for two specific topics

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
C. Zoning and Land Use Recommendations, continued					
7. Use the "Harbor Plan" report as a model to acquire state clout to enforce local plans and ordinances.	Citizens for Open Space, HARBOR Inc., Tip of the Mitt Watershed Council, Government Agencies, LTBB Odawa, City of Petoskey	10 years	$50,000	PF, GOV	Distribute copies of the "Harbor Plan" to the Advisory Committee
8. Implement an ongoing education program for local governments on land use planning tools that can help protect water quality and encourage better coordination amongst neighboring townships (e.g. conservation planning and design and impact coordination rules, provide tools, examples, model ordinances).	Charlevoix County Planning, Emmet County Planning, HARBOR Inc., Citizens for Open Space, MSU Extension, Townships, Tip of the Mitt Watershed Council, LTBB Odawa, Drain Commissioners	10 years	$70,000	PF, GOV	Develop program by year 3; hold first program by year 4
9. Form a partnership of interested agencies and organizations to set standards for septic systems that protect water quality.	Northwest Community Health Agency, HARBOR Inc., Emmet County Planning, Charlevoix County Planning, Tip of the Mitt Watershed Council, Walloon Lake Association	10 years	$20,000	PF, GOV	Set standards by year 4
10. Sponsor annual education program for lake and river realtor/ developers/ builders on special regulations and management for riparian properties.	Charlevoix County Planning, Emmet County Planning, Walloon Lake Association, Tip of the Mitt Watershed Council, Little Traverse Conservancy, Charlevoix County Land Conservancy, Michigan Department of Natural Resources	10 years	$30,000	PF, GOV	25% of realtors attend first the event

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
C. Zoning and Land Use Recommendations, continued					
11. Annually sponsor a program for new planning commissioners, zoning board of appeals members, and township and county board members, to provide information about how their decision-making role influences water quality.	Tip of the Mitt Watershed Council	10 years	$30,000	PF, GOV	25% of officials attend first event
12. Organize a network of local planning units in the Watershed and work towards developing shared, high standards for provisions that protect water quality (e.g. setbacks).	Charlevoix County Planning, Emmet County Planning, MSU Extension, Townships, Tip of the Mitt Watershed Council, LTBB Odawa, Drain Commissioners	10 years	$60,000	PF, GOV	75% of local governments adopt similar high standards
13. Develop a yearly summary of variances of sanitary code/zoning to determine if there are water quality impacts.	Northwest Michigan Community Health Agency, Tip of the Mitt Watershed Council	10 years	$10,000	PF, GOV	Summary reports produced
14. Increase awareness and promote the benefits of purchase of development rights (PDR) programs as a tool for water quality protection.	Walloon Lake Association, Tip of the Mitt Watershed Council, Little Traverse Conservancy, Charlevoix County Land Conservancy, Citizens for Open Space, HARBOR Inc.	10 years	$40,000	PF, GOV	PDR program adopted by a local government
15. Promote sound community planning and development to promote watershed protection (e.g. support the Citizens for Open Space, open space preservation, redevelopment).	Citizens for Open Space, Charlevoix County Planning, Emmet County Planning, MSU Extension, Townships, Tip of the Mitt Watershed Council, LTBB Odawa, City of Petoskey	10 years	$50,000	PF, GOV	Adoption of open space provisions of 50% local governments

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
C. Zoning and Land Use Recommendations, continued					
16. Encourage more coordination of township planning efforts on a county wide scale including efforts to review existing plans and studies.	Citizens for Open Space, HARBOR Inc., Tip of the Mitt Watershed Council, Government Agencies	10 years	$100,000	PF, GOV	Develop inventory of existing plans
17. Educate watershed residents, including students, about land use issues and foster citizen involvement in local land use decision making.	Charlevoix County Planning, Emmet County Planning, Walloon Lake Association, Tip of the Mitt Watershed Council, HARBOR Inc., Citizens for Open Space, LTBB Odawa, Charlevoix County Land Conservancy	10 years	$50,000	PF, GOV	Conduct survey to document current status of knowledge and involvement
D. Road/Stream Crossing Recommendations					
1. Develop strategy to update inventories on a regular basis and evaluate severity taking into account locations identified as environmentally sensitive.	Emmet County Road Commission, Charlevoix County Road Commission, Tip of the Mitt Watershed Council, Conservation Resource Alliance, LTBB Odawa	1 year	$15,000	PF, GOV	Database is placed online
2. Develop a method to keep track of repairs/records of culverts and problems.	Emmet County Road Commission, Charlevoix County Road Commission, Tip of the Mitt Watershed Council, Conservation Resource Alliance	1 year	$20,000	PF, GOV	Implement LIAA/CRA method in year 2

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
D. Road/Stream Crossing Recommendations, continued					
3. Develop and implement strategy to restore moderate and minor road/stream crossing sites on a subwatershed basis.	Emmet County Road Commission, Charlevoix County Road Commission, Tip of the Mitt Watershed Council, Conservation Resource Alliance	2 years	$3,000,000	PF, GOV	Identify funding sources, timelines, and other potential partners for six sites
4. Work closely with road commissions to utilize best management practices (BMPs) on road work within the priority area.	Emmet County Road Commission, Charlevoix County Road Commission, Tip of the Mitt Watershed Council, Conservation Resource Alliance	6 years	$30,000	PF, GOV	Sponsor two better back road trainings for road commission staff
5. Restore most severe road/stream crossings in cooperation with the Emmet and Charlevoix County Road Commissions.	Emmet County Road Commission, Charlevoix County Road Commission, Conservation Resource Alliance	10 years	$5,000,000	PF, GOV	25% are restored by year 5
E. Agriculture Recommendations					
1. Work with farmers to implement GAAMPs (Generally Accepted Agricultural Management Practices) for severe and moderate agricultural sites and possibly use as demonstration sites.	Emmet and Charlevoix Conservation Districts	4 years	$100,000	PF, GOV	50% of the severe and moderate are improved
2. Work with Conservation Stewardship Program (CSP) to implement best management practices and GAAMPs.	Emmet Conservation District, Charlevoix Conservation District	10 years	$50,000	PF, GOV	Implement 25% more BMPs and GAAMPs

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
E. Agriculture Recommendations, continued					
3. Promote sustainable agriculture (both financial and ecological) and value-added crops or products for agricultural producers (the water quality connection to this activity is to maintain low-impact agriculture, the open space associated with the farms, and minimal impervious surface).	Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension	10 years	$100,000	PF, GOV	Fund sustainable agriculture conference registration for ten ag producers
4. Promote local agriculture and encourage local residents to purchase locally grown products.	Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension	10 years	$50,000	PF, GOV	Have two ag producers from the watershed participating in local farmers' markets
5. Investigate minor sites to determine extent of problems and implement GAAMPS where possible.	Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension	10 years	$25,000	PF, GOV	25% of the minor sites are improved
6. Cooperate with Groundwater Stewardship Program to encourage better nutrient management and other activities on farms that are both a surface water and ground water concern.	Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension	10 years	$15,000	PF, GOV	25% reduction in fertilizer use on agricultural fields
7. Distribute information to farmers on manure application, benefits of filter strips, and other topics using existing materials on agricultural best management practices.	Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension	10 years	$4,000	PF, GOV	20% increase in use of BMPs
8. Work to maximize funding available for GAAMPS by accessing federal programs (farm bill, EQIP, and others) and state programs.	Emmet and Charlevoix Conservation Districts, Natural Resources Conservation Service, MSU Extension	10 years	$25,000	GOV	50% of the projects benefit from these programs

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
F. Land Protection Recommendations, continued					
1. Share the selection criteria for identifying sensitive areas with local units of government for master plans and other land use decisions.	Little Traverse Conservancy, Charlevoix County Land Conservancy, Walloon Lake Trust and Conservancy, LTBB Odawa	1 year	$15,000	PF, GOV	TASK COMPLETED
2. Send follow-up letter to property owners identified with priority sensitive lands and make personal contacts with landowners.	Little Traverse Conservancy, Charlevoix County Land Conservancy, Walloon Lake Trust and Conservancy	10 years	$30,000	PF, GOV	Letters sent bi-annually
3. Continue to work with Michigan Department of Natural Resources on potential assist and transfer projects on priority sensitive lands in the Little Traverse Bay Watershed.	Little Traverse Conservancy, Charlevoix County Land Conservancy, Walloon Lake Trust and Conservancy	10 years	$6,000	PF, GOV	200 acres protected through assist and transfer
4. Review the priority sensitive land parcel inventory annually to track land protection progress and identify additional priority parcels for protection.	Little Traverse Conservancy, Charlevoix County Land Conservancy, Walloon Lake Trust and Conservancy, Tip of the Mitt Watershed Council	10 years	$5,000	PF, GOV	Priority parcel list generated annually
G. Forestry and Mining Recommendations					
1. Work with Michigan Department of Natural Resources to revise forest management plans to reduce impacts from forestry and recreation for sensitive parcels in the Watershed.	Tip of the Mitt Watershed Council, Mackinac Forest Council, LTBB Odawa	2 years	$15,000	PF, GOV	Attend DNR Open Houses
2. Send information packet on forestry best management practices to key property owners in the priority areas of the Watershed.	Emmet and Charlevoix Conservation Districts	10 years	$5,000	PF, GOV	Gather newest materials on forest management for packets

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
G. Forestry and Mining Recommendations, continued					
3. Develop guidelines to minimize impacts to water quality from mineral extraction and require adequate restoration.	Tip of the Mitt Watershed Council	10 years	$25,000	PF, GOV	Collect existing model standards, ordinances, or research on restoration
4. Work with Michigan Department of Natural Resources, Forestry Division to review forestry plans within the Watershed and ensure BMPs are required in all contracts, and management plans are consistent with Watershed project goals.	Emmet and Charlevoix Conservation Districts, Michigan Department of Natural Resources, Mackinac Forest Council	10 years	$25,000	PF, GOV	Review 25% of plans by year 5
5. Offer development of forest management plans for private landowners in the priority area that emphasize BMPs to protect water quality.	Emmet and Charlevoix Conservation Districts	10 years	$10,000	PF, GOV	Provide 20 plans in 5 years
H. General Information and Education Recommendations					
1. Produce a summary of the Watershed Plan and distribute to Watershed residents.	Tip of the Mitt Watershed Council	1 year	$12,000	PF, GOV	TASK COMPLETED
2. Develop a program to educate boaters at the marinas to reduce their impacts from invasives, boat washing, tank pumping, litter, and boating practices.	Tip of the Mitt Watershed Council, Emmet County Lakeshore Association, Walloon Lake Association	5 years	$50,000	PF, GOV	Involve 75% of the marinas in 5 years
3. Create a long-term funding source to help fund the actions in this plan.	Tip of the Mitt Watershed Council	10 years	$100,000	PF, GOV	Begin fundraising in year 2
4. Develop a "place-based" water resource education program for elementary and secondary students.	SEE-North	10 years	$100,000	PF	Develop program outline and obtain funding
5. Initiate Volunteer Purple Corp to manage and control purple loosestrife.	Tip of the Mitt Watershed Council	10 years	$15,000	PF, GOV	Conduct inventory around Walloon Lake and Bear River

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
H. General Information and Education Recommendations, continued					
6. Develop a portable display about the Watershed and actions needed to protect and improve its health and take it to local events (fairs, festivals, camps).	Tip of the Mitt Watershed Council	10 years	$20,000	PF, GOV	Develop display by year 3
7. Continue to educate the public about nonpoint source pollution using organizational newsletters of the Little Traverse Bay Watershed Plan partners and press releases.	Tip of the Mitt Watershed Council, project partners	10 years	$5,000	PF, GOV	Print 3 articles annually
8. Give presentations to promote the project's goals and activities.	Tip of the Mitt Watershed Council	10 years	$20,000	PF, GOV	Conduct 5 presentations annually
9. Sponsor clean-ups of the Bear River and other tributaries to remove litter and increase civic pride and community connection to area resources.	Tip of the Mitt Watershed Council	10 years	$30,000	PF, GOV	Sponsor clean-ups biannually
10. Sponsor Bear River Bio Blitz to build a data base of ecological health of the river and engage the community.	Tip of the Mitt Watershed Council	10 years	$50,000	PF, GOV	Gather 10 data sets at 4 locations in 10 years
I. Water Quality Monitoring Recommendations					
1. Involve associations along the Bay in monitoring beaches for bacteria.	Tip of the Mitt Watershed Council	10 years	$10,000	PF, GOV	Three associations collect weekly bacteria samples
2. Work with volunteers to gather data on Little Traverse Bay algae and develop database.	Tip of the Mitt Watershed Council	10 years	$50,000	PF, GOV	Establish 10 monitoring sites in year 1
3. Monitor stormwater outlets around the Bay to document pollutant loadings and changes over time.	Tip of the Mitt Watershed Council	10 years	$100,000	PF, GOV	Collect two seasons of data for Harbor Springs
4. Monitor the physical, chemical, and biological characteristics of Little Traverse Bay.	Tip of the Mitt Watershed Council, LTBB Odawa	10 years	$100,000	PF, GOV	Develop monitoring protocol by year 2

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
I. Water Quality Monitoring Recommendations, continued					
5. Advocate for stronger water quality standards for Little Traverse Bay, Walloon Lake, and its tributaries.	Tip of the Mitt Watershed Council	10 years	$75,000	PF, GOV	Research process for upgrading standards and outline strategy
6. Monitor physical, chemical, and biological characteristics of tributaries throughout the watershed.	Tip of the Mitt Watershed Council, LTBB Odawa	10 years	$100,000	PF, GOV	Collect data on 50% of tributaries
7. Establish air quality monitoring stations to detect trends in air quality.	Tip of the Mitt Watershed Council	10 years	$200,000	PF, GOV	Identify potential locations for stations
8. Research how to determine the "air shed" for Little Traverse Bay and identify potential pollution locations.	Tip of the Mitt Watershed Council, LTBB Odawa	10 years	$100,000	PF, GOV	Gather existing information on Lake Michigan airshed
9. Recruit volunteer stream monitors for the tributaries in the watershed.	Tip of the Mitt Watershed Council	10 years	$50,000	PF, GOV	Monitor four of the larger tributaries in 5 years
10. Monitor reports from point source discharges to Little Traverse Bay.	Tip of the Mitt Watershed Council	10 years	$10,000	PF, GOV	Share annual updates with advisory committee
11. Establish an on-going program to monitor and study the shoreline along Bay Harbor to determine levels of contaminated leachate and assess the impact to the Bay's ecosystem.	Tip of the Mitt Watershed Council, LTBB Odawa	10 years	$50,000	PF, GOV	Review clean up progress annually
J. Hydrology Recommendations					
1. Develop a ground water recharge management plan in cooperation with the Michigan Department of Natural Resources and the District Health Department for identified sensitive locations in the Watershed.	Tip of the Mitt Watershed Council, Michigan Department of Natural Resources	4 years	$7,000	PF, GOV	Develop plan by 2010

Recommendations	Responsible Organizations	10 Year Timeline (2006-2016)	Estimated Costs	Possible Funding Sources	Task Milestone
J. Hydrology Recommendations, continued					
2. Develop guidelines and adopt policies to manage potential water extraction.	Tip of the Mitt Watershed Council	10 years	$150,000	PF, GOV	Establish guidelines by year 3
3. Assess the condition and impacts of dams in the Watershed and develop management options; prioritize dams for removal that are not providing economic or ecological benefits.	Tip of the Mitt Watershed Council	10 years	$600,000	PF, GOV	Conduct an inventory of existing dams
4. Develop maps to show ground water recharge, major aquifers, and general direction of ground water flow.	Tip of the Mitt Watershed Council	10 years	$20,000	PF, GOV	Develop maps by 2011
K. Evaluation					
1. Document the before status of all physical improvements with photographs.	Tip of the Mitt Watershed Council, Conservation Resource Alliance, Charlevoix and Emmet Conservation Districts	10 years	$5,000	PF, GOV	Develop an online photo database of before and after photographs
2. Develop evaluation methods for the variety of information and education programs. Sponsor focus groups where most appropriate.	Tip of the Mitt Watershed Council	10 years	$10,000	PF, GOV	Compile list of information and education projects and outcomes to share with Advisory Committee
3. Conduct annual evaluation and overall evaluation of implementation activities.	Tip of the Mitt Watershed Council, Advisory Committee members	10 years	$30,000	PF, GOV	Gather feedback from the Advisory Committee at the December meetings

Glossary

Aquatic nuisance species: (ANS) are nonindigenous species that threaten the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters.

Ballast water: Fresh or salt water (sometimes containing sediments) held in tanks and cargo holds of ships to increase stability and maneuverability during transit.

Best Management Practices (BMP): Structural, vegetative and managerial practices implemented to control nonpoint source pollution.

Buffer strips: *see* greenbelt

Bulkhead: A structure that retains or prevents sliding of land or protects against wave action.

Cladophora: Cladophora is a branched, filamentous, green algae that occurs naturally in low densities in Northern Michigan lakes, mostly on rocky shorelines. Dense growths typically form in areas where nutrient levels, particularly phosphorous, are high. These high nutrient levels can occur naturally, but often are caused by nutrient pollution such as lawn fertilization, malfunctioning septic systems, poor agricultural practices, soil erosion, and wetland destruction.

Conductivity: Measures water's ability to conduct electricity. Measurements above background levels may indicate pollution.

Confluence: Point at which two or more watercourses intersect.

Critical area: That part of the watershed that is contributing a majority of the pollutants and is having the most significant impacts on the water body.

Culvert: A covered channel or a large diameter pipe that directs water flow below the ground level.

Designated uses: Recognized uses of water established by state and federal water quality programs. The Water Resources Commission Act requires all waters of the State of Michigan to be of the quality to meet seven designated uses: 1) agriculture; 2) navigation; 3) industrial water supply; 4) public water supply; 5) warm water fishery; 6) habitat for indigenous aquatic life and wildlife; and 7) partial or total body contact recreation. An eighth designated use, cold water fishery is applicable for many rivers and lakes in Michigan.

Agriculture
Industrial water supply
Public water supply
Navigation
Warm water fishery
Cold water fishery
Other indigenous aquatic life and wildlife
Partial body contact
Total body contact

E. coli: Bacterium used as an indicator of the presence of waste from humans and other warm-blooded animals.

Ecosystem: A community of plants and animals and the physical environment they inhabit, e.g., wetlands, rivers, upland. The ecosystem reflects the interaction among soil, climate, vegetation, and animal life.

Erosion: The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices related to farming, residential or industrial development, road building, timber cutting, or recreation.

Focus groups: Groups of individuals brought together to discuss a particular topic or situation.

Generally Accepted Agricultural Management Practices (GAAMP): The Michigan Right to Farm Act, P.A. 93, was enacted in 1981 to provide farmers with protection from nuisance lawsuits. This state statute authorizes the Michigan Commission of Agriculture to develop and adopt Generally Accepted Agricultural and Management Practices (GAAMPs) for farms and farm operations in Michigan. These voluntary practices are based on available technology and scientific research to promote sound environmental stewardship and help maintain a farmer's right to farm.

GIS: Geographical Information System: A system that analyzes and models data in a spatial context and displays digitally recreated map layers.

GPS: Global Positioning System: A system capable of providing worldwide navigation and positioning by pinpointing locations.

Greenbelt: A strip of natural vegetation located between the shoreline and lawn or structures. It protects water quality by absorbing precipitation, preventing soil erosion, and filtering out sediment, nutrients, and other pollutants.

Ground water: Water that seeps below the surface of the ground and fills interconnected pores in soil and cracks in rocks. It is the subsurface water supply in the saturated zone below the water table.

Ground water recharge: The addition of water to the ground water system by natural or artificial processes.

Habitat: The environment in which the requirements of a specific plant or animal are met.

Headwaters: The origin and upper reaches of a river or stream.

Heavy metals: A group of elements that is present in the environment from natural and anthropogenic sources and can produce toxic effects. This group includes mercury, copper, cadmium, zinc, and arsenic.

Hydrologically distinct: Defined by drainage basins or watersheds rather than areas arbitrarily defined by political boundaries.

Impervious: A surface through which little or no water will move. Impervious areas include

paved parking lots, streets, sidewalks, and roof tops.

Infiltration: The penetration of water through the ground surface into subsurface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.

Marl: Lake Michigan and most of Northern Michigan's waters are considered to have "hard water," meaning they have moderately high levels of calcium and magnesium carbonates dissolved in the water. Natural chemical reactions (especially the photosynthesis of aquatic plants and algae which lowers carbon dioxide levels) causes these minerals to come out of solution and coat rocks, plant leaves, even the lake bottom with a greyish-white, putty-like substance. This mineral deposit is known as marl.

Master plan: A community's vision for future land use. It contains background information on the natural, cultural, and physical characteristics of a community, including population. It provides a framework and a basis for a zoning ordinance. Michigan law requires that communities review/update their master plans every five years.

Nonpoint source pollution: Pollution caused when rain, snowmelt, or wind carry pollutants off the land and into the water bodies.

Nutrient: Any mineral, compound, or element that promotes biological growth or development.

Oligotrophic: Lacking in plant nutrients and having an abundance of dissolved oxygen.

pH: The measure of acidity or alkalinity, where 7 is neutral, less than 7 is acidic, and more than 7 alkaline.

Permit: An authorization, license, or equivalent control document issued by EPA or an approved state agency to implement the requirements of an environmental regulation; e.g., a permit to operate a wastewater treatment plant or to operate a facility that may generate harmful emissions.

Point source: The release of an effluent from a pipe or discrete conveyance into a waterbody or a watercourse leading to a body of water.

Pollutant: Any substance of such character and in such quantities that when it reaches a body of water, soil, or air, it contributes to the degradation or impairment of its usefulness or renders it offensive.

Priority area: That portion of the watershed that is most sensitive to environmental impacts and which has the greatest likelihood to affect water quality and aquatic habitat. For this Little Traverse Bay Watershed, the priority area includes all areas within 1,000 feet of a lake, stream, wetland, and urban areas that drain to surface waters via storm sewers, as well as areas of steep slope (25% and greater).

Purchase of Development Rights (PDR): PDR is a voluntary program, where a land trust or some other agency makes an offer to a landowner to buy the development rights on a parcel of land. If an agreement is made, a permanent deed restriction is placed on the property which restricts the type of activities that may take place on the land in perpetuity. The deed restriction may also be referred to as a conservation easement.

Resource management system: A combination of best management practices that, when installed, will at a minimum protect the resource base by meeting acceptable soil losses; protect or improve water quality; and conserve plant, air, and animal resources.

Riparian: Person who lives along or holds title to the shore area of a lake or bank of a river or stream.

Riparian corridor: Areas bordering streams, lakes, rivers, and other watercourses. These areas have high water tables and support plants requiring saturated soils during all or part of the year.

Road/Stream Crossing: Where a road crosses over a river or stream.

Riprap: A protective layer or facing of quarrystone, placed to prevent erosion, scour, or sloughing.

Runoff: That portion of the precipitation or irrigation water that travels over the land surface and ends up in surface streams or water bodies.

Sediment: Soil, sand, and minerals which can take the form of bedload, suspended, or dissolved material.

Sedimentation: The process of nutrients and sediments entering waterbodies and wetlands.

Seiche: Like water sloshing in a bathtub, seiches are tide-like rises and drops in Great Lakes coastal water levels caused by prolonged strong winds that push water toward one side of the lake, causing the water level to rise on the downwind side of the lake and to drop on the upwind side. When the wind stops, the water sloshes back and forth, with the nearshore water level rising and falling in decreasingly small amounts on both sides of the lake until it reaches equilibrium.

Setback: Minimum distance that must be maintained between a structure and property lines or between two structures.

Shoreline hardening: Armoring the shoreline with revetments, walls, boulders, and other hard structures.

Spatially referenced data: Assigning specific geographic locations to data.

Stakeholder: Any organization, governmental entity, or individual that has a stake in or may be affected by a given approach to environmental regulation, pollution prevention, or energy conservation.

Stewardship (land): To care for and manage natural land in a way that maintains its ecological integrity for the benefit of present and future generations.

Storm drain (storm sewer): A system of gutters, pipes, drains, or ditches used to carry stormwater from surrounding lands to streams, ponds, and lakes.

Stormwater: Excess water that accumulates on the surface after the ground has become saturated from precipitation (rain, snow, or snowmelt) and begins to flow over land.

Substrate: "Supporting surface" on which an organism grows. The substrate may simply provide structural support, or may provide water and nutrients. A substrate may be inorganic, such as rock or soil, or it may be organic, such as wood.

Surface water: All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, wetlands impoundment, and seas).

Suspended solids: Sediment particles in the water column and carried with the flow of water.

Swimmer's itch: Swimmer's itch is a skin rash caused by a parasite (shistosomes) which ordinarily infects birds, semi-aquatic mammals, and snails. As part of their developmental life-cycle, these parasites migrate through the water and are capable of penetrating human skin. After penetration, the parasites remain in the skin and die but can cause an allergic reaction in some people. The parasite in humans does not mature, reproduce or cause any permanent infection.

Topographic maps: Land maps that display elevation along with natural and man-made features.

Topography: The physical features of a surface area including relative elevations and the position of natural and man-made features.

Tributary: A river or stream that flows into a larger river or stream.

Turbidity: Turbidity refers to how clear the water is. The greater the amount of total suspended solids (TSS) in the water, the murkier it appears and the higher the measured turbidity. The major source of turbidity in the open water of most lakes is typically phytoplankton. Closer to shore, particulates may also be clays and silts from shoreline erosion, resuspended bottom sediments, and organic detritus from stream and/or wastewater discharges.

Upland: Any area that does not qualify as a wetland because the associated hydrologic regime is not sufficiently wet to elicit development of vegetation, soil, and/or hydrologic characteristics associated with wetlands.

Urban runoff*: see* runoff

Vegetative controls: Control measures or practices that usually involve the use of cropping systems, permanent grass, or other vegetative cover to reduce erosion and control.

Water quality: The biological, chemical, and physical conditions of a waterbody, often measured by its ability to support life.

Watershed: The geographic region within which water drains into a particular river, stream, or body of water. Watershed boundaries are defined by the ridges separating watersheds.

Watershed Management Plan: A document developed co-operatively by government agencies and other stakeholders to manage the water, land/water interactions, aquatic life and aquatic resources within a particular watershed, in order to protect the health of the ecosystem as land uses change. It recommends how water resources are to be protected and enhanced in relation to changing land uses.

Wetland: An area that is regularly saturated by surface or groundwater and subsequently is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

Windshield survey: Conducting an inventory of the watershed via a motorized vehicle.

Zoning: Regulations created and enforced by county and city governments to promote the compatibility of land uses by dividing tracts of land into different districts or zones. Zoning ensures that a factory is not located in the middle of a residential neighborhood or that a bar is not located next to an elementary school.

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