Watershed Management Plan



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EXECUTIVE SUMMARY

Otísco Lake Watershed Management Plan



The Otisco Lake Watershed Management Plan provides a comprehensive review of the state of Otisco Lake and its watershed. The purpose of the plan is to identify issues affecting the water quality and ecology of Otisco Lake and to provide specific recommendations to protect the lake's future.

Otisco Lake is located in southwestern Onondaga County and is one of New York State's Finger Lakes. Slightly over 6 miles long with a maximum width of .8 miles, Otisco Lake is bordered by three townships (Marcellus, Otisco and Spafford) with small portions of four other towns (Onondaga and Tully in Onondaga County; Preble and Scott in Cortland County) comprising the rest of the watershed.

As a major drinking water supply source for Onondaga County, Otisco Lake is protected by the Otisco Lake Watershed Rules and Regulations implemented by the Onondaga County Water Authority (OCWA). The lake also serves as an important recreational and environmental resource. The Otisco Lake outlet dam is operated by

OCWA, but water levels are largely weather dependent since OCWA has limited abilities to control lake elevations. Except for a narrow connection, Otisco Lake is divided by a causeway separating the smaller and much shallower southern end from the rest of the lake. The two sections are effectively distinct lakes.

There are two private boat launching access points at Otisco Lake with shoreline access located along the extreme northeastern portion of the lake, the southwestern corner near the lake causeway, and at the Onondaga County Otisco Lake Park near Turtle Bay on the east shore which operates as a "carry in / carry out" facility. Otisco Lake does not have a public boat launch.

The OCWA monitoring program is focused on treatment needs for water supply purposes and provides a comprehensive long-term water quality database for Otisco Lake. Data collection with a more lake water quality focus was done remotely from 2002 to 2007 by the Upstate Freshwater Institute (UFI) under a grant program known as Our Lake. Since 2008, Hobart William Smith College-Finger Lakes Institute has also sampled Otisco Lake as a part of its current Finger Lakes monitoring program.

Otisco Lake does not meet dissolved oxygen standards, but there is no conclusive evidence that conditions (such as nutrient levels and oxygen depletion) have changed appreciably over the period of record which dates back to the early 1900s.



Otisco Lake has a diverse aquatic plant community with native coontail and the non-native Eurasian watermilfoil predominant. There is evidence that the area of the lake showing the greatest amount of aquatic vegetation expansion has been at the north end of the lake immediately south of the Narrows. Extensive areas of shallow water throughout the lake are impacted by an abundance of Eurasian watermilfoil and by nuisance levels of other species. Mechanical harvesting, benthic barrier placement and suction removal control efforts have provided a minimal measure of relief. Early detection and hand-pulling control efforts by the Otisco Lake Preservation Association (OLPA) have nearly eradicated the invasive water chestnut.

Diverse populations of game fish including walleye, tiger muskellunge, smallmouth bass, largemouth bass, white perch, yellow perch, and brown trout are found in Otisco Lake

The Otisco Lake watershed is 38.7 mi² (24,777 acres) and is large enough relative to the lake's size and volume to flush fairly rapidly. The watershed is approximately 42% agricultural, 33% forested lands and 9% shrub/scrub. Wetlands and open water comprise almost 13% of the watershed. Approximately 50% of the occupied dwellings in the watershed are lakefront residences with the majority of residential development along the east shore and northern third of the western shoreline.

Otisco Lake faces challenges in maintaining and improving its water quality in the coming years. These include the control of internal sources of nutrients (primarily phosphorus) as well as stormwater runoff containing nutrients, sediments, pesticides, and other pollutants from agricultural and non-agricultural watershed sources. Sediment inputs from three major tributaries were shown to have increases from 100 to 400 percent over an approximate 25-year period (1981-83 compared to 2005-08).



This plan evaluated and identified changes needed in priority area Tier V Agricultural Environmental Management (AEM) plans. Recommendations were made to implement these changes and to inventory and remediate other sources of contamination.

A review of land use regulations and policies in the primary watershed towns indicate they provide an adequate level of resource protection.

Rural communities often struggle to evaluate the potential impacts of development. This management plan recommends an evaluation of ecosystem services to better understand the value of the services provided by forested and agricultural environments to facilitate better decision-making.

Watershed resident and stakeholder surveys were conducted to better understand public perception of Otisco Lake and the problems it faces. The resident survey with 177 responses identified dense aquatic weed growth interfering with boating and public access to the lake as a major concern.

A stakeholder opinion survey identified invasive species prevention/education, high nutrient levels, septic effluent, and fishing as high priority issues of concern to lake quality. Watershed issues identified as of highest priority included: hydrofracking, chemical fertilizer application, affects of runoff, hazardous household waste disposal, and watershed inspection and maintenance of onsite septic systems.

Maintaining a successful future for the water quality and ecology of Otisco Lake will require protecting it from impacts originating from the watershed, addressing in-lake sources of nutrients and levels of nuisance vegetation while minimizing the impact of invasive species. The recommendations outlined in the management plan provide a first step in this direction. Long-term success can be achieved through continued and expanding cooperative working relationships among municipalities, public entities, the lake and other private resource oriented associations, and local landowners. Otisco Lake and watershed issues and concerns are summarized below:

| Summary of Otisco Lake and Watershed Issues and Concerns | | | | | | |
|----------------------------------------------------------------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------|--|--|--|--|
| Area | Category | Issues | | | | |
| Lake | Need to assess on-going lake water quality. | | | | | |
| | Aquatic vegetation | Excessive growth and effective methods of control. | | | | |
| | Invasive species | Control of current species, prevention of fu- ture introductions, on-going education of lake users. | | | | |
| | Water quality | Elevated levels of nutrients and near-shor sedimentation. | | | | |
| Watershed | Monitoring | Need to assess on-going tributary inputs. | | | | |
| | Fishing | No public boat launching facility available. | | | | |
| | Agriculture | Sediment, nutrient, pesticide and pathogen runoff. | | | | |
| | Commercial and industrial in- fluences | Surface and groundwater pollution. | | | | |
| Shoreline residences Household hazardous waste disp septic maintenance. | | | | | | |



AT A GLANCE

OTISCO LAKE

- Lake Length: 6 miles
- Maximum Width: .8 miles
- Lake Surface Elevation: 787 feet
- Lake Surface Area: 2048 acres
- Average Depth: 33 feet
- Maximum Depth: 66 feet
- Volume: 21 billion gallons
- Hydraulic Retention Time: 1.7 years
- DEC Water Quality Classification: AA
- Water Level Control: Some Otisco Lake Outlet Dam
- Shoreline Length: 15.5 miles
- Watershed Area: 24,777 acres
- Primary Watershed Land Use: Agriculture (42%)
- Highest Point in Watershed: 1986 ft (Ripley Hill)
- Number of Towns in Watershed: 7
- Lake Associations: Otisco Lake Preservation Association (www. otiscolakepreservation.org)



CHAPTER 1 INTRODUCTION 1.1 Project Introduction and Background

O tisco Lake is the easternmost of New York State's Finger Lakes. It serves as a public drinking water supply source for Onondaga County residents and provides an important recreational and environmental resource for permanent and seasonal residents as well as visitors from other parts of central New York and beyond. Being such a valuable resource, it is incumbent upon residents, lake users, and stakeholders to protect and manage Otisco Lake to the best of their ability.

Since a watershed can be defined as the total area that eventually drains into a lake, all surface and groundwater generated from precipitation and snowmelt in the area defined as the "Otisco Lake watershed" will makes its way into Otisco Lake. Thus, it is imperative that a plan for Otisco Lake includes its watershed since decisions regarding land use within the watershed have a direct influence on the water quality, aquatic biology, and recreational opportunities in the lake.

As a public drinking water supply source, Otisco

Lake is provided a level of enhanced protection thorough the Otisco Lake Watershed Rules and Regulations. However, while applicable to lake resource management, these rules and regulation focus on drinking water quality needs. There is some state and federal agency authority over lake resource management and land use, but it is limited. As a result, actions and activities having the greatest impact upon land use and ultimately the lake are conducted at the local level. Therefore, municipal decisions play a much larger role in how well a lake is protected from development activities.

There is a long history of lake and watershed stewardship conducted cooperatively by OCWA as the drinking water supply purveyor, Onondaga County agencies, and a number of federal and state agencies. A more recent addition has been OLPA, a local non-profit lake association, as a primary impetus for lake management activities (e.g., aquatic vegetation management, invasive species control, land use policy) and public outreach activities.



A view of Otisco Lake north of the Narrows. Primary roadways adjacent to the lake are Otisco Valley Road (left) and Route 174 (right). Otisco Lake outlet dam is also visible (center left)

Otisco Lake is provided a level of enhanced protection through the Otisco Lake Watershed Rules and Regulations.





1.2 Cultural History of the Otisco Lake Region

he Finger Lakes region has been occupied by Native Americans for about 9,000 years since the retreat of the Pleistocene glaciers. The Iroquois were one of the first tribes to permanently inhabit the area and thought to have arrived during the thirteenth or fourteenth century. Three of the five Iroquois Nation tribes (the Onondagas, the Senecas, and the Cayugas) lived in the Finger Lakes region. They held dominion over the area until the 1700s when Europeans arrived. in maintaining water levels in the Erie Canal. The dam raised the lake's water level by approximately 9 feet. It also submerged a road that existed at the southern end linking residents in the towns of Otisco and Spafford. In addition to expanding the lake's surface, the wetlands at the southern end were submerged. The road was rebuilt with hemlock logs in 1908. A storm in 1929 washed out portions of the causeway and the structure continued to deteriorate until it was re-



Although it is known that the Onondagas had a trail leading to Otisco and other lakes in the area for fishing and hunting, there are no recorded permanent Native American settlements in the Otisco Lake watershed. However, there are stories and signs indicating their camps were near the lake.

Permanent European settlement began after the Revolutionary War when lands were given by the United States Government to soldiers as payment for their services. In 1804, the first house by a white settler (Oliver Tuttle) was erected at the head of the lake in the present day Town of Otisco, which was formed two years later in 1806.

The name, "Otisco" is thought to have originated from the Native American term, "waters dried up, or gone away." This likely referred to the shallow nature of the lake and its surrounding environs; especially the southern end. The watershed landscape changed permanently with the construction in 1869 of a dam at the north end to impound water for use constructed in 1983 (Deyle 1985).

In the early part of the last century, Syracuse residents would come to the lake by way of the Marcellus-Otisco Railway for boat excursions. Heath's Grove contained a pavilion that was used for parties and town picnics. Rental cottages were available. Over the ensuing decades, most of the lake's shoreline (except for areas with steep slopes along the western shore) was developed.

In 1908 the Suburban Water Company obtained the right to use Otisco Lake for a public water supply. The Company raised the dam in 1909 which increased the water level another 4 feet. In 1926, the Federal Water Company bought Syracuse Suburban and changed its name to the Onondaga Water Service. From the 1920s on, demand for Otisco Lake water grew with the expanding economy and housing boom. After a series of changes and ownership, the Water Service became known in 1955 under its present name, the Onondaga County Water Authority.

CHAPTER 2

STATE OF OTISCO LAKE 2.1 Overview and Summary

O tisco Lake is a valued water body serving as a major source of drinking water for approximately 340,000 customers in Onondaga County and provides recreational, aesthetic and ecologically benefits to residents and visitors alike. These uses are intrinsically bound by the quality of the lake.

In order to protect, preserve or enhance a resource, it is important to understand how it functions. To that end, monitoring and investigations over several decades have helped determine whether conditions in Otisco Lake have changed, what factors are responsible for the lake's present condition, and what are the threats to its future well-being.

Long-term management is dependent upon the physical characteristics of the lake and its watershed, water

quality data, information on biological communities living in the lake, and how people use both the lake and surrounding watershed. Obtaining such information can be time-consuming, costly, and at times inconclusive. Nevertheless, these steps are necessary to make sound decisions and commitments for the future of Otisco Lake. Fortunately, the existing data base provides more than an adequate amount of information to help formulate a number of management decisions.

Focused on drinking water supply treatment needs, the OCWA lake monitoring program provides the lake's longest-standing water quality data set. Lake and tributary data has been collected during the last decade through the Central New York's Near-Real-Time Surface Water Quality Network (Our Lake), Hobart-William Smith College-Finger Lakes Institute, and the United States Geological Survey (USGS). There is also an historical data base of special studies and investigations. Otisco Lake is usually described as mesotrophic or moderately nutrient - enriched. While the watershed contributes phosphorus, nitrogen, sediment and other contaminants, the lake bottom sediments are a major source of phosphorus which is the nutrient most responsible for algal growth.



The existing database provides no conclusive evidence lake conditions, including nutrient levels and oxygen depletion, have changed appreciably.

However, the "open water" or midlake area normally exhibits very good water clarity which is thought to have increased since zebra mussels established themselves in the late 1990s. Aquatic vegetation expansion in parts of the lake, most notably the area immediately south of the Narrows, may also be a result of the increased water clarity.

Oxygen loss from the deeper waters and warm temperatures in the water column limit Otisco Lake's ability to support trout

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thorough late summer. Nevertheless, Otisco Lake supports a healthy aquatic system providing a diversity of game fish including walleye, tiger muskellunge, smallmouth bass, largemouth bass, white perch, yellow perch, and brown trout. While walleye are the most sought after game species, Otisco Lake has developed a region wide reputation for tiger muskie.

The existing database provides no conclusive evidence lake conditions, including nutrient levels and oxygen depletion, have changed appreciably over the period of record which dates back to limited data collection and narrative accounts from the early decades of the 1900s.

Data indicate overall water quality condition in Otisco Lake is similar to Honeoye, Cayuga, and Owasco lakes rather than its more pristine neighbors such as Skaneateles and Canandaigua lakes.



2.2Lake Characterístics and Hydrology

O tisco Lake is the most easterly of the eleven Finger Lakes. It is 6.01 miles long and contains 15.53 miles of shoreline. The average width is .59 miles with a maximum width of .80 miles. It is a shallow lake compared to most of the other Finger Lakes with an average depth of 33 feet and a maximum depth of 66 feet. Thirty-five percent of the lake's volume is found at depths greater than 33 feet.

With a surface area of 3.2 mi² and a volume of 21 billion gallons, Otisco Lake has the fourth smallest surface area and third smallest volume of the Finger Lakes. Net flow direction is south to north. On average, Otisco Lake flushes approximately once every two years which is the third fastest rate of all the Finger Lakes.

A notable feature of Otisco Lake is its division by a causeway separating the smaller and much shallower southern end from the rest of the lake. Average depth in the southern section of the lake is about 3 feet and the maximum depth around 9 feet. A narrow channel through the causeway serves as the only connection and means for water exchange between the two lake sections.

The southern basin normally has a brown, turbid appearance attributed to sediment resuspension. While there is deposition from Spafford Creek, bottom sediments in the southern basin are organic soils derived from the former wetland area flooded when the elevation of Otisco Lake was first raised in 1869 for use in maintaining water levels in the Erie Canal, as discussed previously.

Winkley (1989) included Otisco Lake in the hydrogeological setting known as the northwarddraining troughs. The glacial troughs of Onondaga County are unusually deep valleys and oriented in the same direction (parallel) to the regional topographical trend. Groundwater from the east and west sides of the lake generally flows toward the lake. Longitudinal flows move along the axes of the valley which is generally in a northward direction. Otisco Lake has the fourth smallest surface area and third smallest volume of the Finger Lakes.



Turbid conditions characterize Otisco Lake south of the Causeway (upper right of photo).



2.3 Water Quality and Clarity

Chemical Characteristics

O tisco Lake is classified as mesotrophic meaning it supports a moderate level of biological productivity. Lakes of this trophic status are generally described as being moderately clear with an increasing probability of the hypolimnion (bottom waters) becoming depleted of dissolved oxygen (i.e., anoxic) during the summer. In a mesotrophic system, numerical ranges for average summer values for the following parameters include: total phosphorus: 12-24 ppb, secchi disc transparencies: 16.6 ft-13.1 ft (2-4m) and chlorophyll a: 2.6- 7.3 ppb. This also translates into a Carlson Trophic State Index (TSI) value of 30-50 (Carlson and Simpson 1996).

Mean values for secchi disc transparencies, total phosphate (TP), and chlorophyll-a for the 2008-2011 data set are indicative of a mesotrophic lake.

| Otisco Lake Mean Values 2008-2011 for Trophic Indicators | | | | | |
|-------------------------------------------------------------|-----------------------|---------------|--|--|--|
| Secchi Disc | Total Phosphorus (TP) | Chlorophyll-a | | | |
| 10.5 ft (3.2m) | 18.4 ppb | 2.0 ppb | | | |

Likewise, TSI values computed over the past two decades **Table 1**, (Appendix A) exhibit some variability, but also are in the mesotrophic range.

Otisco Lake was one of several local waterbodies where water quality data was collected from 2002 to 2007 by the UFI thorough a multiorganizational effort (<u>www.ourlake.org</u> 2009). Hobart William Smith College-Finger Lakes Institute has been sampling Otisco Lake as a part of its Finger Lakes monitoring program since 2008. Surface and lake bottom values for several parameters in 2008, 2009, 2010, and 2011 are summarized in **Table 2**, (Appendix A).

An interesting anomaly is seen in the high mean total phosphate and large standard deviation reported for the 2009 data in Table 2. Both the high mean value and large standard deviation reflect a single sample taken on July 22, 2009 showing an elevation spike in a surface water sample: TP > 150 ppb. Explanations include: i) the sample being taken soon after a strong precipitation or wind event, ii) an event induced by carnivorous zooplankton predation upon herbaceous zooplankton, or iii) bottom water mixing due to wind events inducing blue green algae blooms. The latter phenomenon has been reported to occur in Honeove Lake (J. Halfman pers. comm. 2010). This explanation is also an indication of the role bottom sediments likely play in supplying phosphorus (called internal cycling) for phytoplankton (algae) growth.

Otisco Lake shows strong temperature stratification during the summer months. Average depth of the thermocline in the July through August time period is typically around 26-33 feet <u>www.ourlake.org</u> 2009, Halfman, pers. comm 2012). At the same time, dissolved oxygen is depleted rapidly from the lower waters resulting in close to or the complete loss of oxygen from virtually the entire hypolimnion.

The widespread depletion of dissolved oxygen, has lead some investigators to consider Otisco Lake as being eutrophic (Halfman and O'Neill 2009).

The precipitation of calcium carbonate known as



"whiting" is another interesting, recurring phenomenon in Otisco Lake that varies with respect to timing and magnitude. It is a distinct component of lake turbidity in the upper waters and arises



abruptly. Whiting events can easily be mistaken for phytoplankton blooms due to the green, turbid appearance of the lake water.

From a limnological standpoint, Otisco Lake south

The release of phosphorus from bottom sediments due to anoxía ín the hypolímníon has long been thought to play a role ín Otísco Lake nutríent dynamícs.

of the causeway can be considered a separate lake. Total phosphorus, phytoplankton biomass, and turbidity levels are much greater than those found in the main lake while transparencies are much lower (Callinan, 2001).

Chemical Characteristics-Historical

Not unexpectedly, secchi disc transparencies, which are a measure of visibility or water clarity, show seasonal and annual variability. A general increase in mean values for May-September is seen since zebera mussels became established in the lake in 1997.

Of historical interest is a single August secchi disc reading of 9.8 feet from Birge and Juday (1910) and a mean of two readings in 1973 of 10.8 feet reported by Oglesby(1974), and included in Appendix A.

Further indication of the lake's historic low levels of dissolved oxygen in the deeper lower waters is seen in an assessment of the lake fishery by Eaton (1928) who described Otisco as the shallowest, warmest, and weediest of the lakes he surveyed. The author added the deeper waters were not suited for fish during the summer due to low dissolved oxygen levels.

Internal cycling or the release of phosphorus from bottom sediments due to anoxia in the hypolimnion

The pattern of seasonal dissolved oxygen loss has shown no substantive change.. There are indications this pattern was present in the early 1900s...

has long been thought to play a role in Otisco Lake's nutrient dynamics. Concentrations up to 80 mg/l of total phosphorus were reported from the hypolimnion by Effler et al. (1989).

Major ion trends over several past decades indicate declines in calcium, magnesium and alkalinity, but

increases in sodium, chloride, and sulfate. Sediment accumulation rates of 0.3 in/year have been calculated for Otisco Lake; one of the highest rates measured for the Finger Lakes (Callinan, 2001).



Water Quality Classification

Otisco Lake is classified as AA (best usage classification-drinking water) and serves as a public and private drinking water supply source. It also provides multi-recreational uses including fishing, boating and swimming.

Otisco Lake is on the New York State Department of Environmental Conservation (NYSDEC) Waterbody Inventory/Priority Waterbodies List (WI/ PWL) with the following use impairments, causes and sources:

| Aquatic life: | Known to be stressed |
|---------------|----------------------------------|
| Recreation: | Known to be stressed |
| Water Supply: | Possibly threatened |
| Causes: | DO/Oxygen Demand |
| Sources: | Agricultural, streambank erosion |
| | |

Otisco Lake does not meet current dissolved oxygen standards due to undetermined natural or unnatural causes. As a result, Otisco Lake is on the Federal Clean Water Act Section 303 (d) list as a "Listed Waterbody Not Meeting Dissolved Oxygen Standards, Pending Verification of Impairments/ Pollutants/Sources." The NYSDEC is conducting an evaluation of 45 lakes identified by the USEPA, including Otisco Lake, to determine whether these waters are impaired in any significant manner by pollutant loadings from other than natural conditions.

2.4 Lake Water Level

O_{CWA} is responsible for the operation and maintenance of the Otisco Lake dam. There is an ongoing program of monitoring and inspection of the dam to meet NYSDEC regulations as well as a schedule for future needs of the dam (Anthony Geiss, pers. comm. 2013). OCWA is required to maintain a minimum flow release into Nine Mile Creek of 1 million gallons per day or 1.5 cubic feet per second. As a target level, OCWA tries to maintain a daily lake level average computed from a 50 year record. The lake level is based upon the spillway crest elevation of 786.60 feet (Mark Murphy, pers. comm. 2013). However, lake levels throughout the year are largely weather dependent since OCWA has limited ability to control lake elevations. The average minimum level over the past 52 years has been 28.5 inches below the spillway crest and the average maximum 4.4 inches above it (Mark Murphy, pers. comm. 2013).



Map showing historical lake water levels.

Lake levels throughout the year are largely weather dependent since OCWA has limited ability to control lake elevations.



2.5 Aquatíc Lífe

Phytoplankton and Zooplankton

There are no known recent studies of phytoplankton and zooplankton population dynamics for Otisco Lake. The most comprehensive phytoplankton data set comes from OCWA's weekly analyses on water samples drawn from their water supply intake (depth 20 feet) and samples historically taken at several locations and depths in the lake. Identification is done to the genus level. In recent years, *Fragilaria* sp., have typically been dominant during bloom periods. The cyanobacteria (blue-green algae), *Anacystis sp.* is dominant through most of the growing season (OCWA 2011).

Studies of diatom species presence in bottom sediment cores have been used to infer historical changes in total phosphorus concentrations in lakes. Such an investigation has included a number of New York lakes, including Otisco Lake. Findings indicated *Fragellaria crotonensis*, a well known eutrophic and a mesotrophic indicator, increased significantly in top sections of core samples (the more recently deposited) when compared to the bottom sections (older deposition) which are estimated to be from approximately 1940.

Some mesotrophic species were also found in the lower sections (older) of the Otisco Lake core suggesting moderate nutrient concentrations have been present for some time or that the core sample was not deep enough to represent conditions prior to the lake's human-induced nutrient enrichment (Enache et al. 2012).

Fisheries







Otisco Lake provides a diversity of game fish and has developed a reputation for tiger muskie. Ice fishing for this species is especially popular.

Otisco Lake provides a diversity of game fish including walleye, tiger muskellunge, smallmouth bass, largemouth bass, white perch, yellow perch, and brown trout. White perch are the most abundant sport fish caught. Stocking includes walleye, tiger muskellunge, and brown trout.

While walleye are the most sought after game species, Otisco Lake has developed a reputation for tiger muskie and ice fishing for this species is especially popular. An ice fishing world record fish was caught in February 2009. Otisco Lake provides an excellent environment for tiger muskie growth (NYSDEC, 2009).

Otisco Lake has a limited ability to support trout through late summer because the water tempera-

tures throughout much of the water column are too warm (>20 degrees C or 68 F) and not oxygenated sufficiently (>5 mg/l). This more than likely affects the number of stocked brown trout surviving into the fall (NYSDEC, 2009).

In July 2008, the NYSDEC conducted its first comprehensive fisheries survey in Otisco Lake since the 1990s. White perch were by far the most abundant species caught which was also the case in the previous survey. Smallmouth bass were more abundant than in past surveys with walleye more abundant than in previous sampling, but below what was considered peak populations levels in the 1998-2001 time period.



Alewife were common as were bluegill and pumpkinseed. Similar to past surveys, relatively few yellow perch were caught. Infrequent or incidental collections were made of brown trout, rock bass, carp, white sucker, black crappie, brown bullhead, and spottail shiner (D. Lemon, pers. comm. 2010).

Fish Advisories

There are no special advisories for eating sport fish in Otisco Lake. Only the general health advisory for freshwater systems applies which is eating no more than one meal (one-half pound) per week of fish from the state's freshwaters.

<u>Wildlife</u>

No site-specific investigations on waterdependent wildlife were identified, but anecdotal evidence provides some information on reptile and amphibian abundance. In the 1960s, Turtle Bay, as the name implies, was the home to large number of turtles, but since then the populations have been decimated and turtles are no longer observed in the bay. Based on local conversations, turtle harvesting during the 1990s resulted in the loss of the turtles. Likewise, incidental reconnaissance of tributaries to the lake indicate amphibians may be absent from some of these streams.

Over the past decade, Canada geese have begun to inhabit areas of the lake throughout the summer months. The extended presence of Canada geese provides a new source of nutrients to the lake.







2.6 Floodplains and Important Habitats

A long the lake, the current 100-year floodplain is restricted to the extreme southeast corner adjacent to and just north of the Causeway. The areas adjacent to the lower and middle reaches of Spafford Creek are the primary flood plain areas in the watershed (Federal Emergency Management Agency 2012).

Regulated wetlands are found in the upper reaches of Van Benthuysen Brook, Amber Brook, Rice Brook, and in areas adjacent to Spafford Creek. Portions of the Spafford County Forest are located within the extreme southern and southwestern portions of the watershed. Spafford Forest contains 701 acres of wilderness available for hiking and outdoor exploration. The 3-acre Onondaga County Otisco Lake Park on the lake's eastern shore provides shoreline fishing access and leisure opportunities.







2.7 Aquatic Plants

Present Conditions

he most recent comprehensive work on submerged aquatic vegetation was conducted in 2003-2004 by Hairston, Johnson and Lord (2005) as part of an investigation to assess the use of biological control for Eurasian watermilfoil in Otisco Lake. In this investigation the littoral zone or area where rooted or attached plants grow was defined as 18.4 feet or less.

Twenty aquatic plant species were identified from Otisco Lake with native coontail (*Ceratophyllum demersum*) and the non-native Eurasian watermilfoil (*Myriophyllum spicatum*) as codominants. Other abundant species included: water stargrass (*Zosterella dubia*), water celery (*Vallisneria americana*). elodea (*Elodea canadensis*), southern naiad (*Najas guadalupensis*) and curly leaf pondweed (*Potamogeton crispus*).

Greatest macrophyte abundance was found in the extreme northern end of the lake to roughly one mile south of the Narrows. Densities were greater in the eastern half of the lake than on the western side. On the western side of the lake, the Lader Point area had the highest densities of aquatic vegetation while the rest of the western shore had densities characterized as sparse or non-existent.

This is largely due to the steep drop-off in water depth which provides a very narrow littoral zone. The only area along the Causeway where medium to dense vegetation densities were found was in the extreme southeast corner. Most of the eastern near shore was found to have moderate or high densities. Little vegetation was present south of the Causeway. Hairston, Johnson and Lord 2005). Locations of dense vegetation from the study are shown in (Figure 1, Appendix A).

Historical Conditions

A less comprehensive study using a different methodology was conducted in 1987 (Auer and Effler 1987). The objective was to assess areas where mechanical harvesting would be beneficial. *Myriophyllum* species (likely all or predominately *M. spicatum* - Eurasian watermilfoil) and *Potamogeton crispus* dominated in heavily vegetated areas.

As with the most recent survey, much of the area north of the Narrows was found to have dense vegetation growth as was the Lader Point area and near shore areas north of where Amber Brook enters the lake (eastern shoreline).

However, several changes in conditions can be inferred. With the exception of a few inshore areas of medium or moderate growth, the area immediately south of the Narrows had generally sparse growth. This contrasts greatly with the dense growth reported by Hairston et al. (2005). Auer and Effler (1987) also identified much of the near shore area south of



Dense areas of aquatic vegetation include the invasive Eurasian watermilfoil.

Algae growth and shoreline buildup of aquatic vegetation.



the Causeway as having moderate to dense aquatic vegetation growth while this area was found to be generally void of rooted vegetation by Hairston et al. (2005)

Along with other lake parameters, Shaffner and Ogelsby (1979) reviewed macrophyte conditions. Perhaps of greatest interest was reference to the general absence of rooted aquatic plants reported in the lake by Baston and Ross (1975) in the mid-1970s and the possible role played by low lake levels due to a drought in 1965. Water levels did not return to normal until 1967.

2.8 Invasíve Specíes

S everal non-native or invasive species are of particular concern for Otisco Lake and the watershed. Both the zebra mussel (*Dreissena polymorpha*) and rooted aquatic Eurasian watermilfoil (*Myriophyllum spicatum*) are wellestablished in Otisco Lake. Zebra mussels were first sighted in Otisco Lake in 1997. While the closely related quagga mussel (*Dreissena bugensis*) has not been reported in the lake, this may be due more to the absence of any concerted effort to identify it from Otisco Lake as opposed to its true absence. Water chestnut (*Trapa natans*) has been present in the northeastern section of the lake north of Turtle Bay since at least 2006.

Asian clams (*Corbicula fluminea*) were found in the southwest corner of the lake by the Causeway and off the County Park near Turtle Bay in September 2012. Based upon size, it is estimated Asian clams have been in Otisco Lake since about 2010.





A mat of the highly invasive species, Hydrilla verticillata. (Photo by David J. Moorhead, University of Georgia, Bugwood.org and taken from the Cornell Cooperative Extension Invasive Species Program and the New York Invasive Species Clearinghouse publication: Hydrilla verticillata: What Marinas Need to Know-March 2012.)



Volunteers hand-pulling water chestnut from Otisco Lake.



The Asian clam is found in Otisco Lake.

2.9 Invasíve Specíes Management

▲ nvasive species management in Otisco Lake has focused on the aquatic plants, Eurasian watermilfoil and water chestnut. Mechanical harvesting and limited "suction dredging" have been used to help control an overabundance of Eurasian watermilfoil and other aquatic plants. These efforts have been funded privately and through New York State Finger-Lake-Lake Ontario Watershed Protection Alliance (FLLOWPA) funds made available to Onondaga County. A pilot one-acre benthic matting project was conducted in 2012. In 2013, matting was made available for seasonal use by lake residents through the OLPA. This popular program was expected to continue in 2014. An approximate one-acre area of water chestnut has been the target of hand-pulling efforts for successive years with the plant nearly eradicated from Otisco Lake. Public education and awareness efforts have been used separately and in conjunction with the Watercraft Steward Program thorough the Finger Lakes Institute to inform lake users about invasive invertebrate and plant species of concern or of imminent threat to Otisco Lake. Over the past several years, Cornell Cooperative Extension of Onondaga County (CCE) has conducted workshops and other information sessions on invasive species for lake and watershed residents.

> Three methods of aquatic plant management (clockwise from top); suction removal, mechanical harvesting and benthic matting.





CHAPTER 3 OTISCO LAKE WATERSHED AND LAND USE

3.1 Introduction

The water quality of a lake is a direct reflection of present and past land uses in the watershed. Numerous studies show a direct relationship between the amount of development and corresponding decreases in lake water quality. Thus, it is no surprise that lakes with the poorest water quality are usually in highly developed settings.

However, it is inevitable that land development and changes in existing land use will take place since much of our economy hinges upon new residential, commercial, and industrial growth. On the other hand, it is not a foregone conclusion that new development or changing land uses must negatively impact a natural resource such as Otisco Lake.

This chapter provides a physical description of the Otisco Lake watershed and its land use patterns. Information has been collected on land uses, highway infrastructure, drinking water supplies/infrastructure, wastewater treatment, population, stream systems, local regulations and



other issues that affect Otisco Lake.

These issues are discussed in greater detail in this document with recommendations for long-term improvement presented in Chapter 5. Information needs were also identified during this process with respect to delineating stormwater runoff patterns and more specific locations of sediments and other upland generated contaminants. As a result, a number of recommendations have been made to help acquire this information.



The water quality of a lake is a direct reflection of present and past land uses in the watershed. it is not a foregone conclusion that new development or changing land uses must negatively impact a natural resource such as Otisco Lake.





3.2 Characterístícs

he Otisco Lake watershed is 38.7 mi² (24,777 acres) and includes portions of five Onondaga County towns (Marcellus, Onondaga, Otisco, Spafford and Tully) plus small portions of the town of Preble (646 acres) and the town of Scott (25 acres) in Cortland County.

Bedrock and Surficial Geology

The bedrock of the Otisco Lake watershed consists largely of sandstones, siltstones and shales of Ludlowville Formation, West River Shale, Moscow Formation, Skaneateles Formation, and Tully Limestone. On a percentage basis, the Ludlowville Formation is predominant (39%)



and comprises much of the Bedrock formation near bedrock at elevation just Otisco lake. above lake level. Skaneate-

les Formation is found immediately surrounding the lake and along the major tributaries .

Formation of all the Fin-Lakes ger was due to both glacial and interglacial periods over approximately the last two million years. It was not simply "ice in/ice out" that created the region, but a complex "dance" of multiple ice



advances and retreats that created the Finger Lakes valleys. The Pre-Illionian glacier flowed over the region about 1 million years ago with the glacier's southern edge stabilized just south of the present day Finger Lakes. The last period of ice advances/retreats was during the Wisconsonian age which occurred about 25,000 to 11,000 years ago and created the current landscape, end moraines (Valley Head Moraine) and the Finger Lakes as we know them today.

Lodgemont till is predominant on the eastern side of the lake watershed and on the western side at lower elevations. It is a generally poorly-sorted mixture of rounded to subrounded cobbles and boulders embedded within a silt/clay matrix locally referred to as "hardpan."

At higher elevations, especially on the western side of the watershed, thin layers of till or exposed Paleozoid sedimentary rocks prevail. However, in the tributary drainages on the eastern side of the lake (Van Benthuysen, Amber and Rice Brooks) along with the Spafford Creek drainage at the lake's southern end, outwash sand and gravel deposits along with ice contact sand and gravel deposits dominant (Winkley 1989).

<u>Soils</u>

The eastern lakeshore area is dominated by Honeoye and Howard series soils. Honeoye soils are classified as deep, well drained, medium-texture soils formed in calcareous glacial till. Howard series soils are deep, well drained and somewhat excessively drained mediumtextured and moderately coarse textured soils formed in stratified sand and gravel outwash material. Seasonal high water table (groundwater) is 2-3 feet below the soil surface. Schoharie soils, which are slow to dry out and where runoff can be rapid after a storm event, are found along the northeastern shoreline of the lake.

Aurora-Farmington-Rock outcrop association is found along much of the central western shoreline between Lader Point and Lundy Point. Soils from this association are mainly found on valley sides with steep slopes very steep gorges, and ledges of bedrock outcrops the prominent features of the landscape.

Other predominant soil types include the Wayland soils found along the tributary streams and in floodplains and Teel silt loams found around the northeastern on "Narrows" area of the lake. Both soil types frequently flood in the spring (Soil Survey of Onondaga County New York 1973). (Figure 2, Appendix A).

Topography

Otisco Lake and its watershed lie within the glaciated

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portion of the Appalachian Plateau Physiographic Province. The region is characterized by broad U-shaped valleys with steep slopes projecting upwards for several



hundred feet and *Western shore of Otisco Lake* capped by rounded *showing steep slope topography*. or gently rolling

hilltops. The northern and southern ends of the lake are low-lying areas representing a continuation of the lake valley in both directions.

In general, steeper slopes or rises in elevation are found along the western side of the lake's mid-portion. The highest elevations in the watershed exceed 1700 feet and are found in its extreme southern, southeastern, and southwestern portions.

<u>Climate</u>

New York State's climate is generally representative of the humid, continental type found in the northeastern United States. Two different air mass types are responsible for the

dominant continental charac-

teristics of the state's climate. Masses of cold, dry air frequently arrive from the continent's northern interior with prevailing south and southwesterly winds transporting warm, humid air from the Gulf of

Mexico and adjacent subtropical waters. Having less of an influence especially away from southeastern New York is a third type of air mass that flows inland from the North Atlantic Ocean producing cool, cloudy and damp weather conditions.



Variations in month-to

-month precipitation

or for the same month

on a year-to-year basis

can vary considerably

with fluctuations of 6

inches or more.

During most winter seasons, temperatures of -

 15° F or colder can be expected in the eastcentral highlands of the Southern Plateau which includes the Otisco Lake region. The summer climate is cool in the higher elevations of the Southern Plateau with daytime temperatures usually in the upper 70s to mid-80s range and infrequently exceeding 90°F. The region's average freeze-free season is 120-150 days.

New York State has a fairly uniform precipitation distribution pattern during the year with

The region is characterized by broad U-shaped valleys with steep slopes projecting upwards for several hundred feet and capped by rounded or aently rolling hilltops. no distinctly dry or wet season repeated on a regular basis. In the Otisco Lake region, minimum precipitation occurs in the winter and maximum amounts in summer.

However, variations in month-to-month precipitation or for the same month on a year-to-year basis can vary considerably with fluctuations of 1-6 inches or more. Average annual precipitation recorded at Syracuse, New York is 40.1 inches (30 year record-Regional Climate Center data). For comparative purposes, annual precipitation at the Otisco Lake outlet for 2005-09 and recorded by OCWA was 44.2 inches (Mark Murphy, pers.

comm. December 2010).

Topography, elevation and proximity to large water bodies such as Lake Ontario result in



considerable variation in snowfall amounts in the state's interior even within relatively short distances. Average annual snowfall for Syracuse, New York is 118.6 inches (59 year record -Regional Climate Center data). Similarly, annual snowfall recorded at the Otisco Lake outlet by OCWA was 119.1 inches for the 2005-09 time period (Mark Murphy, pers. comm. December 2010).

Despite a rather long-term record characterizing stable climatic conditions, the region is presently experiencing greater climate variability which is affecting water levels and water quality of all the Finger Lakes.

3.3 Land Use and Development in the Watershed

<u>General</u>

The watershed is approximately 42% agricultural, 33% forested lands and 9% shrub/scrub. Wetlands and open water comprise almost 13% of the watershed. Only a little over 4% of the watershed is categorized as "developed" with the majority of development along the eastern shoreline and on the western shore about as far southward as Lader Point. Most of the forested lands are along the steep-sloped western side

of the lake and south of the lake, proper.

Agricultural-General

The OCWA 2011 annual census enumerated 42 farms in the Otisco Lake watershed. This is in close agreement with the 38 farms listed on the Onondaga County 911 record (SOCPA, pers. comm. February 2013). Farm counts can vary depending upon the definition used to describe an active farm. Many of the farms are not being farmed by the owners, but are rented out to other watershed farmers.

Agriculture in the Otisco Lake watershed is following the general countywide trend with a reduction in the number of farms, but an increase in their size. Agriculture activity is seen in the map of Agricultural District parcels present in the watershed. The Otisco Lake watershed served as a model for



OTISCO LAKE WATERSHED LAND USE





the New York View showing agricultural, wooded and residen-State Agricul- tial development land use in the Otisco Lake watural Environ-

mental Management (AEM) program with about 80% of the watershed farms in some stage of the AEM program (D. Fisher, pers. comm. August 2013).

The OCWA 2012 census classified 11,508 acres as "active" meaning devoted to cropland and pasture. Corn was the major crop constituting 4,858 acres. Other crops and acreages were as follows: hay (4,781), soybeans (716); wheat (300), oats (275); rye (226) and barley (6). The total number of livestock counted was 6,656.

Liquid manure systems were noted at 5 of the 12 dairy operations while the remaining operators handled manure in a solid form (OCWA Report on Otisco Lake Reservoir Watershed Inspections 2012).

Minor fluctuations in crop types and pastured acreages are seen on a year-to-year basis, but the predominant crops planted (i.e., corn, hay, soybeans) have not changed.

Agricultural Tier V Assessment

In 2013, the Onondaga County Soil and Water Conservation District (SWCD) mailed out a Tier

1/Tier 5 questionnaire to all farmsin the watershed to update SWCDrecords regarding animal numbers, acres, and land use patterns*Operation that may warrant*

lifespan issues. BMPs installed were reviewed with producers, and they were given the opportunity to discuss what problems, if any, they had with the BMPs. Potential new projects were iden-

District staff interviewed pro-
ducers regarding changes in
operation that may warrant
new Best Management Practic-
es (BMPs), operation and
maintenance concerns, and
lifespan issues.Lined for some far
restrict
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were held





landowners. (Appendix D)

Additionally, the SWCD has provided assistance through OCWA funding to implement cover crops on 700+ acres of land in the watershed. Farms that implement and document the cover crops will receive a reimbursement at a per acre price.

Public Access

There are two private boat launch-

ing access points on Otisco Lake with shoreline access found along the extreme northeastern portion of the lake, the southwestern corner near the lake causeway, and from the County park near Turtle Bay on the east shore. The Otisco Lake County Park operates as a "carry in / carry out"



Soil sampling as part of a Tier Vassessment.

in the watershed. Farms that did not respond were given a follow-up call to fill out the data, or the data was updated during the farm site visit. At this date, 20 Tier 1/Tier 5 questionnaires out of 33 are completed. Five farms had been sold, and 8 farms had not completed the question-



naire. The sold farms A buffer is designed and installed to capture have been added to other and filter barnyard runoff.

farms and the SWCD has updated this information accordingly. At least one of these farms did not previously work land in the Otisco Lake watershed.

Meetings were arranged with multiple farms that had participated with the SWCD in the past. SWCD staff interviewed producers regarding changes in operation that may warrant new Best Management Practices (BMPs), operation and maintenance concerns, and



Public access at Otisco Lake County Park.

facility. At present, Otisco Lake does not have a public boat launch, but discussions as to a location and size (auto/trailer capacity) of such a facility have been held.

Roads

The Otisco Lake outlet is located approximately 2½ miles south of U.S. Route 20, the major eastwest roadway through southern Onondaga County. New York State Route 174 runs north-south from U.S. Route 20 and along the west shore of Otisco Lake for about 1.5 miles before turning to a predominant east-west orientation. The only other road adjacent to the lake's west shore is West Valley Road which runs north-south between the lake's southern extreme and the Causeway. Otisco Valley Road runs adjacent or in close proximity to the lake's east side.

Drinking Water Supply and Infrastructure

OCWA provides drinking water for Onondaga County outside of the City of Syracuse and to a small portion of Madison County. While OCWA is licensed to withdraw 20 mgd on an annual basis and up to 25 mgd on a daily basis from Otisco Lake, withdrawals currently average around 17.5 mgd. Water is withdrawn by two intake pipes and is immediately disinfected with either sodium hypochlorite or chlorine dioxide to discourage the growth of zebra mussels. The water then travels, by gravity, approximately 5 miles to OCWA's Water Treatment Plant located in Marcellus, NY for further treatment before transport through the distribution system.

The majority of watershed residents rely on private wells for their water supply needs.

Mountain Glen, a spring water supply source, previously serviced 80 customers in the Otisco Lake area.

This supply has been replaced by the Southern Onondaga Area Water District which allows for construction of infrastructure facilities to provide area customers with Otisco Lake public water from OCWA.

This public water supply service extends on the lake western shore south to the Glen Cove area and to an additional 1600 feet from where County Route 174 turns westward. On the east side of Otisco Lake, service extends southward on Otisco Valley Road to 300 feet north of the Otisco Lake Marina which is in close proximity to the Otisco







Road (County Route 246)/ Otisco Valley Road intersection. Almost 200 customers (196) are serviced on this side of the lakeshore.

Wastewater Management/Bulk **Storage Facilities**

There are no publically owned wastewater treatment facilities discharging to Otisco Lake or to tributaries located within the watershed. Wastewater treatment is handled almost exclusively by septic systems with very few holding tanks, chemical toilets, or privies in service. For example, of 1,011 residences inspected, 978 used septic systems, 27 had holding tanks, 4 used chemical toilets, and 2 utilized privies (OCWA 2011).

There are no regulated point Wastewater treatment is sources discharging either handled almost exclusivedirectly into Otisco Lake or *by septic systems* ... any of its tributaries.

A small number of NYSDEC permitted bulk storage facilities are present in the watershed.

The upgrading or conversion of seasonal, lakeshore homes or "camps" to more permanent-style residences is worth noting. Septic systems providing



adequate treatment to meet limited seasonal use may not be capable of properly handling the increased wastewater loads associated with more extend-

ed seasonal use or permanent residency.

Another challenge is in areas around the lake where soil suitability for septic system treatment is less than optimal. While there are acceptable alternatives to conventional septic systems, the small

size of many lake shore parcels presents difficulties to obtaining system approval from the County Health Department. As a result, the County Health Department and local municipalities work cooperatively serving in a land use regulatory capacity.





3.4 Watershed Socio-economic Characteristics

he estimated watershed population shows the following breakdown by town:

| Otisco Lake Watershed Population by Town | | | | |
|---------------------------------------------|---------------------------------|--|--|--|
| Town | 2012 Watershed Population | | | |
| Marcellus | 305 | | | |
| Onondaga | 174 | | | |
| Otisco | 1289* | | | |
| Tully | 84 | | | |
| Preble | 0 | | | |
| Spafford | 585 | | | |
| Total | 2437 | | | |

*From OCWA 2012 watershed census. Total includes 8 residents listed only as from Marietta and included in the town of Otisco total.

Since median household income is reported by township, only data for the *mental pressure*. two towns (Otisco

The Otisco Lake watershed has not experienced develop-

and Spafford) comprising most of the land area and population in the Otisco Lake watershed are presented.

Comparing the 2000 and 2010 census data, the town of Otisco had a decrease of 0.8% and the town of Spafford showed a 1.5% increase. Population density in the town of Otisco is 86 persons per square mile and 51.6 persons per square mile in the town of Spafford. Median ages are 42.2 years for Otisco and 48.1 for Spafford. American Community Survey data for the period 2005-2010 shows the median household income in the town of Otisco as \$61,898 and \$71,908 in the town of Spafford.

Reflecting the above population totals and trends, the Otisco Lake watershed has not experienced developmental pressure. New septic system approvals provide a fairly accurate measure of development. In the years 2010 through 2012, there

were 16 approvals by the Onondaga County Health Department within the watershed: five in 2010, five in 2011 and six in 2012. While these numbers may have been depressed by recent economic conditions, they do not differ significantly from years prior to 2010.

OCWA conducts an annual watershed population survey as part of its Annual Report made to the New York State Department of Health. Based upon population counts plus an estimate for residences that could not be surveyed, the breakdown for the watershed population of 2,437 in 2012 was 1,829 permanent and 608 seasonal residents (M. Murphy, pers. comm. 2013).

The 2011 survey found the number of occupied dwellings in the watershed was 1,275 with an additional 76 vacant. Of the 1,011 occupied dwellings OCWA inspectors were able to survey in 2011, a total of 515 or just over 50% were lakefront residences (OCWA 2011). In 2012, the percentage of lakeshore residences defined as seasonal was 57% and 43% permanent. (M. Murphy, pers. comm. 2013). Percentages are based upon the number of occupied dwellings at the time of the survey and accounts for most, if not all, of the slight annual variations seen in the percentages.

The type of lakeshore dwellings has changed with summer or seasonal dwellings being upgraded to yearround homes.

These percentages have remained largely unchanged over the past 25 years. For example, 280 of an estimated 500

lakeshore residences (56%) were classified as seasonal and 44% permanent from OCWA census data in the mid-1980s (Onondaga County Water Quality Management Agency 1986). However, the type of dwellings has changed with summer or seasonal dwellings being upgraded to yearround homes.

An improving economy and corresponding increase in development of the Onondaga Hill area could lead to expansion of infrastructure services (i.e., water, sewer, roads, etc.) and also make the nearby eastern portion of the Otisco lake watershed (towns of Marcellus, Onondaga and Otisco) more desirable for development.

3.5 Streams of the Otisco Lake Watershed

O tisco Lake has five major tributaries: Amber Brook, Van Benthuysen Brook, Rice Brook, Spafford Creek and Willow Brook. Spafford Creek, the largest tributary, enters Otisco Lake at its southern end and contributes about 33% of the annual inflow. The ungaged portion of the watershed contributes about the same percentage (34%). Other tributaries and their contributions are: Van Benthuysen Brook (11%), Amber Brook (9%), Willow Brook (8%), and Rice Brook (6%) (Paschal and Sherwood 1987).

Spafford Creek and Rice Brook are classified as C (T) (best usage-fishing /suitable for trout) with the remaining tributaries (Amber Brook, Van Benthuysen Brook, and Willow Brook) classified as C (best usage-fishing).

The sub-basin drainage areas are as follows: Spafford Creek (12 mi²), Willow Brook (3.7 mi²), Amber Brook (3.7 mi²), Van Benthuysen Brook (3.5 mi²), Rice Brook (2.4 mi²) and drainage directly into the lake or by minor watercourse (11.0 mi²).



Delta build-up at the mouth of Rice Brook (center of photo).



Trout in lake tributary.



Creek monitoring.



3.6 Watershed Pollutant Inputs

S ampling of the major lake tributaries has been sporadic with the exception of two sampling periods which are over twenty years apart: 1981-83 and 2005-08. The yields (quantities per acre) of selected nutrients and suspended sediment transported in three tributaries: Spafford Creek, Rice Brook, and Willow Brook were reported by Coon et. al (2009) for 2005-08 and compared to 1981-83.

The 2005–08 precipitation-weighted yields (tributary contributions) of TKN (ammonia-plus organic nitrogen), PO4 (orthophosphate), and TP (total phosphorus) were comparable to those from 1981-83. Yields of NOx (nitrate-plus nitrite) in Rice Brook and Willow Brook and those of suspended sediments in all three sub basins increased. The largest yield increases were shown for suspended sediments with yields during 2005-08 being 100 to 400 percent greater than during 1981-83. Although Spafford Creek, the largest of the Otisco Lake tributaries, had the highest precipitation-weighted yield of suspended sediments among the three sites, the 2005–08 yields in Rice Brook and Willow Brook increased by a greater percentage compared to their 1981-83 yields, as well as relative to Spafford Creek's increase. (Table 4, Appendix A).

Beyond the studies discussed above, no investigations have been conducted to ascertain principle pollutant sources on a sub watershed basis. While Otisco Lake is subject to a generic list of watershed-derived contaminants impacting many area lakes, several inferences can be made.

For example, Rice Brook's sediment loadings can be largely attributed to erodible cliffs and stream banks. Spafford Creek's large sediment loads are due to its flows thorough lacustrine silt and clay deposits. Comprising nearly half of the watershed land use on a percentage basis, it stands to reason that agricultural activity is a source of nutrients (phosphorus/ nitrogen). Installation of a public water system has provided unlimited water to residents of the water district along Otisco Lake (see Section 3.3 Drinking Water Supply and Infrastructure). Previously, a reliance on ground water from private wells provided a constraint on water use. Since residents generally rely on on-site septic systems, increased discharge of wastewater from the public system could result in an increase in the volume of wastewater in shallow ground water and recharge to the lake. The extent, if any, of groundwater quality impacts to the lake are not known.



Otisco Valley Road and impervious runoff adjacent to the lake's eastern shore.



Best Management Practices were installed at this site to prevent agricultural runoff.



Tributary inputs from eroding streambanks such as from Rice Brook.

3.7 Upland Invasive Species Management

he Emerald Ash Borer (EAB) presents the most significant threat to the watershed's upland landscape. With its presence in Onondaga County documented in 2013, the elimination of native ash species from the area landscape is highly likely. Onondaga County, through the Onondaga County SWCD will complete an inventory of ash trees along county roads.

This will help prioritize trees to be scheduled for removal based upon hazard potential. CCE of Onondaga County is conducting educational programs to help landowners identify ash trees and provide alternatives for addressing EAB impacts. It is estimated that roughly 15% of the Otisco Lake watershed forest consists of ash species.

Another terrestrial invasive species expected to impact the Otisco Lake watershed is a small, aphid-like insect known as Hemlock Woolly Adelgid (*Adelges tsugae*) or HWA. In 2014, HWA was confirmed on hemlock trees in the Bahar Nature Reserve along the western shore of Skaneateles Lake in the Town of Niles, and along the eastern shore in the Town of Spafford.

Ecological impacts expected with the loss of hemlock trees from the watershed forest include increased stream water temperatures, loss of nutrient-retaining waterway buffers, destabilization of shallow soils, loss of shelter for animals and plants, and increases in invasive species taking over open stands. Hemlock are found in the deep coves and steep slopes characteristic of the Finger Lakes region including the western and southern portions of the Otisco Lake watershed.



The Emerald Ash Borer presents the most significant threat to the watershed upland landscape.



3.8 Lake and Watershed Stewardship



Onondaga County Water Authority

By Anthony J. Geiss, Jr., PE, Deputy Executive Director

O_{CWA} supplies drinking water to a four county area in Central New York. OCWA delivers water from Otisco Lake and Lake Ontario to accomplish this mission. OCWA supplies and treats Otisco Lake water at its own facilities. The Lake Ontario water supply is a wholesale purchase from the Metropolitan Water Board.

The Otisco Lake supply consists of water intakes, dam, and treatment plant and transmission lines. OCWA inspects the Otisco Lake watershed as part of its monitoring the water quality in the Lake. The watershed inspection includes dye tests of existing septic systems, survey of farms for animal, manure systems and crops planted, and monitoring new construction.

The raw water quality is monitored for temperature, turbidity, pH, alkalinity, and algae. The lake level is measured each day as well. The treated water is also monitored for water quality according to drinking water regulations.



Otisco Lake Preservation Association By Anita Williams, Past-President

The OLPA was formed in 2008 as a grassroots organization with a mission to preserve the health and welfare of Otisco Lake with a primary focus on invasive weeds. Since then we have expanded our focus to ensure not only the health and integrity of the lake, but the entire watershed. We became a 501(c)(3) organization in 2009. Our goal has expanded to maintain and protect the quality of the lake not only for recreational purposes, but as a primary drinking water source for CNY residents. OLPA works towards promoting the common interests of preserving, maintaining and assuring the integrity of Otisco Lake, its shores and watershed

so as to achieve optimum quality of the lake for its surrounding communities through education, materi-

als and programs. We actively seek advice and assistance from experts in government, universities and private companies, donate our time, solicit volunteers and seek funding through grants, fund raising events, and individual donations.

Past Activities

Health).



Harvesting water chestnut on Otisco Lake.

Annually fund mechanical harvesting to control weed growth and remove biomass bogs in heavily trafficked areas of the lake (with additional assistance from FLLOWPA funds through the Onondaga County Health Department- Division of Environmental

- * With grant monies through FLLOWPA (from the Onondaga County Health Department- Division of Environmental Health) an area matting project was conducted in 2012. Using the same materials in 2013, matting was provided to lake residents to assist in weed control for improved recreational use.
- Annually partner with the NYS DEC and Onondaga County CCE in efforts to eradicate the water chestnut weed in Turtle Bay.
- * Created and provided "Responsible Boating" brochures, posters, signage and place mats through a grant from the BoatUS Foundation.
- * Formed a Lake Weed Committee to patrol the lake; track weed growth and provide feedback and direction.
- Annually work with CCE to provide educational programs/materials to the Otisco Lake communities regarding invasive weed identification and control, maintaining septic systems, and reducing stormwater runoff.
- Provide strong advocacy for regulations to protect the lake, its watershed and communities.
- Helped to secure hydrofracking bans in 4 of the 5 Otisco Lake Towns (5th has a moratorium).
- * Member of NYFOLA (Federation of Lakes Association) and Finger Lakes Regional Watershed Alli-



CHAPTER 4 OPINION SURVEY RESULTS

4.1 Watershed Resident Survey

A survey was conducted in 2010 to gauge permanent and seasonal resident opinion on water quality conditions in Otisco Lake. Survey questions closely resembled those provided in the NYSFOLA's *Diet for a Small Lake: A New Yorker's Guide to Lake Management.* The Onondaga County Council on Environmental Health finalized the number and wording of questions to be asked so they could be easily answered as part of the OCWA annual watershed survey. OLPA assisted by publicizing the survey on its website. The survey and tabulated responses are included in **Appendix B.**

A total of 177 responses were received. Eighty percent of those identified themselves as permanent watershed residents. Over 60% said they engaged at least occasionally in one more of the water-based recreational activity categories listed: boating, fishing, or swimming.

Although the responses were based on perception, those responding to the question whether they thought water quality had changed in the lake over the past 1,5, or 10 years indicated



overwhelmingly (one year- 69%, five years- 56%, five to ten years-60%) there had been no change during those time frames.

Though a limited response pool, residents residing in the watershed for over 10 years to 40 or more years were split equally between those that felt the lake had improved (12) versus those feeling it has gotten worse (11). Slightly more than those two groups combined (24) thought there had been no change. Seven respondents were not sure if there had been any change.





Residents were asked to assess 12 potential lake and watershed issues. While every listed problem was identified by the surveyed residents, aquatic weeds and algae blooms were the most frequently cited as being a problem to some degree.

4.2 Stakeholder Survey

T n the spring of 2012, a water quality survey was taken of watershed stakeholders (27 respondents) that had been invited to serve on the Otisco Lake Watershed Advisory Committee. (Appendix C) The primary role of the Advisory Committee is to facilitate communication and cooperation of the involved local governments, state agencies, and other stakeholders essential to the preparation and implementation of the watershed plan.

A main objective of the survey was to identify priority lake and watershed issues to be addressed in the lake management plan. Monitoring tributaries and the lake was selected as a high priority by 84% of those responding, with long-term regional planning selected as a high priority by 74% and open space planning by 67%. The in-lake issues selected as highest priorities were: invasive species prevention/ education (82%), nutrient levels being too high (81%), septic effluent (81%), and fishing (71%).

Stakeholders were asked to rank watershed issues of concern for five specific categories. Those issues noted as of "high priority" by 70% or more of the respondents are shown in the accompanying table:

| | | Kel | |
|---------------|---------|------------|-----|
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| PV LCO | | | |
| | Ne | | |
| | | | 7-1 |
| | Lake | | |
| | | | |
| CACKER CACKER | | | |
| A CONTRACT | April 2 | Kog | |
| | | | |
| | | | |

| Category/Issue | Selected as High Priority |
|-------------------------------------------------------------------------------------------------------------|---------------------------|
| I. Development: • Hydrofracking | 75% |
| II. Affects of agriculture to surface and groundwaterChemical fertilizers | 86% |
| III. Commercial and /industrial affects to surface/groundwater:Affects of runoff | 70% |
| IV. Residential affects to surface and groundwater | 71% |
| Stormwater runoff Hazardous household waste disposal | 71% |
| V. Onsite septic systemsLack of watershed inspection& maintenance schedule | 70% |

REFERENCES

Auer MT, Effler SW. 1987. Otisco Lake Macrophyte Study. Upstate Freshwater Institute, Inc. Prepared for Onondaga County. Unpublished 7p.

Baston L Jr, Ross B.1973. The Distribution of Aquatic Weeds in the Finger Lakes of New York State and Recommendations for Their Control. Public Service Legislative Studies Program. New York State Assembly.

Callinan CW. 2001. Water Quality Study of the Finger Lakes, New York State Department of Environmental Conservation, Albany, New York. 152p.

Carlson, RE and J Simpson. 1996. A Coordinator's Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. P6 p.

Coon WF, Hayhurst, BA, Kappel, WM, Eckhardt DAV, Szabo CO.2009. Water-quality characterization of surface water in the Onondaga Lake basin, Onondaga County, New York, 2005–08: U.S. Geological Survey Scientific Investigations Report 2009–5246, 67 p.

Eaton EH. 1928. The Finger Lakes fish problem. In A Biological Survey of the Oswego River system. Suppl. 17th Annual Report 1927. Chapter II, pp.40-66. New York State Conservation Department, Albany, New York.

Effler SW, Johnson DL, Perkins MG, Brooks C.1985. A Selective Limnological Analysis of Otisco Lake, NY. Publication of the Upstate Freshwater Institute, Inc. Syracuse, NY

Effler SW, Greer H, Perkins MG, Field SD, Mills E. 1987. Calcium Carbonate Precipitation and transparency in Lakes: A Case study. J. Environmental Engineering Div. ASCE (113): 124-133.

Effler SW, Perkins MG, Wagner B, Greer H.1989. Limnological Analysis of Otisco Lake, 1988. Upstate Freshwater Institute, Inc. Prepared for Onondaga County. 79p

Enache MD, Charles DF, Belton TJ, Callinan CW. 2012. Total phosphorus changes in NewYork and New Jersey lakes (USA) inferred from sediment cores, Lake Reserv. Manage. 28:293-310.

Federal Emergency Management Agency 2012. Digital Flood Insurance Rate Map Database for Onondaga County, NY. USA

Hairston NG Jr, Johnston RL, Lord PH. 2005. Otisco and Skaneateles Lakes: Developing biological control of Eurasian watermilfoil (Myriophyllum spicatum L.) Department of Ecology and Evolutionary Biology. Cornell University, Ithaca, NY 113 p.

Halfman JD, Cummings E, Carver Dionne L. 2010. Comparative Limnology of the Eight Eastern Finger Lakes: 2005-2010. 6th Annual Finger Lakes Research Conference.

Onondaga County Water Quality Management Agency 1986. Review and Evaluation of Local Watershed Rules and Regulations. Unpublished. 36p.

Meyers. S (ed). The Otisco Lake Book-A Citizens Guide to Protecting Otisco Lake. 74 p.

(Continued)

Paschal JE, Sherwood DA. 1987. Relation of sedimentation and nutrient loads to watershed characterization and land use in the Otisco Lake Basin Onondaga County. USGS-Water Resources Investigation Report 86-4026. 62 p.

Schaffner WR, Oglesby RT. 1978. Limnology of Eight Finger Lakes: Hemlock, Canadice, Honeoye, Keuka, Seneca, Owasco, Skaneateles, and Otisco. In Bloomfield JA, editor. Lakes of New York State Vol. 1 Ecology of the Finger Lakes. New York (NY): Academic Press.p.313-470.

U.S. Department of Agriculture Soil Conservation Service, 1977. Soil Survey of Onondaga County, New York 233p.

Winkley S J.1989. The Hydrology of Onondaga County, New York. Prepared for the Onondaga County Environmental Management Council, Onondaga County Health Department and Onondaga County Water Quality Management Agency. Unpublished. 171 p.5.



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<u>Appendix B</u>

2010 Otisco Lake Watershed Resident Survey Questions 2010 Otisco Lake Watershed Resident Survey Results

Appendix C

Watershed Stakeholder Survey

Appendix D

Other Data and Information Onondaga SWCD Planning Needs for Otisco Lake Watershed, 2013

Table 1. Trophic Status Index and Parameter Values for Otisco Lake

(Effler et. al 1989 and Halfman and O'Neill, 2009, Halfman, pers. comm. 2012)

| Year | Total Phospho | rus | Chlorophyll a | | Secchi Disc | |
|------|---------------|-------|---------------|-------|-------------|-------|
| | mg/m3) | TSI | (mg/m3) | TSI | (m) T | SI |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 1979 | | | 5.1 | 46.5 | 2.4 | 47.3 |
| 1982 | | | | | 2.6 | 46.2 |
| 1983 | | | 2.8 | 40.6 | 2.5 | 46.7 |
| 1986 | 13.7 | 41.8 | 2.6 | 39.9 | 2.8 | 45.1 |
| 1988 | 17.0 | 45.0 | 1.8 | 36.3 | 2.55 | 46.5 |
| 2008 | 13.5 | 41.6* | 3.4 | 42.6* | 3.1 | 43.7* |
| 2011 | 16.8 | 44.8* | 2.3 | 38.7* | 2.9 | 44.7* |

* TSI calculated separately using the data from Halfman and O'Neill, 2009 and Halfman, 2012)



Table 2. Annual Mean Otisco Lake Data (Annual Mean ± 1σ)

(from Halfman and O'Neill, 2009 and Halfman, pers. comm. 2012)

| Parameter | 2008 | 2009 | 2010 | 2011 |
|-------------------------------------------|--------------------|--------------------|--------------------|-------------------|
| Total Suspended Solids (mg/l) Surface | 2.3 <u>+</u> 1.9 | 2.2 <u>+</u> 0.8 | 1.5 <u>+</u> 0.7 | 2.3 <u>+</u> 0.7 |
| Total Suspended Solids (mg/l) Bottom | 2.1 <u>+</u> 0.7 | 1.8 <u>+</u> 0.6 | 1.6 <u>+</u> 0.9 | 1.8 <u>+</u> 0.6 |
| Dissolved Phosphate (µg/l SRP) Surface | 0.8 <u>+</u> 1.2 | 0.5 <u>+</u> 0.4 | 0.4 <u>+</u> 0.3 | 1.2 <u>+</u> 2.3 |
| Dissolved Phosphate (µg/l SRP) Bottom | 4.8 <u>+</u> 9.7 | 1.9 <u>+</u> 2.1 | 2.0 <u>+</u> 3.9 | 2.0 <u>+</u> 1.7 |
| Total Phosphate (µg/l TP) Surface | 12.8 <u>+</u> 3.21 | 36.1 <u>+</u> 60.3 | 8.6 <u>+</u> 2.2 | 16.6 <u>+</u> 7.6 |
| Total Phosphate (µg/l TP) Bottom | 14.2 <u>+</u> 9.6 | 10.6 <u>+</u> 11.1 | 11.4 <u>+</u> 10.3 | 16.9 <u>+</u> 7.4 |
| Nitrate as N (mg/l) Surface | 0.3 <u>+</u> 0.1 | 0.2 <u>+</u> 0.1 | 0.3 <u>+</u> 0.2 | 0.3 <u>+</u> 0.3 |
| Nitrate as N (mg/l) Bottom | 0.3 <u>+</u> 0.2 | 0.3 <u>+</u> 0.1 | 0.3 <u>+</u> 0.1 | 0.4 <u>+</u> 0.2 |
| Silica (SR, µg/l) Surface | 334 <u>+</u> 413 | 321 <u>+</u> 297 | 467 <u>+</u> 206 | 1106 <u>+</u> 598 |
| Silica (SR, µg/l Bottom | 1298 <u>+</u> 890 | 854 <u>+</u> 444 | 935 <u>+</u> 241 | 1124 <u>+</u> 534 |
| Chlorophyll a (µg/l) Surface | 3.7 <u>+</u> 0.6 | 5.7 <u>+</u> 4.1 | 3.0 <u>+</u> 1.7 | 2.8 <u>+</u> 1.3 |
| Chlorophyll a (µg/l) Bottom | 3.0 <u>+</u> 1.7 | 2.8 <u>+</u> 2.1 | 2.2 <u>+</u> 0.7 | 1.8 <u>+</u> 1.7 |

Table 3. Comparison of Secchi Disc Transparencies: May-September

(modified from Effler et al. (1989)

| Year | Ave (m) | Std. Dev | Min (m) | Max (m) | n | Original Data Source |
|------|---------|----------|---------|---------|----|-------------------------------|
| 1979 | 2.43 | 0.36 | 1.0 | 4.6 | 17 | Litten et al. (1980) |
| 1982 | 2.55 | 0.23 | 1.75 | 3.95 | 16 | Effler (unpublished) |
| 1983 | 2.46 | 0.27 | 1.25 | 3.7 | 19 | Effler et al. (1985) |
| 1986 | 2.72 | 0.22 | 1.65 | 4.0 | 23 | Effler et al. (1987) |
| 1988 | 2.55 | 0.25 | 1.3 | 3.5 | 29 | Effler et al. (1989) |
| 2001 | 3.0 | 0.8 | 1.2 | 3.7 | 11 | OCWA (unpublished) |
| 2002 | 2.7 | 1.0 | 1.5 | 4.6 | 8 | OCWA (unpublished) |
| 2003 | 2.8 | 0.7 | 1.8 | 4.6 | 12 | OCWA (unpublished) |
| 2004 | 3.5 | 0.9 | 2.1 | 5.2 | 14 | OCWA (unpublished) |
| 2007 | 3.6 | 1.7 | 2.4 | 5.5 | 17 | OCWA (unpublished) |
| 2008 | 3.1 | 0.9 | | | | Halfman and O'Neill (2009) |
| 2008 | 3.5. | 1.7 | 2.3 | 4.9 | 15 | OCWA (unpublished) |
| 2009 | 3.5 | 0.96 | 2.4 | 5.0 | 17 | OCWA (unpublished) |
| 2009 | 2.8 | 0.8 | | | | Halfman (unpublished) |
| 2010 | 3.8 | 0.6 | | | | Halfman et. al (unpublished) |
| 2011 | 2.8 | 1.6 | 2.0 | 5.0 | 12 | OCWA (unpublished) |
| 2012 | 3.2 | 0.17 | 2.3 | 6.1 | 16 | OCWA (unpublished) |



Table 4. Concentrations and yields of nutrient and suspended sediment in Otisco Lake tributaries water years 2006-2008 and comparisons to 1982-83 (from Coon et. al 2009)¹

| | Spafford Creek | Rice Brook | Willow Brook ² | | |
|---------------------------------------|--------------------------------|-------------------------------|------------------------------|--|--|
| М | ean Annual Precipitation | 43.4 in | | | |
| | Ammonia-plus organ | nic nitrogen, unfiltered (TKN | J) | | |
| Max. conc. (mg/l) | 3.3 | 14.0 | 12.0 | | |
| Water weighted mean conc. (mg/l) | .73 | .71 | .95 | | |
| Min. conc. (mg/l) | .14 | .15 | .19 | | |
| Yield (lbs per acre) | 4.48 | 4.31 | 6.73 | | |
| Yield percent difference from 1982-83 | -2.82 | -16.1 | 5.98 | | |
| | Nitrate-plus-nitrite, filtered | | | | |
| Max. conc.(mg/l) | 2.03 | 4.60 | 7.88 | | |
| Water weighted mean conc. (mg/l) | 1.20 | 3.07 | 2.66 | | |
| Min. conc. (mg/l) | .39 | .84 | .35 | | |
| Yield (lbs per acre per year) | 7.30 | 18.6 | 18.9 | | |
| Yield percent difference from 1982-83 | 55 | 136 | 52.5 | | |
| | Orthop | bosphate. Filtered | | | |
| Max. conc. (mg/l) | .049 | .464 | .217 | | |
| Water weighted mean conc. (mg/l) | 0.14 | .030 | .039 | | |
| Min. conc. (mg/l) | .003 | .003 | .003 | | |
| Yield (lbs per acre per year) | .08 | .18 | .28 | | |
| Yield percent difference from 1982-83 | -33.3 | 38.5 | -6.7 | | |
| | Phosphorus, unfiltered | 1 | | | |
| Max. conc. (mg/l) | .80 | 3.31 | 1.81 | | |
| Water weighted mean conc. (mg/l) | .18 | .13 | .18 | | |
| Min. conc. (mg/l) | .010 | .008 | .010 | | |
| Yield (lbs per acre per year) | 1.08 | .76 | 1.26 | | |
| Yield percent difference from 1982-83 | +25.6 | +55.1 | +77.5 | | |
| | Suspended sediment | | | | |
| Max. conc. (mg/l) | 1,870 | 5,600 | 1,960 | | |
| Water weighted mean conc. (mg/l) | 347 | 202 | 175 | | |
| Min. conc. (mg/l) | 19 | 1 | 16 | | |
| Yield (tons per acre per year) | 1.06 | .61 | .62 | | |
| Yield percent difference from 1982-83 | +121 | +454 | +210 | | |

1 USGS water year defined as October 1st to September 30th of the following year. For example, water year 2006 includes the time period October 1, 2005 through September 30, 2006.

2.Data for Willow Brook during 1982-83 water years collected at a site near the mouth of the stream (USGS station number 0424016205); whereas those for water years 2006-2008 water years were from a site about 1.1 miles upstream (number 04240158).

Table 5. Trophic Status Index and Parameter Values for Otisco Lake

(Effler et. al 1989 and Halfman and O'Neill, 2009, Halfman, pers. comm. 2012)

| Year | Total Phosphor | rus | Chlorophyll a | ı | Secchi Disc | |
|------|----------------|-------|---------------|-------|-------------|-------|
| | mg/m3) | TSI | (mg/m3) | TSI | (m) | TSI |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 1979 | | | 5.1 | 46.5 | 2.4 | 47.3 |
| 1982 | | | | | 2.6 | 46.2 |
| 1983 | | | 2.8 | 40.6 | 2.5 | 46.7 |
| 1986 | 13.7 | 41.8 | 2.6 | 39.9 | 2.8 | 45.1 |
| 1988 | 17.0 | 45.0 | 1.8 | 36.3 | 2.55 | 46.5 |
| 2008 | 13.5 | 41.6* | 3.4 | 42.6* | 3.1 | 43.7* |
| 2011 | 16.8 | 44.8* | 2.3 | 38.7* | 2.9 | 44.7* |

* TSI calculated separately using the data from Halfman and O'Neill, 2009 and Halfman, 2012)



Table 6. Comparison of Secchi Disc Transparencies: May-September

(modified from Effler et al. (1989)

| Year | Ave (m) | Std. Dev | Min (m) | Max (m) | n | Original Data Source |
|------|---------|----------|---------|---------|----|-------------------------------|
| 1979 | 2.43 | 0.36 | 1.0 | 4.6 | 17 | Litten et al. (1980) |
| 1982 | 2.55 | 0.23 | 1.75 | 3.95 | 16 | Effler (unpublished) |
| 1983 | 2.46 | 0.27 | 1.25 | 3.7 | 19 | Effler et al. (1985) |
| 1986 | 2.72 | 0.22 | 1.65 | 4.0 | 23 | Effler et al. (1987) |
| 1988 | 2.55 | 0.25 | 1.3 | 3.5 | 29 | Effler et al. (1989) |
| 2001 | 3.0 | 0.8 | 1.2 | 3.7 | 11 | OCWA (unpublished) |
| 2002 | 2.7 | 1.0 | 1.5 | 4.6 | 8 | OCWA (unpublished) |
| 2003 | 2.8 | 0.7 | 1.8 | 4.6 | 12 | OCWA (unpublished) |
| 2004 | 3.5 | 0.9 | 2.1 | 5.2 | 14 | OCWA (unpublished) |
| 2007 | 3.6 | 1.7 | 2.4 | 5.5 | 17 | OCWA (unpublished) |
| 2008 | 3.1 | 0.9 | | | | Halfman and O'Neill (2009) |
| 2008 | 3.5. | 1.7 | 2.3 | 4.9 | 15 | OCWA (unpublished) |
| 2009 | 3.5 | 0.96 | 2.4 | 5.0 | 17 | OCWA (unpublished) |
| 2009 | 2.8 | 0.8 | | | | Halfman (unpublished) |
| 2010 | 3.8 | 0.6 | | | | Halfman et. al (unpublished) |
| 2011 | 2.8 | 1.6 | 2.0 | 5.0 | 12 | OCWA (unpublished) |
| 2012 | 3.2 | 0.17 | 2.3 | 6.1 | 16 | OCWA (unpublished) |

APPENDIX B 2010 Otísco Lake Watershed Survey Questíons

Property Location_

- 1. Are you a year-round resident? Yes or No If Yes, How Long?_____
- 2. Are you a seasonal resident? Yes or No If Yes, How Long?_____
- 3. Does your property contain lakeshore frontage? Yes or No
- 4. How often do you participate in these activities on Otisco Lake?

| | 1 | 2 | 3 |
|----------|-------|--------------|------------|
| | Never | Occasionally | Frequently |
| Swimming | 1 | 2 | 3 |
| Boating | 1 | 2 | 3 |
| Fishing | 1 | 2 | 3 |
| Other | 1 | 2 | 3 |

Have you noticed any change in the water quality of Otisco Lake? (Check as appropriate)

| No change | Better | Worse | Not sure |
|-----------|-----------|--------------------------|----------------------------------------|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | No change | No change Better | No change Better Worse |

Which of the following conditions are problems in Otisco Lake?

| | no problem | minor problem | serious problem | don't know |
|-------------------------------------|------------|---------------|-----------------|------------|
| | 1 | 2 | 3 | 4 |
| | | | | |
| Aquatic weeds | 1 | 2 | 3 | 4 |
| Algae blooms (green scum) | 1 | 2 | 3 | 4 |
| Turbid/colored water | 1 | 2 | 3 | 4 |
| Undesirable taste or odors | 1 | 2 | 3 | 4 |
| Lake level too high or low | 1 | 2 | 3 | |
| Poor bottom conditions for swimming | 1 | 2 | 3 | 4 |
| Swimmers itch or bacteria problems | 1 | 2 | 3 | 4 |
| Poor fishing | 1 | 2 | 3 | 4 |
| Fish kills | 1 | 2 | 3 | 4 |
| Boating: Too many boats | 1 | 2 | 3 | 4 |
| Excessive boat speed | 1 | 2 | 3 | 4 |
| Intoxicated boaters | 1 | 2 | 3 | 4 |

2010 Otísco Lake Watershed Resídent Survey Results

| Resident Type | # | % of responding | % of total |
|--------------------|-----------|-----------------|------------|
| Permanent Resident | 134 | 80% | 76% |
| Temporary | 34 | 20% | 18% |
| No response | 9 | | 6% |
| Years of Residence | # | | |
| (147 responses) | 19 | | |
| lyr or less | 13 | | |
| 2-5 yrs | 24 | | |
| 6-10yrs | 17 | | |
| 11-25yrs | 51 | | |
| 26-40yrs | 25 | | |
| 40+yrs | 18 | | |
| Property | # | % of responding | % of total |
| Lakefront Property | 72 | 56% | 41% |
| Non-Lakefront | 57 | 44% | 32% |
| No response | 47 | | 27% |

Lake Use

Over 60% of the total 177 engage in boating fishing, swimming occasionally or frequently

Have you noticed any change in the water quality of Otisco Lake in the last

| | 1yr | 5yrs | 5-10yrs | $10-25 \mathrm{yrs}$ | $25-40 \mathrm{\ yrs}$ | 40+yrs |
|-------------|-----|------|---------|----------------------|------------------------|----------|
| No Change | 77 | 34 | 35 | 11 | 8 | 5 |
| Better | 12 | 13 | 8 | 7 | 4 | 1 |
| Worse | 13 | 9 | 11 | 6 | 3 | 2 |
| Not Sure | 9 | 5 | 4 | 2 | 2 | 3 |
| No Response | 66 | 116 | 119 | 151 | 160 | 166 |

Which of the following conditions are problems on Otisco Lake?

| | No problem | Minor Problem | Serious Problem | Don't Know | No Response |
|-----------------------------------------|------------|------------------|--------------------|---------------|-------------|
| Aquatic Weeds | 39 | 31 | 64 | 15 | 28 |
| Algae Blooms | 44 | 35 | 42 | 16 | 40 |
| Turbid/Colored Water | 52 | 14 | 8 | 15 | 88 |
| Undesirable Taste/Odors | 86 | 12 | 0 | 15 | 64 |
| Lake Levels too high or low | 48 | 17 | 3 | 11 | 98 |
| Poor bottom conditions for swimming | 43 | 13 | 3 | 11 | 107 |
| Swimmers itch or bacte- ria problems | 50 | 4 | 1 | 11 | 111 |
| Poor Fishing | 49 | 4 | 0 | 12 | 112 |
| Fish kills | 48 | 6 | 2 | 13 | 108 |
| Too many boats | 66 | 10 | 4 | 15 | 82 |
| Excessive boat speed | 61 | 9 | 5 | 14 | 87 |
| Intoxicated boaters | 57 | 6 | 1 | 17 | 96 |

(Number of Responses)

Other Comments

- \diamond "Aquatic Weed" problem. Mostly that it is bad; a commenter said it was not a problem
- ♦ by their residence.
- \diamond Algae creating odor.
- ♦ Comments about trash; especially at causeway
- ♦ Several comments about zebra mussels. .
- ♦ Sediment erosion control needed
- ♦ Septic system maintenance
- ♦ Clarity/turbidity-some saying lake clearer
- ♦ Lake level too low
- ◊ "Mess" around Marina
- \diamond Jet skis
- ♦ Several offers to "help"



APPENDIX C QUESTIONS FOR STAKEHOLDER SURVEY

1. What is your full name?

2. What is the e-mail address that we can contact you by regarding Otisco Lake? water quality?

3. What agency, organization, municipality, or farm are you affiliated with?

4. Please rank the importance of incorporating each of the following general actions into the goals of the watershed management plan.

____ Economic development

____ Open space planning

____ Long-term/regional planning

_____ Short-term/site specific planning

_____ Monitoring tributaries and lake

____ Review and enforcement of permits and regulations

____ Infrastructure planning/development/maintenance

_____ Watershed education

____ Energy production and consumption

Other (please specify):

5. IN-LAKE issues Lake water levels and quality:

____ Water levels too high

<u>Management and regulation of water levels</u>

_____ Nutrient level in the lake is too high

_____ Heavy metals and organics, including chemical and petroleum contaminants

_____ Septic waste and sewage discharge to the lake

_____ Turbidity and water clarity

____ Fish kills

____ Odor

Other (please specify):

6. IN-LAKE issues Non-native plants and animals:

____ Zebra mussels

____ Water chestnut

____ Milfoil

____ Education and monitoring to prevent new introductions such as Hydrilla and European frog-bit

Other (please specify):

| 7. IN-LAKE issues Aquatic Vegetation: |
|--------------------------------------------------------------------------|
| Rooted aquatic plants |
| Algae |
| Floating/ Decomposing plant materials |
| Other (please specify): |
| 8. IN-LAKE issues Recreation: |
| Swimming |
| Boating |
| Fishing |
| Hunting |
| Hiking |
| Birding |
| Off-road vehicles |
| Boating proximity to shoreline |
| Excessive noise |
| Other (please specify) |
| 9. In-LAKE issues Access to Otisco Lake: |
| Too much public access |
| Not enough public access |
| Too much available docking space |
| Not enough available docking space |
| Other (please specify): |
| 10. What are the most significant UPLAND OR WATERSHED issues of concern? |
| Development: |
| Too much shoreline development |
| Not enough shoreline development |
| Urban sprawl/Rural sprawl |
| Loss of open space and diminishing natural habitat including wetlands |
| Hydraulic Fracturing |
| Wind Power |
| Other (please specify) |
| |
| |



11. UPLAND OR WATERSHED Tourism:

| Lake access |
|----------------------------------------------------------------------------------------|
| Access to non-lake recreation, such as hiking, camping, hunting |
| Too few seasonal residents |
| Too many seasonal residents |
| Image, marketing, and/or branding |
| Economic development opportunities |
| Year-long attractions |
| Other (please specify) |
| 12. UPLAND OR WATERSHED Erosion: |
| Stream bank |
| Road bank |
| Lakeshore |
| Maintenance of lake and streambank protection structures |
| Other (please specify) |
| 13. UPLAND OR WATERSHED Stream management: |
| Debris buildup/log jams |
| Maintenance of bridges and culverts |
| Other (please specify) |
| 14. UPLAND OR WATERSHED Affects of agriculture to surface and groundwater: |
| Pesticide use |
| Manure storage and spreading |
| Chemical fertilizers |
| Sediment loss |
| Other (please specify) |
| 15. UPLAND OR WATERSHED Commercial and industrial affects to surface and |
| groundwater: |
| Material stockpiles |
| Age of storage systems |
| Cost to upgrade existing storage systems |
| Location of storage systems (please specify): Please indicate in the "Other" box below |
| Transport and transfer stations |



| Wells |
|-----------------------------------------------------------------------------------|
| Forestry operations |
| Regulations and enforcement |
| Affects of runoff from landfills/illegal dumping/hazardous |
| Other (please specify): |
| 16. UPLAND OR WATERSHED Highway maintenance impacts to water quality: |
| Application of road deicing material |
| Storage of road deicing material |
| Roadside ditch maintenance practices (increasing erosion, velocity and flooding) |
| Other (please specify) |
| 17. UPLAND OR WATERSHED Residential affects to surface and groundwater: |
| Lawn care products and landscaping practices |
| Landscaping practices |
| Hazardous household waste disposal |
| Stormwater runoff |
| Other (please specify) |
| 18. UPLAND OR WATERSHED On-site septic systems: |
| Lack of watershed-wide inspection and maintenance schedule |
| Improperly sized systems |
| Poorly sited systems |
| Maintenance/inspection/replacement cost to homeowners |
| Other (please specify) |
| 19. Local laws and regulations: |
| Inadequate to protect water resources |
| Enforcement of existing laws and regulations is inadequate/inconsistent |
| Laws and regulations contradict effective management |
| Groundwater contamination from all sources impacting drinking water supplies |
| Stormwater runoff from impervious surfaces and roadside ditches impacting surface |
| And groundwater quality |
| Severe storm events |
| Impacts from climate change |
| Other (please specify) |
| |



20. List the top 5 issues that as a stakeholder, you are in a position to address.

- 21. What assistance or additional information would help your agency, organization or municipality when addressing lake and watershed issues?
- 22. Please list specific products that you would like from the watershed management plan (for example - technical assistance, education, opportunities for intermunicipal cooperation).
- 23. How can we improve communication between municipalities, government agencies and stakeholder groups?
- 24. If educational workshops are scheduled in your municipality what topics should be addressed?

25. PLEASE USE THE SPACE BELOW TO PROVIDE OTHER COMMENTS

APPENDIX D Onondaga SWCD Planning Needs for Otisco Lake Watershed - 2013

| Best Management Practice | Number of Potential Practices |
|------------------------------------------------------|-------------------------------------|
| Manure Loading room Repair | 1 |
| Rotational Grazing System/Grazing Plan Update | 14 |
| Soil Samples/Nutrient Management Plan Update | 14 |
| Barnyard Repair/Replacement | 12 |
| Milkhouse Waste System Repair/Replacement | 4 |
| Cropland Management/Soil Erosion Practices | 12 |
| Silage Leachate Management System Repair/Replacement | 4 |
| Streambank Stabilization | 2 |
| Cover Crops | 14 |
| Petroleum/Agrichemical Secondary Containment | 1 |
| Plan Update (Tier 5) | 3 |
| Farm Pond Dredging/Repair, Pond Development | 2 |
| Soil Management Plan Update | 1 |
| Manure Storage/Management | 2 |
| Laneways | 2 |
| Access Control/Exclusion Fencing | 1 |
| Roofwater Management | 3 |
| Pasture Waterer Repair/Replacement | 1 |
| Access Road Improvements | 2 |
| Enhanced Nutrient Management | 1 |
| Needs Assessment: New Plan or Plan Update | 10 |
| Horse Paddock Management | 2 |
| Composting Facility Repair | 1 |
| Sold/Rents to CAFO | 9 |
| Sold/Rents to Non-CAFO | 4 |
| Out of Operation-Needs Verification | 1 |



MANAGEMENT PLAN RECOMENDATIONS

Overview

The Otisco Lake Management Plan recommendations have been grouped under the following categories:

I. Watershed Management and Regulatory
II. In-Lake
III. Land Use
IV. Agriculture
V. Stormwater Management
VI. Streams/Shoreline
VII.Invasive Species Management
VIII.Stewardship

For the implementation of each recommendation, lead parties, funding required, potential sources of funding, and a time frame for completion are provided.

Lead parties are defined as, "**Recommended Lead Parties**" and not intended to be all inclusive. In many instances, there will likely be partner agencies, organizations, as well as public and private institutions/ organizations that may be sources of expertise and/or funding.

Assigning realistic cost estimates for recommendations can be challenging and can quickly become outdated or irrelevant depending upon the actual scope of work and date implemented. As a result, estimated costs shown under the column, "**Funding Level Required**" are provided as the following categories:

Minimal (<\$5,000) Low (\$5,000-\$20,000) Moderate (\$20,000 - \$100,000) High (\$100,000- \$250,000) Very High (>\$250,000)

For simplicity, "**Potential Funding Source(s)**" are designated as either federal, state, local public funds, or private. In addition to government agency appropriations, there is a myriad of grant programs, academic and private funds, as well as volunteer assistance.

The column, "**Time Frame Needed For Completion**" is assigned "Short-term" (completed in two years or less) and "Long-term" (more than two years for completion).

It should be noted assignment as a lead party does not commit that entity to any specific task, funding, or assignment of personnel. At this point, recommendations have not been assigned a priority since this will be the responsibility of the watershed consortium.

| List of Acronyms Used in the Recommendations | | | |
|----------------------------------------------|----------------------------------------------------------------|--|--|
| CNYRPDB | Central New York Regional Planning and Development Board | | |
| CCE | Cornell Cooperative Extension of Onondaga County | | |
| County Fis | heries Advisory Board Onondaga County Fisheries Advisory Board | | |
| NYSDEC | New York State Department of Environmental Conservation | | |
| OCDOH | Onondaga County Health Department | | |
| OCDOT | Onondaga County Department of Transportation | | |
| OCRRA | Onondaga County Resource Recovery Agency | | |
| OCWA | Onondaga County Water Authority | | |
| OLPA | Otisco Lake Preservation Association | | |
| SOCPA | Syracuse Onondaga County Planning Agency | | |
| SWCD | Onondaga County Soil and Water Conservation District | | |
| USGS | United States Geological Survey | | |
| | | | |

I. WATERSHED MANAGEMENT AND REGULATORY

Although a major player in water supply and watershed protection as the purveyor of the Otisco Lake drinking water supply, OCWA can not be expected to have sole responsibility for lake and watershed protection initiatives. Partnerships with watershed towns, watershed residents Onondaga County government entities, and lake users are also needed. In drinking water supply watersheds such as Otisco Lake, the NY SPDES general permit covering construction activity is not applicable for land disturbances of one acre or more where the slope is greater than 25% and individual permits must be obtained.

| RECOMMENDATION | RECOMMENDED LEAD PARTIES | FUNDING LEVEL REQUIRED | POTENTIAL FUNDING SOURCE(S) | TIME FRAME NEEDED FOR COMPLETION |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|------------------------------|-----------------------------------|----------------------------------------|
| Create a watershed consortium or similar mechanism to identify, define and address lake and watershed is- sues of mutual concern to residents, municipalities, agricultural and com- mercial business, water suppliers, and other stakeholder groups. Such a group would also be a mechanism for information exchange, public educa- tion, and to solicit funding opportuni- ties on lake and watershed related topics. | Municipalities, CCE, Finger Lake Institute, OLPA | Minimal | Local, Private | Long term |
| Review and amend zoning and/or land use regulations to improve con- sistency among townships in near lake areas. Develop generic environ- mental guidelines for land develop- ment. | Municipalities | Low | Local | Short term |
| Provide copies of required Storm- water Pollution Prevention Control Plans–(SWPPPs) to OCWA. | Municipalities, NYSDEC, OCWA | Minimal | Local, State | Short term |

II. IN-LAKE RECOMMENDATIONS

OCWA monitors lake water quality as an operating requirement for the water treatment plant. Sampling and monitoring efforts have provided a basic understanding of present and past conditions in Otisco Lake. Such programs should continue in order to assess lake conditions and potential changes over time. Nutrient loading from internal or external sources need to be controlled to prevent future water quality degradation. Rooted plant (macrophytes) overabundance in the shallow waters (littoral zone) impacts lake aesthetics and recreational opportunities.

| RECOMMENDATION | RECOMMENDED LEAD PARTIES | FUNDING LEVEL REQUIRED | POTENTIAL FUNDING SOURCE(S) | TIME FRAME NEEDED FOR COMPLETION |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------------------|-----------------------------------|----------------------------------------|
| Monitor in-lake parameters (nutrients, dis- solved oxygen, temperature profiling, and oth- er trophic level indicators) at appropriate time intervals. Ensure continued inclusion of Otisco Lake in the Finger Lake Institute's Finger Lakes sampling program. Re-establish remote data collection site(s). | Consultant/ NYSDEC/OCWA | Moderate | Local, State | Long term |
| Quantify phosphorus release and oxygen de- mand from deepwater (hypolimnetic) sedi- ments. | Consultant | Moderate | Local, State | Short term |
| Develop and implement a comprehensive aquatic vegetation management program in- clude, but not limited to, the following: aquat- ic plant harvesting, suction dredging, and the collection of accumulated aquatic vegetation along shorelines. | Consultant/ Contractor/ OLPA | Moderate | Local, State | Long-term |
| Assess the feasibility of winter lake draw- down as an aquatic vegetation control option. | Consultant/OCWA | Moderate | Local | Short term |
| Assess the results of the benthic matting pro- ject(s) and the feasibility of its expanded use as part of the aquatic plant management pro- gram. | OLPA/Consultant/ NYSDEC | Minimal | Local, State | Short term |
| Explore the feasibility of bottom sediment dredging in selected areas of the lake includ- ing tributary mouths, the area north of the Narrows, Turtle Bay and Lader Point. | Consultant, NYSDEC, OCWA , OLPA | Low | Local, State | Long term |
| Provide additional lake access while address- ing the needs of user groups including, the fishing public, kayak and other car top boat- ers, marina operators, and lakeshore resi- dents. | OLPA, NYSDEC, Onondaga County, Municipalities, OCWA, County Fisheries Adv.Bd. | High | Local, State | Short term |
| Continue enforcement of existing boat and personal water craft laws. | Onondaga County Sherriff's Dept. | Moderate | Local | Long term |

III. LAND USE

While a limited amount of development has taken place in the watershed in recent years, there is no guarantee such a trend will continue. An opportunity exists to guide future land use in the Otisco Lake watershed. Most obvious is the need for a strategy to review large-scale proposed projects of lake and watershed wide interest or potential impact.

| RECOMMENDATION | RECOMMENDED LEAD PARTIES | FUNDING LEVEL REQUIRED | POTENTIAL FUNDING SOURCE(S) | TIME FRAME FOR NEEDED COMPLETION |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|------------------------------|-----------------------------------|----------------------------------------|
| Develop a watershed open space plan in conjunction with regional and/or countywide plans of a simi- lar nature, such as the Onondaga County Sustainability Plan. | Municipalities/ SOCPA/ CNYRPDB/ Consultant | Moderate | Local | Short term |
| Complete a watershed biodiversity assessment to characterize the cur- rent status and protection needs of the Otisco Lake watershed's biolog- ical resources. The biodiversity as- sessment should include valuation of environmental services within the watershed to support discus- sions of land uses. | Municipalities/ SOCPA/ CNYRPDB/ Consultant | Moderate | Local, State, Private | Short term |
| Develop Environmental Reserve Character Areas using information from the watershed open space plan and biodiversity assessment (see above). These areas considered to be of extreme significance to the watershed's environmental well- being and natural beauty, need to be identified and protected. | Municipalities/ SOCPA/ CNYRPDB/ Consultant | Moderate | Local, State, Private | Short term |

IV. AGRICULTURE

Agriculture is a predominant land use and economic activity in the Otisco Lake watershed. However, the potential exists for excessive amounts of nutrients, sediments, pathogens and other pollutants to enter the lake. Whole farm plans have been developed and implemented on most watershed farms, but there have been changes in farming operations and some BMPs are beyond their operational life span. Implementation of new BMPs and updating of previous practices are needed for water quality protection.

| RECOMMENDATION | RECOMMENDED LEAD PARTIES | FUNDING LEVEL RE- QUIRED | POTENTIAL FUNDING SOURCE(S) | TIME FRAME NEEDED FOR COMPLETION |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------------------|-----------------------------------|----------------------------------------|
| Implement the recommended changes identified in the Tier V review of wa- tershed whole farms plans. | SWCD | Moderate | State, Private | Long term |
| Encourage and assist watershed farms to use winter cover crops to prevent soil and nutrient loss due to runoff. | SWCD | Low | State, Private, | Long term |
| Hold a "Day on the Farm" program to promote a better understanding of ag- ricultural practices among the non- agricultural communities in the water- shed. | SWCD | Minimal | Private | Short term |
| Re-establish an Otisco Lake Water- shed Agricultural Advisory Committee as a means of communication among and with agricultural operators in the watershed. | SWCD/CCE | Minimal | Local | Short term |
| Develop and implement programs to address waste removal from farms such as waste tires, pesticides, waste oils and agricultural plastics. Removal of horse manure from small operators in the watershed should also be ad- dressed. | SWCD | Low | Local, State, Private | Short term |
| Partner with watershed farms to mon- itor event-driven runoff patterns in priority farm fields | SWCD | Low | Local | Long term |
| Investigate potential incentives to pro- mote organic farming in the water- shed. | SWCD | Minimal | Local, State | Short term |



V. STORMWATER MANAGEMENT

Nonpoint sources of sediments, pesticides, fertilizer, and other contaminants not derived from agricultural sources enter Otisco Lake directly from stormwater runoff or via tributary inflows.

| RECOMMENDATION | RECOMMENDED LEAD PARTIES | FUNDING LEVEL REQUIRED | POTENTIAL FUNDING SOURCE(S) | TIME FRAME NEEDED FOR COMPLETION |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|------------------------------|-----------------------------------|----------------------------------------|
| Inventory roadside ditches, culvert outlet areas and other public infra- structure locations in need of repair and then remediate to eliminate sources of sedimentation and other contaminants. | Municipalities/ County DOT, SWCD/OLPA | High | Local | Long term |
| Provide training on erosion control practices (e.g., revegetation, hy- droseeding, water bars, diversion ditches) for municipal highway de- partments operating in the water- shed. | SWCD/CCE/ CNYRPDB | Minimal | Local/State | Short term |
| Implement Best Management Prac- tices (BMPs) such as hydroseeding and other approved methods in con- junction with road construction and maintenance projects. | Municipalities/ County DOT/ SWCD | Moderate | Local | Long term |
| Encourage the use of green infra- structure practices for all new resi- dential construction and, where practicable, at redevelopment (retrofit) projects. Examples: use of rain gardens and rain barrels, biore- tention areas, vegetative swales, porous pavement/pavers, natural feature preservation and stream buffer establishment or restoration. | Municipalities/ CCE/ SWCD/ OLPA | Minimal | Local | Long term |

VI. STREAMS/SHORELINE

Before large scale remediation efforts can be implemented, better quantification and site specific locations of watershed inputs are needed. Tributary derived sediments have resulted in siltation of nearshore areas of the lake and some site-specific sources such as sediment derived from erosion in the Rice Brook subwatershed are known. Though not part of a regulated MS4, Otisco Lake is part of the Onondaga Lake watershed and may be subject to phosphorus allocations to meet TMDL requirements.

| RECOMMENDATION | RECOMMENDED LEAD PARTIES | FUNDING LEVEL REQUIRED | POTENTIAL FUNDING SOURCE(S) | TIME FRAME NEEDED FOR COMPLETION |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------|--------------------------------------|----------------------------------------|
| Conduct streambank erosion surveys on the major tributaries in the Otisco Lake watershed to identify sources of sediment to the lake and to prioritize sites for stabilization / remediation. | SWCD | Low | State | Short term |
| Refer any areas of streambank erosion to the SWCD for design assistance. Refer sites associated with roadway crossing to the re- spective highway department(s). | Municipalities/ County DOT/ SWCD | High | Local, State. Federal | Long term |
| Evaluate the feasibility of delta sediment build-up removal thor- ough dredging; especially at Am- ber Brook, Van Benthuysen Brook and Rice Brook. | Town of Otisco/ OCWA/SWCD | Low | Local | Short term |
| Conduct comprehensive tributary monitoring focusing on loading data for nutrients and sediments on a recurring time interval (three years). Use of results would include: numerical model development, BMP assessments, and future watershed projects. Other constituent analyses may include pathogens, pesticides and baseline inorganic parameters as determined. | USGS | Very High | Local, State, Federal | Long term |
| Conduct a site specific groundwa- ter sampling program to assess potential impact of nutrient in- put from nearshore septic sys- tems | USGS/OCWA/ OLPA | Moderate | Local, State, Federal. Private | Short term |

VII. INVASVE SPECIES MANAGEMENT

Zebra mussels and Eurasian watermilfoil are well-established invasive species in Otisco Lake. Asian clams have recently been identified in the lake. Early detection and hand-pulling events conducted by the Otisco Lake Preservation Association have nearly eliminated water chestnut. The most significant aquatic invasive species threat is Hydrilla. Emerald ash borer (EAB) is an imminent threat to ash trees in the watershed. Giant Hogweed poses a threat to the landscape.

| RECOMMENDATION | RECOMMENDED LEAD PARTIES | FUNDING LEVEL REQUIRED | POTENTIAL FUNDING SOURCE(S) | TIME FRAME NEEDED FOR COMPLETION |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|------------------------------|-----------------------------------|----------------------------------------|
| Establish/expand a lake steward program to operate at boat public access points to help prevent inva- sive species introductions. | CCE/OLPA | Minimal | Local, State | Long term |
| Continue efforts to eradicate rem- nant water chestnut population by annual hand-pulling and surveil- lance. | OLPA/CCE | Minimal | Local, Private | Long term |
| Create or re-establish a lake "weed watch" program for shoreline resi- dents as an early detection and re- moval of invasive species. <i>Hydrilla</i> should be of highest priority. | OLPA/CCE. | Minimal | Local, State. Private | Long-term |
| Monitor the impact of <i>Corbicula</i> (Asian clam) on the lake's water quality and ecology, | Consultant/ OCWA/NYSDEC | Minimal | Local. State | Long term |
| Implement public education pro- grams pertaining to emerald ash borer identification, monitoring and management for watershed resi- dents. | CCE/ SWCD/ OLPA/ Municipalities | Minimal | Local, State, Private | Long term |
| Provide training to all highway per- sonnel in the watershed on the iden- tification of invasive species with the focus on Giant Hogweed and damaged ash trees. Establish an early detection and eradication pro- gram for targeted invasive plants. Include a reporting and removal protocol for EAB impacted ash trees. | CCE/ Municipali- ties/County DOT | Minimal | Local | Long term |

VIII. STEWARDSHIP

In addition to being a prime public drinking water supply source, Otisco Lake provides numerous recreational opportunities. Issues of concern revolve around dense aquatic weed growth interfering with boating and public access to the lake.

| RECOMMENDATION | RECOMMENDED LEAD PARTIES | FUNDING LEVEL REQUIRED | POTENTIAL FUNDING SOURCE(S) | TIME FRAME NEEDED FOR COMPLETION |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------------------------------|--------------------------------------|----------------------------------------|
| Develop a public education program to en- courage planting and protection of stream and lake shore vegetation including estab- lishing buffers, discourage the use of pesti- cides and fertilizer. Encourage homeowners to install shoreline erosion control measures and other lake-friendly landscaping tech- niques. | CCE/OLPA | Minimal | Local | Long term |
| Provide educational materials including the encouraging of water quality testing to wa- tershed private well owners. | County Health, CCE, OLPA | Minimal | Local | Short term |
| Develop or continue a public education effort emphasizing the adverse impacts associated with boat speed in areas of aquatic vegeta- tion, preventing the introduction of invasive species and existing boat and personal wa- tercraft laws. | CCE | Minimal | Local | Long term |
| Enroll Otisco Lake in the NYSDEC Citizen Statewide Lake Assessment Program (CSLAP). Implement tributary sampling through Project Watershed or similar citizen science effort. | OLPA, NYSDEC, Izaak Walton League, Ameri- can Chemical Society Local Chapter | Minimal | Local, State, Private | Long term |
| Encourage participation in OCRRA's house- hold hazardous waste drop-off program. | OLPA/CCE | Minimal | Local, Private | Short term |
| Explore and participate, if found feasible, in the "Adopt-a-Highway Program" within the Otisco Lake watershed. | OLPA/ NYSDOT | Minimal | State, Private | Short term |
| Obtain grant funding for these and other identified stewardship, conservation protec- tion and remediation initiatives. | Municipalities, OLPA/OCWA/ SOCPA, OCDOH/ SWCD/ CCE/ CNYRPDB | Moderate | Local, State, Federal, Private | Long term |
| Evaluate implementation progress of the Watershed Plan and update recommenda- tions every five years | Municipalities | Minimal | Local | Long term |

