GOOD HARBOR BAY WATERSHED

PROTECTION PLAN

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Good Harbor Bay Watershed Protection Plan

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Good Harbor Bay Watershed Protection Plan Partners

Lime Lake Association (LLA), Little Traverse Lake Property Owners Association (LTLPOA), Little Traverse Conservationists (LTC), Michigan Department of Environmental Quality (MDEQ), Michigan Department of Natural Resources (MDNR), Leelanau Conservation District (LCD), Conservation Resource Alliance (CRA), Grand Traverse Band of Ottawa and Chippewa Indians (GTBOCI), Grand Traverse Regional Land Conservancy (GTRLC), Leelanau Conservancy, Natural Resources Conservation Service (NRCS), NW Michigan Council of Governments (NWCOG), Leelanau County Road Commission (LCRC), Benzie Leelanau Health Department (BLHD), Sleeping Bear Dunes National Lakeshore (SBDNL)

The Good Harbor Bay Watershed Protection Plan can be downloaded at the following websites: www.leelanauconservancy.org or www.leelanaucd.org

INTRODUCTION

The Good Harbor Bay watershed is located in Leelanau County, Michigan, approximately 25 miles from Traverse City, Michigan. The watershed includes 29,020 acres of land area or approximately 45.4 square miles, and intersects with the jurisdictions of five townships, and contains no municipalities. A watershed is an area of land that drains to a common point. On a very broad scale, imagine a mountain, and think of the highest ridges on the mountain as the boundaries of the watershed. Rain, melting snow, and wind carry pollutants from the ridges and sides of the mountains into the water in the valley. Watersheds are inherently defined by topography as water always follows the path of least resistance (EPA 2008).

The Good Harbor Bay watershed originates in the forested uplands, kettle holes and wetlands in Kasson Township and surface water generally flows north through the watershed until it outlets in to Lake Michigan's Good Harbor Bay in Cleveland Township. Major features of the Good Harbor Bay watershed include Lime Lake, Little Traverse Lake and Shalda Creek that travels through the Sleeping Bear Dunes National Lakeshore. The watershed extends along the shore of Good Harbor Bay and includes a number of small tributary streams that outflow into Good Harbor Bay. The watershed also includes a number of smaller lakes, wetland and forested areas, residential areas and resort properties.

The Good Harbor Bay watershed plan was developed to better examine and understand the watershed and to identify ways to protect the watershed's natural functions.

The rationale for watershed management is that if land activities are responsibly managed, the water within that watershed will be protected. All activities within a watershed affect the quality of water as it percolates through and runs across natural and developed landscapes. Watershed planning brings together the people within the watershed to address those activities, regardless of existing political boundaries. By working together, individuals within the watershed can design a coordinated watershed management plan that builds upon the strengths of existing programs and resources, and addresses the water quality concerns in an integrated, cost effective manner (EPA 2008).

The Good Harbor Bay Watershed Protection Plan is the result of a steering committee being formed in fall of 2011 to draft the first watershed plan for this area. This watershed planning effort includes the last major watershed in Leelanau County to complete the watershed planning process. The Good Harbor Bay Watershed Protection Plan is a comprehensive document that coordinates the Lime Lake Association (LLA), Little Traverse Lake Property Owners Association (LTLPOA), the Little Traverse Conservationists (LTC), and other project partner's ongoing efforts to protect water quality with other watershed-wide stakeholder groups to achieve designated and desired goals.

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Purpose

The Good Harbor Bay Watershed Protection Plan (GHB Watershed Plan) is a comprehensive document that coordinates the ongoing efforts of various partners to protect water quality with those of other watershed-wide stakeholder groups to achieve designated and desired goals. These goals are addressed in a consolidated task implementation chart designed to achieve and maintain the high water quality. It is important to note that this document is a planning framework that prescribes tasks designed to achieve watershed goals, however it is not regulatory in nature. The plan itself and the Steering Committee are non-political entities and neither have regulatory powers.

Background

The Good Harbor Bay watershed community has become increasingly interested in water resource issues. Notable examples are the efforts by the lake associations, Leelanau Conservancy and Sleeping Bear Dunes National Lakeshore.

The quality of life derived from healthy ecosystems and the numerous forms of high quality outdoor recreation that they provide makes the Good Harbor Bay watershed a very desirable area for residents and visitors alike. In order to maintain the quality of this resource, local governments, concerned citizens, and numerous agencies all need to work together towards a common goal – protecting the entire watershed from poor management decisions to prevent any further water quality degradation. Watershed protection means conscientious stewardship of all water and land within the watershed. This watershed protection plan summarizes existing watershed conditions, identifies and prioritizes major watershed pollutants and proposes specific tasks, project partners and costs to reduce the impact and amount of pollution entering the system. The GHB Watershed Plan also outlines the implementation and evaluation strategies as well as resources for the local units of government including township planning and zoning boards.

Watershed Characteristics

The Good Harbor Bay watershed is located in Leelanau County, Michigan, approximately 25 miles from Traverse City, Michigan. The Good Harbor Bay watershed has a total drainage area of 29,020 acres or approximately 45.4 square miles and is about 8-11 miles in length, and intersects with the jurisdictions of five townships, and contains no villages. The forested uplands, kettle holes and wetlands in Kasson Township form the southern limit of the watershed. Most of the northern portion of the watershed is within the Sleeping Bear Dunes National Lakeshore. The entire watershed empties, into Lake Michigan. The upland areas of the watershed flow into Lime Creek and Lime Lake in Cleveland Township. Lime Lake flows through Shetland Creek to Little Traverse Lake. Little Traverse Lake flows into Shalda Creek. A number of tributary streams flow into Shalda Creek after traveling through a number of wetland areas before it empties into Lake Michigan's Good Harbor Bay. Cleveland Township provides the majority of ground and surface water flow in the center of the watershed.

The Good Harbor Bay watershed extends east along the Good Harbor Bay shoreline up to the Village of Leland in Leland Township. One inland lake and a number of small streams empty into Good Harbor Bay. This portion of the watershed includes the Lake Michigan waterfront residential area along Michigan Highway 22 (M-22). The western portion of the Good Harbor Bay watershed includes the rest of the Good Harbor Bay shoreline and into a portion of the Sleeping Bear Bay area of Glen Arbor Township. The large portion of the western area of the watershed is within the Sleeping Bear Dunes National Lakeshore and includes School Lake, Bass Lake and Shell Lake. The Lakeshore area includes wetlands, dune and swale habitat and forested areas.

Priority and Critical Areas

Although watershed management plans address the entire watershed, there are certain areas within the Good Harbor Bay watershed that warrant more extensive management or specific protection consideration. Areas that are most sensitive to impacts from pollutants are considered **Priority Areas.** Areas that require focused monitoring, restoration, remediation and/or rehabilitation are considered **Critical Areas**.

Priority Areas

Priority areas in the Good Harbor Bay watershed are defined as the geographic portions of the watershed that are most sensitive to impacts from pollutants and environmental stressors. The prescribed goals, objectives and tasks for these areas typically focus on preservation and protection. The priority areas for the Good Harbor Bay watershed are divided three different tiers of protection priorities that cover four geographic areas of the watershed (A-D). These tiers and areas are described below and shown in (Figure 27, page 143):

Priority Area Descriptions –

Area A- This area includes the kettle lakes and wetlands in the very upper part of the watershed in Kasson Township. This area contains several isolated kettle lakes with wetland complexes and significant amounts of forested land-use that maintains groundwater recharge for the watershed.

Area B- This area focuses on the wetlands and stream corridors feeding Lime Lake and includes the wetlands, riparian corridors, along Lime Creek.

Area C- This area focuses on the outlet of Lime Lake, Shetland Creek, between Lime Lake and Little Traverse Lake. This area also contains the majority of the coldwater fishery habitat for the watershed

Area D- This area includes the wetland complex on the western end of Little Traverse Lake (Shalda Creek), which flows through the Sleeping Bear Dunes National Lakeshore and eventually into Lake Michigan.

Tier 1:

- Habitat for or areas with threatened, endangered or species of special concern
- Existing public or protected land within the SBDNL, State, Conservancies and or Natural Areas, Preserves and Forest Reserves
- High Risk Erosion Areas

Tier 2:

- Surface water bodies (lakes/streams), shorelines, wetlands and land within 500' of them.
- High Priority Land Protection areas (Top two tiers of Natural Lands Inventory and 500 foot Riparian Buffer)
- Ground water recharge areas

Tier 3:

- Steep Slopes
- Wildlife Corridors

Critical Areas

Critical Areas are specific sections of the watershed that are suspected to contribute a significant amount of pollutants or have been documented as impacted by stressors or pollutants and require restoration to achieve designated or desired uses. Critical Area designation indicates that implementation of identified tasks will be needed to achieve load reductions identified in the plan (Figure 27). The critical areas for the Good Harbor Bay Watershed include the following areas:

- Little Traverse Lake outlet system
- Lime Creek Road Crossings- Narlock and Cemetery Road
- Sugar Loaf Resort and area golf courses

Designated and Desired Uses

Identified designated uses and water quality standards for Michigan surface waters were used to assess the condition of the watershed. Michigan's surface waters are protected by Water Quality Standards for specific designated uses (R323.1100 of Part 4, Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended). These standards and designated uses are designed to 1) protect the public's health and welfare, 2) to enhance and maintain the quality of water, and 3) to protect the state's natural resources. Protected designated uses as defined by Michigan's Department of Environmental Quality that are found in the Good Harbor Bay watershed include: agricultural, industrial water supply, navigation, warmwater and/or coldwater fishery, other indigenous aquatic life and wildlife, fish consumption, and partial and total body contact recreation.

None of the designated uses for the Good Harbor Bay watershed are impaired on a watershed wide scale (Table 20, Page 108). The steering committee and stakeholder input verified the need to establish specific desired uses particular to the Good Harbor Bay watershed that are not addressed by designated uses based on state water quality standards. Desired uses can be defined as the ways in which people use the watershed and how they would like to manage and protect the watershed to ensure the sustainability of those uses for future generations. Desired uses for the Good Harbor Bay watershed include recreational, aesthetic, human health, and ecosystem preservation.

Pollutants, Sources, and Causes

Designated and desired uses may be negatively affected by a number of different pollutants and environmental stressors in the Good Harbor Bay watershed. The term environmental stressor is used to describe factors that have a negative effect on the ecosystem or water quality, but are not accurately categorized as a specific pollutant. The Good Harbor Bay watershed has pollutant threats from loss of habitat, invasive species, excessive nutrients, sedimentation of stream channels, as well as failing septic systems near water bodies and improper waste disposal. Habitat loss, invasive species and excessive nutrient loading are the primary threat to the watershed, followed by hydrology and sediment. Other issues that threaten these designated and desired uses include toxic substances, pathogens, and thermal pollution. These specific threats were identified through scientific research reports, water quality monitoring reports, steering committee member input and contributions from watershed residents, general public input and scientific experts on the Good Harbor Bay watershed. Table 25 identifies known or suspected sources and causes of pollutants and environmental stressors that impact specific designated or desired uses.

Watershed Goals:

The following goals for the Good Harbor Bay watershed were developed by the Steering Committee to protect the designated and desired uses of the watershed:

1. Protect aquatic and terrestrial ecosystems.
2. Protect the quality and quantity of water resources.
3. Preserve high quality of recreational opportunities.
4. Ensure that all property owners, visitors, users and other stakeholders understand stewardship and are able to support and promote watershed protection activities.
5. Protect the health and safety of watershed users, residents and stakeholders.
6. Protect the economic viability within the watershed while ensuring water quality and quantity resources are protected.

The goals are recommendations for implementation efforts within the watershed. Each goal generally has multiple objectives that outline specific elements required to meet the goal. Tasks are then assigned to address the individual goals and multiple objectives. The detailed task implementation chart describes the task, provides interim milestones, approximates projected costs and assigns a plausible timeline for completion. The implementation tasks in Chapter 8 are designed to address individual watershed objectives under each main goal. Some of the tasks are designed to address multiple objectives under one treatment. And many of the tasks are grant or dependent on funding availability.

Pollutant Load Reductions

To help maintain the high water quality resources of the Good Harbor Bay watershed it is important to address known sources of pollution while at the same time preventing increases in pollutant loading overtime from emerging or currently unknown pollutant sources. Protecting Priority Areas identified in the GHBWPP with voluntary conservation easements is an excellent strategy to meet this objective. The Leelanau Conservancy is the local land conservancy using these strategies to protect high quality land in the Good Harbor Bay watershed, in addition to the rest of Leelanau County.

Land conservation BMPs are excellent ways to preserve water quality. When dealing with pollutant reduction from these specific types of BMPs the idea is to estimate the amount of pollution prevented from entering the watershed by keeping the land in its natural state. The load reduction is essentially the difference between the loading from the current land use and the loading from a more developed land use.

Permanent Conservation Easement Pollutant Load Reduction (lb/yr)

The total pollutant load reduction from a permanent conservation easement is determined by subtracting the total pollutant loading coefficient for the more developed land use, such as low density residential, from the total pollutant loading coefficient for a more natural land use, such as wetland or forest.

Table 30, page 161 contains annual pollutant loading coefficients for various land uses found in the Good Harbor Bay watershed as determined by measured total phosphorus concentrations and their respective nitrogen and sediment ratios. Subtracting annual pollutant loads for forested land uses in Table 31 from the annual pollutant loads for low density residential (LDR) and then multiplying by the conservation easement acreage yields an estimation of the reduction in annual pollutant load resulting from a permanent conservation easement implementation in Priority Areas.

(Low Density Residential lbs/ac/yr – Forested lbs/ac/yr) x Conservation Easement acres = Load reduction from permanent conservation easement

The watershed plan goal is to permanently protect 2500 acres of land within identified Priority Areas throughout the watershed by 2024 (See Land Protection and Management Goals in Section 5.2). Successful implementation of permanent voluntary conservation easements over 2500 acres will prevent 168,750 tons of sediment, 4500 lbs N, and 602.6 lbs P from entering the Good Harbor Bay watershed each year (Table 31, page 162).

Information and Education Strategy

Chapter 9 outlines an Information and Education Strategy that addresses the communication necessary for implementing the watershed protection plan. These outreach efforts are important because developing and carrying out a vision for stewardship of the Good Harbor Bay watershed will require the public and community leaders to become knowledgeable about the issues and solutions, engaged and active in implementing solutions and committed to both individual and societal behavior changes necessary.

Evaluation Procedures

An evaluation strategy will be utilized to measure progress during the Good Harbor Bay Watershed Protection Plan's implementation and to determine whether or not water quality is improving. The timeline for the evaluation is approximately every 5 years, with ongoing evaluation efforts completed as necessary. The main purpose of the evaluation strategy is to measure how well the stakeholders are doing at actually *implementing* the watershed management plan and assesses if project milestones are being met. Measuring accurate pollutant load reductions is the most essential element of the evaluation strategy since it will provide objective, quantified results. The evaluation strategy will also focus on public education of watershed issues and will monitor success of the Information and Education Strategy by looking at public perception of watershed issues over time. The Good Harbor Bay Watershed steering committee has a goal to meet yearly to go over the watershed plan and review the goals, task, outreach and education and accomplishments.

CHAPTER 2: GOOD HARBOR BAY WATERSHED DESCRIPTION

2.1 LOCATION AND SIZE

The Good Harbor Bay watershed has a total drainage area of 29,020 acres, or approximately 45.4 square miles (Figure 1). The watershed extends to 11 miles in length. The watershed intersects with the jurisdictions of five townships, and contains no municipalities. The forested uplands, kettle holes and wetlands in Kasson Township form the southern limit of the watershed. Most of the northern portion of the watershed is within the Sleeping Bear Dunes National Lakeshore. The entire watershed outfalls or empties into Lake Michigan. The upland areas of the watershed flow into Lime Creek and Lime Lake in Cleveland Township. Lime Lake flows through Shetland Creek to Little Traverse Lake. Little Traverse Lake flows into Shalda Creek. A number of tributary stream flow into Shalda Creek after traveling through a number of wetland areas before it outfalls into Lake Michigan's Good Harbor Bay. Cleveland Township provides the majority of ground and surface water flow in the center of the watershed.

The highest elevations of the watershed in upland area (Kasson Township) are about 1,000 feet (NAVD88). The average daily elevation of Lake Michigan is 579 feet, which mean a total fall of the land through the watershed of 420 feet. The majority of upland soils in the watershed are loamy sandy soils.

Lime Lake is an oval shaped morainal lake 1.6 miles long, along its north-south axis, and 0.8 miles wide, covering 670 acres. Its bottom is a mixture of marl and sand. In the northeast corner the bottom is covered with slabs and edgings from a former sawmill. The lake is 67 feet deep at its deepest point just west of the center of the lake. There is also a shallow spot near the center which some residents remember as being an island in the 1930's (Steinburg et al. 1994).

Little Traverse Lake is a crescent shaped lake, 2.1 miles long and 0.7 miles wide at its widest point, covering an area of 640 acres. It is 54 feet deep at its deepest point northwest of the center of the lake. The bottom is primarily a mixture of marls, silts and sands with marls on the south side, silts and sand on the north side, and an area of gravel bottom at the eastern end (Steinburg et al. 1994).

Neither lake has a truly independent watershed, but rather, the lakes are interconnected. Due to the nature of the soils both surrounding the lakes and in the watershed as a whole, there is also extensive groundwater movement throughout (Steinburg et al. 1994). These soils also influence the way in which home development or other land uses can be accomplished around the lakes, while still maintaining water quality. Through sandy soils, groundwater may travel as much as 15 meters per day (Steinburg et al. 1994).

The average water level in Lime Lake is 617 feet (188 m) and the mean water level for Little Traverse Lake is 594 feet (181 m). In general, Lime Lake is 23 feet above Little Traverse Lake. Little Traverse Lake is approximately 14 feet above than the mean water level of Lake Michigan (Steinburg et al. 1994).

The Good Harbor Bay watershed extends east along the Good Harbor Bay shoreline up to the Village of Leland in Leland Township. One inland lake and a number of small streams empty into Good Harbor Bay. This portion of the watershed includes the Lake Michigan waterfront residential area along Michigan Highway 22 (M-22). The western portion of the Good Harbor Bay watershed include the rest of the Good Harbor Bay shoreline and into a portion

Figure 1: Good Harbor Bay Watershed – Base Map

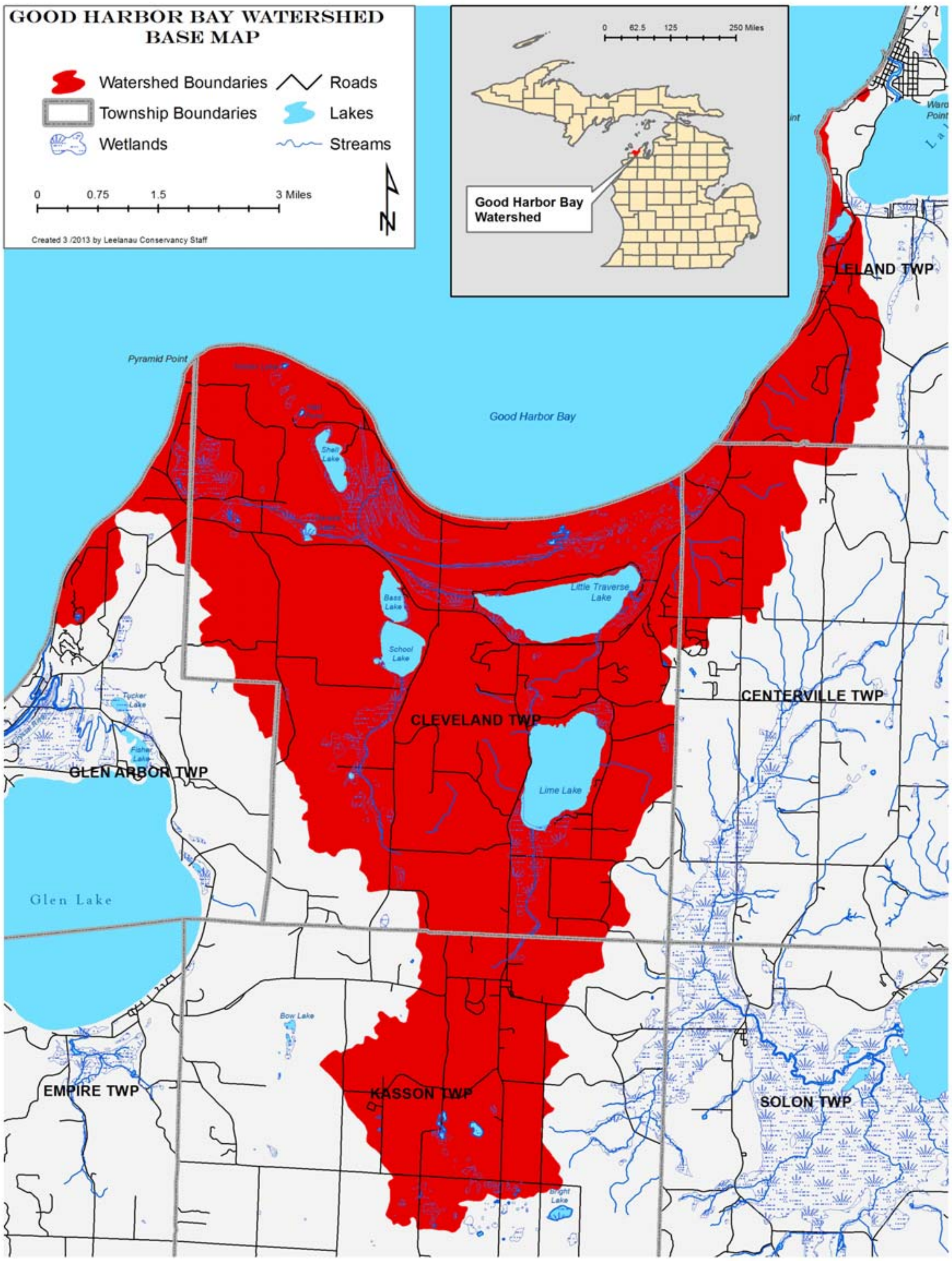


Figure 2: Good Harbor Bay Watershed – Aerial Photo Map

2.2 HYDROLOGY AND GROUNDWATER RECHARGE

There are many surface water bodies in the Good Harbor Bay watershed including numerous streams and lakes including Lime Lake, Little Traverse Lake, Shell Lake, School Lake and Bass Lake. The hydrologic balances for the Lime and Little Traverse Lakes were computed by Bill Cutler of the Leelanau Conservancy in November 1993 and are summarized below by Steinburg et al 1994.

Lime Lake

Lime Lake is a 670-acre lake with a maximum depth of 67 feet (Table 1), and extensive shoal areas with depths less than 15 feet (Seites 2011). The substrate in Lime Lake is predominately sand and marl, with some areas of cobble and gravel present. Vegetation in Lime Lake is sparse, though there is some emergent vegetation near the shoreline and some small submerged weed beds in water from 5 to 20 feet deep (Seites 2011). Lime Lake is fed by several hillside seeps, springs, and small creeks, with the largest being Lime Creek which flows in at the southern end of the lake. Shetland Creek flows out of the north end of Lime Lake and into Little Traverse Lake, and from there Shalda Creek flows out of Little Traverse Lake and into Good Harbor Bay on Lake Michigan (Seites 2011).

Lime Lake receives 47% (7.0 cfs) of its water supply from subsurface groundwater discharge, another 33% (4.9 cfs) from surface flow, and the remaining 20 % (3.0 cfs) from precipitation (Steinburg et al. 1994) (Table 2). Additionally, a good portion of the measured surface flow values include groundwater seeps, which flow over the land a short distance before reaching the lake. Groundwater is an extremely important factor in the hydrological budget of Lime Lake. Therefore it is essential that groundwater is replenished or “recharged”. This underscores the importance of protecting upland areas from impervious surfaces or other development that can inhibit the percolation of precipitation through the soil into the groundwater and decrease groundwater recharge. Areas that have a low slope gradient combined with permeable soils in general have a higher potential for groundwater recharge, especially when adjacent to high slope gradient uplands (Steinburg et al 1994).

Table 1: Parameters Lime and Little Traverse Lakes

Parameters	Lime Lake	Little Traverse Lake
Maximum length (feet)	8,448	11,088
Maximum Breadth (feet)	4,224	3,686
Surface Area (acres)	670	640
Volume (Cubic feet)	521,000,000	267,000,000
Maximum Depth (feet)	67	54
Mean Depth (feet)	17.8	9.6
Turnover Time (years)	1.1	0.4
Shoreline (feet)	22,992	27,026
Shoreline Development	1.2	1.44

(Source: Steinburg et al 1994)

Table 2: Lime Lake Water Balance

Lime Lake Water	Rate of Flow (cubic feet per second)	Percent of Total
Streams In:	4.9 cfs	33%
Precipitation	3.0 cfs	20%
Ground Water In:	7.0 cfs	47%
Total In:	14.9 cfs	100%
Streams Out:	11.8 cfs	79%
Evaporation Out:	3.0 cfs	20%
Groundwater Out	0.1 cfs	1%
Total Out:	14.9 cfs	100%

(Source: Steinburg et al 1994)

Lime Creek, Shalda Creek and Shetland Creek are the main stream systems in the Good Harbor Bay watershed. The primary tributary flowing into Lime Lake is Lime Creek, originating near Maple City and entering through a wetland area at the southern end of the lake. There are several other small ground water tributaries along the west side of Lime Lake, one just south of the public access point and one midway up the west side (Steinburg et al. 1994). There are also several springs feeding the lake in the southwestern quadrant. The springs create cold spots and sometimes the up welling water causes a noticeable disturbance at the lake surface (Steinburg et al. 1994). Lime Lake is primarily groundwater fed, [with several small stream tributaries] from the east and west shores, which are surrounded by high hills. Weed beds are thickest in the southern end, possibly due to the influx of nutrients from the ground water, springs and Lime Creek (Steinburg et al. 1994). The primary discharge from Lime Lake is through Shetland Creek which drains the lake from the northwest comer and then flows north and east to Little Traverse Lake. The water level in Lime Lake is maintained by a small rock pile at the entrance to Shetland Creek (Steinburg et al. 1994). A summary of the history and status of the rock pile is described below this section.

Approximately 50-60% of the shoreline of Lime Lake is developed with homes and cottages, and the surrounding land is predominately forested and residential. Lowland swamps dominated by cedar, hemlock, and birch trees surround the lake, while rolling hillsides with upland hardwoods and conifers round out the nearby landscape (Seites 2011). The northeastern corner of the lake has some slab wood on the bottom, remnant from the Lime Lake Lumber Company mill that was constructed around 1880 (NPS 2011). Timber was harvested from the land surrounding Lime and Little Traverse Lakes, cut at the mill, and then hauled down a 3-mile plank road to Good Harbor Bay for shipping (NPS 2011).

Rock Pile History and status (Submitted by Mark Fisher, Dean Manikas- Lime Lake Association)

Annually, people express concerns regarding the lake level, either being too high or too low. Here is a summary of the history of the dam located at the north end of the lake:

The rock pile on the north shore of Lime Lake, at the mouth of Shetland Creek, has roots going back to the early 1970's. In a Lime Lake Association newsletter from August 1973, it stated the lake level that summer was 10" lower than past years because someone removed all the natural obstructions from the mouth area of Shetland Creek. It also stated during the past several falls, salmon spawning had eroded a natural clay/marl creek bottom that was at the mouth area.

In October 1975 the Lime Lake Association (LLA) made application with the Michigan Department of Natural Resources (MDNR) to construct a temporary weir across the mouth of the Shetland Creek. This application was later withdrawn.

The lake level continued to be problematic over the years. In the early 1980's some lake residents put rocks in a large hole the salmon created just north of the mouth of the creek. A small rock pile was added at the mouth. During the 80's and early 90's there were differences in opinion about the ideal lake level. Unknown individuals would remove or add rocks trying to adjust the lake level without taking into consideration heavy rains, periods of drought, and the effects on the lake's general health.

The tug of war continued and in the summer of 1993, one resident on the lake filed a complaint with the MDNR. In August of 1993 the DNR cited the property owner of the land adjacent to the rock pile for violations of the Inland Lake and Streams Act. The citation specified the unauthorized activity as the individual, "Placed fieldstone across the outlet of Lime Lake (Shetland Creek)." Following the citation a series of misunderstandings developed between the DNR staff and residents of the lake. As a result, one lake owner took it upon himself to remove all the rocks from the mouth of the creek.

The removal of the rocks resulted in an order of restoration from DNR representative, Stuart Kogge, to restore the rocks to the original 1992 elevation. Mr. Kogge also recommended that the Lime Lake Association file an application to the DNR for a permit to allow the lake association to restore the dam in order to stabilize the lake level and protect the creek. With Mr. Kogge's help designing the rock pile, the lake association submitted an application for the rock pile. The DNR approved the application and issued the permit #94-6-112.

On April 8, 1994 a rock pile was constructed at the mouth of Shetland Creek according to DEQ permit #94-6-112. Over the following two years, the rock level was adjusted until an acceptable lake level was reached. The lake level will fluctuate depending on amounts of rain and evaporation. In any given year, over time, the lake level will return to the correct level.

Since the permit was granted, the Lime Lake Association Board has annually monitored the rock pile height. The lake level is cyclical be nature, highest after spring thaw and heavy rains, and lowest in late August after a summer of evaporation and low precipitation. Data on evaporation rates is provided by the MSU Research Station in Bingham Township and monitored by the Board. This data shows a direct correlation between the level of the lake and the amount of rainfall and evaporation over a given period of time.

Low lake levels may cause inconvenience for residents on the north end (e.g., trouble with boat mooring, pooling water behind sandbars) but low lake levels do no damage to the lake shoreline or ecology. High levels (as currently experienced after a very wet fall and last spring after the heavy snows of last winter) impact water quality through excessive runoff and soil deposits from shoreline erosion. According to the shoreline survey from the summer of 2013, as part of the Watershed planning work, 74% of Lime Lake shoreline has evidence of minor to severe erosion. Erosion does add excessive sediment to the lake's water, affecting its ecology. Additionally, excessively high water levels may foul the lake further by compromising existing septic systems. (Neighbors to the north on Little Traverse Lake have been experiencing all of these problems as noted at township meetings and in the Enterprise). Low levels may be inconvenient but high levels can be costly to property owners and destructive to the lake's ecology.

Left in its natural state, the water level would have greater lows. As some "old timers" report, years before there were houses on the north shore, people would drive their cars onto the north end sand bars for a good washing in the late summer.

The varying lake level is a natural process, mitigated by a regulated rock pile to preserve the quality of our water. The Lime Lake Association Board is the only entity authorized to adjust the rock pile, by DNR order.

<u>Little Traverse Lake</u>

Little Traverse Lake is 640 acres and 267,000,000 cubic feet in volume (Table 1, page 18). It receives 16% (3.4 cfs) of its water supply from subsurface groundwater discharge, another 71% (15.3 cfs) from surface flow, and the remaining 13% (2.8 cfs) from precipitation (Table 3) (Steinburg et al. 1994). Little Traverse is primarily fed by surface water (71 %) (Steinburg et al. 1994). The primary tributary into Little Traverse Lake is Shetland Creek which empties into the lake at its South Eastern edge. Numerous small ground water flows [and small tributaries] enter the lake off the hills to the east and southwest with some minor groundwater flow from the south (Steinburg et al. 1994). The primary discharge is via Shalda Creek which exits the lake at the western ends of Little Traverse Lake and flows to Lake Michigan.

Lime Lake is predominantly fed by ground water; however, Little Traverse Lake receives most of its water by surface water recharge and has higher total flow. The nominal turnover for the lakes is the time required to completely change the water in the lake. (Steinburg et al 1994).

Table 3: Little Traverse Lake Water Balance

Little Traverse Lake	Rate of Flow (cubic feet per second)	Percent of Total
Streams In:	15.3 cfs	71%
Precipitation	2.8 cfs	13%
Ground Water In:	3.4 cfs	16%
Total In:	21.5 cfs	100%

Streams Out:	18.4 cfs	86%
Evaporation Out:	2.8 cfs	13%
Groundwater Out	0.3 cfs	1%
Total Out:	21.5 cfs	100%

(Source: Steinburg et al 1994)

The streams are not the only outlets in this watershed. Just as the lakes have ground water recharge they also discharge via ground water flow (Steinburg et al. 1994). A shallow unconfined aquifer of sands and some gravel extends from the surface to depths of 30 to 70 feet. According to Steinburg et al (1994) the upper aquifer is in direct hydraulic connection with Lime Lake, Little Traverse Lake and Lake Michigan, and is recharged by precipitation within the basin. immediately below the upper, unconfined aquifer is a silt and clay aquitard that is present throughout the lake basin. The aquitard is composed of silts, silt and sandy clays, and pure clays. It is estimated to range from 10 to 80 feet in thickness, and provides flow separation between the upper unconfined aquifer and a lower, confined aquifer system (Steinburg et al. 1994). Beneath the aquitard is the confined aquifer system, which probably has little or no flow interaction with Lime or Little Traverse lakes or surface water streams. A north-south cross section shows the upper surface of the lower confined aquifer rising with the land slope to the south. The recharge area for the deeper aquifer is probably the Kasson Moraine area, an elevated plateau, with thick sand and gravel deposits just south of Maple City (Steinburg et al. 1994).

The deeper aquifer can be excluded in determining the hydrologic budget for the watershed, as only ground water recharge and flow within the upper, unconfined aquifer is in communication with the lakes of the watershed (Steinburg et al. 1994). Most residential water wells in the area draw from the lower confined aquifer. Along the north shore of Lime Lake and along portions of Little Traverse Lake, some shallow wells only reach into the upper, unconfined aquifer and are therefore vulnerable to ground water contamination (Steinburg et al. 1994).

Shalda Creek is the main outflow of water from the watershed into Lake Michigan. Originally Little Traverse's outlet into Shalda Creek was 27 feet wide (Len Allgaier). In the fifties the road was paved and the logger's wooden bridge spanning it was replaced, closing the outlet down to a 42 inch diameter culvert reducing the outlet area significantly. Today, the width of Shalda Creek is 27 feet (personal communication with Len Allgaier, measured by Brett Fessel with the Grand Traverse Band of Ottawa and Chippewa Indians (GTB). Direct overland runoff to the lake is insignificant, as rainwater quickly infiltrates soils and becomes integrated with the groundwater and surface spring inputs to the lake. Thus, land use practices in the entire watershed have a much greater potential to impact water quality than is the case for many other watersheds in the State with less permeable soils.

In 2011 and continuing today (2015) Little Traverse Lake is experiencing high water levels, specifically on the north side. Concerns were raised over the culvert on the west end of the lake. Local residents along with various organizations including the Little Traverse Lake

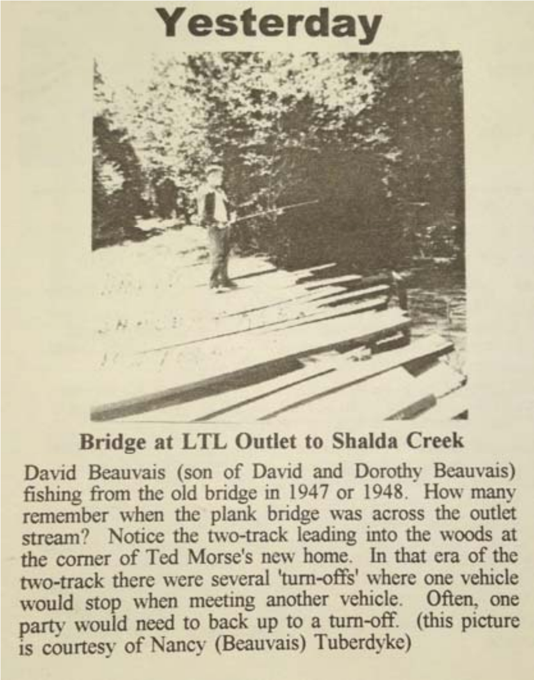
Property Owners Association, Cleveland Township, Little Traverse Conservationists, the Michigan Department of Environmental Quality, Sleeping Bear Dunes National Lake Shore (SBDNL), the Leelanau County Road Commission and the Grand Traverse Band of Ottawa and Chippewa Indians, have been working together to come up with a reasonable solution. The SBDNL hydrologist study was commissioned in response to this concern in 2011 to determine the main cause of the high lake levels. The results of this report are summarized in Chapter 4- Critical Areas (page 146). For more details on this study see the appendices (B-D).

Approximately 1/2 mile downstream of the Traverse Lake Road culvert, Bohemian Road or County Road 669, is similarly paved across Shalda Creek using a single culvert, which is currently submerged between 1-2 feet at its discharge end (Source, Len Allgaier). The elevation drop between the mean level of Little Traverse Lake and the mean level of Lake Michigan is 18 feet or 6 feet of drop per mile.

Below and on the next few pages are a few current and historical photos of the Lime Lake outlet to Little Traverse Lake (Shalda Creek) and Little Traverse Lake shoreline as well as the culvert on the west end of Little Traverse Lake and the culvert on County Road 669.

Figure 3: Shalda Creek outlet to Little Traverse Lake

Figure 4: Original Bridge across 27 foot wide Shalda Creek



Yesterday

Bridge at LTL Outlet to Shalda Creek

David Beauvais (son of David and Dorothy Beauvais) fishing from the old bridge in 1947 or 1948. How many remember when the plank bridge was across the outlet stream? Notice the two-track leading into the woods at the corner of Ted Morse's new home. In that era of the two-track there were several 'turn-offs' where one vehicle would stop when meeting another vehicle. Often, one party would need to back up to a turn-off. (this picture is courtesy of Nancy (Beauvais) Tuberdyke)

Figure 5: Original (pre culvert(s) beach protecting shore from erosion

Figure 6: Fall 2014 photo of Culvert on West end of Little Traverse Lake and Shalda Creek

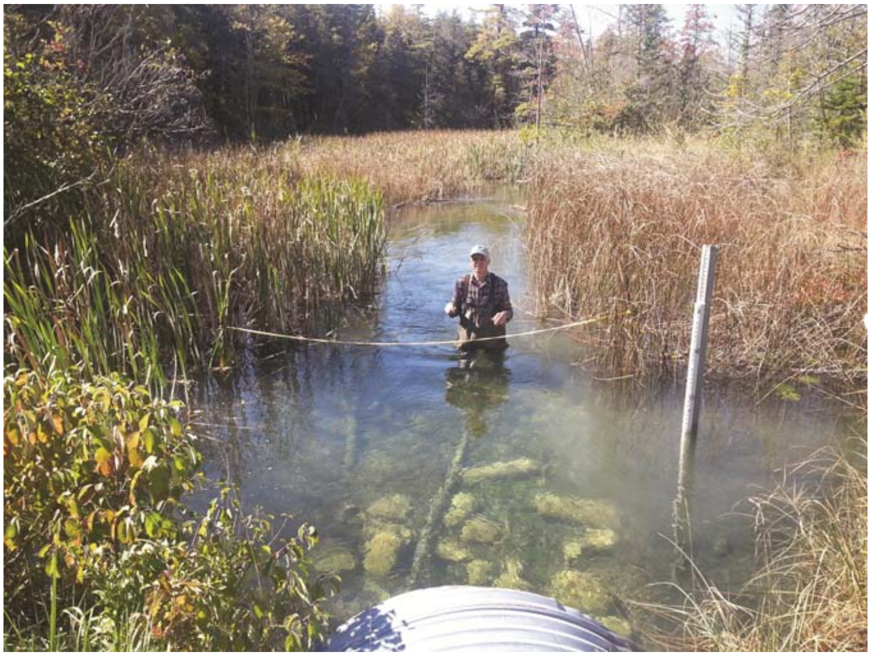


Figure 7: August 2014 photo of Culvert on County Road 669 (Shalda Creek Crossing), looking upstream towards Little Traverse Lake

Figure 8: August 2014 photo of Culvert on County Road 669 (Shalda Creek Crossing), looking downstream

Figure 9: August 2014 photo of Culvert -County Road 669 (Shalda Creek Crossing), looking upstream

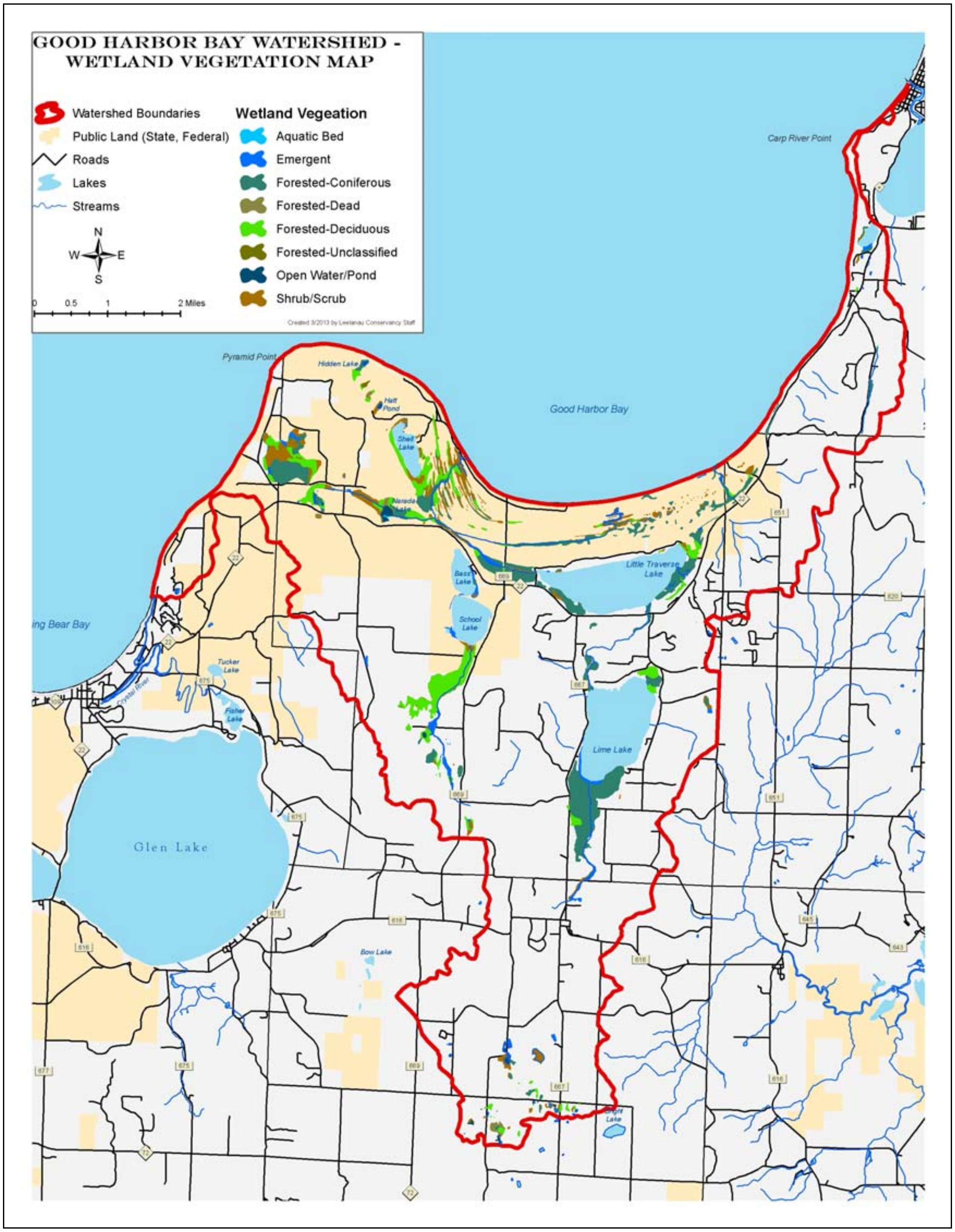
Figure 10: 2014 photo of Culvert -County Road 669 (Shalda Creek Crossing), looking upstream

Wetlands

Wetlands comprise a vital link in the preservation of high water quality in the Good Harbor Bay Watershed. The watershed buffers between upland habitats and surface water bodies. These relatively narrow bands of wetlands along stream channels and at the base of infiltration basins protect groundwater springs and small stream channels by filtering out sediment and extracting nutrients from surface run-off before it reaches the stream channel and ultimately the lake (Figure 11).

Wetland soils and vegetation are also very important natural defenses against flooding by absorbing surface runoff and storm water and releasing it slowly into streams and groundwater. In addition to the water quality benefits of intact wetlands, the Good Harbor Bay Watershed contains critical habitat for several threatened and endangered plants and animal populations (see section 2-7). The diversity of micro-habitats found within wetlands allows them to host more types of plants and animals than any other biological community.

Figure 11: Composite Wetlands of the Watershed



In order to perpetuate the enjoyment and use of the Good Harbor Bay watershed it is essential to protect sensitive wetland areas. Recreational interests such as birding, fishing, hunting and wildlife viewing are all enhanced by the healthy and intact wetland areas adjacent to Lime and Little Traverse Lake. Development in and adjacent to wetland areas threatens to degrade the aquatic resources, which are the heart of this watershed's desirability and attractiveness.

Currently the Federal Army Corps of Engineers and the State of Michigan regulate wetlands that are 5 acres or greater or connected to the Great Lakes. Additionally, the State of Michigan also protects wetlands under state law PA 451 of 1994 if they meet any of the following conditions:

- Located within 1,000 feet of one of the Great Lakes or Lake St. Clair.
- Connected to an inland lake, pond, river, or stream.
- Located within 500 feet of an inland lake, pond, river or stream.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, and less than 5 acres in size, but the DEQ has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner.

A study to identify potential wetland areas, combining different sources of wetland information using Geographic Information Systems (GIS) software, was completed in early 2000 by the Northwest Michigan Council of Governments (NWMCOG) through the Special Wetland Area Management Project (SWAMP), coordinated by the Michigan Department of Environmental Quality (DEQ). The dataset is a composite of three sources of wetland information:

1. The National Wetland Inventory (NWI), conducted by the U.S. Fish and Wildlife Service.
2. The U.S. Soil Conservation Service Soil Survey, which identifies hydria soils and soils with hydric inclusions and/or components.
3. The Michigan Resource Inventory System (MIRIS) Land Cover interpretation from aerial photographs.

Section 5.3, Priority and Critical Areas, describes the most important wetland areas in the watershed for maintaining water quality and sustaining rare plants, animals and habitats. The largest wetland areas within the watershed are found south of Lime Lake along Lime Creek

(Figure 6). Lime Creek and Shalda Creek are the largest surface water tributaries to Lime and Little Traverse Lake, meandering through an ecologically rich wetland that provides a diverse habitat for many plant and animal species, some threatened or endangered. The undisturbed wetland located there is critical to the creek's biological diversity and its preservation is a high priority in the watershed.

Looking at the data in Table 4, the total wetland area in the Good Harbor Bay watershed is approximately 4200 acres or 14.5 % of the total watershed area, compared to only 4.4 % using only the land use data (Tables 8 and 9, Figure 15, pages 51-53). These data provide a useful tool in determining the location of potential wetland areas, but because the data has not been field checked, it does not guarantee the presence or absence of a wetland. It should be used only for general planning purposes.

Table 4: Composite Wetland Areas in the Good Harbor Bay Watershed

Type of Wetland	Acres	% of Watershed
Aquatic Bed	1.4	0.005
Emergent	152.3	0.5
Forested:	897.2	3.1
Conifer	27.2	0.09
Dead	566.5	1.9
Deciduous	9.0	0.03
Unclassified	40.8	0.14
Open Water	406.9	1.4
Shrub Scrub	2101.3	7.2
Total	4,202.5	14.5

**The wetland descriptor in the land use tables (Tables 8 and 9) do not contain all wetlands. Total wetlands are delineated in the table above, and cover 20% of the watershed. As an example of this difference, Table 6 represents cedar swamp areas as coniferous forest, as opposed to the 'forested-conifer' wetland description in the above table.*