

State of the Owasco Lake Watershed



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**WITH SUPPORT
FROM**

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Dedicated to Ken White, Geographic Information Analyst for the Cayuga County Planning Department from 1984 to 1998.

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PREFACE

According to the Native American legends, the Finger Lakes region is the land of the Hidden Guns, the Barren Hills, the Painted Rocks, and the Burning Spirit (Merrill 1945). The Finger Lakes themselves are claimed to have come into being when the Great Spirit had pressed his outstretched fingers upon the bedrock and filled the depressions with waters of many springs. There are seven major Finger Lakes: Canandaigua, Keuka, Seneca, Cayuga, Owasco, Skaneateles, and Otisco; and four minor Finger Lakes: Conesus, Hemlock, Canadice, and Honeoye (Baston and Ross 1975; Merrill 1945).

Archaeologists have unearthed the bones of prehistoric settlers in this area that date back at least 5,000 years. Three Iroquois nations, the Onondagas, the Cayugas, and the Senecas lived in the Finger Lakes area for more than a 1,000 years. In the late 1940's, excavation for a trolley loop at the foot of Owasco Lake turned up some Algonkian pottery with an estimated age of 800 years (Merrill 1945).

The Native American name of Owasco means "the crossing" (Merrill 1945). The Owasco community nourished the roots of the great League of the Iroquois. Owasco Native Americans went through a long, slow transition from being nomadic hunters and fishermen to having relatively permanent homes and communities. About 100 A.D., the Owasco culture, developed into a more communal form as a fishing village. By 1050 A.D., the Owasco community developed well-defined methods of cultivating beans, corn, and squash, and treating illnesses by the use of herbs. These changes in cultural practices are evident in the design and ornamentation of their pottery and skills in other crafts (O'Connor 1975).

In the book *Slim Fingers Beacon* (1945), Archibald Merrill describes Owasco Lake as a "sapphire gem of purest ray serene seemingly born to shimmer unseen, away from casual tourist gaze." Around its rugged head stretches the farm countryside where a President of the United States, Millard Fillmore, was born, where an Oil King, John D. Rockefeller, lived as a boy, and a New York State Governor, Enus T. Throop, was given birth."

This report is about the quality of Owasco Lake and its watershed. In essence, this state of the watershed report characterizes land use patterns as well as cultural, economic, and natural resources associated with the lake. This report will also review the work of many researchers who performed numerous water quality laboratory tests on Owasco Lake and its tributaries over the past 100 years.

This report will not only describe past and current conditions of the lake and its watershed, but will also introduce a discussion of issues that affect, or will affect, the future of the lake and watershed. The report does not seek to fully explain or bring closure to any issue; it is the first step in the management plan process. Ultimately, this information will be utilized in the development of a watershed management plan that reflects community priorities and recommendations.

Owasco Lake Management Plan Steering Committee

EXECUTIVE SUMMARY

Watershed Characteristics

Owasco Lake, located centrally in Cayuga County, New York is among the smallest of the Finger Lakes. Owasco Lake is in the central part of the Oswego River Basin, between Cayuga and Skaneateles Lakes, just south of the city of Auburn. It has a mean elevation of 712 feet above sea level, a length of 10.7 miles, an average width of 1.2 miles, and a maximum depth of 177 feet.

The water from Owasco Lake is used for human consumption and irrigation. The city of Auburn, the town of Owasco, and lakefront property owners all draw water from the lake. In fact, more than 70% of Cayuga County's population obtain their drinking water from the lake.

The Owasco Lake Watershed (hereafter referred to as the watershed), or area of land that serves as the drainage basin for the lake, is 205 square miles. The topography of the lake and watershed area reflects glacial origins with hilly deposits and glacially carved depressions.

Although Owasco Lake is one of the smallest Finger Lakes, its watershed ranks third of all the Finger Lakes. The watershed is comprised of all or portions of ten towns in Cayuga County (81.5% of the land area), one town in Onondaga County (2.3%) and three towns in Tompkins County (16.2%). Major tributaries of the watershed include the Owasco Inlet, Dutch Hollow Brook, Veness Brook, and Sucker Brook. Additionally, there are over fifty small and intermittent streams that flow into the lake. Many of these streams are less than a mile long. The Inlet accounts for nearly 55% of all surface water entering the lake; Dutch Hollow Brook accounts for 20%; Veness and Sucker Brook account for 15%; and the other minor tributaries account for 10%.

Surface runoff into the lake is 0.47 meters/year. Ground water recharges the lake through bedrock, which is primarily shale, siltstone, and sandstone, as well as through unconsolidated glacial deposits. The long-term water retention time for the lake is approximately three years.

Generally, soils within the watershed are glacially formed and deposited; deep, well drained, gently to moderately sloping, and of medium texture. The most dominant soils are calcareous (containing significant amounts of calcium) limestone, shale, and sandstone. The most common soil associations in the drumlins (large, hilly glacial deposits) are the Ontario series, which contain high amounts of sandstone and limestone.

Approximately 41% of the watershed is forested, including: mixed forest (38.5%), evergreen forest (2.1%), and shrub and brush rangeland (0.6%).

The Owasco Lake Watershed contains approximately 9,557 acres of New York State Department of Environmental Conservation (NYSDEC) classified wetlands. The Owasco Flats wetlands, in particular, are a significant natural resource value. This 750-acre area located at the southernmost end of the lake has significant capability to act as a biological filter of nutrients, chemicals, and sediments; store floodwaters; and recharge the aquifer from which the village of Moravia obtains its water. The Flats is a rich and diverse ecosystem serving as important habitat and breeding grounds for fish, waterfowl, migratory and nesting birds, mammals, plants, amphibians, and reptiles.

Due to the many habitat types, Owasco Lake and its watershed are filled with a wide

variety of wildlife. Mammals that inhabit the watershed include whitetail deer, coyote, fox, raccoon, opossum, woodchuck, cottontail rabbit, skunk, meadow vole, gray and red squirrel, muskrat, mink, beaver, and black bear. Confirmed breeding waterfowl include the mallard duck, Canada goose, and the wood duck. During the fall, winter, and spring, the numbers and individual species of waterfowl increase greatly as migrating birds visit. This includes rare species such as the common loon and the tundra swan. Other birds that nest in the watershed include many varieties of songbirds and raptors.

The city of Auburn, Cayuga County Department of Health and Human Services, Cayuga County Planning Department, Owasco Watershed Lake Association (OWLA), and Cornell Cooperative Extension (CCE) are each involved in ongoing lake water quality sampling efforts. The Cayuga County Planning Department monitors nutrient and sediment loading (total phosphorus, soluble reactive phosphorus, and total suspended solids) from Dutch Hollow Brook and the Owasco Inlet into the lake. The Cayuga County Health and Human Services Department is obligated under the NYS Public Health Law to monitor the quality of public bathing beaches. Cornell Cooperative Extension of Cayuga County offers support to citizens interested in monitoring streams in Cayuga County by providing equipment, training, and educational materials related to water quality.

Except for fecal coliform densities, most historical chemical, physical, and biological parameters of Owasco Lake are within state and federal water quality standards. Between 1989 and 1998, levels of fecal coliform in the north end of the lake have increasingly become a problem. During that period, the Cayuga County Environmental Health Division closed the swimming beaches at Emerson Park because water samples were above the NYSDOH standard of 200 colonies per 100 mL a total of 105 days. In 1993, the beaches were closed for 45 days, in 1997 for 4 days, and in 1998 for 56 days.. In the fall 1998, Dr. Mansour Samadpour used DNA ribotyping techniques to determine the sources of fecal contamination. The major source of contamination at the Emerson Park beaches was wildlife, while agriculture was an intermediate source, and humans and pets were minor sources. The study also showed that agriculture and wildlife were the major sources of fecal contamination in the tributaries, while humans and pets were minor sources.

Dissolved oxygen levels are a concern for trout waters if they drop below the NYSDEC fresh surface water standard (AA water body classification) of 6.0 mg/L. Studies on Owasco Lake from 1910 to 1986 showed the concentration of dissolved oxygen consistently between 6.0 and 11.0 mg/L at all depths.

Nitrate-nitrogen levels measured from 1955-1973 were between 516-1,657 $\mu\text{g/L}$, which are well below 10,000 $\mu\text{g/L}$ set by the NYSDEC. The current NYSDEC AA water body standard for soluble reactive phosphorus is 20 $\mu\text{g/L}$. Review of phosphorus data taken from 1971 to 1973 generally fall between 1.2 and 7.6 $\mu\text{g/L}$. Of the five studies performed on Owasco Lake's main tributaries between 1927-1981, all determined that the major source of nutrients entering the lake was from agriculture runoff.

Although, there are no NYSDEC AA water body standards for major ions (e.g. sodium, calcium, and magnesium) a review of these values from 1950 to 1973 shows a slight increase. Between 1927 and 1986 pH values ranged from 8.0 to 8.4, which is within the NYSDEC range of 6.5 to 8.5. There are no NYSDEC AA water body standards for alkalinity. From 1927 to 1986 alkalinity levels ranged from 107 to 111 mg (as CaCO_3).

There are no state standards set for transparency measured by Secchi discs. Average Secchi disc transparencies measured between 1971 and 1986 ranged from 2.6 to 4.0 meters. The NYSDEC AA water body standard for turbidity is 5.0 Nephelometric Turbidity Units

(NTUs). Turbidity showed significant improvement from 1964 to 1986. In 1964, the mean value was 12.2 NTUs. In 1986 the mean value was 2.66 NTUs.

In 1997 two pesticide studies found that all pesticides tested were well below the NYSDOH maximum contamination levels for drinking water. Temperature profiles examined between 1910-1985 showed little change. Although there are no NYSDEC standards for chlorophyll *a*, Effler et al. (1988) used 8.0 mg/m³ as a level approaching eutrophication. Studies revealed that concentrations of chlorophyll *a* in the lake dropped from 5.3 mg/m³ in 1973 to 1.8 mg/m³ in 1986.

A measure of a lake's health depends to a large extent on the nutrients that enter it. The nutrient level, or trophic state, of a lake is generally determined by its level of phytoplankton production (algae). In 1972, Mills measured various chemical, physical, and biological conditions in four Finger Lakes, including Owasco Lake, and ranked their order for various parameters (see Table 3). Mills concluded that Skaneateles Lake was oligotrophic, Owasco and Hemlock Lakes were mesotrophic, and Conesus Lake was eutrophic. In a 1986 study, Effler et al. classified Owasco Lake as being oligo-mesotrophic. In other words, phytoplankton at the time of Effler's 1986 study had improved since the early 1970's, most likely due to detergent phosphorus bans that were enacted in the 1970's (Effler et al. 1988).

Mills also found that the dominant phytoplankton species in Owasco Lake was consistent with other mesotrophic Finger Lakes. Concerning identification and quantification of zooplankton species in the lake, the dominant species changed from study to study between 1910 and 1986. This observation is expected under typical mesotrophic conditions.

Watershed Land Use, Economy, and Cultural Resources

The first archaeological site in the watershed where historians studied the early Native American transition from hunting and gathering (Owasco) to a culture based on agriculture (Iroquois) is located in the Owasco Valley. The Owasco culture preceded the Iroquois and existed around 1000 AD. The earliest white settlers to the watershed were a company of Dutch Reformed Christians.

The Owasco Lake Watershed is characterized by a relatively low population density of approximately seventy-nine persons per square mile. Based on an analysis of data compiled by the U.S. Census Bureau in 1990, the Cayuga County Planning Department has calculated the total 1990 population of the watershed to be approximately 15,900.

The watershed covers approximately 123,131 acres of land area. The largest portion of land use within the watershed is agriculturally related (55.4%), followed by mixed forestlands (38.5%), evergreen forestland (2.1%), residential use (1.4%), and wetlands (0.8%). Agricultural land is widely dispersed, but is most concentrated to the east and west of the lake. Many of the residential areas in the watershed are low-density/rural, however, there is a higher concentration of homes along the lakeshore. Many of the lakeshore residences are seasonal and fully functional for only three months out of the year.

There are approximately 200 farming operations in the watershed. The variety of operations varies as much as the size of the farms, which range from 15 to 2,100 acres. A majority of farmland remains in continuous crop production, most notably corn production, because of the relatively high productive soil quality. Major field crops grown in the watershed include corn, wheat, soybeans, hay, snap beans, sweet corn, peas, barley, oats, and potatoes.

There are approximately 480 miles of maintained roads within the watershed. Of the 480 miles, approximately 120 miles can be classified as major roads (either state or county routes).

Owasco Lake and its surrounding watershed offer a number of recreational opportunities, especially during the summer months. There is one public park, Emerson Park, located at the north end of the lake. Emerson Park offers public beaches, picnic facilities, boat launches and fishing areas. In addition to boating access from private lakeshore properties, Emerson Park and the South Shore provide mooring and access to the lake. Several other marinas provide boating access via the Owasco River.

Owasco Lake is considered to be an exceptional fishery. A variety of species prized for recreational fishing are present in the lake including yellow perch, smallmouth bass, northern pike, lake trout, brown trout, and landlocked salmon.

Within the watershed boundary, there are several parks and trails including Fillmore Glen State Park, located in Moravia; Frozen Ocean State Reforestation Area, in the town of Niles; and Summerhill State Reforestation Area. There is currently one completed multi-use trail within the watershed that runs from Auburn to Fleming (approximately two miles) along the west side of the lake.

Owasco Lake is a major marketing tool for tourism in the area. To a large extent, the tourism focus is on high quality boating, fishing, swimming and family recreation opportunities, particularly at Emerson Park. There are also numerous special events conducive to tourism, such as the Merry-Go-Round Playhouse Theatre presentations and Tomato Fest.

There are two municipally owned wastewater treatment plants (WWTPs) located within the watershed. One is located in the village of Moravia, the other in the village of Groton. Currently, there are no active landfills located in the watershed, however, there are seven closed landfills in the watershed; six are located in Cayuga County and one in Tompkins County. There is one inactive hazardous waste site (Smith Corona) in the town of Groton.

Watershed Laws/Ordinances/Regulations

Local land use and zoning laws for municipalities within the watershed vary. Local land use controls include comprehensive plans, various forms of zoning, subdivision regulations, site plan reviews, and planning boards.

Under the New York State Health Code, the city of Auburn is responsible for regular inspection of the reservoir, watercourses, and the watershed to insure compliance with Watershed Rules and Regulations. These Watershed Rules and Regulations set forth the conditions and types of activities allowable within the watershed, as well as the conditions to be met by agricultural and business practices to ensure a pure and safe drinking water supply for Auburn and surrounding towns.

Significant portions of the watershed are located within agricultural districts. Agricultural districts were created to protect and preserve agricultural lands from loss to non-agricultural development. The Cayuga County Sanitary Code mandates that individual residential wastewater treatment systems (septic systems) within Cayuga County be periodically inspected and repaired if found to be failing. Frequency of inspections is based on the system's proximity to Owasco Lake or Little Sodus Bay, which is located on Lake Ontario.

Watershed Management Programs

There are numerous local, state, and federal management programs that currently apply, or are being practiced, within the watershed. Agricultural Environmental Management (AEM) is a voluntary, locally-led and implemented initiative that provides one-on-one help to farmers who want to identify environmental concerns on their farms and implement appropriate solutions. AEM provides a framework for existing agricultural agencies and private sector organizations to coordinate the delivery of their services to farmers. Services provided through AEM include aid in identifying environmental concerns; planning and design of needed environmental practices, and the opportunity to apply for financial assistance.

The Cayuga County Graze Program promotes and supports the practice of intensive rotational grazing that, where implemented, improves water quality. The Cayuga County and the Finger Lakes-Lake Ontario Watershed Protection Alliance Aquatic Vegetation Control programs seek to sustain a balance of aquatic plants and algae among recreational, economical, and ecological concerns. These programs include integration of both short and long-term goals.

The Dutch Hollow Brook Stream Assessment provides a design tool that can evaluate suitable techniques and land uses to restore a stream's ecological integrity. It also can serve as groundwork for a stream corridor management plan. As part of the Walleye Pike Restoration project, the Owasco Lake Angler's Association works cooperatively with the NYS Department of Conservation to produce walleye fingerlings to stock the lake.

Technical assistance and limited financial incentives are available to watershed landowners through a variety of United States Department of Agriculture programs. Some of these programs are administered in conjunction with regional or state offices. These programs include: Conservation Farm Option, Conservation of Private Grazing Lands, Conservation Reserve Program, Conservation Reserve Enhancement Program, Environmental Quality Incentives Program, Farmland Incentives Program, Forest Stewardship Incentives Program, Wetlands Reserve Program, Wildlife Habitat Incentives Program, and Partners for Fish & Wildlife.

There are a number of organizations involved in various educational programs ranging from formal workshops and conferences, to hands-on workshops, activities, and consultations. Since the inception of the Cayuga County Revised Sanitary Code in 1994, the Cayuga County Department of Health & Human Services, Division of Environmental Health, has conducted outreach efforts in order to inform the public and local officials about the code and its changes. These efforts include providing general information about septic systems.

Cornell Cooperative Extension (CCE) is a community-based educational system that links the resources of Cornell University to the needs of the state's food and natural resource system. In recent years, CCE has conducted programs in various agriculture and watershed-related areas including: zebra mussels, household hazardous waste collection, manure management, septic systems, farm business management, 4-H sportfishing, stream monitoring, solid waste management/recycling, crop production, well water, and other environmental issues as they develop or on a community need basis.

Groton Community Links is a community group composed of Groton town and village officials, enforcement officers, highway personnel, business, education individuals, and high school students. The group, which is facilitated by CCE of Tompkins County, has sponsored local meetings regarding the management plan and has agreed to facilitate an advisory group for the Owasco Inlet subwatershed.

Envirothon and Conservation Field Days are two educational programs that County Soil & Water Conservation Districts are typically involved with. Envirothon is a program for high school students to learn more about the environment. The program tests students' knowledge on topics such as soils, water resources, forestry, wildlife and other environmental issues. Envirothon exists at three levels: regional (county), state, and national. Conservation Field Days is an outdoor environmental education event for 6th grade students.

Towns/Municipalities

There are eighteen government bodies within the watershed. Each has its own set of activities, interests, and concerns regarding the watershed and its subsequent management plan.

Issues of Concern

Among watershed residents, use of the lake and watershed varies, however, survey results indicate that there are numerous common perceptions of watershed problems and management recommendations. The five most common concerns are: 1) public and private wastewater treatment systems; 2) waterborne pathogens (such as fecal coliform); 3) agricultural runoff; 4) fuel spills and/or hazardous waste, and, 5) public and private water supplies. The top five public recommendations are: 1) monitoring Owasco Lake and its tributaries to identify pollution; 2) limiting adverse effects of septic tank systems and sewage, treatment plant effluent; 3) a hazardous spill response program to maximize participation and minimize response time; 4) boating rules & regulations; and, 5) a watershed inspection program.

Of the businesses within the watershed, 70% feel Owasco Lake is important to their business and 64% felt it has economic impact on their business. Forty-four percent see the lake as important to attracting customers, while 52% feel that the lake is important to attracting employees to their businesses.

There are a large number of issues that governments, residents, businesses and watershed users see as important to addressing the future of Owasco Lake and its watershed. Each issue has its own history, unique set of circumstances, and manageability that will dictate what actions can be taken and how an Owasco Lake Watershed Management Plan should be developed.

SCIENTIST RECOMMENDATIONS

Based on the review of existing scientific data regarding the state of the lake and its watershed, as well as current trends in land use, the following management recommendations are being proposed by Mike Pacelli, Lake Scientist for this project, of Cayuga Community College.

Agriculture

1. Riparian buffer zones

The use of riparian buffer zones along tributaries and other hydrologically sensitive areas has been shown to improve water quality. A riparian buffer is an area of trees and other vegetation, including grasses such as tall fescue and switchgrass, that separates cropland or pasture from a stream or groundwater recharge area. Riparian buffers are designed and managed to provide shade, restore stream habitat, and to trap and remove nutrients, sediments, pesticides, and other chemicals from surface runoff and subsurface groundwater flows. These areas are retained, enhanced, or planted.

The general theory is to have four zones in the area adjacent to a stream (the riparian area):

1. Furthest upland along the streamside, the farmer maintains hayland, controlled pasture, or cropland where agri-chemicals are carefully managed.
2. Next, a grassy runoff zone where concentrated flows are converted to dispersed flows. Tall fescue and switchgrass can be planted within this zone.
3. Closer to the stream, a managed forestry is practiced where filtration, deposition, plant uptake, anaerobic denitrification, and other processes remove sediment and nutrients from surface and subsurface flows.
4. Along the stream grows an undisturbed forest that provides detritus to the stream and helps maintain lower water temperature vital to fish habitat.

One potential incentive for buffer strip implementation is to provide property tax credits to landowners that voluntarily create buffer zones. Optimal locations for agricultural riparian forest buffer zones could be determined by the Cayuga County Planning Board's digitized maps, assessments of farm operations, stream geomorphology, riparian corridor soils, and the farm's watershed.

2. Constructed wetlands

Constructed wetlands within or near problem tributaries such as the Owasco Inlet, Dutch Hollow, Sucker, and Veness Brooks, could be constructed to reduce runoff problems. Wetlands can act as efficient biological filters to reduce various contaminants, such as sediments, nutrients, and pesticides, from entering both surface and ground waters.

3. Nutrient load studies

Tributaries should be segmented and analyzed by subwatersheds to help identify problem locations.

Bathing Beaches

1. Circulation

Prior to the construction of the seawall, conducting a thorough hydrology study is essential to identifying potential physical improvements to benefit water circulation at the Emerson Park Beaches. Analyzing dissolved oxygen concentrations within the beach areas would also be beneficial in determining hydrology factors that affect water quality at the north end of the lake. This study should be completed as soon as possible by a professional hydrologist.

2. Lake Level

Re-evaluating the Army Corps of Engineers 1984 rule curve so that the lake levels can be lowered in the months of July and August would increase the lake's outflow and may benefit circulation at the north end of the lake.

3. Bacteria

Re-examine Dr. Samadpour's DNA study results and recommendations as new data is generated and the study is completed.

a. *Waterfowl*

Continue to consult wildlife specialists for information and advice on most appropriate methods of discouraging waterfowl from flocking in waters close to the beaches.

b. *Agriculture*

Implement a farm management program as previously explained.

c. *Animals*

If results of the DNA study show continued fecal bacteria from wild animals (raccoon, skunk, woodchuck, etc.) then a trapping program could be implemented to reduce populations.

d. *Septic systems*

Septic system inspection program should continue, however, it should be periodically examined and re-evaluated based on scientific results (e.g. frequency of inspections for specific portions of the watershed could be reduced or increased).

Monitoring

1. Limnology study

Scientific studies should be performed every 10 years to monitor changes in water quality. This should be contracted to an unbiased institution such as a College or University.

2. Wastewater Treatment Plants

Effluent from the Moravia and Groton Wastewater Treatment Plants should be spot checked for fecal coliform by the Cayuga County Health and Human Services Department

during the months of July and August. Upgrading the Groton Wastewater Treatment Facility is strongly recommended.

3. Annual Report

Results of lake monitoring and other lake projects should be made available to the public in the form of annual reports or displayed in area newspapers

Education

Education should focus on sources of contamination identified from scientific studies, such as Dr. Samadpour's 1999 DNA study.

1. **Farm management** -- Education may lead to voluntary implementation of best management practices.
2. **Septic systems** -- Education will reinforce and increase compliance with the Sanitary Code.
3. **Public awareness** -- Education of the general public regarding various everyday activities that residents should practice both at home and in public locations is critical.

SECTION I -- WATERSHED CHARACTERISTICS

Geography of the Lake

Owasco Lake, located centrally in Cayuga County, New York, is among the smallest of the Finger Lakes. Owasco Lake is in the central part of the Oswego River Basin, between Cayuga and Skaneateles Lakes, just south of the city of Auburn. Like the other Finger Lakes, Owasco Lake (hereafter referred to as the lake) was formed by glaciers in the Pleistocene Era and is characterized by a long, thin shape and a north-south orientation. The northern end of the lake is broad and shallow with relatively low, flat terrain; the southern end is narrower and deeper, and has steeper banks.

In terms of volume and surface area, Owasco Lake is the sixth largest of the eleven Finger Lakes (Bloomfield 1978). It has a mean elevation of 711 feet above sea level, a length of 10.7 miles, an average width of 1.2 miles, and a maximum depth of 177 feet (*see* Table 1 for more information). The shoreline is relatively straight and steep with minor flat points and deltas. A swampy floodplain is located at the southern end. The lake bottom is characterized by both sandy plains and large cobbles. The lake maintains an average depth of 96 feet, with the central area of the lake reaching a maximum depth of 177 feet. More than 60% of the lake's volume is associated with depths of greater than 50 feet (Effler et al. 1988).

The water from the lake flows northward through the Owasco, Seneca, and Oswego Rivers, and eventually empties into Lake Ontario.

Classification of the Lake

The New York State Department of Conservation (NYSDEC) classifies Owasco Lake as AA, meaning it is a fresh surface waterbody. As of 1986, Owasco Lake had low to intermediate level of nutrients for the growth of algae and was considered oligo-mesotrophic (Effler et al. 1988).

Owasco Lake as a Water Supply

The water from Owasco Lake is used for human consumption and irrigation. The city of Auburn, the town of Owasco, and lakefront property owners all draw water from the lake. In fact, more than 70% of Cayuga County's population obtain their drinking water from the lake. In 1996, the combined users drew more than three billion gallons of water from the lake, serving more than 58,000 residents of Cayuga County. In addition, the Owasco Country Club draws water from Owasco Lake for golf course irrigation. Homeowners along the lake may also use the lake as a water source for a variety of uses. The volume of water used for irrigation is unknown.

In 1997, the city of Auburn water supply ranked first place in the best tasting drinking water in New York State as judged by participants at the New York State Fair.

The City of Auburn

As described in their 1996 Annual Water Supply Statement, the city of Auburn draws

water from the lake through a single 30-inch cast-iron raw water intake line that extends about 1,875 feet into the lake. The intake structure is a submerged concrete crib. A 75 horsepower pump (and one backup pump) draws an average of 8.3 million gallons per day (mgd).

The city presently has two filtration plants in use, a slow sand plant and a rapid sand plant. The slow sand filtration plant was constructed in 1919. The plant contains four beds with a total capacity of about 8.0-mgd. The beds consist of approximately three feet of sand supported by twelve inches of gravel.

The rapid sand filtration plant was constructed in 1969 and consists of three dual-media filters with a combined capacity of about 5.4-mgd. In the rapid sand plant, all water is pretreated with aluminum sulfate to facilitate coagulation and sedimentation prior to filtration. All water is disinfected with gaseous chlorine prior to distribution. The city has a ten million-gallon reservoir and a three million-gallon reservoir to maintain reserves.

The Auburn water serves approximately 58,000 residents; 32,000 from the city of Auburn and 26,000 from surrounding communities within Cayuga County. As disclosed in Auburn's 1996 Annual Water Supply Statement, there were no organic or inorganic contaminants above NYS Department of Health (NYSDOH) potable water standards.

The Town of Owasco

As described in their 1996 Annual Water Supply Statement, the town of Owasco draws water from the lake through a single ten-inch cast iron raw water intake pipe that extends about 450 feet into the lake. The low lift pumping station is located at the shoreline on East Lake Road. It consists of two 700 gal/min, 75 horsepower electric pumps. The town of Owasco draws about 300,000 gallons per day (0.3 mgd). Reservoirs on Melrose Road and Martin Road maintain reserves of 500,000 gallons (0.5 million gallons) and 250,000 gallons (0.25 million gallons) respectively.

The town is currently in the process of replacing their water filtration plant. The new plant should be on-line during the winter of 1999. This plant consists of three package units. Each unit is designed to provide clarification and filtration of 0.5 mgd. The water will be pretreated with a polymer coagulant and disinfected with liquid chlorine prior to distribution.

The town of Owasco water supply serves approximately 3,100 residents in the town. As disclosed in the town of Owasco's 1996 Annual Water Supply Statement, there were no organic or inorganic contaminants above NYSDOH potable water standards.

Lakefront Property Owners

The third group of consumers of drinking water from the lake are approximately 260 individual property owners that have either seasonal or year-round dwellings along the lake who do not receive public or well water (Cayuga County Department of Health & Human Services, unpublished data, 1998). Data regarding the volume of lake water drawn from individual lakefront property owners is not known. Although individual treatment is not regulated, the NYSDOH recommends that surface water be filtered and disinfected before consumption.

Watershed Description

The Owasco Lake Watershed (hereafter referred to as the watershed), or area of land that serves as the drainage basin for the lake, is approximately 205 square miles. Although Owasco Lake is one of the smallest Finger Lakes, its watershed ranks third of all the Finger Lakes. The watershed is comprised of all, or portions of, ten towns in Cayuga County (81.5% of the land area), one town in Onondaga County (2.3%) and three towns in Tompkins County (16.2%) (see Figure 1). The ratio of land to lake surface area is 19.9 square miles of watershed per square mile of lake surface area.

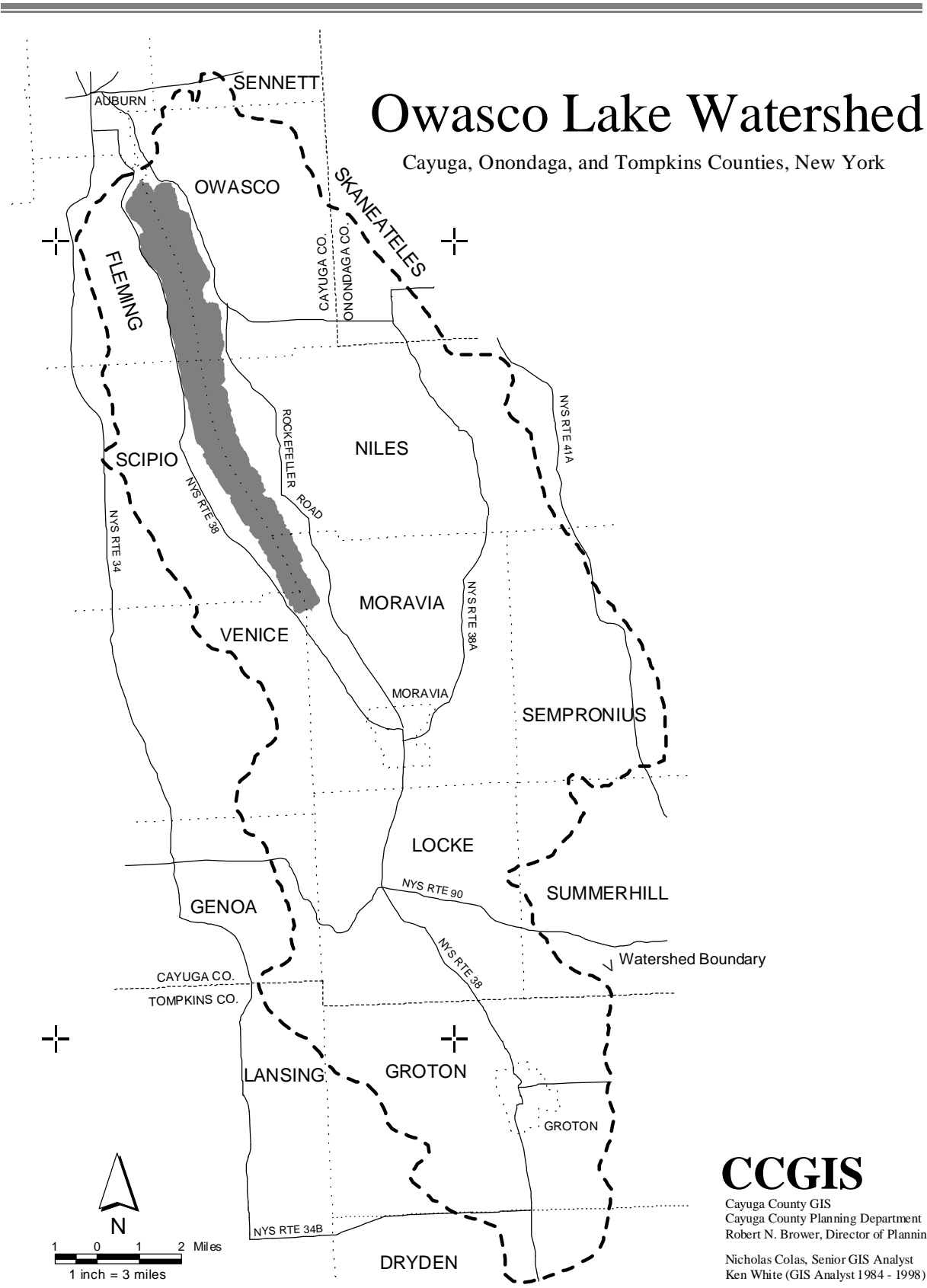
Major tributaries of the watershed include the Owasco Inlet, Dutch Hollow Brook, Veness Brook, and Sucker Brook (see Figure 2). Additionally, there are over fifty small and intermittent streams that flow into the lake. Many of these streams are less than a mile long. The Inlet accounts for nearly 55% of all surface water entering the lake; Dutch Hollow Brook accounts for 20%; Veness and Sucker Brook account for 15%; and the other minor tributaries account for 10% (Hennigan 1986). The principal tributary of the lake is the Owasco Inlet, which enters at the south end of the lake and transverses a stretch of swampy flood plain called the Owasco Flats before it empties into the lake. In times of a severe storm event, the Owasco Flats provide an essential reservoir for floodwaters.

Geology

In geological terms, the shape of the Owasco Lake basin is primarily the result of two factors. First, during the Pleistocene Era, some 9,000-10,000 years ago, continental glaciation occurred and resulted in glacial drift dams that plugged river valleys. As the glaciers receded and melted, the huge trough that was left filled with water from streams and brooks from the surrounding hillsides.

The second factor in the development of the basin's shape is the rock structure which consists of limestone, sandstone, and shale beds approximately 8,000 feet thick (Oglesby et al. 1973). Much of the limestone is located in the northern part of the watershed with the sandstone and shale to the south. The extensive limestone, which contributes calcium carbonate to the water, is responsible for the excellent buffering capacity of the lake.

Much of the lake's bottom consists of sand and cobble stones left from the grinding action of the glaciers. As of 1984, the sediments in the north end of the lake are composed of 93% sand, 5% silt, and 2% clay (Miller 1984). The substrate at the south end of the lake primarily consists of various silts and clays deposited by the Owasco Inlet. Table 1 provides geographic and morphometric information about the lake.



CCGIS
 Cayuga County GIS
 Cayuga County Planning Department
 Robert N. Brower, Director of Planning
 Nicholas Colas, Senior GIS Analyst
 Ken White (GIS Analyst 1984 - 1998)

Figure 1. Map of Owasco Lake Watershed, New York.

Tributaries and Wetlands

Owasco Lake Watershed

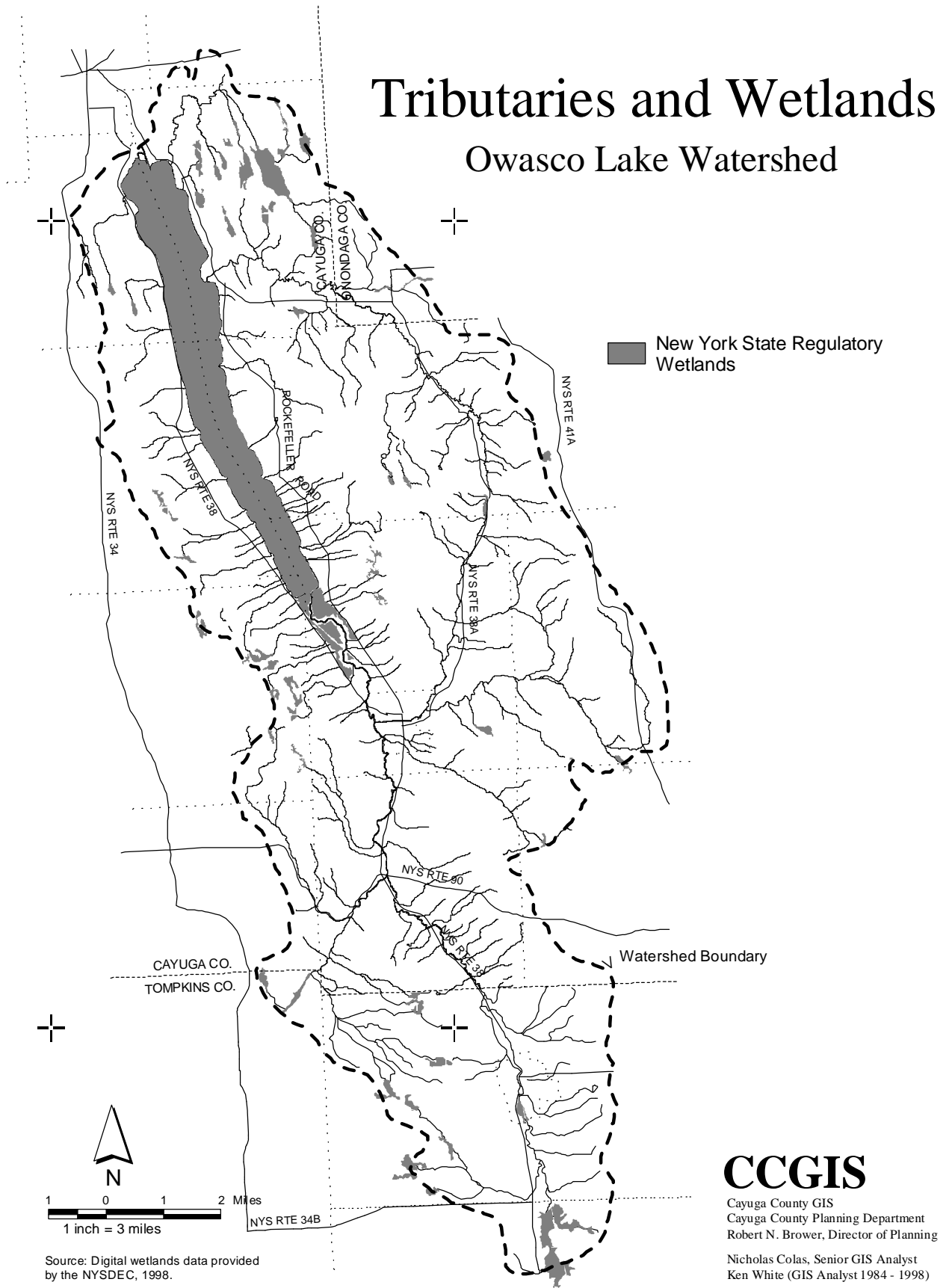


Figure 2. Map of tributaries and wetlands in the Owasco Lake Watershed.

Table 1
Geographic and Morphometric Information of Owasco Lake, New York

Latitude:	42.5° to 43° N
Longitude:	76.3° W
Watershed Counties:	Cayuga, Onondaga, Tompkins
County:	Cayuga
Surface Area:	10.3 sq. miles
Mean Depth:	96.0 ft.
Maximum Depth:	177.0 ft.
Volume:	1021.06 million cubic yards
Watershed Area:	205 sq. miles
Hydrologic Retention Time:	3-4 years
Elevation:	711 ft.
NYSDEC Water Quality Class:	AA (fresh, surface water body)

Topography

The topography of the lake and watershed area reflects glacial origins with hilly deposits and glacially carved depressions. The highest elevation within the watershed occurs at 1,350 feet in the towns of Scipio and Venice on the west side, and 1,800 feet in the town of Sempronius on the east side. The lowest elevation is the lakeshore at 711 feet above sea level.

Climate and Precipitation

The closest first-order weather station for climatological data is at Hancock International Airport located near Syracuse, New York, approximately 26 miles from Auburn. Records for temperature and precipitation began in 1902; records for snowfall began in 1940.

Temperature

The normal annual temperature is 47.7°F, with July being the warmest month (71.7°F) and February the coldest month (15.9°F). The highest recorded temperature was 98°F in June 1953; the lowest was -26°F in February 1979 (US Army Corps of Engineers 1984).

Precipitation

The normal annual precipitation is 35.78 inches, with monthly averages ranging from 2.15 inches (water equivalents) in January to 3.59 inches in June. The maximum monthly-recorded precipitation is 13.07 inches, and the minimum monthly-recorded precipitation is 1.20 inches. The maximum 24-hour value is 4.27 inches. The normal annual snowfall is 83.04 inches with the maximum monthly average occurring in December at 21.4 inches (US Army Corps of Engineers 1995).

Precipitation Gauges

Aerial and temporal distribution of precipitation over the watershed are recorded by a hourly precipitation gauge at the Aurora Research Farm, and three daily precipitation gauges at Auburn, Locke, and Skaneateles. The gauge at Auburn was inactivated from May

31, 1978 to September 1984, however, it is currently recording (US Army Corps of Engineers 1995).

Hydrology

Runoff

Based on long-term estimates, surface runoff into the lake is 0.47 meters/year. As described in a 1995 U.S. Army Corps of Engineers (ACOE) report, runoff characteristics were calculated from historical records from weather stations in Auburn, Cortland, and Ithaca. Data from these stations were used to express runoff (overland flow) as a percent of the average amount of precipitation from each season as follows: winter, 64.7% runoff; spring, 94.7% runoff; summer, 30.0% runoff, and fall, 27.6% runoff. The remaining precipitation either infiltrates the soil, percolates into groundwater or evaporates into the atmosphere. The long-term water retention time for the lake is approximately three years.

Groundwater

Groundwater recharges the lake in two basic water-bearing units. First through bedrock, which in the Owasco Lake Watershed is primarily shale, siltstone, and sandstone. The second major ground-bearing unit is unconsolidated glacial deposits.

The majority of the area within the watershed boundary is underlain by glacial till generated during the formation of the Finger Lakes. This layer is of variable thickness and modestly yields one to five gallons of water per minute to wells. Beneath the till is a layer of shale bedrock capable of yielding water in larger quantities.

South of the lake, along the Owasco Inlet, is a sand and gravel aquifer that may yield a range from five to more than 500 gallons of groundwater per minute. Another sand and gravel aquifer is located along Decker Brook and Dresserville Creek northeast of the village of Moravia. This aquifer is close to the surface and capable of supplying between 10 and 100 gallons of water per minute.

Other isolated sand and gravel aquifers may exist elsewhere in the watershed, but are too small to be mapped (Miller 1987; Kantrowitz 1970).

Groundwater quality: The median concentration of dissolved solids in the shale, siltstone, and sandstone is 455 mg/L, three times that found in overland runoff from regions underlain by this bedrock unit. This relatively high dissolved solids content is due to the presence of thin beds of carbonate rock, and a matrix of calcium carbonate around the relatively insoluble silicate materials (Bloomfield 1978).

Lake Levels

The majority of information on Owasco Lake levels comes from an extensive study by the ACOE done in 1984. On or about this time, the city of Auburn wanted to raise the level of the lake to maximize the energy output of their newly renovated hydroelectric facility. However, public concern over this issue led ACOE officials to undertake a hydrological analysis of the lake and its watershed. The following is a summary of their data that has led to the current Owasco Lake level target rule curve.

Background

The first control structure for the lake was a dam built by the state of New York enabling use of the lake as a water feeder for the Erie Canal (date of construction unknown). In 1886, the city of Auburn began managing lake levels. The lift gates were initially constructed of wood. They were rebuilt as steel gates in 1954. The taintor (radial) gates were built in 1967.

In 1969, the city acquired complete control of the operation of the State Dam. At that time, it was still necessary to maintain satisfactory flows for the small businesses that obtained hydropower from the outlet. During the 1972 flood, however, these small facilities were severely damaged. Since that time, the city of Auburn has repaired and updated the hydroelectric station below the Mill Street Dam and a second hydroelectric facility near North Division Street (US Army Corps of Engineers 1984).

The average Owasco Lake elevation is 711 feet above sea level. This elevation is the third highest of the major Finger Lakes, with only Skaneateles (863 feet) and Otisco (788 feet) lake levels being higher. The city of Auburn owns and operates the State Dam near Swift Street, approximately 1.8 miles downstream from the north end of the lake. The State Dam controls lake outflows.

Approximately 2.5 miles downstream from the north end of the lake, just above the Genesee Street Bridge, is a United States Geological Survey (USGS) gauging site. With 68 years of recorded data, the average flow at this gauge is 289 cubic feet per second (cfs). The drainage area of the gauge is 206 square miles.

Between the State Dam and the USGS gauge, the Mill Street Dam provides water pressure (head) for an existing, city owned hydroelectric facility on the outlet. Additionally, the city of Auburn also owns and operates another hydroelectric facility located near North Division Street (US Army Corps of Engineers 1984). The city of Auburn Water Department inspects the dams and hydroelectric facilities on the outlet on a daily basis.

Lake and Stream Gauges: The USGS has operated a lake gauge at the city of Auburn water intake and pumping station since 1967. Records after October 1967 can be obtained from the USGS. As previously mentioned, another stream gauge is located 4-miles downstream from the State Dam on the Owasco Outlet. This gauge is also operated by the USGS.

Since 1912, the average flow in the Owasco River (Outlet) has been 289 cfs, the maximum discharge was 3,250 cfs on June 23, 1972, following hurricane Agnes, and the minimum discharge was 2 cfs on December 5, 1936 (US Army Corps of Engineers 1995).

National Geodetic Vertical Datum (NGVD): It should be mentioned that throughout various studies on Owasco Lake, different values have been used to convert elevations based on the Auburn datum to NGVD of 1929. The conversion used throughout this report is NGVD = Auburn Datum + 4.38 feet. All elevations cited in this report are in NGVD (U.S. Army Corps of Engineers 1984).

US Army Corps of Engineers Projects

There have been two projects and one study on the lake by the ACOE. The first project consisted of improving channels along Owasco Inlet, Mill Creek, and Dry Creek in Moravia, as well as the construction of a dike along the north bank of Dry Creek. This project was completed in 1948.

The second project consisted of channel improvements on the Owasco River (Outlet) from the lake to the State Dam. To minimize flooding, this project included the development of a target rule curve for lake levels. This project was completed in 1962.

In 1984, the ACOE undertook a study to examine the feasibility of modifying the existing lake level management plan for the lake. The study was comprehensive and included the effects of plan modification on flood protection, hydropower generation, fish and wildlife management, municipal and private water supply, water quality, and water-based recreation around the lake. The 1984 study addressed the effects of raising lake levels in order to increase storage for hydroelectric power generation. From this study, a new target rule curve for lake levels was developed. In 1995, the ACOE released the operations manual for controlling the lake levels.

Operation Procedure

A minimum flow of 30 cfs is needed at all times for Auburn to provide biological assimilation of the treatment plant effluent, which discharges into the Owasco River (Outlet) at the Bradley Street Wastewater Treatment facility. The 1984 target rule curve calls for lake levels to be maintained between 710 and 713 feet above sea level. Shoreline flooding begins at approximately 713 feet and reaches serious conditions at 715 feet. Levels below approximately 710 feet may cause private water intakes to freeze. If snow cover is heavy in February and March, the winter level can be drawn down to 708 feet in order to allow storage of an additional 1.2 inches of runoff. (US Army Corps of Engineers 1995; Hennigan 1986).

At the beginning of the summer, the level of the lake is maintained at 713 feet. Due to evaporation, the lake typically decreases to about 712 feet by the end of the summer. In October, the major draw down begins at a rate of 300 cfs to provide maximum storage capacity to prevent spring flooding. Withdrawal continues until January 1, when the 710-foot level is reached. The spring runoff will then raise the lake level to 713 feet (US Army Corps of Engineers 1995). A detailed description of this procedure is shown in Figure 3.

Soils

Soils within the Owasco Lake Watershed can be summarized by listing soil associations found in the 1971 Soil Survey of Cayuga County. Associations are intended to broadly describe the soil characteristics that are most dominant within an area.

Most of the watershed is within the Allegheny Plateau soil physiographic area. The Allegheny plateau is distinguished by highlands cut by narrow valleys. The most productive soils are in the valleys and on rolling uplands, while forests occupy the poorer soils.

Generally, soils within the watershed are glacially formed and deposited, deep, well drained, gently to moderately sloping, and of medium texture. The most dominant soils are calcareous (containing significant amounts of calcium) limestone, shale, and sandstone. The most common soil associations in the drumlins (large, hilly glacial deposits) are the Ontario series, which contain high amounts of sandstone and limestone (see Figure 4). A list of soil association acres in the watershed is listed in Table 2.

An effort is underway to update the soil survey of the Owasco Lake Watershed and to create digital soil maps in order to provide better understanding of soil properties needed for sustainable land use.

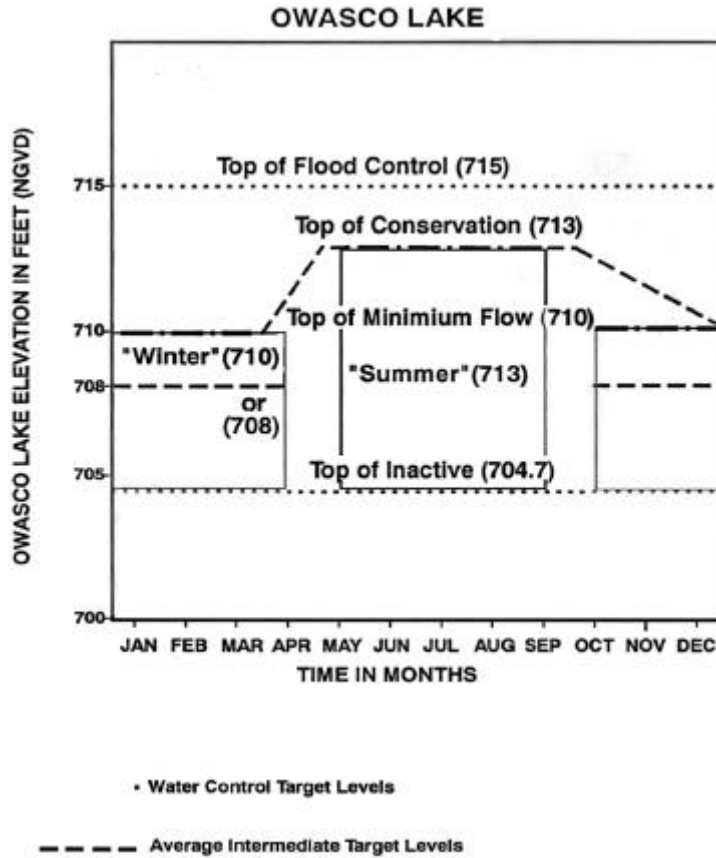


Figure 3. Owasco Lake Target Levels (US Army Corps of Engineers 1995).

Table 2

Soil Association Acres and Percentages for the Owasco Lake Watershed

Soil Association	Acres	Percentage of Total
Mardin-Lordstown-Volusia (NY 126)	52151.13	42.31
Honeoye-Ontario-Lima (NY 128)	48075.80	39.00
Chenango-Howard-Palmyra (NY134)	8563.31	6.95
Valois-Bath-Howard (NY 125)	6104.36	4.95
Manlius-Marilla-Fremont (NY058)	3680.68	2.99
Darien-Cazenovia-Nunda (NY131)	2327.99	1.89
Teel-Wayland-Hamlin (NY159)	1691.51	1.37
Urban Land-Howard-Niagara(NY143)	388.58	0.32
Minoa-Arkport-Lamson (NY140)	298.09	0.24

General Soil Units

Owasco Lake Watershed

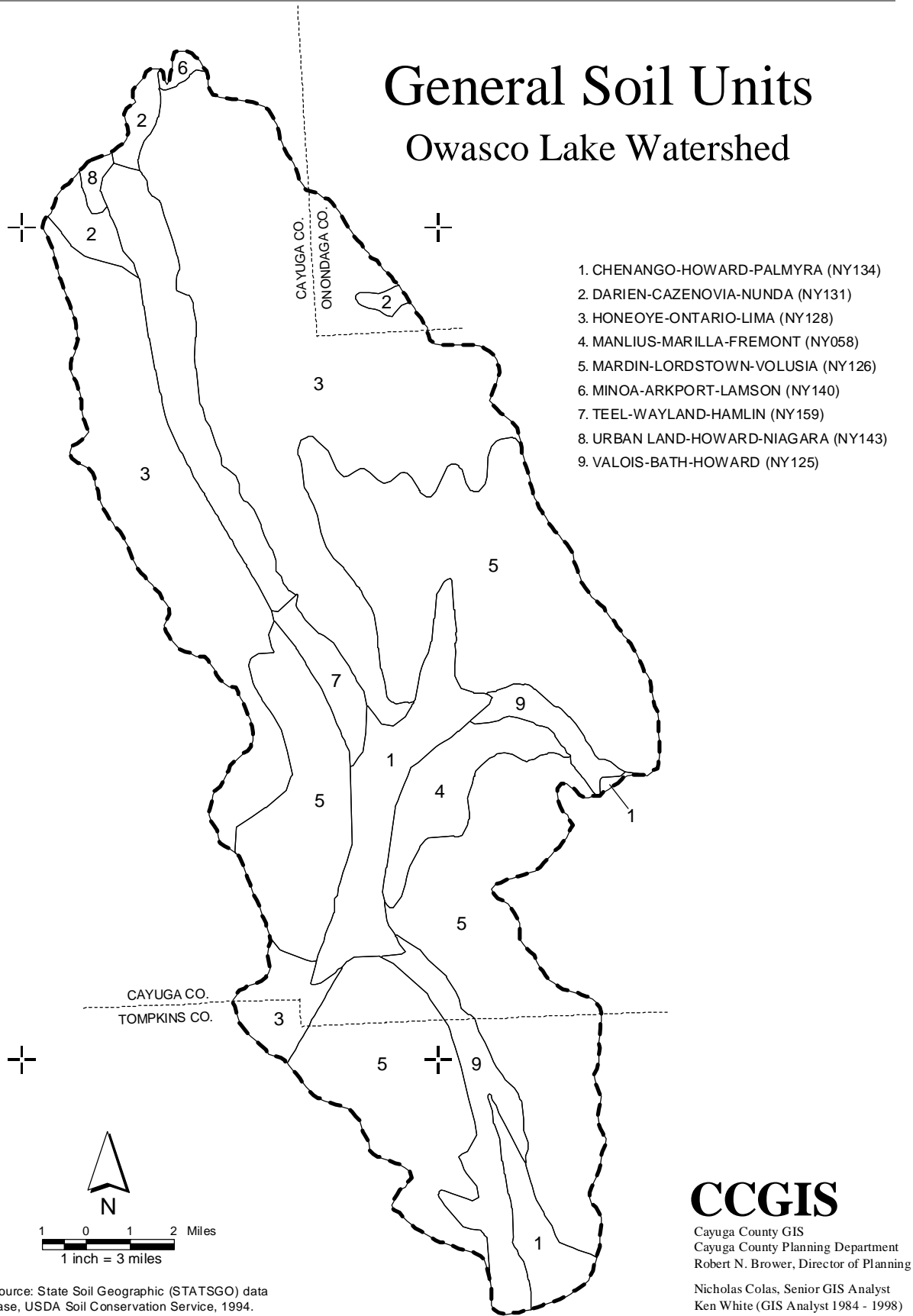


Figure 4. Map of soil associations in the Owasco Lake Watershed.

Wetlands

The Owasco Lake Watershed contains approximately 9,557 acres of NYSDEC classified wetlands. These wetlands range in environmental significance on a classification scale of I - IV. A wetland classified with a "I" is most sensitive or unique, while a rating of "IV" is used for the wetlands that are most common or resilient. A more thorough description of wetland classes is presented in Table A-1 in Appendix A, page 99.

Forestry Resources

According to the U.S. Forest Survey of 1993, land is considered forested when it is at least 10% stocked with trees of any size (USDA 1980 and 1993). Using land cover data collected by the USGS from 1977 to 1980, the Cayuga County Planning Department has calculated the percentage of the watershed consisting of the most heavily forested areas as follows:

Mixed Forest	38.5%
Evergreen Forest	2.1%
<u>Shrub and Brush Rangeland</u>	<u>0.6%</u>
Total	41.2%

This total does not include inactive cropland that may be considered forested using the U.S. Forest Survey definition. Analysis of aerial photographs of Cayuga County taken in 1979 revealed that 10% of the land in the county's portion of the watershed consisted of inactive cropland. Therefore, it may be estimated that more than 51% of the land in the watershed contains forest resources.

This estimation reflects the land use trend typical of the northeastern United States--from agricultural land use to forest regeneration, particularly where the soils are marginal. For example, soils are marginal in the southern and southeastern regions of the watershed where many gorges and steep slopes exist. These geographic conditions present obvious challenges in agricultural land use.

A significant portion of the forested land in the watershed is publicly owned. The NYSDEC Division of Lands and Forests manages the 9,349-acre Hewitt-Cayuga Highlands Management Unit. Of that land, 3,500 acres is in the Owasco Lake Watershed with the adjoining remainder primarily in the Skaneateles and Cayuga Lake Watersheds (NYSDEC 1994). The state emphasizes the management of these lands for sustainable timber production, many recreational uses, wildlife diversity, and watershed protection.

The New York State Office of Parks, Recreation and Historical Preservation manages nearly 1,000 acres of forested land in Fillmore Glen State Park. This portion of the watershed drains into the Owasco Inlet and recharges the aquifer that serves the village of Moravia and the Cayuga Correctional Facility. There are an additional 600 acres in municipal ownership, notably of which are lands that protect the hamlet of Locke and the city of Auburn's water sources.

The composition of the forest resource is divided between oak-northern hardwoods and northern hardwoods (NYSDEC 1982). The state lands are 63% conifer plantations in various species of pine, spruce, and larch. The state land size classes are listed as: seedling-sapling - 9%; poletimber - 70%; and sawtimber - 21%. Foresters consider such forests as young or maturing.

The forested land in private ownership may also be considered young and maturing, since most of this forest was cleared prior to 1900.

Wildlife

Due to the many habitat types, Owasco Lake and its watershed are filled with a wide variety of wildlife. Whitetail deer is the largest and most easily recognized of the mammals often seen throughout the watershed. It is estimated that population levels average 40 deer per square mile with a variation level ranging from 20 to 80 per square mile. Other mammals that inhabit the watershed include coyote, fox, raccoon, opossum, woodchuck, cottontail rabbit, skunk, meadow vole, gray and red squirrel. An occasional black bear has been observed in the more remote areas of the watershed. Bear sightings are likely to become more frequent as populations to the south and east grow. Other mammals that are found along the lake and tributaries include muskrat, mink, and beaver.

The upper end of the watershed, near its junction with the Fall Creek and Bear Swamp Creek Watersheds, has been selected as a possible river otter release site. The New York River Otter Project is an effort to enhance the natural reintroduction of central and western New York otter habitats.

Of larger birds, wild turkey and ruffed grouse are found throughout the watershed. In addition, farm and grasslands are home to ringneck pheasant populations. Unfortunately, this majestic, introduced species is very sensitive to habitat changes.

Waterfowl vary in abundance with the largest diversity occurring in the Owasco Flats wetland area. In addition to waterfowl and numerous wetland obligate species, the Flats host a great blue heron rookery and potential osprey nesting habitat. In addition, there are numerous smaller marshes and swamps in the watershed, as well as many temporary ones, created by beavers, that serve as favorable waterfowl habitat. Confirmed breeding waterfowl include the mallard duck, Canada goose, and the wood duck. During the fall, winter, and spring, the numbers and individual species of waterfowl increase greatly as migrating birds visit. This includes rare species such as the common loon and the tundra swan.

Other birds that nest in the watershed include many varieties of songbirds and raptors. Large numbers of gulls and crows are often present in the north end of the watershed. Bald eagles are known to occasionally travel through the watershed although there are no confirmed bald eagle breeding sites.

As land use changes, so does available habitat. Many of the small farms that were once standard in the watershed are being consolidated or abandoned. This change can result in loss of habitat for some species as hedgerows are removed to create bigger crop fields or the fields reverted to forest. While some species adapt relatively quickly to these changes, others can not and disappear.

Water Quality Sampling Efforts

The city of Auburn, Cayuga County Department of Health and Human Services, Cayuga County Planning Department, Owasco Watershed Lake Association (OWLA), and Cornell Cooperative Extension (CCE) are each involved in ongoing lake water quality sampling efforts.

During 1998, city personnel and OWLA volunteers conducted weekly bacteriological

testing at Emerson Park and other areas of the lake as needed. As a result of this collaborative effort, 896 water samples were analyzed at the Auburn Wastewater Laboratory.

The Cayuga County Planning Department monitors nutrient and sediment loading (total phosphorus, soluble reactive phosphorus, and total suspended solids) from Dutch Hollow Brook and the Owasco Inlet into the lake. The planning department's sampling efforts also record stream flow measurements at ten-minute intervals using data loggers deployed at each site. In addition, rainfall is recorded and retrieved from automatic rain gauges connected to the data loggers.

The Cayuga County Health and Human Services Department is obligated under the NYS Public Health Law to monitor the quality of public bathing beaches. In addition to the public bathing beaches at Emerson Park there are numerous bathing beaches at children's camps around the lake that are also monitored. In 1998, the Health Department took 232 samples from Emerson Park alone.

Cornell Cooperative Extension of Cayuga County offers support to citizens interested in monitoring streams in Cayuga County by providing equipment, training, and educational materials related to water quality. Through the Watershed Watch: Volunteer Monitoring Program, both youth and adult groups are able to sample and test for nitrogen, phosphorous, dissolved oxygen, bacteria, temperature, pH and biological indicators (aquatic organisms). More information regarding this program is available on the Internet at: www.co.cayuga.ny.us/wqma/watershedwatch.

Chemical, Physical and Biological Data--Lake

Overview

Except for fecal coliform densities, most chemical, physical, and biological parameters reviewed in this section are within state and federal water quality standards. Between 1993 and 1998, levels of fecal coliform in the north end of the lake have increasingly become a problem. Of the 772 samples taken at Emerson Park beaches by the Cayuga County Environmental Health Division between 1993 and 1998, 36% (281) were above the NYSDOH fecal coliform density standard of 200 colonies/100 mL. In the fall 1998, Dr. Mansour Samadpour used DNA ribotyping techniques to determine the sources of fecal contamination. The major source of contamination at the Emerson Park beaches was wildlife, while agriculture was an intermediate source, and humans and pets were minor sources. The study also showed that agriculture and wildlife were the major sources of contamination in the tributaries, while humans and pets were minor sources.

Dissolved oxygen levels are a concern for trout waters if they drop below the NYSDEC standard of 6.0 mg/L. Studies on Owasco Lake from 1910 to 1986 showed the concentration of dissolved oxygen consistently between 6.0 and 11.0 mg/L at all depths.

Nitrate-nitrogen levels measured from 1955-1973 were between 516-1,657 µg/L, which are well below 10,000 µg/L set by the NYSDEC. The current NYSDEC standard for soluble reactive phosphorus is 20 µg/L. Review of phosphorus data taken from 1971 to 1973 generally fall between 1.2 and 7.6 µg/L. Of the five studies performed on Owasco Lake's main tributaries between 1927-1981, all determined that the major source of nutrients entering the lake was from agriculture runoff.

Although, there are no NYSDEC standards for major ions (e.g. sodium, calcium, and magnesium) a review of these values from 1950 to 1973 shows a slight increase. Between 1927 and 1986, pH values ranged from 8.0 to 8.4, which is within the NYSDEC range of 6.5 to 8.5. There are no NYSDEC standards for alkalinity. From 1927 to 1986 alkalinity levels ranged from 107 to 111 mg (as CaCO₃).

There are no state standards set for transparency measured by Secchi discs. Average Secchi disc transparencies measured between 1971 and 1986 ranged from 2.6 to 4.0 meters. The NYSDEC standard for turbidity is 5.0 Nephelometric Turbidity Units (NTUs). Turbidity showed significant improvement from 1964 to 1986. In 1964, the mean value was 12.2 NTUs. In 1986, the mean value was 2.66 NTUs.

In 1997, two pesticide studies found that all pesticides tested were well below the NYSDOH maximum contamination levels for drinking water. Temperature profiles examined between 1910-1985 showed little change. Although there are no NYSDEC standards for chlorophyll *a*, Effler et al. (1988) used 8.0 mg/m³ as a level approaching eutrophication. Studies revealed that concentrations of chlorophyll *a* in the lake dropped from 5.3 mg.m³ in 1973 to 1.8 mg.m³ in 1986.

In 1972, Mills found that the dominant phytoplankton species in Owasco Lake was consistent with other mesotrophic Finger Lakes. Concerning identification and quantification of zooplankton species in the lake, the dominant species changed from study to study between 1910 and 1986. This observation is expected under typical mesotrophic conditions.

Trophic State

A measure of a lake's health depends to a large extent on the amount of nutrients that enters it. The nutrient level, or trophic state, of a lake is generally determined by its level of phytoplankton production (algae). This method of measurement is used because the growth of phytoplankton directly corresponds to the amount of nutrients present in the lake.

The three trophic states that describe the levels of nutrients and amount of phytoplankton in a lake are oligotrophic, mesotrophic, and eutrophic. Oligotrophic means nutrient levels, particularly phosphate or nitrogen compounds, are low. When lakes are young, they are oligotrophic. Eutrophic means nutrient levels are high, and mesotrophic means nutrient levels are between oligotrophic and eutrophic.

There are numerous factors that determine nutrient levels in a lake. Human land use practices, such as manure application or maintenance of septic systems, are crucial determining factors because fecal wastes can be significant sources of phosphorus and nitrogen. On the other hand, if a lake's watershed is largely forested, nutrients are more likely to be held either in the soil, plant biomass or detritus. There is less leaching of nutrients or erosion, and as a result, the water draining into the lake is more likely to be low in nutrients. Another factor contributing to the nutrient content of natural waterways is the presence of wetlands. Wetlands are critical in filtering and removing nutrients from surface and ground waters that pass through them.

As the water of an oligotrophic lake becomes enriched with nutrients and phytoplankton production increases, numerous changes take place. Like all green plants, phytoplankton produce oxygen, causing the surface of the water to become supersaturated with oxygen. However, oxygen generated by phytoplankton does not replenish the dissolved oxygen levels of deeper water. Phytoplankton have remarkable high growth and reproductive rates. Eventually, a maximum population is reached and a die off occurs. Dead

phytoplankton settle, resulting in heavy deposits of detritus on the bottom of the lake. The accumulation of detritus then supports abundance of decomposers, mainly bacteria. Finally, the depletion of dissolved oxygen results in the suffocation of higher organisms, such as fish. Furthermore, if the lake is a source of drinking water, its value may be greatly impaired because phytoplankton rapidly clog water filters and may cause a foul taste.

Although trophic levels are generally measured by phytoplankton populations, phytoplankton themselves can be assessed by measuring chlorophyll *a* concentrations, transparency, phosphorus concentrations, and surface oxygen depletion. Eutrophic lakes, for example, would have high concentrations of chlorophyll *a*, low transparency, high concentrations of phosphorus, and low concentrations of oxygen near the lake bottom.

In 1972, Mills measured various chemical, physical, and biological conditions in four Finger Lakes, including Owasco Lake, and ranked their order for various parameters (see Table 3). Mills concluded that Skaneateles Lake was oligotrophic, Owasco and Hemlock Lakes were mesotrophic, and Conesus Lake was eutrophic. In a 1986 study, Effler et al. classified Owasco Lake as being oligo-mesotrophic. In other words, phytoplankton at the time of Effler's 1986 study had improved since the early 1970's, most likely due to phosphorus bans that were enacted in the 1970's (Effler et al. 1988).

Bacteria

Indicator Microorganisms: Water supplies and public bathing beaches are routinely monitored for the presence of fecal contamination by testing for the presence of indicator microorganisms. Indicator microorganisms are chosen because they are present in relatively high numbers in feces and are easily cultured in the laboratory. Their presence in the water indicates that there may be fecal matter in the water and therefore a potential for disease causing pathogens (Techobanoglous 1991).

Fecal Coliform and E. Coli: The intestinal tract of man contains numerous rod-shaped bacteria known as coliform organisms, which are commonly used as indicator organisms. In addition to other kinds of bacteria, each person discharges 100 to 400 billion coliform organisms per day (Techobanoglous 1991). The use of coliform as an indicator organism is complicated by the fact that some coliform groups can grow in soil. Therefore, the presence of coliform does not always mean contamination by human or animal wastes. As a result, when determining the quality of bathing beaches, the NYSDOH uses fecal coliform only as an indicator organism.

Escherichia coli (*E. coli*) are entirely of fecal origin and a suitable indicator species, but in the past they were difficult to culture and differentiate between the soil coliform (Techobanoglous 1991). Because microbiology techniques have advanced, today *E. coli* is routinely cultured and quantified in the lab. Therefore, when determining beach closings, many local Health Departments test for *E. coli* in addition to fecal coliform.

Table 3

Comparison of Various Physical, Chemical, and Biological Properties of Several Finger Lakes

Physical-Chemical						
Lake	Mean depth (m)	Weighted rank order	Average % D.O. saturation in hypolimnion during summer stratification, 1972-73	Weighted rank order	Mean annual Secchi disc transparency 1972-73 (m)	Weighted rank order
Conesus	11.5	1.0	25.8	1.0	3.9	1.60
Hemlock	13.6	1.2	51.4	2.0	2.4	1.00
Owasco	29.3	2.5	71.8	2.8	2.9	1.20
Skaneateles	43.5	3.8	86.3	3.3	5.9	2.50

Physical-Chemical						
Lake	Potential phosphorus concentration (mg/L)	Weighted rank order	Specific phosphorus loading (g P/m ² /yr)	Weighted rank order	Morpho-edaphic index*	Weighted rank order
Conesus	0.058	11.6	0.67	2.9	18.3	5.3
Hemlock	0.032	6.4	0.43	2.0	9.7	2.9
Owasco	0.030	6.0	0.87	3.8	5.9	1.7
Skaneateles	0.005	1.0	0.23	1.0	3.4	1.0

Biological						
Lake	Mean annual chlorophyll <i>a</i> (mg/m ³)	Weighted rank order	Mean annual phytoplankton biomass (g/m ³)	Weighted rank order	Pigment diversity (carotenoid/chlorophyll <i>a</i>)	Weighted rank order
Conesus	6.7	7.6	1.6	2.9	0.3	1.0
Hemlock	4.3	4.8	1.7	3.2	0.6	2.0
Owasco	3.4	3.8	1.3	2.5	0.6	2.2
Skaneateles	0.9	1.0	0.5	1.0	0.7	2.5

Phytoplankton					
Lake	Average integrated phytoplankton biomass (g/m ³)		Major phytoplankton specie	% of total biomass	Degree of relative eutrophy (1 highest 4 lowest)
	summer stratification	summer stratification			
	1972	1973			
Conesus	1.39	1.44	<i>Melosira granulata</i>	26.5	1
Hemlock	2.52	2.92	<i>Peridinium cinctum</i>	9.8	2
Owasco	1.14	2.20	<i>Asterionella formosa</i>	22.8	3
Skaneateles	1.13	0.75	<i>Dinobryon sertularia</i>	16.2	4

* Morphoedaphic index combines total dissolved solids concentrations and mean depth.

Source: Mills 1975

Emerson Park Beach Closings: Since 1992, numerous areas of the lake have been routinely sampled for the presence of *E. coli* and fecal coliform. The Cayuga County Department of Health & Human Services Environmental Division is responsible for monitoring contamination in all public bathing beaches, including permitted children's camps, within the county. In addition, OWLA monitors bacteria levels at several locations on the lake. Emerson Park's Main beach (east) and Deauville beach (west) have been areas of concern for high *E. coli* and fecal coliform counts and have been closed on numerous occasions.

Between 1989 and 1998, the Cayuga County Environmental Health Division closed the swimming beaches at Emerson Park 105 times because water samples were above the NYSDOH standard of 200 colonies per 100 mL. In 1993, the beaches were closed for 45 days, in 1997 for 4 days, and in 1998 for 56 days.

The hydrology of the northern part of the lake, where the Emerson Park beaches are located, is considered a major factor in development of high coliform populations. The ability for water to flow out of the beach area into the Owasco River (Outlet) is very limited at both Emerson Park beaches. Consequently, the contaminated water remains in the beach area where the coliform organisms are able to reproduce in the stagnant warm water and sediments.

There are six possible sources of fecal coliform contamination in Owasco Lake: (1) failing septic systems; (2) inadequate treatment at the Moravia and Groton Wastewater Treatment Facilities; (3) runoff from agricultural manure; (4) fecal wastes from wild animals (e.g. gulls, raccoons, deer) and/or pets, (5) bathers (such as from soiled diapers); and (6) holding tanks from boats. (see Boating in Section VI, Issues of Concern).

DNA Fingerprinting Study: Dr. George Simmons Jr. of the Virginia Polytechnic Institute recently developed a new technology to identify the more than 600 strains of *E. coli*. Through this new process, DNA sequences from *E. coli* samples that are obtained from fecal contaminated water are compared to the DNA sequences of *E. coli* from known animals that harbor a particular strain of *E. coli* (Simmons et al. 1995). This genetic comparison or "fingerprint" can identify the source of fecal contamination. In May 1998, Dr Simmons met with Cayuga County officials and recommended that the county retain the services of Dr. Mansour Samadpour.

Dr. Mansour Samadpour is from University of Washington Department of Environmental Health and has one of the most extensive DNA libraries (database) of known *E. coli* strains in the world (over 25,000 *E. coli* fingerprints). In August of 1998, Cayuga County financed a DNA study for Dr. Samadpour to determine the source of fecal contamination in Owasco Lake.

During the late summer and early fall of 1998, the Environmental Division of the Cayuga County Department of Health & Human Services took weekly water samples at Emerson Park beaches and at the mouth of the lake's four tributaries -- the Owasco Inlet, Sucker Brook, Veness Brook, and Dutch Hollow Brook -- as well as the Owasco River (Outlet). At the same time, George Bumann, a wildlife biologist from State University of New York College of Environmental Science & Forestry was hired to collect and identify scat samples from animals within the watershed. *E. Coli* from scat and water samples were isolated and quantified by Gary Lewis of the Auburn Memorial Hospital Microbiology Laboratory. These samples were then sent to the University of Washington for DNA analysis.

The results of Dr. Samadpour's study were released in February 1999. The report stated that there are multiple sources of fecal contamination of the lake. Dr. Samadpour

stated that due to the limited nature of the study, specifically the small number of samples, it is prudent to look at the data as a qualitative index of sources of pollution. He therefore categorized the sources as being major, intermediate or minor.

The report stated that the major source of fecal contamination at Emerson Park is wildlife, particularly waterfowl. Agriculture is the intermediate source, while human and pet wastes were listed as minor sources (see Table 4).

Table 4
Microbial Source Tracking Results for the Emerson Park Swimming Beaches and Owasco Outlet

Sampling Station	# of <i>E. coli</i> Strains Analyzed	Sources the <i>E. coli</i> Strains Were Matched To
EP, Main Beach, Shallow	21	Duck (3), Goose (2), Sea Gull (2), Raccoon, Deer, Cow, Human
EP, Main Beach, Deep	15	Duck (2), Goose (2), Sea Gull, Cow, Raccoon, Rodent
EP, Island Beach, Shallow	19	Duck, Goose, Deer, Cow, Pig, Rodent
EP, Island Beach, Deep	19	Duck, Goose, Sea Gull, Cow, Deer
EP, Main Beach, Shallow, Sediment	12	Duck, Goose, Sea Gull, Dog, Raccoon, Human
EP, Island Beach, Shallow, Sediment	18	Duck, Goose, Cow
Owasco Outlet	15	Duck (2), Goose, Sea Gull, Dear, Human

Total: 7 Sampling Stations

119

Major Sources: Wildlife

Intermediate Sources: Agriculture

Minor Sources: Human, Pets

Note: EP=Emerson Park
Source: Samadpour 1999

Dr. Samadpour stated that agriculture and wildlife are the major sources of fecal contamination in the tributaries, while humans and pets are minor sources (see Table 5).

Table 5
Microbial Source Tracking Results for the Tributaries of Owasco Lake

Sampling Station	# of <i>E. coli</i> Strains Analyzed	Sources the <i>E. coli</i> Strains Were Matched To
Vanness Brook	10	Cow (2), Duck, Deer, Human
Sucker Brook	13	Cow (3 matches), Cat, Dog-Cat, Sea Gull
Dutch Hollow Brook	16	Cow, Human, Duck, Raccoon
Owasco Inlet	21	Cow (2), Human (2), Dog, Cat, Goose, Duck, Deer (2)

Total: 4 Tributary Stations

60

Major Sources: Agricultural, Wildlife

Minor Sources: Human, Pets

Source: Samadpour 1999

Dr. Samadpour made the following recommendations in his report:

1. A source control plan should be developed and implemented in order to reduce the population of waterfowl in the watershed, particularly Emerson Park. This can be achieved by several means, including capture and removal, interference reproductive cycles, and harassment of the waterfowl using trained dogs.
2. The impact of the agricultural sources can be reduced by the implementation of manure management practices and the introduction of buffer zones between farms and waterways that discharge into the lake.
3. The possibility of an animal control program to reduce the raccoon and rodent population should be considered.
4. More frequent testing of septic systems located near creeks discharging into the lake and an evaluation of the contribution of the sewage treatment plant effluent discharging into the Owasco Inlet should be considered.

The Cayuga County Water Quality Management Agency (WQMA) is in the process developing a plan to address the recommendations presented by Dr. Samadpour. Furthermore, additional DNA testing is planned for the spring of 1999 in order to increase the sample size of the study and determine possible seasonal trends or changes.

Dissolved Oxygen

When determining overall water quality, dissolved oxygen (DO) is an important chemical parameter to consider. Dissolved oxygen is important to aquatic life because detrimental effects can occur when DO levels drop below 4.0 to 5.0 mg/L, depending on the aquatic species.

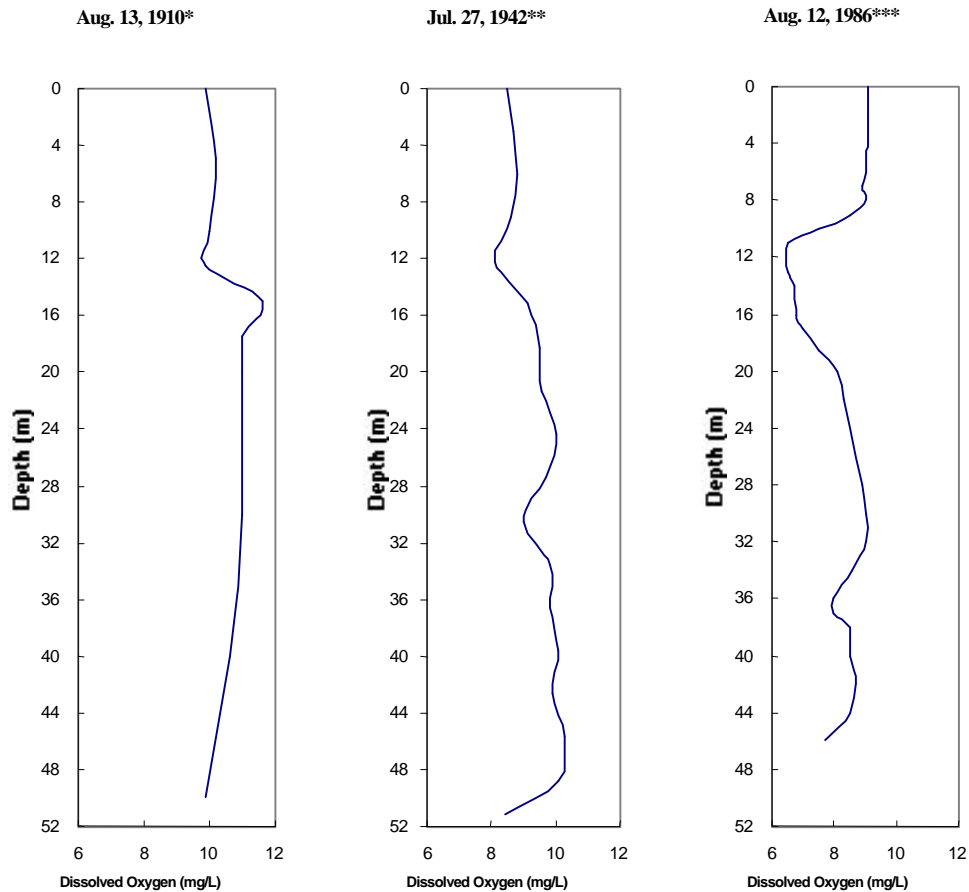
Ambient DO levels can be affected by the growth of algae (phytoplankton) and weeds (macrophytes) feeding on ammonia and nitrate. In this context, these nitrogenous compounds are nutrients. Algae and weeds constitute an oxygen source during daylight hours due to photosynthesis and a continuous oxygen sink due to respiration at night. For moderate nutrient level, photosynthesis and respiration tend to compensate for each other with small overall impact. Higher enrichment levels, however, lead to eutrophication with potentially strong effects on DO. Diurnal fluctuations can develop with supersaturated DO levels during daylight hours due to photosynthesis and very low DO level at night due to respiration. Longer-term fluctuations result from photosynthesis/respiration imbalances during high biomass growth and decay periods.

In addition to nitrogen, other nutrients are needed for biomass growth, notably phosphorus and silica. The average molar ratios of nitrogen to phosphorus to carbon in algal protoplasm (Redfield ratios) are approximately N:P:C = 15:1:105. If one of these nutrients is available in smaller proportion to the others, it tends to limit growth, while any nutrient increase will result in a direct increase of biomass. In lakes, phosphorus is typically the limiting nutrient so that the addition of phosphorus will spur growth while the addition of nitrogen will have minimal effects in a lentic (standing water) lake system. The major sources of oxygen are from air as well as from photosynthetic aquatic plants and phytoplankton. The major oxygen depleting processes are cell respiration (from all organisms that live in the lake) and the decomposition of dead organic matter.

Once the lake stratifies in early summer, the hypolimnion (lower depths) becomes largely isolated from sources of oxygen. However, the rate of oxygen depletion in the hypolimnion is correlated with the level of biological activity in the epilimnion (upper depths). That is, as the number of phytoplankton increase in the epilimnion, the oxygen

concentration in the hypolimnion decreases. There is an increase in oxygen demand as the dead phytoplankton that have sunk to the bottom decompose.

Historical dissolved oxygen data is scarce for Owasco Lake. Figure 5 compares dissolved oxygen profiles from three studies conducted in 1910, 1927, and 1986. Generally, the profiles look similar, indicating that in 76 years (1910-1986) the dissolved oxygen concentrations have changed little (see Table 6). Comparing the historic data, Effler (1988) states “a dramatic degradation of the oxygen resources of Owasco Lake has not occurred”.



* From Birge and Juday (1921).

** From DEC (unpublished) found in Oglesby (1973)

***From Effler (1988)

Figure 5. Historic vertical dissolved oxygen profiles for Owasco Lake.

Table 6

Comparison of Dissolved Oxygen Concentrations in Owasco Lake at Depths Greater Than 45 meters

Year	Dissolved Oxygen (mg/L)	Description
1910 ^a	9.9	one measurement on 8/13/10
1927 ^b	8.3	one measurement on 8/4/27
1942 ^c	8.4	one measurement on 7/27/42
1971 ^d	9.6	mean of 22 samples
1972 ^d	8.9	mean of 17 samples
1986 ^e	8.0	one measurement on 8/12/86

^a Birge and Juday (1921)

^b NYSDEC (1928) from Oglesby (1973)

^c NYSDEC (unpublished) from Oglesby (1973)

^d Oglesby (1973)

^e Effler (1988)

Nutrients

Nitrogen: Nitrogen is an essential plant macronutrient that exists in many forms. Fixed nitrogen (N₂), ammonia (NH₃), nitrite (NO₂⁻), and nitrate (NO₃⁻) are all forms of nitrogen that can be found throughout the soil, air, plant, and water components of the environment. Nitrate is the form of nitrogen that plants most readily utilize.

There were only four known lake studies that analyzed nitrate-nitrogen between 1955-1973. The results of these studies are listed in Table 7. Oglesby (1973) and Mills (1975) completed the two most comprehensive studies performed on nitrate-nitrogen. The results of both studies were similar. Nitrate-nitrogen concentrations are lowest in the summer and highest in the winter. This observation may be the result of phytoplankton and aquatic plants that absorb and utilize nitrate during the summer growing season. Concentrations of nitrate-nitrogen can vary markedly from one lake to another and from epilimnion to hypolimnion. However, variation in the epilimnion concentrations usually closely parallels similar changes in the hypolimnion (Oglesby et al. 1973; Mills 1975). In 1975, Mills reported the annual range of nitrate-nitrogen in Owasco Lake to be 211– 1,950 µg/L and in 1972 to be 107-2,551 µg/L. Nitrate-nitrogen is discussed in more detail in the tributary section of this report because of its association with agriculture run-off and septage.

Table 7
Range of Nitrate-Nitrogen in the Epilimnion of Owasco Lake from 1955-1973

Period	Reference	Number of samples	Mean nitrate-nitrogen ($\mu\text{g/L}$)
1955-56	Berg 1966	?	0.80
1964-70	NYSDEC 1972	46	0.64
6/15/1971 through 11/3/1971	Oglesby et al. 1973	10	0.52
5/24/1972 through 10/25/1972	Oglesby et al. 1973	20	0.52
1972, summer stratification	Mills 1975	14	0.64
1972, autumnal overturn	Mills 1975	13	0.79
1973, winter	Mills 1975	8	1.66
1973, vernal mixing	Mills 1975	8	0.66
1973, summer stratification	Mills 1975	8	0.61

Note: The current NYSDEC surface and groundwater standard for nitrate/nitrite is 10,000 $\mu\text{g/L}$ (NYSDEC 1994)

Phosphorus: Phosphorus is the limiting nutrient factor which determines aquatic plant production in most lakes, and hence, the trophic state of a lake (Effler et al. 1988). The concentration of phosphorus in a lake is influenced by the lake's retention time, the phosphorus loading rate, and the behavior of phosphorus within the lake (Johnson and Effler 1990).

Phosphorus is found in many different forms in a lake ecosystem. The forms of phosphorus are technically defined according to laboratory extraction procedures rather than their functional role in the environment. For example, two forms of phosphorus that are most commonly quantified for environmental studies are total phosphorus and soluble reactive phosphorus. Total phosphorus includes all forms of phosphorus (soluble, insoluble, organic, and inorganic). Soluble reactive phosphorus (SRP) is inorganic and soluble. SRP is the form of phosphorus most readily available for aquatic plant uptake (including phytoplankton).

Sources of phosphorus can originate from external loading sources, such as agricultural run-off, wastewater treatment facilities, chemical fertilizers or faulty septic systems. Sources of phosphorus can also emanate from internal loads, such as lake sediments. Internal loads do not add to the total phosphorus budget, however, if the sediment is overlain with oxygen depleted water, it can retard or prevent positive response to reduction in external loading (Johnson and Effler 1990).

There are three known phosphorus studies that analyzed samples directly from the waters of Owasco Lake. In addition, there were several other phosphorus studies on the lake's tributaries which are discussed in the tributaries section of this report.

Oglesby (1973) was the first researcher to perform a comprehensive phosphorus analysis of Owasco Lake (see Table 8). Oglesby concluded that the SRP is generally present in lower concentrations during the summer months and in bottom samples. This observation indicated that phosphorus was being concentrated in the hypolimnion (lowest stratum of the lake water; typically cold and relatively undisturbed). Oglesby also noted that there were short-term fluctuations in phosphorus concentrations in both the epilimnion (upper stratum of the lake water; more or less uniformly warm, circulating and fairly turbulent) and the

hypolimnion. This data indicated that a transfer of phosphorus from the epilimnion to the hypolimnion was occurring.

Table 8

Summary of Soluble Reactive Phosphorus for Owasco Lake Epilimnion During the Summer of 1971 and 1972

Period covered	Number of samples	Average for epilimnion (µg/L)		
		Mean	Maximum	Minimum
6/15/71 through 11/3/71	11	5.3	11.2	2.3
5/24/72 through 10/25/72	20	3.1	12.2	0

Note: The current NYSDEC surface and groundwater standard for phosphorus is 20 µg/L (NYSDEC1994)
Source: Oglesby et al. 1973

Mills (1975) sampled nutrients including soluble reactive phosphorus (SRP) and total phosphorus (TP) from June 1971 through August 1973. Samples were taken at one central station located in the middle of the lake. Mills showed the annual range of SRP in the lake to be a trace to 17.8 µg/L in 1972 and to be a trace to 13.4 µg/L in 1973. Mills concluded that, in general, the lowest concentrations of phosphorus were found to occur in late summer. After the summer stratification period, SRP concentrations increased beginning with the autumn overturn in which SRP became mixed throughout the water column (see Table 9). Oglesby (1973) hypothesized that with the die-off of aquatic macrophytes in the fall, considerable phosphorus could have been released directly to the water and/or transformed into detritus.

Table 9

Annual Range of Soluble Reactive Phosphorus in Owasco Lake 1972-73

Period	Soluble Reactive Phosphorus (µg/L)
1972, summer stratification	3.7
1972, autumnal overturn	4.4
1973, winter	7.6
1973, vernal mixing	4.1
1973, summer stratification	1.2

Note: The current NYSDEC surface and groundwater standard for soluble reactive phosphorus is 20 µg/L (NYSDEC 1994)
Source: Mills 1975

Effler et al. (1988) performed an extensive analysis of phosphorus in Owasco Lake. From the spring of 1986 to mid-summer there was a gradual decrease in TP, which is consistent with settling out and incorporation of particulate phosphorus into the lake's sediment. From mid-summer to early fall, however, there was a slight increase of TP, reflecting that external loading occurred.

Effler also looked at the temporal distribution of the volume-weighted concentration of total phosphorus in the epilimnion and hypolimnion of the lake. There was no significant difference in phosphorus concentrations between the epilimnion and the hypolimnion, which suggests that phosphorus settled out and was incorporated into the lake's sediment. The correlation between total phosphorus concentrations and depth were also analyzed. From this it was shown that sediment release and mineralization did not result in significant elevated concentrations in the hypolimnion stratification period.

Effler and Greer (1985) demonstrated that the concentration of total phosphorus has decreased by approximately 50% since the early 1970's (see Table 10). They suggested that the decreases were presumably due to reductions in external loading of phosphorus. A major component of the reduction may have been the statewide ban on high phosphorus detergents that went into effect in 1973. Effler concluded that because of the lake's 3-year retention time, it would take at least 3 to 5 years for a significant response to any nutrient management action.

Table 10
Concentration of Total Phosphorus
in the Epilimnion of Owasco Lake

Year	Total Phosphorus (mg/L)
1972	8.4
1973	9.4
1985	5.4
1986	4.5

Source: Effler et al. 1986

Note: There is no NYSDEC standard for total phosphorus

Finally, when determining phosphorus concentrations in lakes, it is important to determine the portion of phosphorus that is derived from internal loads. In July 1988, Johnson and Effler (1990) drilled three sediment cores at a centrally located monitoring station in the lake in approximately 50 meters (177 ft) of water. The researchers analyzed the sediment cores for phosphorus release rate. The results were between 0.2 and 1.0 mg/m²/day. They concluded that this rate was relatively low and consistent with unproductive lakes (Johnson and Effler 1990).

Major Ions

Ions are grouped into positively charged cations and negatively charged anions. Positively charged ions include calcium (Ca²⁺), sodium (Na⁺), and magnesium (Mg²⁺). Negatively charged ions include carbonate (CO₃²⁻), bicarbonate (HCO₃⁻), sulfate (SO₄²⁻), and chloride (Cl⁻). The major sources of ions are from salts that have leached from mineral soils and rocks. Ions can also originate from anthropogenic sources, such as from road salt, septage, and agriculture run-off.

The major ions in Owasco Lake have been analyzed and reported on three occasions. The first analysis took place during the 1950's (Berg 1966); the second between 1964 and 1970 (NYSDEC 1972); the third and most comprehensive analysis was reported in 1973 (Oglesby et al. 1973).

A comparison of the values identified by these studies is presented in Table 11. According to these values, there is a slight increase in dissolved inorganics between 1955 and 1973 (Oglesby et al. 1973).

Table 11
Comparison of Major Ions in Owasco Lake from the Mid-1950's to 1973

Ion	Major ions (mg/L)		
	Mid 1950's ^a	Mean 1964-70 ^b	January 3, 1973 ^c
calcium	36.00	48.00	38.00
magnesium	6.96	7.92	11.88
sodium	0.78	1.30	0.78
carbonate	na	1.20	13.80
bicarbonate	120.80	128.10	131.80
sulfate	19.70	25.00	18.70
chloride	4.97	11.36	9.94

a = Berg 1966

b = NYSDEC 1972

c = Oglesby et al. 1973

na=data not available

pH and Alkalinity

The pH of a lake is a measure of its acidity or alkalinity. Natural waters exhibit wide variations in relative acidity and alkalinity, not only in actual pH values, but also in the amount of dissolved materials that impact pH. Alkalinity of waters refers to the quantity and kinds of compounds present, which collectively shift the pH to the alkaline side of pH scale. The concentrations of these compounds and the ratio to one another determines the actual pH and buffering capacity of a lake.

In general, pH and alkalinity values for Owasco Lake have changed little from 1927-1986 (see Table 12). The pH of the surface water has remained at approximately 8.4 while the lower depth values are near 8.0. Both of these surface and lower depths values are typical of hard water lakes.

Oglesby (1973) has also shown that the pH values are usually higher in the summer than in the winter and that they are always on the basic side of neutrality. As phytoplankton grow and reproduce, they consume carbon dioxide, which becomes acidic when dissolved in water. Consequently, as carbon dioxide levels decrease, pH levels increase. This process explains why slightly higher basic pH values are found in the summer--when phytoplankton growth peaks, and at the water surface--where phytoplankton are most active.

Concomitant with pH is alkalinity. Calcium carbonate (CaCO₃) precipitate is the major byproduct of the "whiting effect" that occurs in the lake (Effler et al. 1988). The cause of the whiting effect, or whiting phenomenon, has not yet been fully explained by scientists. Some investigators believe warm temperatures initiate the production of phytoplankton, which causes a change in pH and results in the whiting effect. Other investigators suggest that carbonates precipitate out due to groundwater flowing through carbonate containing rock (limestone) and discharging into surface waters (Simmons 1992).

Table 12
pH Values for Owasco Lake

Date	Epilimnion (< 10 m)*		Hypolimnion (>10m)**	
	Mean pH	Number of Samples	Mean pH	Number of Samples
Aug. 4, 1927 ^a	8.4	1	8.0	2
Jul. 28, 1942 ^b	8.2	4	7.9	7
1971-72 ^{cd}	8.0	46	8.0	46
summer 1971 ^e	8.3	11	8.1	10
summer 1972 ^e	8.4	32	8.2	19
summer 1986 ^f	8.4	21	8.0	21

^a NYSDEC (1928) from Oglesby (1973)

^b NYSDEC (unpublished) from Oglesby (1973)

^c NYSDEC (1972)

^d Mean of all depths

^e Oglesby (1973)

^f Effler et al. (1988)

*approximately 0-10 meters in depth

** approximately 10-55 meters in depth

The most common mineral of calcium carbonate is calcite, which is sensitive to temperature and pH. In other words, as temperature increases, the solubility of calcite drops thereby causing calcium carbonate to precipitate out of solution. In addition, as previously mentioned, when photosynthetic activity increases near the surface of the lake, there is a drop in carbon dioxide concentrations, and as a consequence, an increase in pH. Furthermore, an increase in pH causes calcium carbonate to precipitate out of solution. Table 13 shows the historic alkalinity values (as mg/L of CaCO₃) for the lake. In general, alkalinity values are relatively the same from 1927-1986. The lower layers of the lake have somewhat higher alkalinity values in warmer months. This is primarily due to precipitates of calcium carbonate which sink from the upper layers.

Table 13
Alkalinity Values for Owasco Lake

Date	Epilimnion (< 10 m)*		Hypolimnion (>10m)**	
	Mean Alkalinity (mg/L as CaCO ₃)	Number of Samples	Mean Alkalinity (mg/L as CaCO ₃)	Number of Samples
Aug. 4, 1927 ^a	105	1 at 1m	107	1 at 50 m
Jul. 27, 1942 ^b	101	4	102	14
1971-72 ^{cd}	104	49	104	49
summer 1971 ^e	87	9	102	10
summer 1972 ^e	106	31	108	18
summer 1986 ^f	108	19	111	18

^a NYSDEC (1928) from Oglesby (1973)

^b NYSDEC (unpublished) from Oglesby (1973)

^c NYSDEC (1972)

^d Mean of all depths

^e Oglesby (1973)

^f Effler et al. (1988)

* approximately 0-10 meters in depth.

** approximately 10-55 meters in depth

Both the basic pH values and moderate alkalinity values are attributed to calcium carbonate, which ultimately comes from the watershed's limestone bedrock. Basic pH values and moderate alkalinity values provide an excellent buffering capacity, which retards leaching of mineral soils, protects the lake from acid rain, and gives the water its "award winning" taste.

Pesticides

There are two programs that monitor pesticides from the waters of the lake. The NYSDOH administers the Pesticide Monitoring Survey with assistance from the NYSDEC and the United States Geological Service (USGS). The program, which began in June 1997, is designed to measure the presence of pesticides in surface waters throughout the state. There are 80 sites statewide, including Owasco Lake.

Samples are first tested using the experimental immunoassay test kit. If any pesticide is detected, it is confirmed using Gas Chromatography (GC) and U.S. Environmental Protection Agency (USEPA) approved methods.

A sample was taken above the slow sand filters at the Auburn Water Filtration Plant (Swift Street) in June 1997. Although the herbicide Metolachlor was detected at 0.1µg/L (ppb), the level was well below the NYSDOH maximum contaminate level (mcl) for drinking water (50 µg/L). A sample was taken at the town of Owasco Water Filtration Plant (East Lake Road) in June 1997. All pesticides tested in this sample were below the detection limit.

In 1998, a sample from the Auburn Filtration Plant was taken and the pesticide Atrazine was detected at 0.15 µg/L using the immunoassay test kit. This value is not considered a legitimate detection because it is significantly below the GC detection level.

The second pesticide-monitoring program is called the Statewide Pesticide Monitoring Program and is administered by the NYSDEC and assisted by USGS. This program, which began in 1996, is a research initiative designed to help establish a database for long term monitoring of several Finger Lakes. Gas Chromatography-Mass Spectrophotometry (GC-MS) is the method used to measure pesticide concentration for this program and is an extremely sensitive one. In general, the pesticide concentrations detected are two orders of magnitude (200 times) less than the NYSDOH detection limits.

In September 1997 a sample for pesticides was taken approximately 3 miles south of the northeast shore of the lake. Three pesticides were detected, Atrazine at 0.059 µg/L, Cyanazine at 0.0053 µg/L, and Metolachlor at 0.030 µg/L. Three additional pesticides had estimated concentrations (Alachlor at 0.003 µg/L, Diethyl Atrazine at 0.0238 µg/L, and Simazine at 0.0047 µg/L). Estimated concentrations are those which are too close to the detection limit and are therefore estimated. It should be noted that although there were a larger number of pesticides detected with this method, they were detected at relatively low levels – well below the NYSDOH maximum contaminate levels for drinking water (USGS 1997).

Finally, there have been reports of individuals using algaecides and aquatic herbicides to control weeds along docks and shorelines of lakeside residences. The impact of herbicide use along waterways is most clearly evident during an algae kill, which produces a blue-green film on the surface of the water. Watershed rules prohibit the use of algaecides and herbicides to control aquatic weeds (see Appendix D).

Temperature

Historic water temperature profiles for the lakes are depicted in Figure 6. The thermal stratification process and the importance of vertical mixing related to the cycling of nutrients, phytoplankton biomass, and oxygen concentrations will be discussed in their respective segments of this report.

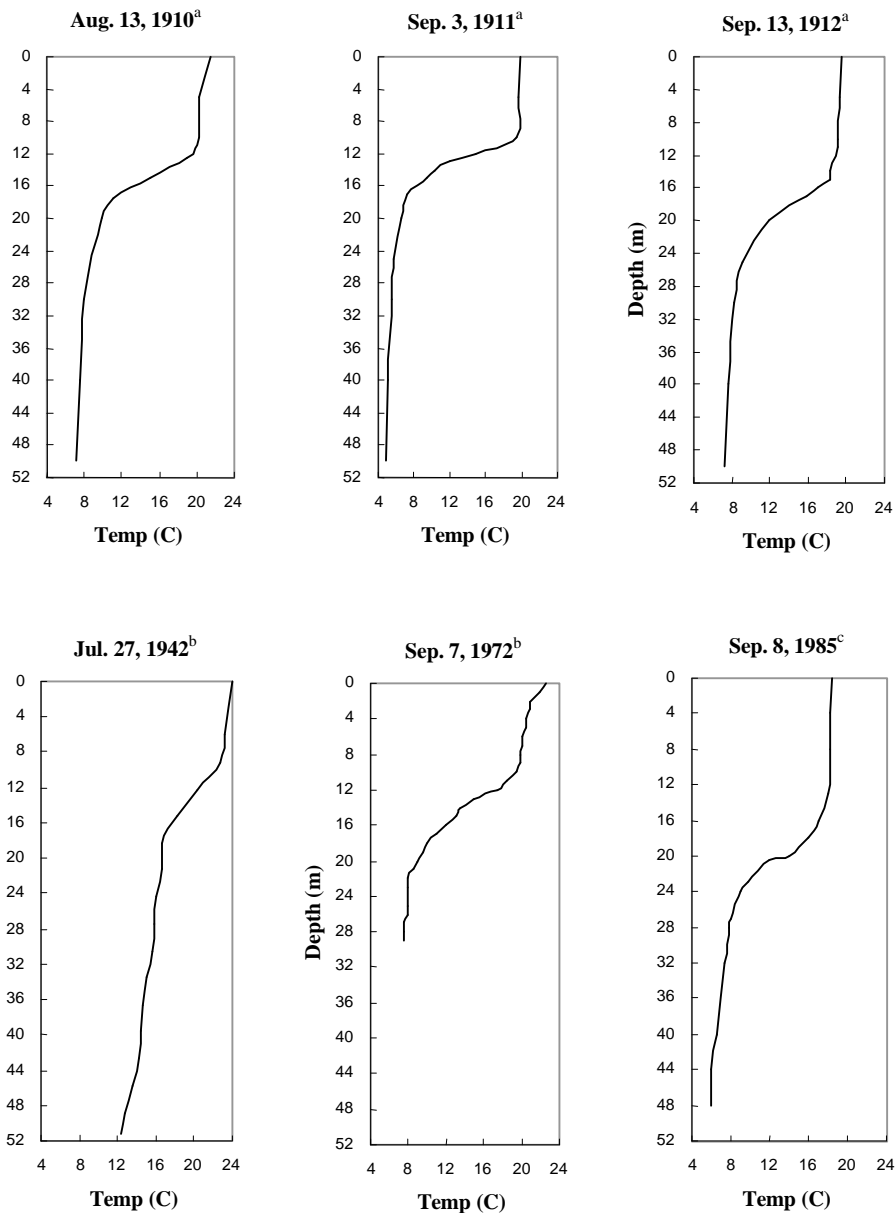


Figure 6. Comparison of individual summer temperature profiles for Owasco Lake 1910 to 1985.

^a Birge and Juday 1921

^b Oglesby 1973

^c Effler et al. 1988

Turnover

As explained in *The Natural History of Lakes* (Burgis and Morris 1987), when the surface waters of a lake begin to warm up in the spring, the heat takes a long time to penetrate to the bottom of a lake. Eventually, there is a marked difference in temperature between the upper layer of the lake and the water at lower depths. This means that there is also a difference in density of the water: lighter water floats on top of denser cooler water. When a lake divides into an upper, warmer layer and a lower, colder layer, the lake is said to be stratified (summer stratification).

The two layers, or strata, are known as the *epilimnion* (the top layer) and the *hypolimnion* (the lower layer). Between the epilimnion and the hypolimnion lies a relatively narrow zone frequently called the *thermocline*. In 1910, Birge and Juday (1921) measured the depth of the epilimnion to be 12 meters, the hypolimnion to be 34 meters and the thermocline to be 8 meters for the summer stratification of Owasco Lake.

As the air temperature declines during autumn, so does the surface water temperature. Eventually there is much less difference in density between the water of the epilimnion and that of the hypolimnion. This situation enables the first strong wind to mix the layers of water so that the temperatures at the top and bottom of the lake are essentially the same. When this process occurs the lake is said to have overturned (fall overturn).

In the winter, if ice covers a lake for prolonged periods, there may be an inversion stratification. An inversion stratification is when the water immediately under the ice is colder and less dense than the deeper waters. When spring arrives and the ice thaws, the surface of the lake is again exposed to the wind, and as a result, the water is mixed until its temperature is the same from top to bottom (spring overturn). Table 14 describes historical dates that stratification and overturn have occurred in Owasco Lake.

Table 14
Dates of Stratification and Overturn for Owasco Lake

Period	Date
Summer Stratification	May 24 – October 19, 1972
Fall Overturn	October 25 – December, 1972
Winter	January 3 – April 1, 1973
Spring Overturn	April 10 – May 21, 1973
Summer Stratification	May 28 – August 26, 1973

Source: Mills 1975

Transparency

How well one can see an object in water is a measure of the water's transparency, or clarity. The ability of light to penetrate the water so that the object can be seen depends on the number of particles dissolved or suspended in the water. Sometimes we say that the water looks "murky" or "crystal clear". Examples of particles that can "cloud up" the water

are phytoplankton (algae), dissolved organic matter (detritus) and inorganic particulate matter (e.g. precipitates of minerals).

One method that measures transparency is the use of a Secchi disc. Typically, the Secchi disc is 20-cm in diameter, is made of metal, and is attached to a rope to be lowered into the water. The depth at which the disc disappears from view is then recorded. The Secchi disc method is based on light penetration and is what the public most often perceives water quality. Generally, in spring or in autumn, when there is a lot of runoff or when mixing occurs after a storm, there are more particles that enter the water resulting in lower transparency. On the other hand, in mid to late summer when there is usually less runoff, higher transparencies are often present. Table 15 lists historic Secchi disc transparency measurements from Owasco Lake.

Table 15
Secchi Disc Transparency in Owasco Lake for 6 Years

Year	Mean (meters)	Maximum (meters)	Minimum (meters)	Number of Samples (n)
1971 ^a	3.4	5.0	2.4	7
1972 ^a	3.3	4.35	2.3	13
1973 ^a	2.6	5.0	1.1	14
1984 ^b	4.0			
1985 ^c	3.1	4.6	1.85	12
1986 ^c	2.7	4.5	1.25	14

^a Oglesby (1973)

^b Miller (1984)

^c Effler (1988)

Within the 15 years of transparency recordings for the lake (1971-1986), there has not been a significant change in the Secchi disc readings but rather to the “whiting effect” phenomena. The whiting effect occurs when species of calcium precipitate under certain conditions of temperature and pH (Effler 1988). Secchi disc readings typically show higher transparency in the open waters of the lake and lower transparency in the shallower areas. Due to the shallowness of the southern end of the lake, particulate levels are historically higher because of the proximity to the Owasco Inlet (Miller 1984). The relatively low Secchi disc readings may not entirely be due to the abundance of phytoplankton as some scientists have suspected (Effler 1988).

Turbidity

Turbidity refers to the amount of suspended particles in water. In a lake, turbidity is typically caused by a mixture of suspended particles that include clay, silt, finely divided organic and inorganic matter, phytoplankton, and other microscopic organisms. These particles can come from tributaries that feed into the lake or they can be resuspended from lake sediment that has been disturbed or agitated (from either natural or human-induced activities). According to Effler et al. (1988), the major source of turbidity for the lake is caused by the precipitation of carbonates, or whiting effect. Table 16 shows the historic turbidity levels for Owasco Lake.

Table 16

Comparison of Turbidity Levels in the Upper Epilimnion of Owasco Lake

Year	Mean (NTU)	Maximum (NTU)	Minimum (NTU)	Number of Samples (n)
1964-70 ^a	12.2			46
1985 ^b	2.18	4.0	1.2	14
1986 ^b	2.66	4.7	1.3	14

NTU = Nephelometric Turbidity Unit

^a NYSDEC (1972) found in Oglesby (1973)^b Effler (1988)**Chlorophyll a**

Chlorophyll *a* is a photosynthetic pigment common to all phytoplankton. Thus, researchers typically measure the level of chlorophyll *a* in water to quantify the amount of phytoplankton. For example, high concentrations of chlorophyll *a* indicate high concentrations of phytoplankton. In turn, high phytoplankton may indicate high nutrient loading and lower transparencies. Table 17 depicts the historic chlorophyll *a* concentrations for Owasco Lake.

This chlorophyll *a* data indicates that the concentration of phytoplankton has been decreasing since 1971. The reduction is most likely due to the ban on phosphorus-containing detergents in the early 1970's (Effler 1988).

Table 17Comparison of Chlorophyll *a* Concentration in the Epilimnion of Owasco Lake During the Summer of 5 Years

Year	Mean (mg/m ³)	Maximum (mg/m ³)	Minimum (mg/m ³)	Number of Samples (n)
1971 ^a	5.3	9.5	undetectable	9
1972 ^a	2.7	5.3	undetectable	20
1972 ^b	5.8	-	-	-
1973 ^b	4.8	-	-	-
1985 ^c	2.3	-	-	12
1986 ^c	1.8	5.2	0.45	12

^a Oglesby (1973)^b Mills (1975) found in Effler (1988)^c Effler (1988)

Phytoplankton

Phytoplankton are microscopic plants that are common to most surface waters. Most often, phytoplankton consist of a large number of algal species which need light, nutrients, and warm temperatures to multiply. Like all green plants that photosynthesize, phytoplankton absorb light and carbon dioxide during the day, which results in the production of oxygen and glucose. During the night, they consume oxygen and use glucose in a process called cell respiration. When phytoplankton die, they fall to the bottom of the lake and decompose. This event also consumes oxygen.

Phytoplankton are the principle regulators of water transparency; they effect oxygen concentrations in lower depths, and are indicators of phosphorus levels. Many researchers quantify phytoplankton by measuring the amount of chlorophyll a pigment found in a cubic meter of water. However, identifying specific species of phytoplankton can also be used as a method to determine the trophic conditions of a lake.

Edward Mills, a doctoral student of Professor Oglesby at Cornell University, classified the trophic conditions of Conesus, Hemlock, Owasco, and Skaneateles Lakes based on physical, chemical, and biological data. The biological data included identification of phytoplankton species. Mills suggested that relative dominance of species representing different taxonomic groups can be used as an indicator of the trophic status of a lake. For example, Conesus Lake was considered eutrophic because of the dominance of *Melosira granulata*, while Skaneateles Lake was considered oligotrophic because of the dominance of *Dinobryon sertularia*. In Owasco Lake, *Asterionella formosa* was the predominant species. *Asterionella formosa* is found in eutrophic as well as oligotrophic lakes. Mills concluded, "The dominant phytoplankton in Owasco Lake are suggestive of a wide range of trophic conditions and so this lake can be classified as relatively mesotrophic insofar as its phytoplankton assemblage is concerned."

The historical data regarding identification of phytoplankton species in the lake is limited. Birge and Juday (1910) were the only other investigators that identified species of phytoplankton (see Table 18). Birge and Juday described the vertical distribution of various phytoplankton.

Oglesby (1973) also identified phytoplankton in his report, but much of this work was included in Mill's (1975) doctoral dissertation. Table 11 is from Mill's 1973 study. It describes the vertical distribution of various phytoplankton. Comparing phytoplankton species found in 1910 to those found in 1972, only three groups are common in depths from 0 to 10 meters: *Anabaena*, *Asterionella*, and *Fragilaria*. If one compares the relative contribution of major phytoplankton species to the total biomass from 1910 (see Table 18) to that of 1972 (see Table 19), there is a shift in the dominance. *Clathrocystis* composed 44.6% in 1910, while in 1972 it was not found. In 1972, the major phytoplankton species was *Asterionella formosa* (22.8%); in 1910 it was 2.0%. Other common phytoplankton are: *Anabaena* 4.7% (1910), 1% (1972); and *Fragilaria* 0.2% (1910), 14.9% (1972). The question arises-- what conditions in the lake (human induced or natural) have caused the change in phytoplankton species dominance?

Table 18
Relative Contribution of Major
Phytoplankton Species to the Total
Biomass for Owasco Lake,
August 10, 1910

Phytoplankton	% of Total Biomass
<i>Clathrocystis</i>	44.6
<i>Aphanizomenon</i>	40.8
<i>Tabellaria</i>	4.8
<i>Anabaena</i>	4.7
<i>Asterionella</i>	2.0
<i>Gloeocapsa</i>	1.9
<i>Oscillatoria</i>	0.9
<i>Fragilaria</i>	0.2

Source: adapted from Birge and
Juday 1921

Table 19
Relative Contribution of Major
Phytoplankton Species to the Total
Biomass for Owasco Lake, Summer 1972

Phytoplankton	% of Total Biomass
<i>Asterionella formosa</i>	22.8
<i>Peridinium cinctum</i>	22.7
<i>Fragilaria crotonensis</i>	14.9
<i>Cryptomonas erosa</i>	13.4
<i>Cryptomonas pusilla</i>	7.1
<i>Microcystis aeruginosa</i>	5.9
<i>Dinobryon sertularia</i>	5.4
<i>Cryptomonas ovata</i>	3.5
<i>Melosira granulata</i>	3.2
All <i>Gymnodinium</i>	2.3
<i>Dinobryon bavaricum</i>	2.1
<i>Cyclotella</i>	2.0
<i>Synedra ulna</i>	1.4
<i>Anabaena flos-aquae</i>	1.0

Source: Mills 1975

Zooplankton

Plankton are microscopic plants and animals composed of zooplankton (animal component) and phytoplankton (plant component). Zooplankton are largely made up of Copepods, Cladocera, and Rotifers and are generally less than 2 mm in length. Some zooplankton feed on plants (herbivores), some feed on animals (carnivores) and some feed on plants and animals (omnivores). Zooplankton are considered a biologically important component of a “healthy” lake. They control algae and other phytoplankton, bacteria populations, and form an important food component for several fish species. As a result, zooplankton populations are valuable indicators of change in the conditions of a lake.

Review of the historical data shows that zooplankton in the lake have changed since Birge and Juday first quantified them in August of 1910. Table 20 summarizes the total number of species for each major group of zooplankton.

Table 20
Summary of the Total Number of Species for Each Major Group of
Zooplankton Found in Owasco Lake

Zooplankton Group	1910 ^a	1965 ^b	1972-73 ^c	1986 ^d
Copepods	4	5	5	4
Cladocera	4	5	5	6
Rotifers	3	0	14	15

^a Birge and Juday (1921)

^b Hall and Waterman (1967)

^c Chamberlain (1975)

^d Effler et al. (1986)

In 76 years (1910-1986), the major zooplankton groups have changed from Copepods and Cladocera to Rotifers. Table 21 shows the average number of zooplankton per cubic meter (m³) in the total water column in the month of August for years 1910, 1972, and 1973.

Table 21

Average Zooplankton (Per Cubic Meter) in Total Water Column Found in Owasco Lake During August of 3 Years

Organism	1910 ^{aγ}	1972 ^{bχ}	1973 ^{cξ}
<i>Nauplii</i>	6,375	85	949
<i>Cyclops spp.</i>	498	114	169
<i>Diaptomus spp.</i>	7,240	12,915	94
<i>Epischura spp.</i>	20	0	0
<i>Senecella spp.</i>	53	127	47
<i>Bosmina</i>	486	566	4,014
<i>Daphnia</i>	222	3,353	0
<i>Diaphanosoma</i>	172	4,674	28
<i>Asplanchna</i>	253	1,638	780
<i>Conochilus</i>	39	1,3919	10,735
<i>Polyarthra</i>	125	0	2,275
Total Zooplankton	15,483	37,391	19,019

^a Birge and Juday (1921)

^γ based on one sample

^b Hall and Waterman (1967)

^χ mean of four samples

^c Chamberlain (1975)

^d Effler et al. (1986)

In 1910 and 1972, *Diaptomus spp.* (from the Copepod group) was the dominant species with 7,240/m³ and 12,915/m³ respectively. However, in 1973, *Polyarthra* (from the Rotifer group) was dominant with 10,735/m³.

Lastly, if one looks at the mean zooplankton/m³ in the upper 15 meters of water, we see that *Polyarthra* is dominant in 1910 and in 1986 (see Table 22). The data indicates that in some years the dominant zooplankton group changes, while in other comparisons the groups stay the same.

Table 22

Mean Zooplankton (Per Cubic Meter) in the Upper 15 Meters of Owasco Lake in August of 2 Years

Organism	1910 ^{aγ}	1986 ^{bχ}
<i>Nauplii</i>	1,690	17,833
<i>Cyclops spp.</i>	1,660	22,917
<i>Diaptomus spp.</i>	4,200	2,000
<i>Epischura</i>	0	-
<i>Senecella</i>	0	-
<i>Bosmina</i>	1,576	12,250
<i>Daphnia</i>	697	7,667
<i>Diaphanosoma</i>	573	833
<i>Asplanchna</i>	843	1,667
<i>Conochilus</i>	130	9,000
<i>Polyarthra</i>	7,336	34,833
Total Zooplankton	33,912	109,000

^a Birge and Juday (1921)

^γ based on one sample

^b Effler et al. (1986)

^χ mean of three samples

Studies have shown that in a given year one group of zooplankton species will dominate oligotrophic lakes, or lakes have stable low nutrient inflow (Effler et al. 1988). The scenario given for Owasco Lake is indicative of a changing nutrient content predisposing to eutrophication conditions.

Macrobenthic vegetation

Aquatic vegetation in Owasco Lake, as in any body of water, is limited to the sandy soils of the littoral zone. This area is loosely defined as the zone between the high-water mark and where sunlight can no longer reach the bottom. Owasco Lake has relatively few littoral zones. The majority of the littoral area is found in the shallow, north end of the lake and the swampy area to the south. A normal balance of growth in the lake would include *Nymphaea* (water lily), *Nuphar* (yellow water lily), *Brasenia* (water shield), several species of *Potamogeton* (stonewort), *Typha* (cattail), *Sparganium* (burr reed) and *Myriophyllum* (milfoil).

Concern has increased over the years as *Myriophyllum* (milfoil) has become more prolific and gradually over-populated the aquatic community at the expense of other species. This increase in growth can be attributed to a number of factors, including nutrient loading and siltation of the shallow waters where aquatic plants root. Managing aquatic vegetation is a priority in many of the Finger Lakes, including Owasco Lake where a weed-harvesting program is currently in place.

Fish

In general, the fish community of Owasco Lake is the cold water, salmonid type. However, the lake supports an exceptional sport fishery for both cold and warm water species. Lake trout, rainbow trout, walleyes, ciscoes, and smelt were present in the lake prior to the 1927 survey of the Oswego River Basin by the New York State Conservation Department (now known as the NYSDEC). There are approximately 35 fish species known to inhabit the lake. Coldwater gamefishes include lake trout, rainbow trout, and brown trout. Important warmwater game and panfishes include walleye pike, northern pike, smallmouth bass, yellow perch, and brown bullheads. Significant forage species include the alewife and smelt. The cisco (*Coregonus artedii*) was once very abundant but is now considered uncommon or rare.

Dominant species in terms of abundance and biomass are lake trout in the coldwater community, yellow perch in the warmwater community, and alewives in the forage species community. Diatoms, dinoflagellates and cryptomonads are the dominant phytoplankton group which form the basis of the food web in the lake. The zooplankton community is dynamic and the sequence of species dominance shifts regularly.

In terms of tributaries, the Owasco Inlet is important to the lake fishery because it serves as a nursery for several species of fish, particularly rainbow trout that spawn in the main stream and at least two of its tributaries. Dresserville Creek and Peruville Creek serve as rearing areas for landlocked salmon. Northern Pike utilize marshy areas of the Owasco Flats for spawning. Dutch Hollow Brook is valuable as a smallmouth bass spawning and nursery stream. In addition, it supports a native population of rainbow trout, but suitable spawning and nursery areas for lake-run fish is very limited.

The principal management tools that have been employed are catch regulation, habitat improvement for anadromous salmonids, and stocking, including the introduction of new species. In terms of management, several issues have been identified by anglers as being most crucial. First, reduction of siltation in tributaries, especially in the Owasco Inlet and Dutch Hollow Brook, is important to maintain productive spawning areas. When siltation occurs during the spring, eggs are smothered and successful spawning is significantly reduced. Secondly, management of water control structures with concern for fisheries could substantially impact both the quality and quantity of fishes in the lake. Aquatic vegetation control practices can also impact the fisheries when habitat for fish is removed or when fish are actually directly destroyed by the harvesting machinery.

Chemical, Physical and Biological Data --Tributaries

Between 1927 and 1981 there were five known studies performed on the lake's main tributaries and its outlet, the Owasco River. The NYSDEC Biological Survey (1928) conducted a small, two-day chemical and physical analysis of the Inlet, Outlet, and Tributary 17 (see Table A-2 in the Appendix A, page 99). A larger, 22-month study (April 1971 – January 1973) of the lake's tributaries was performed by Professor Lawrence Hamilton and Mr. Peter Willing of Cornell University for Oglesby's 1973 study. The results are listed in their entirety in Tables A-3 through A-9 in Appendix A, pages 100-102).

The results indicate that both pH and alkalinity generally increased with distance downstream, and are higher in the warmer months than in the colder months. Alkalinity, and to a lesser extent pH, decreased markedly in response to heavy precipitation. Averages from the study period indicate that the lake removed approximately 18% of the inflowing calcium and 24% of the bicarbonate ions.

Dutch Hollow Brook and Sucker Brook have higher calcium and bicarbonate levels than the Inlet, as might be expected from the underlying limestone formation in the northern portion of the basin (Oglesby et al. 1973). However, the streams are markedly different from one another in the levels of magnesium, sodium, and sulfate. Regarding nitrate and phosphorus, the data indicates that, at the time of sampling, there were higher concentrations of these nutrients downstream of the Moravia and the Groton Wastewater Treatment Facilities. Regarding nutrient loading, since the USGS gauge on the Owasco Inlet was not active during the study period (summer 1971) assumptions were made regarding calculation of nutrient loading.

By comparing the total tributary and outlet loading, it appears that approximately 88% of the entering soluble reactive phosphorus, and about 45% of the nitrate-nitrogen added, is retained in the lake on an annual average basis. Of the total nutrients added by tributaries, 87% of the soluble reactive phosphorus and 67% of the nitrate-nitrogen enters the lake via the Inlet.

One of the major studies on the lake's tributaries on the principal nutrient loading factors was conducted by professors Harry Greer and Roland Gassler of Cayuga Community College in 1979. The study focused on chemical, physical, and biological parameters of the lake's main tributaries: Sucker Brook, Dutch Hollow Brook, Owasco Inlet, and Veness Brook. These four tributaries account for approximately 90% of the water flow into the lake.

The results suggested that the major cause of nutrient loading was from fecal contamination, as indicated by the high fecal coliform counts. Greer and Gassler suggested

recommendations to alleviate this problem. Specifically they recommended minimizing manure and chemical fertilizer run-off, conducting septic system inspections, improving the Moravia and Groton Wastewater Treatment Facilities, and controlling application of lawn fertilizers. The results of this study are listed in Table A-10 in Appendix A, page 103).

In 1980, Greer and Gassler again analyzed waters from Sucker Brook, Dutch Hollow Brook, Owasco Inlet, and Veness Brook. In addition, they examined nitrate and phosphorus in the soils located on the banks and fields adjacent to the tributaries. The results from this (Tables A-11 and A-12 in Appendix A, pages 104-105) indicate that the nitrate and phosphorus in the soils are relatively small compared to surface run-off, and that the majority of all nutrients entering the lake are from surface run-off from agricultural lands.

In 1989, Nasemann, White, Waibel, and Carr (1992) started a comprehensive analysis of phosphorus and solids loading on Dutch Hollow Brook and the Owasco Inlet. In terms of volume, these two tributaries are the largest and account for approximately 75% of the surface water entering the lake. Calculating phosphorus loads required measuring phosphorus concentrations (TP and SRP) and stream flow. An interactive software package called FLUX (Walker 1986) was used in the calculations.

Between 1988 and 1989, 472 samples were taken from Owasco Inlet, while 493 samples were taken from Dutch Hollow Brook. The annual total phosphorus load from Owasco Inlet was approximately 30,000 kg/year. Approximately 1718 kg of the total phosphorus load was SRP. The annual loads from Dutch Hollow Brook were approximately 6,800 kg/year with 507 kg/year being soluble reactive phosphorus. Together, Owasco Inlet and Dutch Hollow Brook contributed a total of 36,000 kg/year of TP, and 2,225 kg/year of SRP.

The researchers concluded that the phosphorus loading estimates for Dutch Hollow Brook resulted almost entirely from nonpoint source, stormwater events. On the other hand, phosphorus loading from Owasco Inlet is partially derived from point-source loading caused by wastewater treatment facilities.

SECTION II -- WATERSHED LAND USE, ECONOMY, AND CULTURAL RESOURCES

History

The first archaeological site in the watershed where historians studied the early Native American transition from hunting and gathering to a culture based on agriculture is located in the Owasco Valley. In 1915, E. H. Gohl discovered some artifacts at the foot of the lake and called the discovery to the attention of Arthur C. Parker of the New York State Museum. Parker and Richie investigated the site at Emerson Park in 1922 and 1944. The Owasco culture preceded the Iroquois and existed around 1000 A.D.

The earliest white settlers to the watershed were a company of Dutch Reformed Christians. These settlers formed two of the earliest churches in the area -- the Owasco Reformed Church in the hamlet and the Sand Beach Church at the foot of the lake. John Hardenburgh, founder of Auburn, and Martina Brinkerhoff were married in the Sand Beach Church when it was a log structure.

President Millard Fillmore was born in Summerhill and grew up in the town of Niles, the location where he also returned to marry his schoolteacher, Abigail Powers. Another resident of the town of Niles was William Rockefeller, scion of the family destined to become the richest in America.

As forests were cleared and the supply of wood for fuel diminished, industrialists in upstate cities began to invest in railroads connecting to the coal supply in Pennsylvania. At that time, the east shore of the lake was the route of the Southern Central Railroad from Auburn to the coalfields beyond Sayre, Pennsylvania. Later, the Lehigh Valley Railroad purchased the Southern Central; the line was dismantled after 1975.

In Moravia, early settlers harnessed the waterpower of Mill Creek, which feeds the Owasco Inlet. It was here that Jethro Wood's cast iron plow was forged, although the inventor fought numerous court battles to secure his patent.

The 19th century saw the development of the lake as a playground for those who could afford it. Grandiose estates ringed the lake. The oldest estate was Willowbrook, home to Governor Throop and later, the Martin heirs. William H. Seward resided at Seward Point while the Underwoods were at Long Point. Across the lake was the Casowasco estate of Theodore Case, inventor of sound on film.

Access to the lake for the general public was limited to few locations, such as Lakeside Park, which had amusement rides that adjoined the electric trolley. In the summertime, Koenigs Point, Edgewater, the Cascade Hotel, and Ensenore Hotel were all connected by steamboat. In later years, most of the surviving places became youth camps for the Knights of Columbus, YMCA, Boy and Girl Scouts, Methodist Conference, and others.

In addition, there are many other accounts and stories that watershed residents, both past and present, can share regarding anecdotal history of grand experiences shared on the shores of the lake.

Human Population

The Owasco Lake Watershed is characterized by a relatively low population density of approximately 79 persons per square mile. Based on an analysis of data compiled by the U.S. Census Bureau in 1990, the Cayuga County Planning Department has calculated the total 1990 population of the watershed to be approximately 15,866. This total was calculated by adding the 1990 populations of census blocks whose corresponding centroids, or geographic centers, are contained within the watershed. Census blocks are the smallest entities for which the Census Bureau collects and tabulates decennial census information. Census blocks are bounded on all sides by roads, streams, railroad tracks, or other features shown on Census Bureau maps. It is possible that small shifts in population have occurred in the nearly ten years since the 1990 data was collected.

Existing Land Use

The watershed covers approximately 123,131 acres of the land area. Approximately 82.5% of the acreage in the watershed lies within Cayuga County with 16.2% in Tompkins County and 2.3% in Onondaga County. The largest portion of land use within the watershed is agriculturally related (55.4%), followed by mixed forestlands (38.5%), evergreen forestland (2.1%), residential use (1.4%), and wetlands (0.8%) (see Figure 7). Agricultural land is widely dispersed, but is most concentrated to the east and west of the lake. Many of the residential areas in the watershed are low-density/rural, however, there is a higher concentration of homes along the lakeshore. Many of the lakeshore residences are seasonal and fully functional for only three months out of the year. Table 23 provides detailed land use data for all the acreage within the watershed.

Land Use/Land Cover

Owasco Lake Watershed

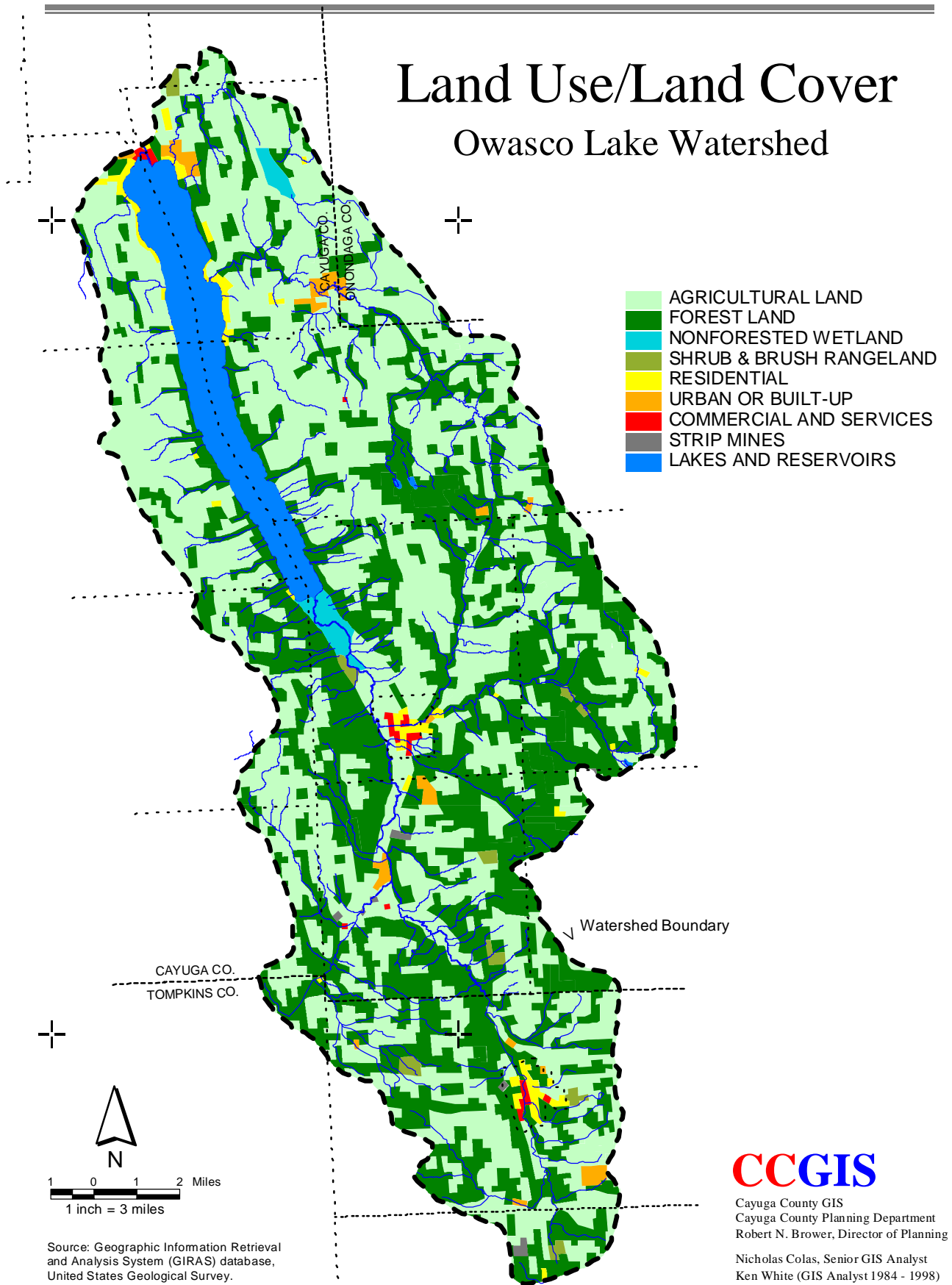


Figure 7. Map of land use/land cover in the Owasco Lake Watershed.

Table 23
Approximate Land Use Acreage in the Owasco Lake Watershed

Land Use	Acreage	Percentage of Total
Commercial and Services	424	0.3%
Cropland and Pasture	67562	54.9%
Evergreen Forest Land	2549	2.1%
Lakes and Reservoirs (other than Owasco)	60	0.1%
Mixed Forest Land	47373	38.5%
Mixed Urban or Built-up	313	0.3%
Non-forested Wetland	980	0.8%
Other Agricultural Land	210	0.2%
Other Urban or Built-up	905	0.7%
Residential	1769	1.4%
Shrub and Brush Rangeland	790	0.6%
Strip Mines	196	0.2%

Source: Geographic Information Retrieval and Analysis System (GIRAS) database, USGS, 1977-1980.

Agricultural Resources

The predominant land use in the watershed is agriculture. There are approximately 200 farming operations in the watershed. The variety of operations varies as much as the size of the farms, which range from 15 to 2,100 acres.

A majority of the farmland is utilized to provide feed and forage for livestock both within and outside the watershed. Some farmers raise only a few animals to supplement their incomes and provide food for themselves and their families. Others raise over 500 animals either in confined feed lots or in grazing programs.

A majority of farmland remains in continuous crop production, most notably corn production, because of the relatively high productive soil quality. Major field crops grown in the watershed include corn, wheat, soybeans, hay, snap beans, sweet corn, peas, barley, oats, and potatoes. Acreage of soybeans and vegetable specialty crops have increased over the past five years primarily due to stagnant corn prices and the availability of convenient markets. In addition to the vegetables listed above, roadside stands produce tomatoes, pumpkins, gourds, strawberries, blueberries, garlic, and beans. There are also several fruit orchards in the watershed.

Forest Resource Use

There are a number of sawmills located within the watershed which process raw wood into construction and landscape timbers, pallets, and lumber. The mills provide employment to residents within the watershed as well as income to both public and private forest owners. Due to recent values for hardwood sawtimber and a declining demand for low-grade logs, there has been significant pressure to high-grade and over-harvest private forested lands (Richard Fox, personal communication, 1998).

Roads/Highways

There are approximately 480 miles of maintained roads within the watershed. Of the 480 miles, approximately 120 miles can be classified as major roads (either state or county routes). Table 24 specifies the mileage for each type of road.

Table 24
Approximate Road Mileage in the Owasco Lake Watershed

County	Mileage	Major Roads
Cayuga	380 miles	105.75 miles
Tompkins	91 miles	11.17 miles
Onondaga	11 miles	3.73 miles

Recreation

Owasco Lake and its surrounding watershed offer a number of recreational opportunities, especially during the summer months. Although numerous activities occur throughout the year, the warmer seasons encounter the highest concentrations of outdoor recreational use. The lake itself offers swimming for lakeshore residents and for the public at Emerson Park, located at the north end of the lake. Emerson Park also offers public picnic facilities, boat launches, and fishing areas.

Boating is popular all along the lakeshore. In addition to boating access from private lakeshore properties, Emerson Park and South Shore provide mooring and access to the lake. Several other marinas provide boating access via the Owasco River.

Owasco Lake is considered to be an exceptional fishery. A variety of species for recreational fishing are present in the lake including: yellow perch, walleye, smallmouth bass, northern pike, lake trout, rainbow trout, brown trout, and landlocked salmon.

Within the watershed boundary, there are several parks and trails. Fillmore Glen State Park, located in Moravia, offers public trails and a swimming area. Frozen Ocean State Reforestation Area, with private recreation trails, is located along the eastern watershed boundary in the town of Niles. In addition, a portion of the Summerhill State Reforestation Area, with public snowmobile trails, lies within the watershed boundary. There is currently one completed multi-use trail within the watershed that runs from Auburn to Fleming (approximately two miles) along the west side of the lake.

Tourism

Owasco Lake is a major marketing tool for tourism in the area. To a large extent, the tourism focus is on high quality boating, fishing, swimming and family recreation opportunities, particularly at Emerson Park. There are also numerous special events conducive to tourism, such as the Merry-Go-Round Playhouse Theatre presentations and Tomato Fest.

Although the lake is considered an exceptional fishery, there is only one charter fishing boat on the lake. Closed beaches, the deteriorated seawall, public access, and zebra mussels

are the primary issues identified by the Cayuga County Tourism Office as being, or potentially being, detrimental to tourism in the area.

The Cayuga County Tourism Office has targeted its efforts towards attracting coach tours, conventions, and individuals. The office is planning to concentrate future efforts on bringing more conventions to the area and will also be looking at niche markets, such as agri-tourism, in the watershed. Another goal of the Cayuga County Tourism Office is to expand the season into the so-called "shoulder seasons" (fall & spring).

Real Estate

Lake front property significantly decreased in value over the last four years, primarily due to the central New York economy. Realtors throughout the watershed have made the following observations:

- Because real estate taxes continue to increase, owning a second property on the lakeshore is costly. In previous years, cottages were assessed at 50% of their full value if they were used only 50% of the year. The move to full assessment has doubled or tripled property taxes, thereby reducing the affordability of lakefront property for many owners and prospective buyers.
- There are fewer available summer cottages because many have been renovated into year round dwellings.
- Four years ago lakefront property sale listings seldomly exceeded four at any given time. Most such properties sold within 90 days. Now there are 35 - 40 properties listed for sale and turn around time is greater than ninety or even 120 days. One realtor reports that lakefront homes are staying on the market well over 180 days.
- Generally, the lakefront is not as desirable as it once was. The price of a single family home on the lake is comparable to building a new home with a pool, which in the opinion of realtors is more desirable to current home buyers. The only exceptions are boating enthusiasts.
- Seasonal cottages priced in the \$99,000 to \$125,000 range attract the most prospective buyers. These buyers come from within 2 to 3 hours of the area. Level frontage is the primary selling point for most seasonal properties. This makes Owasco and Fleming prime property areas, with Niles and Scipio less desirable because of steep slopes.
- The lakeshore development of Martin Point has not reached its potential yet. There is no incentive to develop a piece of property in Owasco with a lake view, because development costs are higher than the potential selling price.
- There are currently two approved subdivision tracts within the watershed in the town of Owasco, plus the balance of the Martin Point subdivision. A maximum of four new units a year may be constructed in any subdivision tract.
- There is a difference of opinion among realtors as to whether lake access increases the sale value of land over land without access. Realtors agree, however, that under the present economic conditions there is no pressure for access development. Dutch Hollow Brook might be the exception (Cayuga County Board of Realtors, personal communication, 1998).

Emerson Park

What is now known as Emerson Park has been a principal recreation facility for more than a century. The portion of the park dubbed Deauville Island was first developed as a recreational facility in 1889 and opened to the public in July of that year. Typically in that era, local rail lines would establish a terminal near a recreational facility as a means to lure paying passengers. In 1890, the Auburn and Syracuse Electric Rail Company located a terminal across the channel from the island and, to add to the area's lure as an attraction, built a pavilion in 1895. The pavilion was used for dances and special events.

In 1899 the island was purchased and the Deauville Island Hotel was constructed (This is the origin of the island's current name). Over the next thirty years, facilities on the island and around the pavilion expanded, while use of the rail line declined. In 1930, the company Enna-Jettick Shoes purchased the railroad's holdings, renamed the area Enna-Jettick Park, and used it as a promotional vehicle for the shoe brand.

In 1944, Fred Emerson, owner of Enna-Jettick Shoes, chose to donate the park to the residents of Cayuga County. At the same time, he purchased some land adjacent to the park and included that as part of his donation to Cayuga County. The newly obtained park was named in honor of Mr. Emerson.

As an amusement facility, the park remains a treasured memory for many who fondly recall childhood visits to an exciting, colorful place filled with thrill rides, games, and glamorous dances at the pavilion. Many mourn, even resent, the loss of that "special place". However, the realities of the depression of the 1930's, the second World War in the '40s, new entertainment alternatives and greater personal mobility that emerged in the post war era of the '50s, along with the birth of massive theme parks in the 1960's, all led to the demise of this and most other small amusement parks throughout the nation.

By the early 1960's, the amusement park had significantly deteriorated. A policy decision was made by county officials to redefine the role of Emerson Park. The decision was made to emphasize the park's lake access and aim development accordingly. The county obtained federal and state funding for park development and purchased several parcels of land. These purchases adjoined the original donated parklands and formally incorporated Deauville Island into the park.

Since the acquisition of the park by Cayuga County, a number of efforts to plan for its development have been undertaken. The current development plan utilizes input from citizen committees as well as professionals from the county planning and parks departments.

The plan as submitted to the Cayuga County Legislature in December 1998 makes the following recommendations: implement the Seawall proposal; add an antique village to the existing Agricultural Museum; reestablish the "island railroad"; improve general landscaping; improve the park's basic facilities to make users comfortable and secure; establish a restaurant; relocate park support facilities (except first aid and security) to a less prominent site; and develop a swimming pool complex.

Although the plan has not been fully implemented, the park has already experienced significant restoration efforts. During 1998, the county legislature funded the face-lift of the Agricultural Museum, replacement of the roof on the pavilion, rehabilitation of road across Deauville Island, resurfacing of the Merry-Go-Round parking lot, and the purchase and removal of a dilapidated store on Whitebridge Road. A walking trail was constructed by the Cayuga County SWCD through the wooded area behind the Agricultural Museum. In addition, several volunteer citizen groups have held beautification events to paint the

playground equipment, pick-up litter, plant flowers, and assist park staff with other time intensive maintenance considerations.

In October 1998, Cayuga County received a \$5 million federal funds grant to restore the seawall. Design and specification development is currently underway. Construction is planned to begin in February 2000 and will take approximately one year to complete.

Owasco Flats

The Owasco Flats is a 750-acre area located along the mouth of the Owasco Inlet. The Owasco Flats wetlands, in particular, are a significant natural resource value. The geographical configuration of this river bottom floodplain may be described as a fairly level valley floor approximately eight miles long and 0.3 to 0.7 miles wide. The many soil types of the valley floor are traversed by a meandering inlet, which is copiously fed by streams that drain mostly heavily forested uplands.

Among the important hydrologic considerations of the unique area are:

- 1) the recharge capacity of the wetlands (2000 feet downstream from the aquifer from which the village of Moravia obtains its water)
- 2) the capacity of the wetlands to act as a biological filter of nutrients, chemicals, and sediments
- 3) the ability of the wetlands to store floodwaters

The Flats is a rich and diverse ecosystem serving as important habitat and breeding grounds for fish, waterfowl, migratory and nesting birds, mammals, plants, amphibians, and reptiles. The most recent New York breeding bird census lists 102 bird species known to nest in the Owasco Valley.

The Owasco Flats is host to the spotted turtle, somewhat rare in New York State, and a number of rare plants including the Big Shellbark Hickory, a tree that occurs primarily in the Owasco Flats and is characteristic of river bottom flood plains. In fact, the Owasco Flats is the primary location of this species in New York State, with only a few other naturally occurring areas. There are a number of other rare plants, including Rose Coreopsis, which is globally rare. In addition to migrating and nesting waterfowl, wood ducks are present throughout the spring and summer; Bald Eagles and Osprey have been sighted in the Owasco Flats.

Because of its biological diversity, the area also provides prime recreational opportunities for people in the watershed to fish, hunt, hike, bird watch, and canoe.

Municipal Waste Water Treatment Facilities

There are two municipally owned wastewater treatment plants (WWTPs) located within the watershed. One is located in the village of Moravia, the other in the village of Groton. The village of Moravia's WWTP is located 3.5 miles south of the lake. The village of Groton's WWTP is located 11.9 miles south of the lake. The following information regarding these WWTPs was obtained from Region 7 of the NYSDEC. Regulation of WWTPs in New York State is carried out by the NYSDEC.

Moravia WWTP

The village of Moravia's WWTP was last upgraded in 1992 and has a capacity of 0.6 mgd. In 1997, the plant discharged an average 0.365-mgd into the Owasco Inlet, a class C stream, as designated by NYSDEC. The plant provides primary, secondary, tertiary and year-round disinfection treatment to the wastewater before it is discharged. Disinfection is provided by ultraviolet radiation.

The Moravia WWTP is currently operating within all discharge limitations under State Pollutant Discharge Elimination System (SPDES) permit issued by the NYSDEC. SPDES criteria and actual discharge values for 1997 are provided in Table 25.

Table 25

Wastewater Discharge Limits for Moravia Wastewater Treatment Plant

Year-round:		
Parameter	Limitation	1997 Average
Fecal Coliform	30 day mean - 200 col/100 ml	6.69 col/100 ml
Chlorine	0.1 mg/L	not reported
pH	6.0 to 9.0	not reported
Settleable Solids	0.3 ml/l	0.1 mg/L
Total Phosphorous	30 day mean - 0.5 mg/L	0.39 mg/L

From June 1 to October 31:		
Parameter	Limitation	1997 Average
UOD	30 mg/L and 150 lbs./day	not reported
Suspended solids	30 day mean - 12 mg/L & 60 lbs./day	1.93 mg/L
Ammonia	30 day mean - 2.4 mg/L as NH ₃ & 12 lbs./d	0.87 mg/L

From November 1 to May 31		
Parameter	Limitation	1997 Average
CBOD	30 day mean - 25 mg/L and 125 lbs./day	3.0 mg/L
Suspended solids	30 day mean - 30 mg/L and 150 lbs./day	1.93 mg/L

Other parameters with no effluent limits in permit:		
Parameter	Limitation	1997 Average
TKN	none	1.48 mg/L

Groton WWTP

The village of Groton's WWTP was last upgraded in 1976 and has a capacity of 0.35 mgd. The plant discharged an average of 0.215 mgd during 1997 into the Owasco Inlet, a class C stream, as designated by NYSDEC. The plant provides primary and secondary treatment as well as seasonal disinfection to the wastewater prior to discharge. Liquid chlorine is used to provide disinfection.

Discharge criteria established under state SPDES permit and actual discharge values for 1997 are listed in Table 26.

Table 26
Wastewater Discharge Limits for Groton Wastewater Treatment Plant

Year-round		
Parameter	Limitation	1997 Average
Suspended solids	30 day mean - 30 mg/L & 88 lbs./day	8.3 mg/L
pH	6.0 to 9.0	6.9 –7.5
Settleable Solids	0.3 ml/L	0.12 mg/L
From June 1 to October 31		
Parameter	Limitation	1997 Average
UOD	30 day mean – 51.4 mg/L & 150 lbs./day	20.76 mg/L
Fecal Coliform	30 day mean - 200 col/100 ml	27.8 col/100 ml
Ammonia	30 day mean – 4.0 mg/L as NH ₃	0.72 mg/L
Chlorine	0.013 mg/L	0.032 mg/L
From November 1 to May 31		
Parameter	Limitation	1997 Average
BOD	30 day mean – 30 mg/L & 88 lbs./day	9.1 mg/L
Other parameters with no effluent limits in permit		
Parameter	Limitation	1997 Average
Phosphorous	none	1.9 mg/L
TKN	none	3.19 mg/L

Landfills

Currently, there are no active landfills located in the watershed. There are seven closed landfills in the watershed; six are located in Cayuga County and one in Tompkins County. Information on these sites is presented in Table 27.

Generally, these solid waste facilities were closed according to standard methods in use at the time of their closure. The table does not include sites that closed prior to 1960, junkyards or similar storage/disposal areas. Also, the table does not include numerous roadside dumps reported and covered during the 1960's, which typically were smaller than a quarter of an acre. There is no list of current illegal roadside dumping sites in the watershed (for more information see Illegal Dumping in Section VI, page 83).

In addition, it should be noted that there is one known inactive hazardous waste site (Smith Corona) in the watershed located in the town of Groton.

Table 27
Closed Landfills in the Owasco Lake Watershed

Name	Location	Year Opened	Year Closed	Code	Remarks
Martinez	Cayuga Co. Town of Owasco	na	1967	3	
Locke	Cayuga Co. Town of Locke	1965	1979	2	Several homes built near site. Listed as active in 1979 report.
Moravia	Cayuga Co. Town of Moravia	na	1973	1	Construction and demolition debris on-site.
Sempronius	Cayuga County Town of Sempronius	na	1967	1	Small site listed in 1979 report.
Fillmore Glen State Park	Cayuga Co. Town of Moravia	na	1971	4	Covered and graded.
Buhl	Cayuga Co. Town of Locke	1978	1987	3	Capped in 1989. Erosion and leachate evident in 1990.
Caswell	Tompkins Co. Town of Dryden	1969	1985	5	Capped in 1987. Monitored and inspected by county.

Ownership Codes

1. Owned and operated by Town or Village
 2. Privately owned and operated by Town, Village or City
 3. Privately owned and operated
 4. State owned and operated
 5. County owned and operated
- na = information not available

SECTION III - WATERSHED RULES AND REGULATIONS

Land Use and Zoning Laws

A summary of local land use and zoning laws for municipalities within the watershed is presented in Table 28.

Table 28
Status of Current Local Land Use and Zoning Laws in the Owasco Lake Watershed

Municipality	County	Comprehensive or Master Plan	Zoning	Sub-division Regulation	Site Plan Review	Planning Board
City of Auburn	Cayuga	√	√	√		√
Town of Dryden	Tompkins	√	√	√	√	√
Town of Fleming	Cayuga		√	√		√
Town of Genoa	Cayuga		*			√
Town of Groton	Tompkins	√	√	√	√	√
Town of Lansing	Tompkins	√	√	√		√
Town of Locke	Cayuga					
Town of Moravia	Cayuga		√	√		√
Town of Niles	Cayuga		*	√	√	√
Town of Owasco	Cayuga		√	√		√
Town of Scipio	Cayuga		√			√
Town of Sempronius	Cayuga		*			√
Town of Sennett	Cayuga		√	√		√
Town of Skaneateles	Onondaga	√	√	√		√
Town of Summerhill	Cayuga		*		√	
Town of Venice	Cayuga					
Village of Groton	Tompkins	√	√	√	√	√
Village of Moravia	Cayuga		√	√		√

* Locality without zoning, but has local law in place regulating lot size, junkyards, and mobile homes.

Summary of Watershed Rules and Regulations

According to the New York State Health Code, section 1100, the city of Auburn "shall make regular inspection of the reservoir, watercourses and watershed to insure compliance with the rules and regulations set forth in this section".

These rules set forth the conditions and types of activities allowable within the watershed. Further, the Watershed Rules and Regulations set forth the conditions to be met by agricultural and business practices, including how such activities may be conducted, to ensure a pure and safe drinking water supply for Auburn and surrounding towns. For a complete listing of the Watershed Rules and Regulations see Appendix D, page 113.

Agricultural District Law

Significant portions of the watershed are located within agricultural districts. Agricultural districts were created to protect and preserve agricultural lands from loss to non-agricultural development. Article 25AA-Agricultural Districts, of the Agriculture and Markets Law states that:

The socio-economic vitality of agriculture in this state is essential to the economic stability and growth of many local communities and the state as a whole. It is, therefore, the declared policy of the state to conserve, protect and encourage the development and improvement of its agricultural land for production of food and other agricultural products. It is also the declared policy of the state to conserve and protect agricultural lands as valued natural and ecological resources which provide needed open spaces for clean air sheds, as well as for aesthetic purposes.

The law provides for the establishment of a county agricultural and farmland protection board and provides for placement of unique and irreplaceable agricultural lands in district by local owner proposal. Advantages include: agricultural tax assessment based on soil classification; limits on local regulation that might unreasonably restrict or regulate farms, limitation on exercise of eminent domain and other public acquisitions; coordination of local planning and comprehensive plans with the policy and goals of agricultural district law; and a "right to farm" clause, stating that a sound agricultural practice shall not constitute a private nuisance.

The Cayuga County Agricultural and Farmland Protection Board was formed in 1994. Included in the duties to be performed by this board was the creation of the Agriculture and Farmland Protection Plan for Cayuga County. This plan identifies and evaluates land use patterns, regulatory factors, and economic circumstances that encourage the conversion of agricultural land to non-farm purposes. Based on this evaluation, a program was developed to minimize, prevent, or reverse the factors identified as contributing to conversion. The plan suggests ways to minimize the negative impacts of any unavoidable agricultural land use conversions.

Cayuga County Sanitary Code

In 1994, Article V of the Cayuga County Sanitary Code was revised as a result of increased public concern for water quality and an increased number of beach closings at Emerson Park during the early 1990's. The revisions called for individual residential wastewater treatment systems (septic systems) within the county to be periodically inspected and repaired if found to be failing. Development of the septic system inspection schedule was based on the system's location to Owasco Lake or Little Sodus Bay as outlined in Table 29.

In addition, the sanitary code requires that all site evaluations and preparation of plans for the repair or replacement of wastewater treatment systems located in the Owasco Lake Watershed be conducted and submitted by a licensed design professional.

Table 29
Cayuga County Septic System Inspection Schedule

Septic System Location	Routine Inspection (years)
Bordering Owasco Lake or Little Sodus Bay	2
Within 500 feet of Owasco Lake or Little Sodus Bay	3
Within the Watersheds of Owasco Lake or Little Sodus Bay	5
Outside the Watersheds of Owasco Lake or Little Sodus Bay	6

Note: All septic systems within Cayuga County are expected to be inspected by the year 2000. It should be noted that septic systems bordering Owasco Lake will be inspected four times by the year 2000.

Inspection Procedure

Through the county's privatized inspection program, homeowners must contract with a certified Cayuga County Wastewater Inspector for septic system assessments. Inspection includes a review of Division of Environmental Health records, an interview with the homeowner, inspection of plumbing and system components, and a dye test. Typically the dye test involves adding a florescent dye and a volume of water (depending on the number of bedrooms) to a wastewater receptacle and observing if the dye surfaces. Lastly, a sketch of system components, such as septic tank, distribution box, and leach field, is drawn in relationship to wells and waterbodies, such as lakes and streams.

Homeowners who are transferring property are required to have an inspector perform a property transfer inspection. A property transfer inspection is more stringent than a regular inspection. More water is added per bedroom and the septic tank must be pumped out by a certified waste hauler. All information relating to a homeowner's septic system is entered onto a six-page inspection form. The information is then logged into a database software package at the Environmental Health Division.

Statistics

By December 1998, all septic systems within the Cayuga County portion of the Owasco Lake Watershed had been inspected. Those that are located on the lakefront had been inspected multiple times. Table 30 shows the number of septic systems in the Cayuga County portion of the watershed in regard to proximity to the lake.

Table 30

Septic Systems in the Owasco Lake Watershed Located in Cayuga County

Septic System Location	Number of Septic Systems
Bordering Owasco Lake	729
Within 500 feet of Owasco Lake	105
Within the Owasco Lake Watershed, but are not bordering or within 500 feet of the lake	1,381
Total septic systems within the Owasco Lake Watershed	2,215

In Cayuga County, there are 2,215 septic systems in the Owasco Lake Watershed with an approximate failure rate of 3% (Cayuga County Department of Health & Human Services, unpublished data, 1998). Compared to other counties in the state, this relatively low failure rate is likely due to the fact that homeowners have, as a result of various educational outreach efforts, become more aware of potential problems and want to have problems fixed prior to inspections.

Table 31 provides statistical information on the age of the septic systems within the watershed. Of the 2,215 septic systems located in the watershed, 611 (28%) are associated with seasonal properties.

Table 31

Age of Septic Systems in the Owasco Lake Watershed Located in Cayuga County

Location With Respect to Owasco Lake	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	Total
Bordering	80	88	118	163	62	511
500 feet Watershed*	15	13	13	21	8	70
Total within watershed	202	292	516	572	270	1,852

* Within the Owasco Lake Watershed, but are not bordering or within 500 feet of the lake.

Of the 2,215 septic system owners in the watershed, 1,852 recalled the date their system was installed (362 were unknown). Of these, more than half (54%) were installed over eighteen years ago; 492 (27%) were installed over thirty years ago.

Of the total number of septic systems in Cayuga County portion of the watershed, 1,190 (58%) have no plans on file with the Environmental Health Division. Either these septic systems were installed before the County Health & Human Services Department starting regulating septic systems or that homeowners illegally installed these systems without obtaining approval from the Health & Human Services Department. In either case, the

implication is that more than half of the septic systems in the watershed do not have accurate installation records.

If one looks at the distances between the absorption area and the currently defined mean high water mark of the lake, 591 (27%) are less than the NYSDOH standard of 100 feet. The current mean high water mark is 717.13 feet, using USGS datum. In 1984, this number was defined in the city of Auburn Watershed Rules and Regulations. Previous to 1984, the distance to the absorption field was measured from the typical shoreline of the lake, which was at an elevation of 712 to 713 feet. When measured from the mean high water mark at 717.13, systems that met the septic system standard at the time of installation are now considered less than 100 feet from the lake.

Although earlier standards allowed smaller tanks, the current standard requires that septic tanks be no smaller than 1,000 gallons. Thirty-two percent (709) of the septic systems in the watershed have septic tanks less than 1,000 gallons. This statistic also provides some insight into the age of septic systems in the watershed.

A look at the age of some of these systems may give insight to their condition. With proper maintenance, septic systems are designed to last approximately 20 to 30 years. The capacity of any leachfield to treat wastewater is limited as soils become saturated over time. As a result, there is less porosity, and therefore, less surface area for bacteria to break down the septage. Eventually, the absorption area can no longer function properly and the system fails. The result is the discharge of untreated wastewater to ground and surface waters.

Seventy-five percent (1,182) of septic systems in the watershed are the conventional septic tank absorption field (leach field) type. Three percent (63) of the 2,212 systems accounted for are holding tanks while less than one percent (10) are privies (outhouses). Five percent (119) are unknown. Table 32 provides information on all types of septic systems installed in the watershed.

The data indicates that most of the septic systems in the watershed are outdated and do not meet current standards.

Table 32
Types of Wastewater Systems in the Owasco Lake Watershed Located in Cayuga County

Types of Wastewater Systems	Location With Respect To Owasco Lake			Total within Watershed
	Bordering	500 feet	Watershed*	
Community System	2	0	0	2
Holding Tank	50	10	3	63
Holding Tank and Seepage Pit	1	0	0	1
Privy	8	0	2	10
Privy and Seepage Pit	8	0	0	8
Seepage Pit (Drywell)	4	0	5	9
Septic Tank-Absorption Bed	62	21	49	132
Septic Tank-Absorption Field	393	73	1,197	1,663
Septic Tank-Seepage Pit	30	4	124	158
Septic Tank-Sand Filter	7	0	22	29
No System (i.e. "porta-john")	10	1	0	11
Other (i.e. evaporation system)	0	0	7	7
Unknown	31	7	81	119
				2,212

* Within the Owasco Lake Watershed, but are not bordering or within 500 feet of the lake.

SECTION IV -- MANAGEMENT PROGRAMS

Agricultural Environmental Management Program

Agricultural Environmental Management (AEM) is a voluntary, locally-led and implemented initiative that provides one-on-one help to farmers who want to identify environmental concerns on their farms and implement appropriate solutions. AEM provides a framework for existing agricultural agencies and private sector organizations to coordinate the delivery of their services to farmers. AEM utilizes a tiered approach to whole farm plan development.

Services provided through AEM include aid in identifying environmental concerns, planning and design of needed environmental practices, and the opportunity to apply for financial assistance. The farmer's business needs are a key consideration throughout the AEM process.

Goals of AEM

1. To help farmers address environmental concerns on their farms in a comprehensive and cost-effective way, while maintaining the farm as a viable business.
2. To protect New York's natural resources, especially ground and surface waters used for drinking.
3. To help farmers comply with existing and new environmental rules and regulations.
4. To direct public resources -- both personnel and financial -- to farms where they are most needed.

How AEM Works: The "Tiered" Approach

AEM is based on a five-tier/step environmental planning and implementation process. This tiered approach is designed to direct personnel and financial resources to farmers with the greatest potential for impacting the environment.

Tier 1 -- Questionnaire: The farmer fills out a standard, general questionnaire designed to identify potential and existing activities on the farm which might impact the environment. If no concerns are identified, the process ends here and the farmer's good stewardship is documented.

Tier 2 - Worksheet: The farmer completes more detailed worksheets in activity areas identified in the Tier 1 questionnaire, usually with the help of a local agricultural agency person or consultant. The worksheet verifies the existence of any environmental concerns that will require the development of a management plan. If environmental concerns are minor and easily remedied, the farmer's good stewardship is documented and the AEM process ends here.

Tier 3 -- Plan: A plan to address the environmental concerns and risks identified in Tier 2 is developed with the help of local agricultural agency staff or a consultant. Existing NYS conservation plans, agricultural waste management plans, or other plans may serve as all or part of the Tier 3 AEM plan.

Tier 4 -- Implementation: The plan is implemented, often through the use of "Best Management Practices" (BMPs). BMPs are measures that prevent or reduce nonpoint source water pollution. Federal, State or local cost-share funds are used when available and necessary to

implement costly environmental practices, such as barnyard improvements and manure handling systems.

Tier 5 -- Evaluation: Both the local AEM program and environmental outcomes on individual farms are evaluated. This includes measuring program participation and effectiveness of the AEM initiative at the individual farm level, and also at the state, county or watershed level.

Throughout the five tiers, follow-up and education are important in order to ensure that environmental practices are effective. The farmer's business needs and goals are also a key consideration throughout the AEM process

AEM Support

Nine different agencies were involved in the development of the Agricultural Environmental Management (AEM) tiered approach to whole farm planning: NYSDEC, NYS Department of State, US Environmental Protection Agency, NYSDOH, Natural Resources Conservation Service (NRCS), county Soil & Water Conservation Districts (SWCD), Cornell University, Cornell Cooperative Extension (CCE), NYS Agriculture & Markets, and NYS Soil & Water Conservation Committee. All environmental aspects of farming are addressed in the worksheets, which let farmers know where there is room for improvement, and where they are doing a good job.

Cayuga County AEM Program

The Cayuga County AEM Program began in the Owasco Lake Watershed in 1995. To date, Tier 1 and Tier 2 surveys have been completed for approximately 60 farms. As a result of those surveys, planning and implementation of BMPs such as grassed waterways, water and sediment control basins, silage leachate control structures, barnyard water management, field strips, cover crops, etc., were conducted on numerous farms.

Planning for BMPs continues based on needs identified through the Tier 2 worksheets. The planning is done through cooperation among the farmers, NRCS, SWCD, the City of Auburn and others as needed. Implementation of BMPs will continue throughout the watershed. Follow-up with farmers in the watershed, which is an essential part of the process, is also on going. Presently, about ten farmers (representing roughly 6,700 acres of land) are actively participating in the Cayuga County AEM Program.

Onondaga County AEM Program

Agricultural producers who are located within Onondaga County but farm land in both the Skaneateles and Owasco Lake Watersheds, are able to participate in a tiered survey/whole farm program under the guidelines of Skaneateles Lake Watershed Agricultural Program (SLWAP). The objective of SLWAP is to carry out a voluntary, cost-effective Whole Farm Planning Program in the Skaneateles Watershed. The goal of the program is to reduce the risk of contamination of the lake from agricultural nonpoint sources. Whole Farm Plans are developed by a multi-agency team that includes the farm manager. The Whole Farm Plan must not only meet the environmental objectives of the watershed program, it must meet the business objectives of the farming enterprise.

Tompkins County AEM Program

This survey program was conducted in 1995 to facilitate and analyze farm practices in the Tompkins County portion of the watershed that potentially contribute to non-point source pollution. The survey is based on the Tier 1/Tier 2 system developed under SLWAP and was conducted through direct interviews and inspections of each of the sixty-two identified farm operations within the watershed. Conclusions are based on extrapolation of existing data, and from observations made during the inspections of the farmlands surveyed. A brief narrative of each farm was compiled. Based on the narratives and survey information, more detailed Tier 2 worksheets for each farm operation were distributed.

The Tompkins County SWCD has also been involved with numerous other management programs within the watershed. Specific activities include: development of nutrient management plans; barnyard improvements; installation of silage leachate treatment systems; roof water management systems; pathogen management systems; and development of rotational grazing systems.

The district plans to continue to conduct similar projects in the near future. The district also intends to revisit farms in the watershed to make a better evaluation of needs and priorities to help farmers be fully prepared for Concentrated Animal Feeding Operation/Animal Feeding Operation (CAFO/AFO) regulatory compliance. The district would also like to work more closely with the village of Groton on water quality issues that could potentially affect the Owasco Inlet, and ultimately the lake.

Cayuga County Nutrient Management Program

A voluntary agricultural nutrient management program was developed for Cayuga County and approved by the County Legislature in February of 1995. The Cayuga County SWCD is the lead agency for the implementation of this program.

In 1996, the Cayuga County SWCD received a grant from the NYS Agricultural Non Point Source Abatement and Control Grant Program for the development of nutrient management plans for 7,500 acres in the Owasco Lake Watershed. Under the terms of the grant, consultants would write the nutrient management plans and SWCD would pay 75% of the fee for writing the plan--up to \$4.50 per acre. The landowner would pay the remainder of the cost.

Between January and March of 1997, contacts for developing nutrient management plans were made with approximately twenty farmers based on the availability of funds. At that time, five farmers were interested in participating in the program. Additionally, a flier describing the benefits of a nutrient management plan and the funding available was developed and distributed through the Cayuga County Farm Bureau newsletter.

To date, the following farms have signed a contract for nutrient management plans:

1. Sunrise Farms (1,100 acres). The plan was completed in the fall of 1997.
2. Melrose Farms (350 acres). Contract was signed in August of 1997.

Funding under this grant was available until December 31, 1998.

Cayuga County GRAZE NY Program

GOAL #1: To improve water quality in the Finger Lakes by reducing the inflow of sediments, pathogens and nutrients into Owasco Lake via nonpoint source pollution, through the implementation of rotational grazing systems.

The practice of intensive rotational grazing is an environmentally sound management practice that, where implemented, improves water quality. Unlike annual tillage crops that expose the soils, rotational grazing stabilizes the soil by providing permanent vegetative cover. As a result of this cover, rotational grazing provides reduced soil erosion and animal waste runoff. In addition to pasture establishment, maintenance practices also encouraged by this program (such as no-till and broadcast seedings, forage tests, soil tests, and proper fertilization techniques) greatly reduce soil erosion as well. Another component of rotational grazing, as well as other BMP programs, is to physically exclude the animals from entering streams and/or other bodies of water. This practice further reduces erosion and improves water quality.

GOAL #2: To hold regular workshops, informational meetings, farm visits, and farm tours to educate farmers about the environmental benefits related to rotational grazing.

Through the use of regular workshops, meetings, visits, and tours, agricultural producers will have an opportunity to share their experiences with, as well as gain information from, peers, grassland specialists, grazing technicians, and dairy nutritionists.

During the past year, the practice of rotational grazing has been an area of increased interest and attention in the watershed. This interest is a direct result of being able to provide financial assistance to farmers with funding received from the NYS Department of Agriculture and Markets. Through a cash or in-kind match of 25%, farmers were able to offset BMP implementation costs incurred as a result of transferring to a rotational grazing system.

Accomplishments to date:

- Approximately 25 farms in the watershed have been visited by the GRAZE NY District Technician.
- Sixteen farms in the watershed have implemented rotational grazing systems. Grazing plans are being developed for three additional farms.
- Approximately 1,200 acres in the watershed are being rotationally grazed.

Cayuga County Aquatic Vegetation Management Program

The principal objective of the Cayuga County Aquatic Vegetation Control Program, which was initiated in the early 1970's, is to sustain a balance of aquatic plants and algae in order to maintain the biological structure of our lakes. The program is not an attempt to eradicate or eliminate aquatic weeds, but rather to control them. The program seeks balance among recreational, economical, and ecological concerns, which includes integration of both short- and long-term goals.

Long term controls

Long term controls address the causes of nutrient and sediment loading to the tributaries of the lake. Since all aquatic plants require nutrients for growth, reducing and controlling their growth requires limiting the amounts of nutrients entering the lake from its watershed. Although the phosphate ban of 1973 has done much to reduce phosphorous levels in the lake, other contributing factors, such as nutrient additions from municipal sewage treatment plants, private septic systems, and agricultural runoff, are other potential sources.

Short term Controls

Short-term controls address the immediate effects of nutrient and sediment loading--excessive weed and algae growth. With the exception of harvesting, many of the methods do not significantly affect the nutrient levels and are therefore considered cosmetic or temporary. Short-term controls are, however, necessary to keep excessive plant growth at a manageable level, while long-term prevention methods are implemented. Owasco Lake has such extensive weed growth that short-term controls are, at times, necessary to maintain the recreational and economic interest in the lake.

Mechanical Harvesting: Involves the use of mechanical equipment to cut and remove nuisance plant growth from the lake. Mechanical harvesting is strictly a temporary measure and must be repeated two or more times in an area for best control. The equipment is expensive and relatively slow. Cut and unharvested plants can float to "clean" areas and begin infestations. Maintenance of the equipment is expensive.

Chemical treatment: Involves the application of herbicides or algaecides to retard or kill aquatic plants and algae. Although these chemicals are relatively easy to apply and provide relatively fast results, permits are required, monitoring costs are high, and environmental effects are not always known or easily monitored. Also, the chemicals can be hazardous to the applicator if not handled properly. Repeated applications are required annually. For the reasons stated above, chemical treatments by public agencies ended in the 1970's.

Finger Lakes-Lake Ontario Watershed Protection Alliance Aquatic Vegetation Control (FL-LOWPA /AVC)

In 1990, through the "Aid to Localities" Program, New York State granted approximately \$150,000 to Cayuga County for aquatic vegetation control activities. The funds were allocated to four Cayuga County agencies: the SWCD, County Planning, County Health Department, and Environmental Management Council (EMC) through the Finger Lakes-Lake Ontario Watershed Protection Alliance (FL-LOWPA).

The SWCD program portion included mechanical harvesting, diver dredging, and nutrient/sediment reduction. The Planning Department and EMC portions included inflow monitoring and support of a tri-county biological control study, guided by Cornell University. The Health Department focused on implementation and education of the Cayuga County Sanitary Code, which entails septic system inspector training and certification as well as a septic system inspection program.

Due to state deficits and reduction in the "Aid to Localities" program, the FL-LOWPA Aquatic Vegetation Program has been significantly scaled-back. In 1991 the diver dredge program was eliminated, and the equipment has since remained in storage.

As part of erosion and sediment control, approximately 2000 ft. of rip-rap and 1,500 ft. of biotech plantings have been installed along portions of the lake's tributaries. Forty acres of critical area seeding along road banks have occurred, and 25 to 30 acres of trees were planted in the watershed. Additionally, three to five acres of buffer strips are created annually by the Cayuga County SWCD.

Dutch Hollow Brook Stream Assessment Project

Geomorphological stream assessment provides a design tool that can evaluate suitable techniques and land uses to restore a stream's ecological integrity. It also can serve as groundwork for a stream corridor management plan.

The Rosgen method of stream assessment has been adapted for use along Dutch Hollow Brook. This assessment contributes to the Owasco Lake Watershed Management Plan by adding to the existing data, and providing layers of information that describe hydrological and geomorphological processes in the watershed. This is a four stage ("level") method of watershed assessment. The first two stages have been completed.

Level 1. Geomorphic Characterization

- a. The initial integration of broad brook characteristics and stream types based on valley landforms and channel dimensions observable on topographic and aerial maps. Brook valley slope, channel shape (narrow, deep, wide, shallow), and channel patterns were determined.
- b. A consistent initial framework for organizing Brook information and communicating the aspects of river morphology were developed.
- c. Priorities for conducting more detailed assessment were established.

Level 2. Morphological Description

Determined stream types with field measurements of specific stream channel reaches and along the brook's valley. These measurements were used to determine the:

- a. Entrenchment ratio
- b. Width/depth ratio
- c. Sinuosity
- d. Channel slope
- e. Dominant channel materials

The Level 2 classification process developed a framework to address questions of sediment supply, the Brook's sensitivity to disturbance, potential for recovery, response to changes in flow regime, and its fish habitat potential.

Levels 3 and 4 are proposed for completion during 1999.

Level 3. Assessment of Stream Condition and Departure from its Potential

- a. Develop a quantitative basis for comparing streams having similar form and structure, but which are in different states or condition.
- b. Describe the potential stability of a stream, as contrasted with its existing condition. A stream channel stability rating is developed based upon the sediment supply, streambed stability, and streambank erosion potential.
- c. Determine the departure of a stream's existing condition from a reference baseline.

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- d. Provide guidelines for documenting and evaluating additional field parameters that influence stream state such as riparian vegetation, flow regime, deposition pattern, debris and channel blockages, and meander pattern.
 - e. Provide a framework for integrating companion studies, such as fish habitat indices.
 - f. Develop and refine channel stability prediction methods.
 - g. Provide the basis for efficient Level 4 validation sampling and data analysis.

Level 4. Field Data Verification

Substantiates the extent and magnitude of stream channel adjustment processes that may be indicated from collected dimension, profile, and pattern data. Such verification permits quantitative extrapolation of stream condition to other tributaries having similar morphologic and physiographic characteristics. This holistic approach integrates both physical and biological function within a watershed context, providing a wide range of interpretations for management applications.

The Level 4 assessment includes sediment measurements and analyses, stream flow measurements, stream stability validation, and time trend monitoring. These measurements are taken to establish process relationships for use in:

- a. Evaluating the accuracy of sediment transport relationships.
- b. Predicting the response of tributaries to changes in land use.
- c. Developing effective mitigation and restoration activities.
- d. The appropriate choice and validation of prediction models.
- e. Development of empirical relations that describe hydraulic resistance and geometry relationships used in stream restoration design.

Walleye Pike Restoration

Background

From 1928-1948, The NYS Conservation Department (predecessor to NYSDEC) stocked the lake with walleye fry (newly hatched fish). This stocking program produced a fair walleye fishery during that era. After 1948, the NYS Conservation Department determined that it would stock the lake with trout or walleye pike, but not both species. The Owasco Lake Anglers' Association (OLAA) opted for the stocking of trout. Since the walleye were unsuccessful at spawning in the lake at that time, they gradually disappeared from the lake ecosystem.

In recent years, there has been widespread interest in the restoration of walleye pike into the Owasco Lake fishery. The walleye, which is a member of the perch family, is a warm water game fish and is highly regarded for its table fare. In addition, walleye do not accumulate toxins as much as trout and salmon do.

Program Components

In 1996, OLAA received permission from NYSDEC to resume stocking of walleye in the lake. The new stocking program, however, is much different than the original fry stocking program.

Under the new agreement, OLAA works cooperatively with NYSDEC in order to produce walleye fingerlings (larger than fry size) to stock the lake. This agreement requires that OLAA members find their own ponds, inoculate them with zooplankton, fertilize them with alfalfa pellets and other nutrients, conduct harvest activities, and then stock the lake with the resulting fingerlings. OLAA is responsible for securing funds to purchase nets, tanks, fertilizers, and other expenses associated with the program. The total annual cost is \$5,000.

NYSDEC provides OLAA with technical advice and the walleye fry in late April. In addition, NYSDEC often assists with the sterilization of the ponds at the end of the season (if required) as well as with the harvest.

Generally in late October, NYSDEC conducts electroshocking and OLAA volunteers probe the shorelines of the lake for walleye. The fish that are captured are measured and their overall health/growth is determined. This portion of program is the final management activity for the year.

The new walleye fingerling-stocking program is very likely to be more successful than the old method of stocking walleye fry. For numerous ecological reasons, such as the presence of alewife, increased weed growth, and higher population of aquatic invertebrates, the lake can now better support a walleye fishery. The program's success will be determined by how well the current commitment of time, effort, and fundraising activities, which is rather significant, can be sustained by relatively few OLAA volunteers.

Accomplishments

- Produced an average of 7,400 walleye fingerlings in 1997.
- Produced over 47,000 fingerlings in 1998 (over 4,200 of them ranged from 2½ to 8" in length).
- OLAA fingerlings, on average, were three times larger than the NYSDEC produced pond fingerlings (due to using deeper ponds and stocking fry of 20,000 per acre versus NYSDEC stocking rate of 30,000 per acre).

Program Needs

One critical factor for the continued success of the walleye restoration program is finding privately owned ponds that best serve the program's purpose. In order to reach the OLAA goal of 30,000 fingerlings per year (at an average size of 2 1/4"), about 3½ acres of pond surface water with an average depth of about 4½ feet is needed. Deeper ponds are generally better, as long as they are drainable. Ponds of about an acre in size with a deep end depth about 8 feet are ideal. Also, for netting purposes the pond should be twice as long as it is wide (e.g. 150' x 300' = 45,000 sq. ft, approximately one acre).

Federal Programs

Technical assistance and limited financial incentives are available to watershed landowners through a variety of United States Department of Agriculture (USDA) programs. Some of these programs are administered in conjunction with regional or state offices, such as the NRCS or NYSDEC. Below is a list of currently funded programs.

Conservation Farm Option (CFO)

- Voluntary pilot program for producers of wheat, feed grains, cotton and rice.

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- Owners or producers enrolled in the Ag Market Transition Act Program are eligible.
 - Participants are required to develop and implement a conservation plan.
 - Combines cost-share programs such as CRP, WRP, and EQIP (see below).

Conservation of Private Grazing Lands (CPGL)

- An initiative, not a cost-share program.
- Ensures states will deliver technical and educational assistance to producers who own private grazing lands.
- Goals include: better grazing land management; protecting soil from erosion by water and wind; using more energy efficient ways to produce food and fiber; sustaining a viable agricultural base through more efficient production methods.

Conservation Reserve Program (CRP)

- Retire highly erodible lands from production of row crops to enhance water quality and wildlife habitat
- Formal sign-up bids are ranked nationally on a competitive basis to maximize environmental benefits for dollars expended.
- Straight retirement program for ten years (fifteen years if planting trees).
- Producer is paid based on soil rental rate. Necessary practices are cost-shared at varying rates. 50% for vegetation, 75% if restoring hydrology.
- Continuous sign-up available. Bids accepted automatically for riparian buffers, waterways, filter strips, etc.

Conservation Reserve Enhancement Program (ECRP)

- Allows states to put together creative package based on specific resource concerns.
- Riparian buffers are a primary focus. Lands with an erosion index over eight are also eligible.
- States or local government entities must contribute 20% of total program cost.
- A state may enroll up to 100,000 acres.

Environmental Quality Incentives Program (EQIP)

- Provides technical, educational, and financial assistance to farmers to address soil, water, and related natural resource concerns.
- Includes funding for structural practices and land management practices.
- Producer enters a five- or ten-year agreement.
- Limited to \$10,000 a year with total contract not to exceed \$50,000.

Farmland Incentives Program (FIP)

- Voluntary program that helps farmers keep their land in agriculture.
- Provides funding to states, and local entities with existing farmland protection programs in place to purchase conservation easements.
- Easement value is determined through appraisal.

Forest Stewardship Incentives Program (FSIP)

- Goal is to assure a reliable supply of timber nationwide.
- Private landowners of non-industrial forests are eligible.
- Minimum eligible acreage must be ten acres of land that is capable of producing marketable timber. May not own more than 1,000 acres of eligible forestland.
- Eligible practices include tree planting and timber stand improvement.

Wetlands Reserve Program (WRP)

- Primary purpose is to restore once naturally occurring wetlands that have been drained for agricultural production.
- Three options available:
 1. Perpetual easements--(100% of agricultural assessed value plus 100% of restoration cost).
 2. Thirty year easements--(75% of agriculture assessed value plus 75% of restoration cost).
 3. Restoration cost-share agreement--(ten year agreement, USDA pays 75% of restoration cost).

Wildlife Habitat Incentives Program (WHIP)

- Goal is to increase aquatic and grasslands habitat for wildlife in New York.
- Continuous sign-up program across the state.
- All landowners are eligible for the program, not just agricultural producers.
- No minimum acreage requirement.
- Cost share is provided on a 50% government, 50% private landowner basis.
- Contract cannot exceed \$10,000.
- Wildlife habitat development plan must be developed.
- All offers are ranked against each other.

Partners for Fish & Wildlife (PFW)

- Main goal is to restore fish and wildlife habitat through voluntary partnerships with private landowners.
- Some other partners in the program include: Ducks Unlimited, the NYSDEC, Trout Unlimited, the Nature Conservancy, county SWCDs, NRCS, schools, nature centers, and individuals.
- Concentrates on restoring wetland, grassland, and riparian (stream) habitats to restore biological diversity to ecosystems.
- Almost any landowner can qualify based on a site visit from U.S. Fish and Wildlife Service personnel to confirm if the site is suitable for restoration.
- The Partners program will share the costs of restoration with the landowner, which can be about \$500 per acre. Several partners are used, including the landowner, to help defray the costs.
- The owner of a restored site agrees to maintain the site for at least ten years.

Educational Programs

There are a number of organizations involved in various educational programs ranging from formal workshops and conferences, to hands-on workshops, activities, and consultations. Below is a summary of recent and current educational activities within the watershed relating to non-point source pollution prevention.

Cayuga County Department of Health & Human Services, Division of Environmental Science

Since the inception of the Cayuga County Revised Sanitary Code in 1994, the Environmental Division has conducted outreach efforts in order to inform the public and local

officials about the code and its changes. These efforts include providing general information about septic systems and their maintenance as well as:

- presenting programs to town and village boards and various private organizations.
- media outreach (newspaper articles, radio).
- sending septic information packets to private individuals
- septic system education programs conducted with Cornell Cooperative Extension.

Cornell Cooperative Extension

Cornell Cooperative Extension is a community-based educational system that links the resources of Cornell University to the needs of the state's food and natural resource system. CCE uses numerous methods to create learning partnerships and conduct programs for local governments, agriculture producers, homeowners and various other youth and adult audiences. Methods include: media articles and announcements, publications, tours and field trips, workshops and seminars, information technologies, and volunteer outreach.

In recent years, CCE has conducted programs in various agriculture and watershed-related areas including: zebra mussels, household hazardous waste collection, manure management, septic systems, farm business management, 4-H sportfishing, stream monitoring, solid waste management/recycling, crop production, well water, and other environmental issues as they develop or on a community need basis.

Groton Community Links

Formed in 1996, the Links is a community group composed of Groton town and village officials, enforcement officers, highway personnel, business and education individuals, and high school students. The group, which is facilitated by CCE of Tompkins County, currently has two subcommittees. The first committee has concentrated on the Main Street renovation. With the help of Cornell's Local Government Program and Cooperative Extension, the committee was instrumental in obtaining funding for the village Main Street renovation. The second committee has primarily looked at social issues.

The group has recognized the desire to make the Owasco Lake Watershed Management Plan project a Community Links issue. The participants from town and village governments agreed that the group was the appropriate venue to develop a list of concerns and interests that should be addressed in the watershed plan. The group has sponsored local meetings regarding the management plan and has agreed to facilitate an advisory group for the Owasco Inlet subwatershed.

Owasco Watershed Lake Association

The Owasco Watershed Lake Association is a 500 member non-profit organization comprised of Owasco Lake enthusiasts from throughout New York State. The membership includes lakeshore and urban residents, students, businessmen and women, retirees, farmers, and various professionals.

OWLA is concerned with promoting sustainable land uses, monitoring the biological health of the lake and its tributaries, fostering communication among various interests concerning the lake and its watershed, site-specific riparian restoration, and implementing best management practices throughout the watershed.

Soil & Water Conservation Districts

Envirothon and Conservation Field Days are two educational programs that SWCD is involved with. Envirothon is a program for high school students to learn more about the environment. The program tests students' knowledge on topics such as soils, water resources, forestry, wildlife and other environmental issues. Envirothon exists at three levels: regional (county), state, and national.

Conservation Field Days is an outdoor environmental education event for 6th grade students sponsored by SWCD and CCE. During the event, classes of students from area schools rotate through numerous interactive educational stations hosted by a variety of conservation professionals and volunteers.

SECTION V -- TOWNS/MUNICIPALITIES

Over the past year and a half, the lake manager interviewed town and village representatives within the watershed to gather information about their current activities, interests, and concerns regarding the watershed and subsequent management plan. Information presented in this section is based on those interviews as well as questionnaires and previously gathered data (such as comprehensive plans).

City of Auburn

Description/Background: Although the city of Auburn does not lie within the Owasco Lake Watershed, Auburn residents rely on the lake and its watershed for numerous public health, economic, and recreational needs. Therefore, under the New York State Health Code, Section 1100, the city is responsible for enforcement of the Watershed Rules and Regulations. Emerson Park and the lake are identified as major regional attractions used by local residents and tourists. According to the 1991 comprehensive plan, Auburn population projections for 1995 were 29,846 with 11,340 households. There is an expected increase in the number of senior citizens in the population.

Concerns/Interests: Proposals from the 1991 Comprehensive Plan that are within the scope of Owasco Lake Watershed interest include: bicycle trail between the Auburn High School and Emerson Park; river front pedestrian walk; and a scenic trail from the lake to Genesee Street. The plan further suggests that the Owasco River's recreational amenities are under utilized and should be developed to allow more public access, additional public gathering places, and pedestrian/bike trails connecting the city to the park. There is also an interest in preserving historic buildings along the Owasco River (Outlet).

Town of Dryden

Description/Background: The town of Dryden is included within the headwater area of the lake. Minimum lot sizes have been established for each of five zoning districts within the town. Tompkins County Department of Environmental Health requirements take precedence over the town requirements when private water and septic systems are proposed. Generally, the requirements are not less than a usable acre (43,560 sq. ft.) with a minimum ability to place a system within a 150-ft. diameter circle. The zoning district referred to as RC is a mixed-use district consisting of residential, agricultural and commercial services. RC is the primary development zone for the town of Dryden watershed area.

Concerns/Interests: The town would like to see common sense programs in place to protect and preserve the watershed and lake. Three primary areas of concern are: 1) attainable control of runoff; 2) assistance to support the changes necessary to preserve the watershed; and 3) access to the lake and watershed by those who support their protection. The town of Dryden believes it shares responsibility for the watershed's protection. They are willing to cooperate in planning and meeting with stakeholders.

Town of Fleming

Description/Background: The eastern third of the town of Fleming is in the watershed. This area includes the western half of Emerson Park. The town has land use and subdivision regulations in effect.

Concerns/Interest: The town would like to see a development project from the High School to Whitebridge at Emerson Park. They would also like to see the wetland area of the park utilized for interpretation and to link it with recreational use and lodging. Regardless of the use, the loss of this area as a natural open space would outweigh any economic gain derived by the general public. Open space retention is recommended. Town representatives expressed concern over siltation, streambank erosion, and decreasing property value due to reduced water quality. Specific areas of concern are along Veness Brook, Poplar Cove, and Fay's Point. The need for dredging is another issue expressed by the town.

Town of Genoa

Description/Background: The town of Genoa lies in the southwestern area of the watershed. Pine Hollow Creek runs through the eastern portion of the town and is a major tributary of Hemlock Creek. The town has enacted local land use control mechanisms including the establishment of minimum building lot sizes (40,000 sq. ft.).

Concerns/Interest: The town board passed a resolution on April 4, 1998 to support the study of issues relating to the Owasco Lake Watershed in an effort to preserve the water resources it encompasses. The board further resolved to take necessary steps to obtain stakeholder input and provide assistance to the lake management planning process and to ensure that areas of concern are included in future plans. The board also expressed that through town participation, future planning for activities in the watershed will be done with consideration of promoting positive impacts, both economic and ecological, to the entire watershed community.

Town of Groton

Description/Background: The town of Groton is located north of the town of Dryden and south of the town of Locke. The town has zoning regulations.

Concerns/Interest: Some of the most severe storm water issues are related to Sovocool Hill. The town sees developmental pressures from the southwest area of the town, which includes Sovocool Hill. The town Supervisor indicated that the town would be looking at extending the sewer district due to current and projected growth in that area.

Village of Groton

Description/Background: The village of Groton borders both sides of the Owasco Inlet and is centrally located in the town of Groton, north of the town of Dryden and south of the town of Locke. The entirety of the village is in the Owasco Lake Watershed. The village is working on a Main Street renovation project funded under several grant sources. The Main Street project addresses utility, water service, storm sewer replacement, and various other aesthetic issues.

Concerns/Interest: Regular flooding of a senior citizens home, located on the banks of the Owasco Inlet, has been a problem that the town and village of Groton have been collaboratively

addressing. The runoff comes from the Dryden area and the north side of the village of Freeville. To alleviate this problem, the town plans to relocate a drain that will direct runoff away from the main flow of the Inlet in hopes of alleviating the flooding. Approximately \$137,000 in state flood control money has been secured to address this problem. A number of alternative plans have been suggested, such as dredging the creek and building a wall around the home, however the current plan, which involves the creation of a runoff retention area, has been approved by the NYSDEC. Federal Emergency Management Agency (FEMA) approval is pending. Also of concern is the disappearance of trout following the construction of a bridge over the Owasco Inlet, which has seriously impacted recreational fishing.

Town of Lansing

Description/Background: The headwaters of Hemlock Creek, a tributary of the Owasco Inlet, are located in the town of Lansing. The town has zoning and subdivision regulations.

Concerns/Interest: Although only a small area of the town is in the watershed, the town board indicated a willingness to cooperate and participate in the watershed planning process.

Town of Locke

Description/Background: The town of Locke has lot size regulations (as part of local law #1, 1993) which specify a minimum building lot size of one acre. Subdivision regulations include planned unit development regulations. The town has a board of appeals for local laws as well as a planning board. The town employs a building inspector and has local laws governing project review. There are also local laws regarding flood insurance, stream corridor protection, mobile homes, and junkyards.

Concerns/Interest: The town supervisor indicated that the town of Locke would like the watershed management plan to result in flood prevention and mitigation as well as the protection and enhancement of outdoor recreational opportunities. Three primary issues of concern are: 1) flooding of Owasco Inlet and tributaries; 2) protection and enhancement of recreational opportunities including fishing, hunting, trapping, and camping; and 3) economic impacts of watershed protection--especially for farmers and residents. The town agrees that the community shares an interest in maintaining water quality and pursuing flood prevention. The town is interested in cooperating in the development of flood prevention measures for the Owasco Inlet drainage basin. The town also indicated a desire to provide input and participate in discussions during all phases of the watershed planning process.

Town of Moravia

Description/Background: The town of Moravia borders the southern part of the lake and the northern part of the Owasco Inlet. According to the 1992 Comprehensive Plan, the town can be described as primarily agricultural with rural character. The town is working on a retention pond project in the Skinner Hill area to remediate flooding of the high school and a mobile home park. The state is increasing the size of the culvert at the bridge on Rt. 38 in order to alleviate some of the problems encountered from 1998 winter/spring storm events that affected areas west of the village of Moravia.

Concerns/Interest: The town would like to investigate securing federal flood monies to construct retention ponds. According to the 1992 comprehensive plan, development should be directed away from flood prone areas. Land use regulations should ensure lakeshore development is consistent with protecting the lake and its watershed. Maintenance of recreational opportunities is also an interest.

Village of Moravia

Description/Background: The village of Moravia borders the Owasco Inlet, but has no direct lake access. The village has an extensive wellhead protection law and a Cross-Connection Law for their water systems. Because of steep topographic features of the surrounding area, there is a high potential for loss of life and property caused by flooding. This flooding potential is likely to severely limit economic development in the area as some of the central business district and most of the industrial district are in flood prone areas. In March 1987 Local Law #1 formally adopted flood insurance program recommendations. The flood law includes subdivision proposals consistent with minimizing flood damages and requires base evaluation data (1992 Comprehensive Plan).

Concerns/Interests: The mayor is very interested in revitalizing the Main Street area. A project similar to the Groton model (see Groton Links in education section) has been discussed, however, the inter-municipal structure required to accomplish this is not in place. While sewer and water lines are in excellent shape, storm water lines and village improvements are important local issues. A state project on an Owasco Inlet culvert will help alleviate flooding. The village passed a resolution of support on February 23, 1998 towards efforts to protect the Owasco Lake Watershed.

Town of Niles

Description/Background: The town of Niles is a rural municipality that borders Owasco Lake on its western boundary and Skaneateles Lake on its eastern boundary. Farming is the dominant land use. There are significant seasonal and year-round residences along the lake. The Hamlet of Niles, which is located in the north-central area of the town, is located in the watershed. The town has a lot size law with a 2-acre lot minimum. The exception to this law are lake front lots on Owasco and Skaneateles Lakes, which have a minimum of 15,000 sq. ft. and a minimum of 75 ft. of lake frontage. The setback on lake front lots is a minimum of 25 ft. from the mean high water mark. The town has a Planning and Appeals Board. Under subdivision regulations the board reviews the following: public street and road design, sanitary sewer design, water system design, stormwater quality restrictions, stormwater drainage design, slope restrictions, and erosion and sediment control. The town has adopted a State Environmental Quality Review Act (SEQRA) law to ensure appropriate consideration of environmental impacts resulting from concentrated development.

Concerns/Interests: One of the town's goals, as stated in its comprehensive plan, is to preserve the rural nature of the area and avoid conflicts with agriculture. The plan indicates an awareness of lakeshore development issues and assumes a proportional share of the responsibility for ensuring water quality. There is no anticipated industrial development.

Town of Owasco

Description/Background: The western half of the town of Owasco, including the eastern half of Emerson Park, lies within the watershed. The town has both land use and subdivision regulations.

Concerns/Interests: The town is concerned about development, especially in the Emerson Park area. The seawall has been a major concern for park users and town officials. The town's comprehensive plan stresses the importance of agriculture to the town and recognizes the sensitive nature of lakeshore development. Public investment in recreational lands has also been identified as an important issue. The town sees a unique responsibility for developing its community within the watershed and is willing to take a proportionate share of responsibility for the protection of the lake.

Town of Scipio

Description/Background: The eastern part of the town of Scipio lies within the watershed. Scipio has no land use regulations. Agriculture is the main economic source. There is a public right of way at Fire Lane 15 at Ensenore. According to the Scipio Comprehensive Plan, flood areas in the town are limited to the lakeshore. The plan contains recommendations for subdivision regulations with a 40,000 square foot minimum.

Concerns/Interests: There are property owner concerns regarding the boat launch. Specifically, an individual homeowner holds the deed to the land on which the boat launch is located, but the town has the right-of-way to the lake. Originally, this arrangement was set-up so farmers and fire trucks could obtain water. Over the years, however, the site has become a free launch site for boaters. The public also uses the area as a beach, which is also a concern to the adjacent landowner.

Town of Sempronius

Description/Background: The town of Sempronius is located in the southeast area of the watershed within the Owasco Inlet subwatershed. More than 50% of the land area of the town is in the watershed. The town has a setback and lot size law, which specifies a minimum lot size of two acres with 300 ft. of frontage. The Mobile Home Law requires that no mobile home community is to be located on less than ten acres, with each lot having a minimum of 0.75 acres. The Mobile Home Law includes storm drainage and fire protection regulations.

Concerns/Interests: The town would like the watershed management plan to provide protection of the lake for all the residents of Cayuga County. The two primary issues of concern of the town are: 1) economic condition of the town (lack of money); and 2) farming (soil/manure management and use of sludge as a soil amendment). The town agrees that it shares responsibility in the protection of the lake.

Town of Sennett

Description/Background: The town of Sennett lies in the northernmost area of the watershed and has the least amount of acreage in the watershed.

Concerns/Interests: The town has not expressed any interests or concerns regarding the lake or its watershed.

Town of Skaneateles

Description/Background: The southwest area of the town of Skaneateles lies in the watershed. Farming and farm related businesses are the predominant and desired land use activities. The area is located exclusively under the R-F (Rural Residential/Farming Areas). The R-F District is comprised of the town's most active agricultural districts. Minimum lot size in the Town is two acres. Resource protection is accomplished through zoning laws, subdivision review, overlay tools with a performance audit factor built in for review on a minimum five-year basis. The Watershed Overlay District sets additional standards to assure that development does not degrade lake water quality. The Skaneateles Comprehensive Plan considered and approved a number of policies recommended in the Onondaga County Water Quality Agency's 2010 Development Guide. This guide was developed to provide oversight and advice on the creation of land use strategies in order to prevent land use degradation in the Owasco and Skaneateles watershed areas. The town's Natural Resource plan states: "Foremost among many concerns is the maintenance of water quality in Skaneateles and Owasco Lakes." Specific note is made of impact on lakes and creeks from erosion, sediment and drainage. There is particular emphasis on sound highway and ditching programs, implementation of erosion control ordinances, support of agricultural efforts, protecting and minimizing impact on sensitive environmental areas, and minimizing pollution of streams and drainage ways.

Concerns/Interests: The town's planning concerns center around assuring the continuation of farming on prime agricultural land, limiting the extent of non-farm development, and cooperating with other agencies to stop lake degradation from surface water runoff and erosion. The town comprehensive plan recommends a feasibility study for the possibility of a ridgeline trail to connect to the Finger Lakes Trail system. The only vista listed in the town plan within the watershed is the intersection of Hencoop and Giles Road looking south and southwest. The town has passed a resolution of support for the Owasco Lake Management Plan Project.

Town of Summerhill

Description/Background: A small area of the western border of the town of Summerhill is in the watershed. Summerhill has site plan review powers. Fillmore Glen Creek originates in Summerhill, runs through Fillmore Glen State Park, and enters the Owasco Inlet just south of the village of Moravia.

Concerns/Interests: The town board indicated a willingness to cooperate and participate in watershed planning.

Town of Venice

Description/Background: The town of Venice lies in the southwest area of the watershed and borders a small section of the southernmost part of the lake. The town has no zoning or subdivision regulations.

Concerns/Interests: The residents and business owners on the lakeshore portion of the town sent a letter indicating concern regarding the silting of that area and problems with debris on the shoreline. Their concern is that these problems impair their use of the lake for recreational boating and fishing. The area is also home to a marina with boat launch. The opinion expressed in the letter, and through interviews, is that the silting and debris come

from the Owasco Inlet, especially during flooding episodes. The town agreed to participate in a sub-watershed municipal committee, if formed.

SECTION VI -- ISSUES OF CONCERN

Watershed Resident Survey

In the spring of 1998, a survey was mailed to approximately 7,600 residents in the watershed. Below are the results of that survey based on the responses of 1,767 individuals.

1. What is your Age Group?

<u>Under 18</u>	<u>18-30</u>	<u>31-50</u>	<u>51-65</u>	<u>Over 65</u>	<u>No response</u>
0	3%	35%	29%	25%	8%

2. Where are you located?

Draw a Circle on the map to indicate where your property is located.

If your property is located within the area shown by this map, you are in the Owasco watershed. This means that water that flows across your property enters Owasco Lake.

This is true whether you are located on the lakeshore or miles away near a stream or a tributary of the lake.

Editor's note: Due to large number of responses, map of property locations in watershed is not included.

Do you live in the watershed?

<u>YES</u>	<u>NO</u>	<u>No response</u>
85%	13%	2%

Is your property on the lakeshore ?

<u>YES</u>	<u>NO</u>	<u>No response</u>
21%	76%	3%

3. How do you use your property?

- a. Agricultural 11%
- b. Residential 72%
- c. Recreational 11%
- d. Business 2%
- e. Vacant land 4%

4a. My source of Drinking Water is:

<u>Public Water System</u>	<u>Private Well</u>	<u>Lake Water</u>	<u>Spring</u>	<u>Other (list)</u>
45%	40%	4%	4%	7%

4b. If a public water system (Indicate which)

<u>Auburn</u>	<u>Moravia</u>	<u>Locke</u>	<u>Groton</u>	<u>Owasco</u>	<u>Other</u>
26%	5%	2%	5%	5%	57%

4c. How do you rate the quality of your drinking water?

	<u>Very Good</u>	<u>Good</u>	<u>Poor</u>	<u>Very Poor</u>	<u>Unsure</u>	<u>No response</u>
a. Taste	40%	38%	6%	2%	1%	13%
b. Looks	40%	40%	3%	2%	1%	14%
c. Smell	37%	39%	7%	3%	1%	13%
d. Purity	34%	37%	5%	6%	6%	12%
e. Other	4%	3%	1%	1%	1%	90%

5. Do you use Owasco Lake & its watershed for any of the following activities?

	<u>Once a week</u>	<u>Once a month</u>	<u>Every 3 months</u>	<u>Once a year</u>	<u>Never</u>
a. Fishing	10%	10%	8%	14%	32%
b. Swimming	19%	9%	7%	15%	30%
c. Boating	20%	9%	6%	12%	31%
d. Scenic Appreciation	49%	11%	8%	6%	11%
e. Ice Skating	1%	<1%	<1%	6%	58%
f. Ice Fishing	<1%	1%	<1%	6%	58%
g. Jet Skiing	4%	1%	1%	1%	59%
h. Biking	7%	5%	<1%	5%	50%
i. Hunting	5%	1%	5%	10%	48%
j. Farming	7%	1%	<1%	<1%	56%
k. Gardening	28%	2%	3%	10%	30%
l. Forestry	5%	2%	2%	3%	53%
m. Camping	3%	3%	4%	8%	52%
n. Hiking	12%	7%	6%	8%	38%
Other Activity*	3%	1%	<1%	1%	15%

6. These are some concerns expressed by people around the watershed. Do you have concerns about?

The concerns were weighted and ranked according to number of responses; "strong concerns" (weight of 4), "concern" (weight of 3), "little concern" (weight of 2), "no concern" (weight of 1), or "unsure" (weight of 0).

Concern	Value
1. Public & Private Wastewater Treatment Systems	309
2. Waterborne Pathogens (such as Fecal Coliform)	294
3. Agricultural Runoff	289
4. Fuel spills and/or hazardous waste	278
5. Public & Private Water Supplies	258
6. Herbicide and Pesticide Use around the Home	256
7. Aquatic vegetation (Weeds)	251
8. Stormwater and Sediment Runoff	243
9. Use of Treated Sewage Sludge on your land or your neighbor's land	240
10. Use of chemical weed control around docks or shoreline	239
11. Shoreline/Streambank Erosion/Siltation	232
12. Herbicide and Pesticide Use in Business/Agriculture	229
13. Zebra mussels	217
14. Boating Speed/Noise/Safety	216
15. Lack of connection between community & Lake.	215
16. Seawall Deterioration/Restoration	215
17. Fisheries Development	209
18. Changes in Lake level	190
19. Lack of Public Access for Recreation on Owasco Lake	183
20. Lack of Public Access for Recreation on Owasco Inlet/ Owasco Outlet (River)	174

7. Have you had any of the following problems on your property last year?

	YES	NO	UNSURE
a. Drinking water contamination	5%	82%	13%
b. Flooding	15%	78%	7%
c. Shoreline or streambank erosion	14%	76%	10%
d. Swimming	6%	82%	12%
e. Boating	5%	87%	13%
f. Other (list)*	4%	30%	66%

8. Are you aware of any problems associated with water quality or recreation in the Owasco Lake Watershed? If so, how did you become aware of the problem? *

9. Recommendations

What would your position be on the following, if you were in charge of managing the Owasco Lake Watershed?

The concerns were weighted and ranked according to number of responses; "strongly support" (weight of 2), "support" (weight of 1), "against" (weight of -1), "strongly against" (weight of -2), or "unsure" (weight of 0).

Recommendation	Value
1. Monitoring Owasco Lake & its tributaries to identify pollution.	123
2. Limiting adverse effects of septic tank systems & sewage treatment plant effluent.	112
3. A hazardous spill response program to maximize participation & minimize response time.	110
4. Boating rules & regulations.	102
5. A watershed inspection program.	100
6. More education on watershed practices.	96
7. Voluntary environmental farm management programs.	89
8. Programs to limit nutrients that cause algae & weed growth.	88
9. Reviewing rules for Lake level control.	85
10. Stabilization of stream banks.	80
11. An aquatic weed harvesting program.	78
12. Erosion & sediment control laws to protect water quality.	76
13. Land use controls to protect water quality.	75
14. Constructed wetlands to regulate runoff.	66
15. A dredging program to deepen particular areas of the lake and streams.	48
16. Government regulation of farming practices.	4
17. Other (Explain)*	4
17. Dividing the lake into use zones (fishing areas, water ski areas, protected wildlife areas, etc.).	-17

9a. Funding sources for recommendations in question # 9

How would you pay for the recommendations?

The recommendations were ranked according to responses of "strongly support", "support", "against", "strongly against", or "unsure".

	Support or <u>Strongly support</u>	Against or <u>Strongly Against</u>	<u>Unsure</u>
Donations	75%	6%	8%
Fund Raising Events (Picnics, Concerts, etc.)	69%	9%	6%
User Fees (per foot of dock or boating fees)	45%	30%	11%
Public water user fees	42%	30%	13%
Watershed Resident Tax: By acreage owned	16%	58%	12%
Watershed Resident Tax: Per Capita	16%	71%	13%

10. Incentives

What is your opinion of the following?

The opinions were ranked according to responses of "strongly support", "support", "against", "strongly against", or "unsure".

	Support or Strongly support	Against or Strongly Against	Unsure
Lower taxes for individuals who voluntarily institute practices that protect the watershed.	61%	14%	16%
Landowners who provide stream protection zones get tax relief.	59%	13%	18%
Other (list)*			

11. Do you feel that any of the following programs are needed in the Owasco Watershed?

The opinions of the programs were ranked according to responses of "strongly agree", "agree", "disagree", "strongly disagree", or "unsure".

	Agree or Strongly agree	Disagree or Strongly Disagree	Unsure
Programs for herbicide, pesticide & fertilizer controls	74%	7%	10%
Voluntary programs for watershed protection	75%	4%	9%
Programs on runoff from farm lands	72%	7%	11%
Boating regulations	69%	10%	10%
Stormwater and erosion control programs and/or construction practices	68%	6%	14%
Education programs	80%	3%	6%
Programs for steep slope and/or shoreline Development	56%	10%	20%
Existing programs and regulations are adequate as they are	17%	35%	32%

11a. Who do you think should carry out these programs?

Local Gov't	County Gov't	State Gov't	Federal Gov't	Unsure
22%	26%	16%	5%	31%

12. In the past five (5) years...

	Agree or Strongly agree	Disagree or Strongly Disagree	Unsure
The overall quality of the lake has improved.	21%	35%	37%
My use and enjoyment of the lake has increased.	27%	45%	19%
The value of my property/business has benefited from proximity to the lake.	22%	44%	25%

MY PERSONAL WISH LIST FOR THE OWASCO LAKE WATERSHED

Are there any problems or issues, which as a property owner in the Owasco Lake Watershed, you feel have not been emphasized enough in this questionnaire? Please use the space below to list your main concerns and share any comments you wish to make. *

* See Appendix B (page 108).

Chamber of Commerce Survey

As part of the Owasco Watershed Management Plan Project, a survey was developed in January 1998 in coordination with the Auburn/Cayuga County Chamber of Commerce. The purpose of the survey was to gather input and measure perceptions of businesses in the watershed regarding perceived problems and solutions of the lake and its Watershed.

There were 77 responses to the 511 surveys mailed (15% rate of return). The survey is presented in its entirety in Appendix C. Below is a summary of the results from that survey.

Background Information

The majority (58%) of the businesses use Owasco Lake for recreation. Forty two percent of the respondents live in the watershed; 23% live on the lakeshore.

Importance to Business

Although 21% of the respondents felt that their business are lake dependent, 70% felt it was important to their business and 64% felt it had economic impact on their business. Forty-four percent of the respondents see the lake as important to attracting customers, while 52% of respondents feel that the lake is important to attracting employees to their businesses. All (100%) of the respondents were concerned or very concerned about the water supply, although only 67% of the respondents depend on the lake as a water supply.

Perceived Problems

The top ranking issues of respondents were as follows (as rated by percent):

Rating	Problem	Strongly Agree/Agree (Combined)	Strongly agree
1	Public and Private Water Supply	100%	61%
2	Seawall Restoration	95%	55%
3	Fuel Spills /Hazardous Waste	93%	61%
4	Agricultural Runoff	92%	64%
5	Tourism	92%	57%
6	Public & Private Wastewater Treatment	92%	55%
7	Shoreline & Streambank Erosion	92%	47%
8 (tie)	Waterborne Pathogens	90%	65%
8 (tie)	Herbicide & Pesticide Use	90%	65%
9	Zebra mussels	89%	44%
10	Aquatic vegetation	88%	44%
11	Property value impact	85%	45%
12	Integration of commercial lake attractions	84%	39%
13	Boating speed, noise & safety	83%	44%
14	Stormwater & sediment runoff	83%	47%
15	Lake levels fluctuations	82%	29%
16	Fisheries development	81%	34%

Solutions

- 88% of the respondents believe watershed education programs are needed to improve watershed conditions.
- Although 32% of the respondents felt that the existing regulations are adequate, 74% believe that stormwater and construction regulations are needed.
- 71% believe that steep slope and shoreline development regulations are needed.
- 70% believe that boating regulations are needed.
- 72% of respondents would like to see voluntary programs for watershed improvement.

Perceptions of Trends

- 28% feel the quality of the lake has improved over the last five years, while 46% disagreed and 27% were undecided.
- The enjoyment and use of the lake has increased for 44% of the respondents, with 42% disagreeing and 10% undecided.
- 36% agreed that the value of their property had benefited from proximity to the lake, 42% disagreed and 21 % were undecided.

Issue Details

The following list provides more detail regarding some of the issues that have been identified by various stakeholders throughout the watershed.

Aquatic Vegetation

Issue: Aquatic plants benefit the lake by stabilizing banks, oxygenating water, protecting small fish and creating spawning habitat, acting as refuges for zooplankton (important to the food chain) and serving as food sources for waterfowl and wildlife. But excessive aquatic vegetation growth can complicate or restrict certain uses of the lake. With decreasing funds available for harvesting the plants, controlling the excessive vegetation is becoming more difficult. Should more attention be given to preventive measures, such as reducing of nutrients and siltation, through watershed management programs and education?

Background: In 1977, an inventory of the nine lakes in Cayuga County, which included Owasco Lake, revealed that excessive nuisance plant growth existed in 15 % (3900 acres) of the total surface areas surveyed (24,748 acres) (Miller, 1984). Thirteen aquatic plants species had been identified at that time. The most dominant species included Eurasian milfoil, muskgrass, eelgrass, elodea, coontail, sago pondweed, and large leafed pondweed. The over abundance of aquatic plants in Owasco Lake is an impediment to swimming, boating, fishing and aesthetic value (Miller, 1984).

In past several years, mechanical harvesting of aquatic plants was conducted in early July and again in late August. The Cayuga County SWCD once operated four harvesters in the lakes of Cayuga County, today two harvesters are operated. It has been estimated that Owasco Lake has approximately 150 acres of nuisance aquatic vegetation growth. Since 1979, an average of 60 acres have been harvested annually, with 295 tons of plant material removed yearly. It is estimated that this harvesting effort results in an average of 1147 lbs. of nitrogen, 254 lbs. of phosphorous, and 998 lbs. of potassium removal from the lake.

Concerns have been raised in recent years about the efficiency and manner in which aquatic plants are harvested. Cutting the aquatic weeds may hurt the food chain and substantially reduce the fish population of the lake. Not only are fish removed during the process, but food and habitat are removed, particularly for young fish.

Furthermore, during the harvesting some weed fragments float away and may reroot in other parts of the lake, potentially intensifying any weed problem. After being cut many of many weeds develop additional branches and grow back more dense.

Boating Speed/Noise/Safety/Water Quality

Issue: Some residents have expressed concern over the increasing congestion of boats and watercraft and their resultant impact on the lake. Requests have been made for implementing speed limits, stricter noise regulations, and better enforcement of present laws. Those opposed to stricter regulation stress the need for better enforcement of the current laws. The need for a marine pump out station on the lake as a means to discourage boaters from emptying holding tanks into lake water has also been raised. Some residents fear that this additional service will attract more boat traffic.

Background:

Navigation Laws--Navigational aids, boat speed, mooring, and other boating restrictions fall under the jurisdiction of the New York State Office of Parks, Recreation and Historic

Preservation. State Navigation law is enforced by the Marine Division of the Cayuga County Sheriff's Department. The Sheriff's Department patrols the lake during the summer months by boat and personal watercraft. Few lakes in New York State have a designated speed limit, including Owasco Lake. In 1993 the Owasco Watershed Lake Association, with the assistance of the County Attorney, proposed a local law to specify a speed limit on the lake. The proposal was similar to the laws in place on Canandaigua and Keuka Lakes. The law called for a daytime speed limit of 45 mph, and 25 mph at night. The proposal met with strong opposition from the boating community and was never acted upon by County Legislature. Stricter noise levels than those presently in place were also considered under the same proposal.

Personal watercraft congestion and noise is also perceived as a significant problem on Owasco Lake, as well as on other area lakes. Recently approved state legislation will mandate safety training for operators of personal watercraft in coming years.

Safety --There are many state and federal laws pertaining to boating safety. These laws cover personal floatation devices, fire extinguishers, distress signaling devices, and engine ventilation are all enforced by the Sheriff's Department. The Sheriff's Department monitors emergency marine radio channels to lend assistance to boaters in distress. Volunteer fire departments in Scipio, Owasco, and Fleming have water rescue boats. The US Coast Guard publishes "Minimum Requirements for Motorboats".

Holding Tank Pump-out -- With the population of large vessels on the lake increasing, a need has developed for a marine pump-out/dump station. Currently, boaters must manually pump their waste tanks into separate containers for later dumping. There is concern that wastes are being dumped on the shore or directly into the lake. Discussions regarding the possibility of placing a pump/dump station at either the north or south end of the lake have been held. Should the decision to construct such a facility be made, federal and state matching grant programs are available under the Clean Vessel Act of 1992, which will aid in the construction and operation of the facility. Some residents feel that providing these services will attract more boat traffic.

Noise Pollution -- A major complaint received at the Owasco Watershed Lake Association hotline in recent years has been noise from boats and personal watercraft. State Navigation Law mandates that vessel noise shall not exceed either 90 decibels while stationary or 75 decibels while moving. Stricter noise regulations were proposed for the lake in 1993. The proposal was similar to modifications made to section 44-D of the State Navigation Law and implemented on Canandaigua Lake and Lake George. Those laws changed the maximum noise level to 82-86 decibels, depending on the date of manufacture.

Water Quality -- Although pollution from boat engines has not been a major complaint on the lake, the issue does come up from time to time. According to the EPA, as much as one-third of all the fuel passing through a boat's engine may enter the water. The worst culprits are older two-stroke outboard motors and jet-skis. The EPA now regulates emissions on all new manufactured engines. No studies have been done on the lake to evaluate the long-term effect of boat pollution on water quality.

Biosolids

Issue: Some farmers in the watershed are using municipal sewage sludge-based products (biosolids) on cropland as a fertilizer and/or liming agent. There is debate over whether recycling of sewage sludge and sludge products via land application as allowed under current federal and state regulations is stringent enough (Harrison et al 1997). Concerns about land spreading of sludge and sludge products include nutrient loading, heavy metal mobility in ground and surface waters, and the bioaccumulation of metals in crops, livestock, and

wildlife, which ultimately affect human health. At the same time, there is general agreement that it is beneficial to recycle the nutrients and organic matter in sludges through land application. When contamination from metals and synthetic organics does not result in environmental and health damage.

Background: Sewage sludge is a byproduct of household and industrial wastewater treatment. Not only does sludge contain nutrients and organic matter, but it also contains contaminants such as metals and chemical residues that are discharged into the sewers from industries and businesses. Metal contaminants that have leached from pipes may also be present. Sludge also contains high levels of pathogens, which can be reduced or eliminated with treatment. Until the late 1980's, most of the eight million metric tons of sludge produced in the United States was dumped in the Atlantic and Pacific Oceans. In 1988, the U.S. Congress passed the Ocean Dumping Reform Act to end the ocean disposal of sludge. This new law forced municipalities to find alternative methods for sludge disposal including landfilling, incineration, and land spreading.

Where applicable, NYSDEC permits specify record keeping and reporting requirements, application limits, and setbacks from streams and wetlands. Regulation of the land disposal of sludge and sludge by-products in New York State falls under the U.S. EPA's §503 Regulations and NY's Part 360 Conservation Law. Where EPA's regulations are more restrictive than New York's, the federal guidelines are followed. Commercial products derived from sludges, must comply with New York's compost regulations, and depending on the quality of the product, may require site-specific permit requirements.

Several Cornell scientists have expressed concern over the application of federal rules to NYS and other parts of the northeastern US. Specifically, these concerns exist where: some soils have a low pH which tends to increase metal availability; where a number sensitive to phytotoxic metals are important; where soils are shallow, increasing concerns for groundwater contamination; and where dairy is the major agricultural use, so that application of additional nutrients from sludges to those already provided by manure application may result in excessive nitrogen and phosphorus (Harrison et al 1997).

Community/Urban Forestry

Issue: As land is developed, various environmental problems typically arise. Soil compaction, increased runoff, flooding, erosion, sedimentation, urban warming, water pollution, and disruption of plant and animal habitat often increase.

Trees can reduce these problems by moderating climate, improving air quality, conserving water, decreasing runoff, and harboring wildlife. Trees also provide other community benefits such as providing privacy, reducing glare and reflection, directing pedestrian traffic, offering recreational spaces, and adding to property values. Although trees provide numerous aesthetic and economic benefits, they also require an investment. Proper selection and maintenance of trees is essential to their long-term success in urbanized areas. It is essential for communities to seek technical assistance in designing site specific tree plans, such as for a high-density residential area, or for community-wide programs.

Background: The village of Moravia is currently being assisted by the NYS Department of Environmental Conservation, Division of Lands and Forests, in developing an inventory of trees and tree sites.

Emerson Park Beach Closings

Issue: During the past few years it has been necessary to close the Emerson Park bathing beaches due to high fecal coliform counts obtained from lake water at the park. High fecal coliform counts observed at the beaches, and the resultant closing of these beaches for swimming, has had a tremendous negative impact on Emerson Park and the lake. The entire community views the quality of Owasco Lake by the status of the beaches. Individuals perceive the quality of Owasco Lake to be much worse than our neighboring Finger Lakes. This perception affects tourism, real estate values, and activity at Emerson Park.

Background: See Bacteria in Watershed Characteristics, Section I (page 16).

Fisheries Development

Issue: There are several management issues that have been identified as affecting the health and integrity of the lake's fisheries. Should the aquatic vegetation management program be reduced to leave isolated beds (spawning areas) uncut? How can the dams be managed to reduce negative impacts on fisheries (installation of ladders/screens, dredging to provide alternatives to spillways, etc.) Also, how can volunteer stocking programs, such as Owasco Lake Angler's Association walleye pike program, be supported?

Background: See fisheries in Watershed Characteristics, Section I (page 36).

Forestry Use

Issue: Private landowners or private logging companies may not be using all of the recommended silviculture best management practices during forest cutting operations, resulting in some water quality degradation. In addition, landowners that contract with private companies for harvesting may not understand the implications of their proposed contract and may be disappointed with the final results.

Background: See forestry resources in Section I (page 12).

Herbicide and Pesticide Use--Ag/Commercial/Municipal

Issue: Improper and overuse of turfgrass and agricultural chemicals may affect water quality in the lake.

Background: Pesticides generally refer to herbicides, fungicides, and insecticides. These products are designed to kill or control pest insects, weeds, and fungal diseases. Chemicals are used throughout the watershed by farmers, private companies and municipalities to manage cropland, turfgrass, forested areas, etc. The effect on water quality of the lake is not known.

Highway Maintenance

Issue: Roadbank erosion occurs from either new road construction or from cleaned out existing road ditches that are not properly stabilized. Over-application and inadequate storage practices of salt other deicing agents and can also negatively affect water quality either directly from runoff, or indirectly by causing damage to vegetation.

Background: Rock salt remains the most common material use by highway departments across the country and in the watershed (for additional information, see Roads/Highways in Section III, page 43).

Household Chemicals

Issue: Many products used around the home, garden and garage contain potentially dangerous chemicals that, if improperly used, stored or disposed of, can contribute to water pollution and adversely affect sewage treatment.

Background: Residents in the watershed have the opportunity to participate in the following collection events, depending on their county of residence.

- Onondaga County holds household hazardous waste (HHW) collection events twice annually (spring and fall) at different locations. Call the Onondaga County Resource Recovery Agency for information at (315) 453-2866. The town of Skaneateles had a collection event in the fall of 1999.
- Tompkins County is currently developing a permanent collection facility that will be open to Tompkins County residents by mid-summer of 2000. Residents and small quantity generators are being asked to safely store their hazardous materials until the program is operational. For more information call the Tompkins County Solid Waste Management Division at (607) 273-6632.
- Cayuga County held its first HHW collection event in the fall of 1997 and second in the fall of 1999. At this time, the collections are not held on a regular basis. Residents are encouraged to properly store their hazardous wastes in a secure location until the next collection (currently planned for the spring of 2001).

The following are some general examples of hazardous products that require special handling, as instructed by product labels:

Adhesives	Lighter fluid
Aerosol cans (with hazardous contents)	Lye
Antifreeze	Mothballs
Batteries (household and automotive)	Pesticides
Cleaning products	Photographic chemicals
Corrosives	Oil-based paints and stains
Driveway sealers	Weed killer
Fuel mixtures	

Illegal Dumping

Issue: Although the number of illegal dumps in the Owasco Lake Watershed is unknown, illegal dumping of waste is a problem in many communities throughout New York. Illegal dumps can be found along roadways, public lands, private property, stream banks, railroads, and farms. Illegal dumps are not only an eyesore, but can also be a potential source of contaminants to surface and groundwater. In addition, dumps can lead to decreased property value.

Background: Effective solid waste management programs that offer recycling and options for hard to dispose of items, along with education and enforcement of dumping laws, are critical to controlling the problem.

Intermunicipal Watershed Council

Issue: There are eighteen individual municipalities (including counties, towns, and villages) operating within the watershed. Should an intermunicipal council be formed to discuss watershed issues and other topics of common interest? What functions could it perform? Is there interest in forming intermunicipal agreements concerning watershed land use, standards of operation or other topics? Can towns assist each other and work cooperatively on comprehensive plans?

Background: Following the example of the Keuka Watershed Improvement Cooperative (KWIC), other Finger Lakes have explored creating intergovernmental agreements and/or councils. These councils are designed to facilitate communication, cooperation, and distribution of information among local government bodies (cities, towns, and villages) within a watershed.

Because the municipalities share a number of common goals, interests, concerns, and benefits of the watershed, a forum to explore and develop areas for cooperative activities could be very efficient, effective, and productive.

Invasive Exotic Species

Issue: Several invasive exotic species have been found in the watershed and represent a biological management concern. There is a need to conduct a thorough scientific inventory of invasive species within the watershed so a management plan can address the problem.

Background: Exotic, or non-native, species are plants/animals that are introduced (either accidentally or purposefully) from a different part of the country or world. Once they are established outside their natural range, exotic species have a potential to seriously disrupt the ecological balance of a terrestrial or aquatic ecosystem by limiting biodiversity and altering natural succession, among other effects. Exotic species can become particularly problematic when they compete with or even eliminate native species. Functionally healthy and established environmental communities seem more resistant to invasion and disruption. Thus, ecosystems already altered and changed by humans are more easily invaded by exotic species.

Purple Loosestrife (*Lythrum salicaria*), Black Swallow-wort (*Cynanchum nigrum* [*Vincetoxicum*]), Common Buck-thorn (*Rhamnus cathartica*), Japanese Knotweed (*Polygonum cuspidatum*), Curly Pondweed (*Potamogeton crispus*), and Eurasian Watermilfoil (*Myriophyllum spicatum*) is a partial list of problematic plant species that have been identified in the watershed.

Several other exotic species are addressed elsewhere in this report.

Lake Levels

Issue: Lake level fluctuations often cause concern for municipalities, lakeshore property owners, and recreational users. Problems include property damage, shoreline erosion, water intake exposure, ice damage, and difficulties with boat docking. Proper lake level management addresses flood protection, hydroelectric power generation, fish and wildlife management, municipal water supply, surface water quality, and water-based recreation.

Background: The Army Corps of Engineers (ACOE) sets the guidelines for maintaining water levels in the Owasco Lake Outlet. The city of Auburn is charged with control of the level by means of the State Dam at Swift Street.

In 1961, the ACOE completed the Owasco Lake Outlet Project. The project is intended to provide 100-year flood protection below the State Dam and 20-year protection on the lake. The Owasco Lake Level Operating Plan calls for maintaining levels between 710 and 713 feet.

Excessive run-off during storms sometimes causes the lake to rise above target levels, resulting in lakeshore flooding. According to the city of Auburn, problems start at 713.4 feet and flood stage is reached at 715 feet.

Drought conditions can also result in undesirable low lake levels, exposed lake bottoms, and impaired access. Private water intakes have been reported to freeze when levels are below 710 feet.

Withdrawals from the lake include the water supply for the city of Auburn, the town of Owasco and their associated service connections. There is also a relatively large number of private water intakes although the exact number is unknown.

Lake level is a very complex and controversial issue in the Owasco Lake Watershed. Public education on lake level management goals, techniques that are employed, and awareness to all of the contributing factors involved, would go a long way toward minimizing the emotion and misinformation that surrounds this complex issue (Hennigan Report 1986; Army Corp of Engineers Reservoir Regulation Proposal 1992). Increasing public awareness and education of the issues involved in lake level management is important in dealing with this issue.

Land Use Changes

Issue: How should the balance of growth and the protection of the environmental integrity of the watershed be addressed? Unfortunately, because development happens so quickly and it occurs in piecemeal, many communities discover the loss of agricultural lands to be problem and take action only after it is too late.

Performing an inventory of open spaces and an assessment of key lands would be helpful in protecting the watershed's water quality, scenic vistas, wildlife, and other values closely linked to land use. Should towns in the watershed collaborate on prioritizing key areas and co-design sub-regional open space plans?

Background: The development of historically agricultural lands to urban/suburban sprawl can potentially lead to numerous environmental and community-based problems. Typically, urban runoff and non-point source pollution increases, wildlife habitat becomes fragmented, open space is lost, and necessary infrastructure modifications stress community resources.

Municipal Wastewater Treatment

Issue: There is concern regarding the degree to which municipal wastewater sources are contributing to the fecal contamination of the lake. Before its upgrade in 1992, the Moravia wastewater treatment facility was of particular concern because it received wastewater in excess of its design capacity. The Groton sewage treatment facility, however, has not been upgraded since 1976.

Background: These facilities are currently meeting state operating guidelines.

Owasco Flats

Issue: How should this unique natural area be used so that property owners, watershed residents, and local communities benefit from its recreational potential while continuing to be a sustainable, desirable, and important natural resource. In the past, littering and illegal dumping of trash has specifically been identified as a problem in the flats.

Background: In 1995, John Weeks, environmental consultant/wildlife biologist, was hired by OWLA to conduct a feasibility study of a portion of the Owasco Flats. The purpose of this study was to determine how the area could serve the public better now and in the future retaining the unique character and integrity of the river bottom flood plain.

The focus of this feasibility study was approximately 89 acres of public property owned in part by Cayuga County and in part by the city of Auburn. Owasco Flats Nature Reserve, Inc., a not-for-profit organization, was formed to address issues identified from this study.

The proposed revisions include the following:

1. Improve access.
2. Provide a recreational area for the handicapped.
3. Provide opportunities for sportsmen to teach hunter safety, fishing techniques, and to share their knowledge and experiences with youngsters.
4. Include winter activities such as snowmobiling and cross-country skiing.
5. Increase local revenue from those who visit the Owasco Flats Nature Reserve.
6. Provide sanitary facilities.
7. Provide a boat launch that would enable easier access to the lake.
8. Provide recreational and educational opportunities such as fishing, hiking, birdwatching, canoeing, photography etc.
9. Allow for the preservation of habitat that allows for these activities.
10. Monitor uses that destroy wildlife habitat.

Since the report was written, there have been a number of litter clean-ups, improvements have made to the access road and trails, water control devices have been repaired, and overall, the area is being better maintained. The issue of invasive species, particularly purple loofestribe (*Lythrum salicaria*), and preservation of biodiversity have become recent issues of concern for the Owasco Flats Nature Reserve group.

Petroleum Storage

Issue: Petroleum products are abundant and may be the most potentially hazardous materials stored in the watershed. Boaters in particular face the dilemma of disposing of unused and potentially unusable petroleum products.

Background: No available background information.

Private Drinking Water Supply Protection

Issue: As with other Finger Lakes, the safety of private water sources is a watershed health concern. This is especially true since some lakeshore residents obtain their water directly from the lake and do not treat it prior to use.

Background: Approximately 260 households take water directly from the lake for their personal use. The NYSDOH has stated that surface water sources should be filtered and disinfected prior to usage.

Private Wastewater Treatment

Issue: Is the conversion of seasonal dwellings to year-round homes having a significant impact on water quality?

Background: Many local code enforcement officers will not issue building permits for new homes or enlargements without checking with the Environmental Health Division of the Cayuga County Health and Human Services Department to determine if their existing septic system is adequate. The key to the successful enforcement of the Sanitary Code regarding this issue involves the cooperation of all the local code enforcement officers.

Public Access

Issue: Since much of the land around the lake is privately held, some citizens have expressed an ongoing desire to have more public access for water recreation. At the north end of the lake, Emerson Park serves as the only public access to the lake. There is a desire by many citizens, for a public access site at the southern end of the lake. Some property owners, however, are concerned that there will be increased traffic and inadequate controls.

Background: Emerson Park is the main public access point to the lake. The park presently provides access for boating, swimming and fishing. There have been several proposals over the years to provide public access at the south end of the lake. The Cayuga County Parks Commission is presently considering how to utilize the property known as the "Owasco Flats" at the mouth of the Owasco Inlet. Owasco Flats Nature Reserve, Inc. has worked over the past two years to provide a plan for public access to the lake, inlet, and wetlands at the head of the lake. The plan includes a potential canoe/boat launch, fishing access, as well as hiking and biking trails.

Real Estate Values

Issue: Lake front property has significantly decreased in value over the last four years. This trend is primarily due to the central New York economy, however, there is concern that poorer water quality will intensify the decline in real estate values throughout the watershed.

Background: The price of a single family home on the lake is comparable to building a new home with a pool, which in the opinion of realtors, is more desirable to current home buyers. Currently, there is no economic incentive to develop a piece of property in the watershed with a lake view because development costs are higher than the potential selling price. Also, there are fewer summer cottages than in years past, mainly because many have been renovated into year-round dwellings.

Many prospective buyers perceive Owasco Lake as not being as clean as other Finger Lakes. Clarity, aquatic weeds and pollution are perceived negatives. There is also concern that the Cayuga County Sanitary Code is less stringent on conversions than transfers. The real estate market may be enhanced by certain tourist attractions, however, the local economy and number of businesses in the area is the primary driving force of the market.

Seawall Restoration

Issue: The Owasco Lake seawall has been in a state of disrepair for several decades. Years of debate of ownership and maintenance responsibility by state and local governments have prevented any significant restoration from being done. Pieces of the deteriorating wall have become a hazard to boaters and cause a threat to the drinking water supply for over 58,000

people. In October 1998, Congress allocated \$5 million for restoration of the seawall. Design and specification development is currently underway. Construction is planned to begin in February 2000 and will take approximately one year to complete.

Background: The Owasco Lake seawall consists of two piers that extend into the lake and form the beginning of the Owasco River (Outlet). The seawall was originally built in the mid-1800's. The west pier is 1,100 feet long and was reconstructed in 1914 by the NYS Department of Public Works as part of the canal feeder system for the Barge Canal. The east pier is 1,243 feet long. The city of Auburn built its water pumping station along the east wall around 1930.

The primary function of the seawall has been and is still, to allow the Owasco Outlet to discharge water with relatively low sediment transport. Prior to construction of the seawall, sand aggradation of the original outlet required annual dredging to insure perennial flows.

Various studies/reports have suggested ideas on how the reconstruction should proceed (Hennigan 1986; Konski Engineers 1996; Cayuga County Parks Commission 1998). Suggestions have ranged from boat dockage along each pier to enhanced channel depth to facilitate better flows from both the east and west beaches. Other ideas include a pedestrian walkway, gazebo shelter, enhanced lighting, and exterior improvements to the water pumping station.

Shoreline Erosion Control

Issue: Impacts of shoreline erosion are many: excessive sediment pollution, loss of vegetation and shoreline habitats, thermal pollution, release of nutrients, loss of underwater habitat, stressed fish and wildlife populations. One of the more obvious impacts is that an eroding shoreline may affect property values.

Background: Shoreline erosion is impacted by lake levels (see Lake Levels in Section I, page 7).

Stormwater and Sediment Control

Issue: Problems of flooding and water quality degradation in developing areas can be attributed to stormwater runoff events. Currently, local governments, through their planning and regulatory functions are responsible for controlling the impacts of stormwater and runoff in the watershed. These local governments may need technical assistance to guide their planning activities in the watershed and in enforcing standards set by the NYSDEC. However, watershed-wide stormwater management implemented on a watershed-wide scale may require the establishment of a regional authority to coordinate multi-jurisdictional land use and development plans, and to ensure their consistency with stormwater management plans, goals and objectives (NYSDEC 1993).

Background: Stormwater management may be defined as a system of vegetative and structural measures that can be used to control the increased rate and volume of surface runoff caused by human changes to the land. These measures are undertaken to maintain existing patterns of flood magnitude and frequency.

Programs for stormwater management have several objectives:

- Prevent increased runoff from new land development or agricultural practices to reduce potential flooding and damage;
- Minimize the erosion potential from construction or agricultural activities;
- Assure the adequacy of existing and proposed culverts and bridges;

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- Increase groundwater recharge;
 - Enhance the quality of stormwater runoff to prevent water quality degradation in receiving waterbodies;
 - Reduce streambank erosion to maintain stream channels for their biological functions as well as for drainage;
 - Prevent reductions in stream base flow caused by intensified land uses.

Watershed-wide management of stormwater begins with simulation models to predict hydrologic and water quality changes in the watershed resulting from anticipated or proposed changes in land use. The control of stormwater runoff, whether from existing land uses or from new land uses can include on-site stormwater management practices, regional systems, or a combination.

The NYSDEC administers the federal Water Quality Act of 1987 regulations under the State Pollutant Discharge Elimination System (SPDES) program. A SPDES General Permit for stormwater discharges from construction activities is required for all construction activities disturbing five acres or more. The owner of the construction site must file a stormwater pollution prevention plan with the municipality before construction begins. When the project is completed, the operator must file a notice of termination with the EPA.

Agricultural land use is essentially grandfathered. Several watersheds in the Finger Lakes have instituted mandatory conservation compliance programs for farmers.

In the Owasco Lake Watershed, the Cayuga County SWCD has engaged in an increasing range of activities to promote stormwater, sediment and erosion control. In the 1980's water resource scientists told the district director that Owasco Lake is particularly susceptible to sediment and nutrient discharges. Since that time the district has engaged in projects of increasing scale to enhance stormwater management throughout the watershed. Many of the projects have occurred near public roads so the community has a sense of what work has been done.

An effort was made in the mid 1990's to encourage the adoption of a countywide sedimentation and control ordinance. The effort foundered on the issue of home rule by town governments. No comprehensive plan is in place to address stormwater management systematically throughout the Owasco Lake Watershed at this time.

Stream Corridor Management

Issue: The watershed lacks sufficient permanently preserved riparian buffer areas to adequately prevent pollutants from reaching watercourses. This is of particular concern in the northern part of the watershed. Some tributaries require streambank stabilization measures to control the most prominent sources of in-stream erosion. Funding sources need to be identified for streambank restoration.

Background: A stream and its riparian area, or stream bank, function as one system. The condition of the riparian area helps determine the quality and integrity of stream channels and habitat available to fish and other wildlife. Riparian areas interact with the flow of surface and groundwater from upland areas and play an important role in water quality.

Natural stream channel stability is achieved by allowing the stream to develop stable dimension, pattern, and profile. For a stream to be stable, it must be able to consistently transport its sediment load, both in size and shape, with local deposition and scour. Channel instability occurs when the scouring process leads to degradation, or excessive deposition results in aggradations.

Although streamside vegetation of any kind is desirable, forests provide the greatest number of benefits and highest potential for meeting both water quality and habitat restoration objectives.

Establishment of riparian forest buffers, sediment and erosion control designs that integrate soil bio-engineering techniques, and innovative land use practices can help restore a stable form and reduce tributary sedimentation. NYSDEC has identified silt as the primary pollutant for Dutch Hollow Brook, a four-mile portion of the Owasco Inlet, Sucker Brook, and Veness Brook.

Impact on Tourism

Issue: Owasco Lake is a major marketing tool for drawing tourism into the area, however, closed beaches due to high coliform counts has hurt the perception of the watershed and could have a negative impact for an extended period of time. Other issues previously identified which also directly influence the generation or reduction of tourism in the watershed include: fisheries, seawall deterioration, zebra mussels, boating, swimming, available family activities (especially at Emerson Park) and public access.

Background: There are approximately 910 sleeping rooms in Cayuga County, including accommodations at Wells College and Casowasco. An overnight facility (hotel) on the lakefront could be a separate and significant draw.

The Cayuga County Office of Tourism has recently targeted coach tours and is focusing on attracting conventions. Other tourism goals include expanding the tourism season into the so-called "shoulder" seasons (fall & spring) and initiating a winterfest or similar winter draw.

Volunteer Agricultural Programs

Issue: To date, interest in participating in the Cayuga County Nutrient Management Program has not been demonstrated.

Background: A member of the original Nutrient Management Committee was interviewed. The farmer's perspective of the program were:

- 1) Some farmers may already believe they are doing the best job possible, and feel that they do not need a plan.
- 2) Some farmers may already know that they are practicing methods they shouldn't and, for fear of repercussions, do not want to be discovered.
- 3) Some farmers have difficulty seeing non-physical results. Savings on fertilizer expenses basically show up on paper whereas fencing, for example, is tangible and easy to see.
- 4) With the price of milk so low, farmers may not feel that a nutrient management plan is a necessary expenditure.
- 5) The 100% financing of BMPs in the neighboring watershed of Skaneateles Lake may also have an impact on the farmers' willingness to participate.

The Cayuga County SWCD staff is currently investigating the reason for the lack of interest in this program and is attempting to develop a new strategy to recruit participation.

Waterborne Pathogens

Issue: In the past twenty years, the number of outbreaks of waterborne disease in the nation has increased substantially (NYSDOH 1997). Reporting waterborne disease outbreaks is voluntary in the United States. State and local public health agencies are primarily responsible for the education and investigation of outbreaks. State health departments voluntarily report waterborne disease outbreaks to the Centers for Disease Control and Prevention (CDC). Therefore, the actual number of waterborne disease outbreaks are most likely much higher than reported (Moore et al. 1994).

Background:

Microorganisms

Giardia

Pathogenic microorganisms such as viruses, protozoa, parasites, and bacteria are most often responsible for waterborne diseases (see Table A-00 in Appendix A for examples). Many of these pathogenic microorganisms live in the gut of warm-blooded animals and are passed through the feces. Consequently, the sources of these diseases include improperly treated sewage and fecal contaminated runoff. One identified cause of outbreaks is the disease causing protozoa, *Giardia lamblia*, which is found as a cyst in some surface water supplies (NYSDOH 1997). The cysts are environmentally resistant, which allows for their extended survival in surface and treated water. The cysts are oval and range in size from 8-14 micrometers (millionths of a meter). Once ingested, the cysts release the parasites that can cause giardiasis, a gastrointestinal illness. An infected animal or human can release as many as 300 million cysts in its feces. It is estimated that 10-28% of the lakes and rivers in the United States have *Giardia* (LeChevallier and Norton 1991).

Cryptosporidium

Another pathogenic protozoa, *Cryptosporidia*, is also found in water supplies. *Cryptosporidia* produce thick-walled, egg-shaped oocysts (ova) which can pass through space smaller than six micrometers. When animals or humans ingest the oocysts, digestive juices dissolve the oocyst wall hatching the parasites that cause severe gastrointestinal illness (LeChevallier and Norton 1991).

In March and April of 1993 an outbreak of Cryptosporidiosis occurred in Milwaukee, Wisconsin. An estimated 403,000 people came down with severe diarrhea caused by *Cryptosporidia* (Moore et al. 1994). This was the largest waterborne disease outbreak ever reported in the United States. Adequate, consistent levels of chlorine are particularly important for disinfection of relatively chlorine-resistant organisms such as *Giardia*. Unfortunately, *Cryptosporidium* is highly resistant to disinfection by chlorine. The only known method today to remove the oocysts is filtration. However, filtration practices are not always consistent and chances of oocysts passing through the filter media are probable. Therefore, in addition to disinfection and filtration, protection of raw-water quality (source reduction) is critical for preventing the transmission of waterborne diseases.

Schistosomatidae

A pathogenic microorganism that causes "swimmers itch" (or duck itch) has been found in some neighboring Finger Lakes, such as Skaneateles Lake. Several species of avian parasites of the family *Schistosomatidae* cause a severe rash when, in their juvenile stage, they penetrate the skin of an unsuitable host such as a human (Schmidt and Roberts 1985). The Cayuga County Department of Health & Human Services reports no documented cases of swimmer's itch associated with Owasco Lake.

There are numerous other pathogens that may be present in human sewage. Their presence underscores the importance of programs designed toward preventing the improper discharge of sewage in the watershed.

Risk to Swimmers

Swimming and other recreational activities during which unintentional ingestion of water occur are known to increase the risk of gastrointestinal illness. Of the 942 cases of waterborne disease outbreaks reported to the CDC in 1991 and 1992, 338 (36%) were caused by recreational activity in lakes (Moore et al. 1994). With this in mind, the Cayuga County Health Department closed the beaches at Emerson Park for most of the summer of 1998. The decision to close a beach is based on measuring the presence of fecal coliform, which is discussed in detail in the bacteria section of this report.

Yard and Garden Management

Issue: A properly maintained home landscape can reduce soil erosion while increasing water retention and soil fertility. However, over-application of lawn and garden chemicals, including fungicides, insecticides, herbicides, and fertilizers can increase toxic and nutrient loading to both surface and groundwaters. Because homeowners use of lawn and garden chemicals are not regulated and many products contain potentially harmful chemicals, the amount of lawn and garden chemicals improperly used within the watershed may have a significant impact on water quality.

Furthermore, the disposal of unused lawn and garden products can also negatively impact water quality (see household chemicals) as can landscaping choices related to water use and disposal of yard wastes. In particular, bonfires and burning of materials near the lakeshore can be a source of nutrients and other contaminants (depending on what is burned) when runoff from the ashes enters the water.

Background: There are approximately 1,800 acres of residential land within the watershed. Nationwide, homeowners use ten times more chemical fertilizers and pesticides per acre than farmers use on farmland. Furthermore, the average American may also use 100 gallons of water each day for landscaping and gardening.

Zebra Mussels

Issue: Lake shore residents are concerned about the unknown impacts of zebra mussels on private water supply intakes and what effective means should be taken to protect their pipes. Since phytoplankton and detritus are major food sources for aquatic food webs, their removal by zebra mussels could result in fewer fish of all kinds, particularly predatory sportfish. There is also evidence in other lakes that zebra mussels have caused the decline of native North American unionids (large clams) (O'Neill and MacNeill, 1996). Observations from Lakes St. Clair and Erie, as well as St. Lawrence and Mississippi River systems reveal severe native unionid mortality in high density areas to the point of extirpation.

Background: In the summer of 1997, the city of Auburn identified the first adult zebra mussel from Owasco Lake. Because the lake is considered productive and has a fairly high calcium level, it's likely to host a sizeable zebra mussel population. Typically, as observed in other Finger Lakes, it can be expected that the population of zebra mussels will remain high for the next two to five years before eventually crashing. However, zebra mussels are now a permanent part of the lake's ecology (O'Neill, personal communication, 1998).

The zebra mussel protection system for the Auburn water supply system, which was installed in the main 30-inch intake line, was activated in July 1997. The system is capable of delivering various chemicals (e.g. potassium permanganate) to prevent the infestation of zebra mussels. In general, the zebra mussel protection system is activated from June through November when water temperatures are above 10° C (50° F).

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LIST OF ACRONYMS

ACOE - U.S. Army Corps of Engineers

AEM - Agricultural Environmental Management

AFO - Animal Feeding Operations

AVC - Aquatic Vegetation Control

BMP - Best Management Practices

CAFO - Concentrated Animal Feeding Operations

CCE - Cornell Cooperative Extension

CDC - Centers for Disease Control

CFO - Conservation Farm Option

cfs - cubic feet per second

CPGL - Conservation of Private Grazing Lands

CRP - Conservation Reserve Program

DO - Dissolved oxygen

DOT - New York State Department of Transportation

ECRP - Conservation Reserve Enhancement Program

ECL - Environmental Conservation Law

EMC - Environmental Management Council

EPA - U.S. Environmental Protection Agency

EQIP - Environmental Quality Incentives Program

FEMA - Federal Emergency Management Agency

FIP - Farmland Incentives Program

FL-LOWPA - Finger Lakes-Lake Ontario Watershed Protection Alliance

FSIP - Forest Stewardship Incentives Program

FWS - U.S. Fish & Wildlife Service

GC - Gas Chromatography

GC-MS - Gas Chromatography-Mass Spectrophotometry

HHW - Household Hazardous Waste
KWIC - Keuka Watershed Improvement Cooperative
mgd - million gallons per day
NGVD - National Geodetic Vertical Datum
NRCS - Natural Resources Conservation Service
NTU - Nephelometric Turbidity Unit
NYSDEC - New York State Department of Environmental Conservation
NYSDOH - New York State Department of Health
OLLA - Owasco Lake Anglers Association
OWLA - Owasco Watershed Lake Association
PFW - Partners for Fish & Wildlife Program
ppb - Parts Per Billion ($\mu\text{g/L}$)
ppm - Parts Per Million (mg/L)
R-F - Rural Residential/Farming
SEQRA - State Environmental Quality Review Act
SPDES - State Pollutant Discharge Elimination System
SRP - Soluble Reactive Phosphorus
SWCD - Soil and Water Conservation District
SLWAP- Skaneateles Lake Watershed Agricultural Program
TP - Total Phosphorus
UFI - Upstate Freshwater Institute
USDA - United States Department of Agriculture
USGS - United States Geological Survey
WHIP - Wildlife Habitat Incentives Program
WQMA - Water Quality Management Agency
WRP - Wetlands Reserve Program
WWTP - Wastewater Treatment Plant

GLOSSARY OF TERMS

Buffer strips - Strips of grass or other erosion-resisting vegetation between or below cultivated strips or fields.

Coliform organism - microorganisms found in the intestinal tract of humans and animals. Their presence in water indicates fecal pollution and potentially dangerous bacterial contamination by disease causing microorganisms.

Dimictic - A lake characterized by two turnover periods in which the water layers stratify.

Dissolved oxygen (DO)- The oxygen freely available in water. DO is vital to fish and other aquatic life and for the prevention of odors. Eutrophic - Rich in phosphates, nitrates, and other nutrients that promote the growth of algae, which deplete the water of oxygen.

Effluent - Wastewater--treated or untreated--that flows out of a treatment plant, sewer, or industrial outfall.

Erosion - The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by human practices.

Fauna - The animals or animal life of a particular place.

Fragipan - A horizon found in glacial till in the deep subsoil that is tightly packed and slowly permeable to water.

Hypolimnion - The lower, cooler water of a lake, below the thermocline.

Leachate - A liquid that results from water collecting contaminants as it trickles through wastes, pesticides, or fertilizers. Leaching may occur in landfills, or farming areas, and may result in hazardous substances entering surface water, ground water or soil.

Littoral Zone - The zone close to the water's edge where one finds rooted aquatic plants.

Metalimnion - Area of rapid temperature change between upper, warmer waters and lower cooler waters in a thermally stratified lake.

Morphometry - The measurement of the external shape or form of a lake or stream.

Nitrate -A compound containing nitrogen which can exist as a dissolved gas in water and which can have harmful effects on humans and animals.

Oligotrophic - Lakes with low nutrient supplies. They contain little organic matter and have a high dissolved-oxygen level.

Outcrop - Coming out of the surface of the earth.

Palustrine - Having to do with a marsh or marshy.

Pesticides -Any substance or mixture intended for preventing, destroying, repelling, or mitigating any pest. Includes insecticides, herbicides, fungicides, and rodenticides. Pesticides can accumulate in the food chain and/or contaminate the environment if misused.

Runoff - The part of precipitation, snowmelt, or irrigation water that flows over the land into streams or other surface water. It can carry pollutants from the air and land into the receiving waters.

Slow sand filtration - Treatment process involving passage of raw water through a bed of sand at low velocity that results in the substantial removal of chemical and biological contaminants.

Turbidity - Cloudiness in water caused by the presence of particles (suspended silt or organic matter) and pollutants.

Watershed - Land area that surrounds and drains into a lake, stream or pond.

Wetland - An area that is regularly saturated by surface or ground water and subsequently is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include swamps, bogs, fens, and marshes. Some wetlands are known for their ability to filter both chemical and biological pollutants from surface and ground water.

APPENDIX A -- SCIENTIFIC DATA, TABLES, AND FIGURES

Table A-1 Description of NYSDEC Wetland Classes and Acres of Each Within the Owasco Lake Watershed

Class I

May be characterized by any of the following:

- permanent habitat of an endangered or threatened species
- supports a species of unusual diversity or abundance
- provides a significant flooding buffer to a densely developed area
- is adjacent to a water body which serve as a public drinking water source

Class II

May be characterized by any of the following:

- is a migratory habitat for an endangered or threatened species
- permanent habitat of a vulnerable species
- provides a significant flooding buffer to a lower density developed area or an agricultural area

Class III

May be characterized by any of the following:

- is a habitat to a species that is vulnerable in that particular region
- has scenic or aesthetic value

Class IV

May be a swamp or meadow that contains none of the characteristics to merit a higher ranking.

<i>Class</i>	<i>Acres</i>	<i>Location</i>
I	3079.2 (32.2%)	Located along the southern boundary of the watershed.
II	4576.2 (47.9%)	Located in the area known as the Owasco Flats and on the east side of the north end of the lake.
III	1819.5 (19.0%)	Located at the north end of the lake and along the east and west sides of the southern end of the lake.
IV	29.0 (0.30%)	Located along the eastern boundary of the watershed.

Source: Digital Freshwater Wetlands Data, NYS NYSDEC Division of Fish, Wildlife, and Marine Resources, March 1998, and *Freshwater Wetlands, Maps and Classification Regulations*, NYS NYSDEC, June 1980

Table A-2 Values of Selected Parameters from Owasco Inlet, Owasco Outlet, and Tributary 17 Taken on June 20, July 27 and August 5, 1927 by the NYS Department of Conservation

Tributary or Outlet	Location	Date Sampled	Temp (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% sat)	Methyl Orange Alkalinity (mg/L as CaCO₃)	CO₂ (mg/L)	pH
Owasco Inlet	entering Groton	June 20, 1927	14.0	9.3	93	116	nil	8.1
Owasco Inlet	at Cortland St.	June 20, 1927	15.5	8.5	87	123	nil	8.1
Owasco Inlet	1.1 mi below Groton	June 20, 1927	17.0	10.4	111	125	nil	8.5
Owasco Inlet	2.8 mi below Groton	June 20, 1927	17.5	10.5	113	131	nil	8.7
Owasco Inlet	entering Locke	June 20, 1927	18.5	9.5	103	131	nil	8.5
Owasco Inlet	leaving Locke	June 20, 1927	18.3	9.4	102	138	nil	8.5
Owasco Outlet		July 27, 1927	22.5	8.8	102	100	nil	8.3
Tributary 17	500 ft above Tributary 17	August 5, 1927	19.0	9.8	107	126	nil	8.1
Tributary 17	Tributary 17 entering Inlet	August 5, 1927	17.0	9.4	99	108	nil	8.1
Tributary 17	2,000 ft below Tributary 17	August 5, 1927	18.8	9.6	105	122	nil	8.1

Source: Oglesby et. al 1973

Note: nil = data too low to be accurate

Table A-3 Values of Selected Parameters From the Owasco Inlet Taken Above Groton

	4- Apr- 71	5- May- 71	14- Jun- 71	29- Jul- 71	29- Jul- 71	26- Aug- 71	28- Oct- 71	23- Nov- 71	9- Dec- 71	25- Jan- 72	6- Apr- 72	22- Jun- 72	7- Jul- 72	17- Aug- 72	15- Sep- 72	11- Oct- 72	1- Nov- 72	11- Dec- 72	14- Dec- 72
Temp. (°C)	2	11	15	17	17	15	13	1	4	2	na	15	14	16	13	na	8	2	2
pH	7.9	8.2	8.3	8.2	8.2	8.3	7.8	8.1	7.8	7.7	na	7.8	7.0	8.2	8.2	8.1	8.1	7.8	7.5
P-alkalinity (mg/L) as CaCO ₃	na	na	na	11	12	8	11	4	0	4	na	0	0	3	4	6	2	0	0
M-alkalinity (mg/L) as CaCO ₃	57	74	65	113	102	152	158	103	44	82	na	45	79	157	154	160	144	64	73
Cl ⁻ (mg/L)	9	14	10	12	19	25	28	29	na	na	na	10	13	15	25	20	17	12	13
Ca ²⁺ (mg/L)	na	na	40	42	na	30	45	na	29	42	na	na	na	54	na	55	58	29	43
SO ₄ ²⁻ (mg/L)	na	na	na	na	na	na	na	na	na	na	na	15	na	17	na	11	na	17	16
Nitrate nitrogen (µg/L)	177	801	1523	910	955	482	162	785	na	2275	na	1267	na	532	317	178	178	2583	1520
Soluble reactive phosphorus(µg/L)	11	6	18	46	92	48	89	27	5	5	na	9050	1064	18	88	23	20	9	13
Na ¹⁺ (mg/L)	na	na	2	11	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Iron (µg/L)	na	na	na	na	na	na	na	na	na	na	na	na	10	22	88	na	na	na	na
Total hardness (mg/L as CaCO ₃)	na	na	na	na	na	na	na	na	na	na	na	na	19	184	na	na	na	na	na
Mg ²⁺ (mg/L)	na	na	na	na	na	na	na	na	na	na	na	na	na	12	na	na	na	na	na

Source: Oglesby et al. 1973

Note: na = data not available

Table A-4 Values of Selected Parameters From Dutch Hollow Brook

	14-Jun-71	29-Jun-71	29-Jul-71	26-Aug-71	28-Oct-71	23-Nov-71	9-Dec-71	25-Jan-72	6-Apr-72	22-Jun-72	7-Jul-72	17-Aug-72	15-Sep-72	1-Nov-72	11-Dec-72	14-Dec-72
Temp. (°C)	20	23	20	19	14	1	4	1	na	16	16	17	15	6	2	2
pH	8.2	8.4	8.4	8.1	8.1	8.2	8.1	8	na	8.3	8.4	8.3	8.3	8.2	8.2	8.2
P-alkalinity (mg/L) as CaCO ₃	10	2	25	4	9	8	10	8	na	3	17	10	8	8	7	6
M-alkalinity (mg/L) as CaCO ₃	144	153	138	157	201	213	107	148	na	101	190	242	182	206	171	191
Cl ⁻ (mg/L)	12	14	12	19	19	18	na	na	18	8	9	11	10	10	8	9
Ca ²⁺ (mg/L)	52	37	56	na	na	na	12	6	12	na	na	67	na	74	69	70
SO ₄ ²⁻ (mg/L)	na	na	na	na	na	na	na	na	27	21	na	24	na	na	20	21
Nitrate nitrogen (µg/L)	213	241	66	na	266	na	2023	2773	1520	659	140	77	405	3545	1064	
Soluble reactive phosphorus (µg/L)	7	7	5	10	10	6	11	3	13	90497	8	10	26	10	14	14
Na ¹⁺ (mg/L)	1	7	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Iron (µg/L)	na	na	na	na	na	na	na	na	na	na	17	15	na	na	na	na
Total hardness (mg/L as CaCO ₃)	na	na	na	na	na	na	na	na	na	na	na	184	na	na	na	na
Mg ²⁺ (mg/L)	na	na	na	na	na	na	na	na	na	na	na	4	na	na	na	na

Source: Oglesby et al. 1973

na = data not available

Table A-5 Values of Selected Parameters From the Owasco Inlet Taken Below Groton

	4-Apr-71	5-May-71	14-Jun-71	29-Jun-71	29-Jul-71	26-Aug-71	28-Oct-71	23-Nov-71	9-Dec-71	25-Jan-72	6-Apr-72	22-Jun-72	7-Jul-72	17-Aug-72	15-Sep-72	11-Oct-72	1-Nov-72	11-Dec-72	14-Dec-72
Temp. (°C)	2	11	16	18	18	18	13	1	4	2	na	16	14	15	13	na	8	2	2
pH	8.0	8.0	8.0	8.3	8.3	8.4	8.0	8.0	7.8	7.6	na	7.9	7.2	8.2	8.2	8.1	8.1	8.0	7.6
P-alkalinity (mg/L) as CaCO ₃	na	na	4	10	14	15	9	4	6	2	na	0	0	4	4	5	3	0	2
M-alkalinity (mg/L) as CaCO ₃	74	91	90	135	118	161	180	154	82	61	na	57	83	160	160	186	157	80	98
Cl ⁻ (mg/L)	9	14	18	16	22	41	31	30	na	na	28	9	14	21	24	25	21	22	16
Ca ²⁺ (mg/L)	na	na	40	46	na	34	45	na	50	50	30	na	na	57	na	62	59	34	42
SO ₄ ²⁻ (mg/L)	na	na	na	na	na	na	na	na	na	na	20	15	na	21	na	21	na	19	19
Nitrate nitrogen (µg/L)	1306	1811	1787	1566	489	463	244	785	na	1821	2532	1267	1216	431	381	165	317	2710	1419
Soluble reactive phosphorus (µg/L)	18	25	21	50	81	55	45	27	15	17	13	9050	14	18	41	734	417	12	54
Na ⁺ (mg/L)	na	na	2	7	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Iron (µg/L)	na	na	na	na	na	na	na	na	na	na	na	na	19	14	na	na	na	na	na
Total hardness (mg/L as CaCO ₃)	na	na	na	na	na	na	na	na	na	na	na	na	na	192	na	na	na	na	na
Mg ²⁺ (mg/L)	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na

Note: na = data not available

Source: Oglesby et al. 1973

Table A-6 Values of Selected Parameters From the Owasco Inlet Taken Above Moravia

	4-Apr-71	5-May-71	14-Jun-71	29-Jun-71	29-Jul-71	26-Aug-71	28-Oct-71	23-Nov-71	9-Dec-71	25-Jan-72	6-Apr-72	22-Jun-72	7-Jul-72	17-Aug-72	15-Sep-72	4-Oct-72	11-Oct-72	1-Nov-72	11-Dec-72	14-Dec-72
Temp. (°C)	1	6	16	19	20	18	14	2	5	2	na	16	15	16	10	na	na	8	2	3
pH	8.1	8	7.5	8.4	8.5	8.5	8	8.1	7.9	7.7	na	8.2	7	8.2	8.3	8.3	8.1	8.2	8	7.9
P-alkalinity (mg/L) as CaCO ₃	na	na	5	8	25	18	10	9	5	0	na	1	0	7	5	8	8	5	0	3
M-alkalinity (mg/L) as CaCO ₃	80	95	95	125	138	146	173	177	63	30	na	61	40	162	157	155	180	156	90	103
Cl ⁻ (mg/L)	8	11	19	11	16	33	32	32	na	na	27	10	5	16	17	13	16	14	10	10
Ca ²⁺ (mg/L)	na	na	52	42	26	26	50	na	na	44	29	na	na	55	na	60	60	60	38	41
SO ₄ ²⁻ (mg/L)	na	na	na	na	na	na	na	na	na	na	19	18	na	18	na	13	22	na	18	18
Nitrate nitrogen (µg/L)	2772	1258	1222	1066	177	352	431	1061	na	667	2653	1495	203	457	165	355	305	532	3798	2279
Soluble reactive phosphorus (µg/L)	17	18	56	43	8	59	144	66	29	3	61	67873	4	0	281	56	589	168	20	19
Na ⁺ (mg/L)	na	na	2	8	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Iron (µg/L)	na	na	na	na	na	na	na	na	na	na	na	na	19	17	na	na	na	na	na	na
Total hardness (mg/L as CaCO ₃)	na	na	na	na	na	na	na	na	na	na	na	na	na	192	na	na	na	na	na	na
Mg ²⁺ (mg/L)	na	na	na	na	na	na	na	na	na	na	na	na	na	13	na	na	na	na	na	na

Note: na = data not available

Source: Oglesby et al. 1973

Table A-7 Values of Selected Parameters From the Owasco Inlet Taken Below Moravia

	4-Apr-71	5-May-71	14-Jun-71	29-Jun-71	29-Jul-71	26-Aug-71	28-Oct-71	23-Nov-71	9-Dec-71	25-Jan-72	6-Apr-72	1-Jun-72	16-Jun-72	22-Jun-72	28-Jun-72	7-Jul-72	20-Jul-72	28-Jul-72	10-Aug-72	17-Aug-72	23-Aug-72	7-Sep-72	15-Sep-72	11-Oct-72	25-Oct-72	1-Nov-72	10-Nov-72	21-Nov-72	11-Dec-72	14-Dec-72	3-Jan-73
Temp. (°C)	5	7	17	19	19	18	14	1	5	1	na	16	16	16	na	15	na	na	na	16	17	na	15	na	na	8	na	na	2	3	
pH	8.0	8.2	8.2	8.4	8.4	8.5	8.0	8.1	8.0	7.8	na	8.1	7.9	8.2	8.4	7.9	8.6	8.4	8.2	8.2	8.3	8.2	7.9	8.0	8.4	8.3	8.0	8.0	8.1	8.0	8.3
P-alkalinity (mg/L) as CaCO ₃	na	na	5	10	11	20	11	9	5	4	na	0	na	1	5	0	10	5	10	4	8	8	0	6	9	2	2	5	3	3	2
M-alkalinity (mg/L) as CaCO ₃	71	74	96	101	95	153	174	177	63	75	na	112	na	57	102	110	121	102	146	150	155	162	125	145	144	143	117	112	93	107	96
Cl ⁻ (mg/L)	8	12	16	9	11	32	24	32	na	na	28	40	12	12	11	10	12	11	12	13	14	16	15	12	14	12	13	10	10	11	11
Ca ²⁺ (mg/L)	na	na	40	40	16	49	48	na	45	44	22	na	na	na	na	na	na	na	na	54	54	na	na	55	53	54	na	46	38	42	44
SO ₄ ²⁻ (mg/L)	na	na	na	na	na	na	na	na	na	na	20	na	21	15	22	na	20	22	22	21	18	21	na	17	24	na	na	18	18	19	17
Nitrate nitrogen (µg/L)	2773	3830	2677	1715	171	376	393	1061	na	3109	2148	735	760	836	91	1191	798	1418	659	495	386	507	148	305	406	469	963	748	3545	3773	1870
Soluble reactive phosphorus (µg/L)	17	31	87	74	8	214	293	153	26	71	27	23	32	180282	21	34	47	40	35	0	59	0	65	47	65	122	25	23	28	41	13
Na ¹⁺ (mg/L)	na	na	2	4	na	na	na	na	na	na	na	na	na	na	22	21	15	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Iron (µg/L)	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	22	12	14	12	na	na	na	na	na	na	na	na	na	na
Total hardness (mg/L as CaCO ₃)	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	176	184	na	na	na	5	na	na	na	na	na	120
Mg ²⁺ (mg/L)	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	10	12	na	na	na	na	na	na	na	na	na	2

Note: na = data not available

Source: Oglesby et al. 1973

Table A-8 Values of Selected Parameters From the Owasco Inlet Taken Above Locke

	15-Sep-72
Temp. (°C)	14
pH	8.3
P-alkalinity (mg/L) as CaCO ₃	5
M-alkalinity (mg/L) as CaCO ₃	160
Cl ⁻ (mg/L)	21
Ca ²⁺ (mg/L)	na
SO ₄ ²⁻ (mg/L)	na
Nitrate nitrogen (µg/L)	436
Soluble reactive phosphorus (µg/L)	372
Na ¹⁺ (mg/L)	na
Iron (µg/L)	na
Total hardness (mg/L as CaCO ₃)	na
Mg ²⁺ (mg/L)	na

Note: na = data not available

Source: Oglesby et al. 1973

Table A-9 Values of Selected Parameters From the Owasco Inlet Taken Below Locke

	15-Sep-72
Temp. (°C)	14
pH	8.3
P-alkalinity (mg/L) as CaCO ₃	6
M-alkalinity (mg/L) as CaCO ₃	164
Cl ⁻ (mg/L)	18
Ca ²⁺ (mg/L)	na
SO ₄ ²⁻ (mg/L)	na
Nitrate nitrogen (µg/L)	381
Soluble reactive phosphorus (µg/L)	326
Na ¹⁺ (mg/L)	na
Iron (µg/L)	na
Total hardness (mg/L as CaCO ₃)	na
Mg ²⁺ (mg/L)	na

Note: na = data not available

Source: Oglesby et al. 1973

Table A-10 Mean Values of Selected Parameters From Four Tributaries of Owasco Lake (Sucker Brook, Dutch Hollow Brook, Owasco Inlet, and Veness Brook) Taken Between May 23 and September 22, 1978

Station			Temp		CO ₂	D.O.	Total Alk	Phen Alk	NH ₃ (N)	NO ₃ ⁻ (N)	Ortho Phos	Total Phos	SO ₄ ²⁻ (mg/L)	Total Coli (#/100mL)	Fecal Coli (#/100mL)	Set Solids (mL/L)	Susp Solids (mg/L)	Volatile Solids (mg/L)
#	Tributary	Location	pH	°C	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(#/100mL)	(#/100mL)	(mL/L)	(mg/L)	(mg/L)
1	Sucker Brook	Bridge, Rt. 38A	7.8	18.0	2.8	3.6	228.0	9.6	0.51	0.21	0.05	0.14	6.6	1185 ^a	545 ^b	0.10	1.03	0.11
2	Sucker Brook	Bridge, Melrose Rd.	7.9	18.0	2.5	5.0	233.0	10.3	0.58	0.05	0.01	0.02	3.1	593 ^c	196 ^c	0.10	0.45	0.36
3	Sucker Brook	Bridge, Town Hall Rd.	7.9	18.0	2.5	5.3	233.0	9.3	0.50	0.47	0.01	0.02	0.0	637 ^c	170 ^c	0.13	1.80	0.39
4	Dutch Hollow Brk.	Bridge, Rt. 38A near Burtis Pt.	8.1	17.0	2.0	5.4	188.0	6.6	0.69	0.60	0.03	1.21	16.4	817 ^c	315 ^c	0.17	4.80	2.10
5	Dutch Hollow Brk.	Bridge, Martin Rd.	7.9	17.0	3.2	4.8	187.0	8.4	0.90	0.90	0.03	0.06	18.8	1025 ^c	539 ^c	0.13	42.00	13.50
6	Dutch Hollow Brk.	North Rd.	8.0	17.5	2.0	6.0	183.0	6.7	0.64	0.68	0.04	0.18	19.2	1066 ^c	1046	0.10	5.50	3.30
7	Dutch Hollow Brk.	Rt. 38A ~ Onondaga Cnty. Line	7.9	16.5	2.0	6.3	172.0	7.7	0.43	0.76	0.04	0.05	14.9	977 ^c	581 ^c	0.10	5.10	2.60
8	Dutch Hollow Brk.	Old State Rd., Hamlet of Niles	7.9	14.5	2.5	6.3	159.0	6.8	0.35	1.23	0.04	0.04	16.9	1172	890	0.10	5.80	4.50
9	Dutch Hollow Brk.	Cream Hollow Rd.	8.2	13.0	2.5	6.5	136.0	5.8	0.35	1.17	0.03	0.06	14.1	950	756	0.10	4.20	4.10
10	Dutch Hollow Brk.	Pumpkin Hill Rd.	7.8	13.0	3.0	5.8	121.0	5.3	0.20	1.80	0.04	0.05	15.2	959	476	0.10	6.60	4.80
11	Dutch Hollow Brk.	Salt Rd. N. of Kellogsville	7.3	13.8	2.5	6.3	50.8	4.3	0.26	1.30	0.04	0.05	11.6	1003	451	0.10	9.30	8.30
12	Dutch Hollow Brk.	White Rd. S. of Kellogsville	7.4	15.0	3.5	5.5	73.8	4.0	0.35	0.99	0.53	0.60	14.4	890 ^b	3440 ^f	0.10	10.00	7.40
13	Owasco Inlet	Near mouth, S. of Boat Livery	9.7	18.0	4.8	5.0	147.0	6.8	0.36	1.18	0.09	0.11	11.4	451	176	0.01	1.10	0.15
14	Owasco Inlet	Bridge Rt. 38 N. of Moravia	7.9	17.0	2.5	6.3	150.0	4.8	0.38	1.51	0.09	0.10	16.4	1740 ^c	567	0.10	4.70	2.30
15	Owasco Inlet	N. of Moravia STP outfall	7.9	18.0	2.7	6.0	155.0	5.3	0.88	1.15	0.16	0.27	17.7	570 ^c	147 ^c	1.20	2.70	2.60
16	Owasco Inlet	S. of Moravia STP outfall	7.9	17.0	1.3	5.7	152.0	6.0	1.40	1.19	0.05	0.07	19.1	110 ^c	229	0.12	4.50	1.00
17	Owasco Inlet	Rt. 38A S. of Moravia 3 miles	8.1	17.0	2.0	6.7	161.0	3.7	0.45	1.21	0.04	0.06	17.4	255 ^c	375 ^c	0.10	3.80	1.45
18	Owasco Inlet	Rt. 38 Locke	8.1	16.0	2.0	6.5	155.0	4.7	0.28	1.31	0.06	0.10	17.1	1395 ^c	930	0.08	5.30	1.65
19	Owasco Inlet	N. of Groton STP outfall	7.9	17.0	3.0	6.3	154.0	5.7	0.45	2.95	0.11	0.22	24.1	3280 ^b	979	2.60	3.30	0.70
20	Owasco Inlet	S. of Groton STP outfall	8.0	16.0	2.7	7.0	154.0	4.7	0.28	1.15	0.06	0.09	18.1	1160	447	0.06	3.80	1.80
21	Veness Brk.	Rt. 38	7.7	18.0	4.0	4.0	225.0	12.0	1.58	0.33	0.03	0.11	13.9	1805 ^c	80 ^c	0.15	1.65	0.60

Source: Greer and Gassler 1979

Table A-11 Mean Values of Selected Parameters From Four Tributaries of Owasco Lake (Sucker Brook, Dutch Hollow Brook, Owasco Inlet, and Veness Brook) Taken Between June and October, 1980

Station #	Tributary	Location	pH	Temp °C	CO ₂ (mg/L)	D.O. (mg/L)	Total Alk (mg/L)	Phen Alk (mg/L)	NH ₃ (N) (mg/L)	NO ₃ ⁻ (N) (mg/L)	Ortho Phos (mg/L)	Total Phos (mg/L)	SO ₄ ²⁻ (mg/L)	Fecal Strep (#/100mL)	Set Solids (mL/L)	Susp Solids (mg/L)	Volatile Solids (mg/L)
1	Sucker Brook	Bridge, Town Hall Rd.	7.8	26.0	2.0	9.0	265	26.0	0.150	0.27	0.010	0.025	0.0	65	0.10	na	na
2	Sucker Brook	Bridge, Melrose Rd.	7.9	22.0	2.0	8.0	240	16.0	0.150	0.68	0.005	0.006	0.0	600	0.10	na	na
3	Sucker Brook	Bridge, Rt. 38A	7.8	23.5	1.0	6.0	145	10.0	0.050	1.88	0.010	0.010	27.0	340	0.10	na	na
4	Dutch Hollow Brk.	Burtis Point	7.3	19.0	1.0	6.7		21.7	0.120	0.58	0.025	0.040	25.3	1680	0.10	2.9	1.8
5	Dutch Hollow Brk.	Bridge, Rt. 38A	7.6	15.8	1.0	8.0	195	19.0	0.800	1.04	0.025	0.040	26.8	3586	0.15	13.0	0.4
6	Dutch Hollow Brk.	North Rd.	7.7	15.8	1.5	7.2	197	19.5	0.640	1.18	0.028	0.050	29.0	3523	0.15	11.4	5.3
7	Dutch Hollow Brk.	Rt. 38A ~ Onondaga Cnty. Line	7.7	15.8	1.5	7.0	182	18.8	0.200	0.19	0.013	0.030	33.5	4531	0.13	2.9	2.8
8	Dutch Hollow Brk.	Old State Rd., Hamlet of Niles	7.7	14.8	1.2	6.8	162	15.3	0.030	1.08	0.010	0.020	34.8	3534	0.01	4.6	na
9	Dutch Hollow Brk.	Cream Hollow Rd.	7.8	13.7	1.3	7.8	159	12.5	0.050	1.35	0.010	0.010	32.0	3955	0.02	6.5	0.2
10	Dutch Hollow Brk.	Burdock Rd.	7.5	12.4	1.3	7.5	137	16.2	0.060	1.56	0.010	0.020	27.0	3580	0.01	na	na
11	Dutch Hollow Brk.	White Rd. S. of Kellogsville	7.2	14.0	1.0	6.0	104	16.2	0.300	1.94	0.090	0.120	17.0	9240 ^b	0.35	12.6	2.0
12	Owasco Inlet	Near mouth, S. of Boat Livery	7.2	16.0	1.0	7.0	142	20.7	0.150	1.25	0.120	0.200	24.0	250 ^a	0.15	25.9	21.0
13	Owasco Inlet	Bridge Rt. 38 N. of Moravia	7.5	14.7	1.0	7.0	129	9.3	0.120	1.37	0.180	0.140	24.3	300 ^a	0.30	21.1	7.0
14	Owasco Inlet	N. of Moravia STP outfall	7.5	14.7	1.3	7.7	131	14.3	0.150	1.25	0.150	0.240	22.7	340 ^a	0.40	16.5	13.0
15	Owasco Inlet	Rt. 38A S. of Moravia 3 miles	7.5	14.7	1.0	8.0	139	19.3	0.450	1.22	0.150	0.200	25.3	450 ^a	0.60	0.3	na
16	Owasco Inlet	Rt. 38 Locke	7.5	14.3	1.0	7.6	132	16.0	0.080	1.40	0.190	0.260	21.7	300 ^a	0.20	na	na
17	Veness Brook	Rt. 38	7.5	25.0	1.0	7.0	214	31.0	0.150	0.75	0.100	0.020	21.0	200	2.60	3.6	na
18	Owasco Outlet	Pumping Station	7.4	19.0	1.0	8.0	130	14.0	0.000	0.50	0.060	0.060	9.0	20	na	na	na
19	Owasco Outlet	Boat Launch	7.7	20.3	1.0	7.0	130	16.0	0.170	0.68	0.030	0.040	19.0	119	0.10	na	na

NO₂⁻ nitrite nitrogen levels were too small to measure accurately;^a= includes 1 samples too numerous to count; ^b = includes 2 samples too numerous to count

Source: Greer and Gassler 1981

Table A-12 Percent Nitrogen and Phosphorus in Soils Near Selected Tributaries of Owasco Lake During the Month of June, 1980

Station #	Tributary	Location	Soil sample location	pH	% moisture at		Loss on ignition	% nitrogen	% P ₂ O ₅
						110 °C			
1	Sucker Brook	Bridge, Town Hall Rd.	Bank	7.2	1.0		8.6	0.15	0.03
			Field	7.2	2.5		9.2	0.22	0.06
2	Sucker Brook	Bridge, Melrose Rd.	Bank	7.2	0.0		6.5	0.18	0.04
			Field	7.2	1.0		6.6	0.14	0.04
4	Dutch Hollow Brk.	Burtis Point	Bank	7.5	1.5		5.6	0.34	0.03
			Field	7.8	2.0		2.0	0.02	0.02
5	Dutch Hollow Brk.	Bridge, Rt. 38A	Bank	7.2	0.0		3.0	0.14	0.03
			Field	7.2	0.5		2.0	0.08	0.03
6	Dutch Hollow Brk.	North Rd.	Bank	7.6	1.5		3.6	0.14	0.04
			Field	7.2	1.5		5.1	0.25	0.03
7	Dutch Hollow Brk.	Rt. 38A ~ Onondaga Cnty. Line	Bank	7.3	2.0		5.1	0.15	0.03
			Field	7.0	0.0		7.5	0.20	0.04
8	Dutch Hollow Brk.	Old State Rd., Hamlet of Niles	Bank	7.1	0.0		4.0	0.17	0.02
			Field	7.0	4.0		4.1	0.32	0.04
10	Dutch Hollow Brk.	Burdock Rd.	Bank	7.4	2.5		9.7	0.25	0.04
			Field	7.1	2.5		8.7	0.27	0.04
11	Dutch Hollow Brk.	Salt Rd. N. of Kellogsville	Bank	7.4	0.0		5.5	0.17	0.04
			Field	6.3	2.0		7.7	0.24	0.03
17	Veness Brook	Rt. 38	Silt Bed	6.8	3.5		6.7	0.36	0.05

Source: Greer and Gassler 1981

APPENDIX B -- RESIDENT SURVEY COMMENTS

Within each section, comments are listed from most frequently mentioned to least.

Septic Systems

Inspections every year or two years is too frequent --

- Every five years would be plenty
- New systems should be exempt
- After 2-3 passed readings the time between testings should be increased
- Every spring for all in the watershed

Inspections are too expensive --

- Discount or exempt senior citizens and low-income houses from inspection fees
- First time inspection fee too high
- Program to help low and fixed income households pay the fee
- Fees should be covered by taxes

Inspections (General) --

- County passing defective fields
- Unbiased inspectors should do -Inspections
- Inspectors doing an inadequate job should have follow-up
- If proper inspections were enforced the lake may be cleaner
- Set-up with inadequate ability to enforce
- Regulations, inspections, and monitoring of septic systems too strict for offshore properties
- Lack of inspections for camps
- Check all septic systems in the watershed
- Check only septic systems along the lake shore
- Inspection forms should list each building owned
- Cayuga County Health Department is going beyond their bounds
- Inspection program is great

Septic System Concerns --

- Faulty and inadequate septic systems leaking into the lake
- Homes may have no septic system
- Need a program for the disposal of household chemicals
- Camps septic systems are overloaded
- Is the prison in Moravia contributing to the pollution
- The sewage treatment plant is overloaded and dumping into the lake
- Storm sewers in Auburn being dumped into the lake
- Septic trucks from various County's to be disposed of on open land in Venice
- Dumping of sewage from homes

Septic System Suggestions --

- Septic Systems should not be allowed in the watershed
(the lake needs a sewer line)
- More rigid inspections and fines
- More inspections
- Homes should be assessed by number of residents not by bedrooms
- County should continue to check the systems but there should be an option to hire a private company
- Test septic system on usage basis

Sewer Systems

Development of sewer line around the lake--

- Build a public sewer line and municipal water source along the lake (possibly all the Finger lakes)
- Require everyone in the watershed connect to the public sewer line
- Sewer line should not be developed until current system is repaired/modified
- No more sewer construction

Sewer System Concerns --

- Auburn sewage effluent already running into the lake, can the system handle current/more loads? Is Auburn dumping sewage into the lake?
- Building a sewage treatment plant in a flood plain
- Need to focus on sewage treatment plant effluent
- City is serving the public sewage water

Sewer System suggestions --

- Cost effective programs to get city water and sewer to cottages
- Get State and Federal assistance with public sewer lines
- OLWA should be lobbying for increased sewer coverage

Beach and Public Areas

Beach Comments --

- Beach closures are a concern, *E. Coli* contamination needs to be stopped
 - Beach and banks dirty and eroding
 - Good beach for visitors

Beach Suggestions --

- Use state, county inmates or pay teenagers to clean beaches.
- Beaches should be raked and debris (especially glass) should be cleaned daily
- Eliminate birds from the beach area, in the winter congregate and bird droppings pushed into the water when the sand is pushed back
- Get stagnant water on the beach moving

Park and Public Areas --

- The park needs attention
- Set-up something like Deauville Park
- More access to the lake
- No fees for parking, park usage or boat launch
- More public points
- Cheaper access to the lake
- Boat launch ramps at an angle making the water run faster causing erosion
- County politicians are using funds for other purposes
- People outside the county do not pay enough money, the local taxpayers should not have to pay more than visitors
- Use "State Bond Money" to improve the waterway
- Park is being managed well, management needs more support
- Park is not being managed well
- Need more fishing areas

Boats and Jet-ski operation

Boats --

- Noise, pollution, speed, number, safety, and size of boats a concern
- Regulate the above concerns
- No above water or through hull exhaust systems
- Regulate distance speeds and distance of boats from shore and fishing boats

-
- Ban powerboats limit to sailboats, rowboats, canoes, etc.
 - Limit size of power boats
 - Stop boats from collecting in groups to party
 - No activity after dark
 - Mandatory personnel watercraft operator education
 - No alcohol in boats
 - Regulate boats that flush into the lake

Jet-skis --

- Jet skis should be banned
- Jet ski numbers, noise, speed and safety should be regulated
- Keep jet-skis away from shore
- No activity after dark
- Use unmarked boats to patrol

Development

Tourism --

- Emerson Park area needs hotel and good restaurant
- More and free access to lake, fish stocking and business development for tourists and residents
- Increase tourism, attractions, wineries
- Create "Darien Lake" atmosphere; lease park to companies, take profit for clean up
- Need night life
- Add lights for night boating
- Spot to launch canoes
- Nature center at S. end of the lake
- More area to enjoy the lake all used by landowner, scenic overlooks, fishing spots picnic areas

Land and Housing --

- Concerned over planned housing development on area with long-standing erosion and run-off problems
- Area over-developed, this should be a concern
- Five acre zoning of existing lands for new homes
- Moratorium on all development until sewer district in Owasco is repaired
- Lake area development ruins lakes, leave brooks and lakeshore natural
- Concerned over the development of seasonal camps to year round residents

Farms

Pollution Problems --

- Concern about runoff from fields with manure spread and runoff from land the animals where the livestock reside
- Outlaw big farms in the watershed
- Run-off from farms should be tested
- Prevent the use of sludge on farms, they are affecting the air and water quality
- Spreading of manure near streams should not be allowed
- Liquid manure running into the streams, lakes, wetlands
- Run-off from farms causing erosion
- Large dairy farms responsible for current contamination
- Farms should be regulated to ensure environmentally sound practices
- Dead animals left to rot

Inlet/Outlet

Inlet --

- Sediment at the south end of the lake is too high, limiting recreational activities
- Dredge the south end of the lake
- Eliminate weeds too thick to get out with a boat or to swim
- Any activity in the south end of the lake should be examined, protect the wetlands that filter the water entering the lake
- Do not dredge the south end of the lake
- Remove debris from the inlet, floating into the lake and is dangerous to skiers
- Erosion of the inlet is a concern, construction to stop it
- Should be checked for pollution
- RT.38 is too close to the inlet
- Buffer zone needed to protect the inlet from pollution

Outlet --

- Outlet is home to sewer rats
- Outlet seawall needs attention, create a walkway when fixing
- Sell 50/50 raffle tickets to raise funds to fix the seawall
- Eliminate the seawall to allow proper wave action

Lake Levels

Better Control of Lake Levels --

- Lake level fluctuation is a concern
- Water level needs to stay up until the end of September in order to get boats out of the water
- Water level is too high, causing flooding and erosion during the summer months
- Hourly monitoring of water levels during rainstorms and snow melt
- Organized unified control over water usage, no power struggle over lake level control

Quality

Concerns --

- Quality of the lake is deteriorating, clarity is down
- Concerned about the quality of drinking water
- Lake pollution and ground wells being polluted
- Pest/herbicides being used in the watershed
- A lot of junk in the creeks after heavy rain
- Dumping old farm equipment near the streams
- Water (well) smells like sulfur

Quality Suggestions --

- Develop a long term process that tracks and measures quality over decades.
- People miles away from the lake should not be bothered, as they do not affect lake quality
- Enforce the current laws would improve the quality of the water; the laws and technology are present
- Individuals should have responsibility for the quality of the water and land
- Eliminate storm drains from dumping into the lake
- County wide agency regulate the watershed

Taxes

Reduce taxes --

- Voluntary and educational programs fine, no other programs

-
- Decrease taxes, use volunteers
 - No more taxes
 - Taxes too high, watershed residents are not the only people using the lake others should also pay
 - Current taxes should be enough to support proposed programs
 - Camp owners and lake users benefit from WQMA, they should pay not the taxpayers

Communication

More communication --

- Communication and feedback are necessary, has the Moravia correctional facility stopped polluting? Christy's lake house? Gas station?
- Who to contact when people see violators
- Communication between the NYSDEC and land owners
- Are there any problems? My impression is that water quality is fine
- Communication on bringing sewer and water around the lake
- Communication regarding the lake, do not feed the ducks

Flooding

Flooding Concerns --

- Would dredging the inlet reduce flooding in Moravia?
- Storm ditches need to stop flooding
- Blocked streams are causing flooding
- Water level kept too high causing flooding
- Hourly monitoring of water levels to reduce flooding
- No one should build on the flood plains
- Flooding and runoff has increased due to construction of new homes

Wetlands

Wetland Concerns --

- How can some get away with draining protected wetlands while others cannot?
- Construction on the lake has caused pollution and is destroying the wetlands around the lake

APPENDIX C -- AUBURN & CAYUGA COUNTY CHAMBER OF COMMERCE SURVEY

RESULTS ARE PRESENTED : PERCENTAGE OF RESPONDENTS/NUMBER OF RESPONDENTS

Please circle the letter which best describes your opinion. Please circle one answer per question.

A. Economic

	Strongly Agree	Agree	Disagree	Strongly Disagree	Undecided
1. Owasco Lake is important to my business	31%/23	39%/30	19%/15	5%/4	5%/4
2. The lake has economic impact on my business	30%/23	34%/26	17%/13	10%/8	9%/7
3. My business depends on proximity to the lake	7%/5	14%/11	48%/37	19%/15	7%/5
4. My business depends on Owasco as a water supply	42%/33	25%/19	22%/17	8%/6	0
5. I depend on Owasco Lake as an attraction for customers	18%/14	26%/20	30%/23	14%/11	12%/9
6. I depend on Owasco Lake as an attraction for employees	13%/5	39%/30	26%/20	13%/11	7%/5

B. Watershed and Lake Emerging Issues of Concern

Please indicate your agreement with the importance of the following issues.

1. Lake level fluctuations	29%/23	53%/41	8%/6	3%/2	7%/5
2. Boating Speed/Noise/Safety	44%/34	39%/30	9%/7	4%/3	4%/3
3. Public & Private Water Supplies	61%/47	39%/30	0	0	0
4. Shoreline/Streambank Erosion/ Siltation.	47%/34	45%/35	3%/2	3%/2	3%/2
5. Zebra mussels	44%/34	45%/35	3%/2	0	8%/6
6. Aquatic vegetation (Weeds)	44%/34	44%/34	5%/4	3%/2	4%/3
7. Increased/ Enhanced Public Lake Access	32%/25	42%/32	9%/7	9%/7	7%/5
8. Seawall Restoration	55%/42	40%/31	3%/2	1%/1	8%/6
9. Fisheries Development	34%/26	51%/39	7%/5	1%/1	8%/6
10. Public & Private Waste Water Treatment Systems	65%/50	27%/21	1%/1	0	5%/4
11. Agricultural Runoff	64%/49	26%/19	3%/2	3%/2	1%/1
12. Waterborne Pathogens (Fecal Coliform)	65%/50	25%/19	4%/3	3%/2	3%/2
13. Herbicide and Pesticide Use/ Home & Commercial	61%/47	29%/22	4%/3	1%/1	4%/3
14. Fuel spills and/or hazardous waste	61%/47	32%/25	3%/2	1%/1	3%/2
15. Stormwater and Sediment Runoff	47%/36	42%/32	9%/7	1%/1	1%/1
16. Integration of commercial and lake attractions	39%/30	45%/35	5%/4	3%/2	1%/1
17. Tourism	57%/44	35%/27	4%/3	3%/2	1%/1
18. Property Value Impact	45%/35	40%/31	5%/4	1%/1	8%/6

C. Regulation (Watershed, Municipal, County, State)

1. Existing regulations are adequate.	3%/2	29%/22	30%/23	13%/10	25%/19
2. Voluntary Programs for watershed protection are needed.	32%/25	40%/31	8%/6	4%/3	13%/10
3. Education programs are needed to improve watershed conditions	35%/27	53%/41	3%/2	0	9%/7
4. Boating regulations are needed	34%/26	36%/28	13%/10	3%/2	14%/11
5. Stormwater and/or construction regulations are needed	29%/22	45%/35	10%/8	0	14%/11
6. Steep slope and/or shoreline development needs regulation	26%/20	45%/35	10%/8	0	16%/12

D. In the past five years

1. The overall quality of the lake has improved	1%/1	27%/21	30%/23	16%/12	27%/21
2. My use and enjoyment of the lake has increased	10%/8	34%/26	36%/28	8%/6	10%/8
3. The value of my property/business has benefited from proximity to Owasco Lake	10%/8	26%/20	29%/22	13%/10	21%/16

I live on Owasco Lake	23%/18
I live in the Owasco Lake Watershed	42%/32
I use Owasco Lake for recreation	58%/45

APPENDIX D -- WATERSHED RULES & REGULATIONS

Pursuant to the authority vested in the Commissioner of Health by Section 1100 of the Public Health Law, section 104.1 of Part 104 of Title 10 (Health) of the Official Compilation of Codes, Rules and Regulations of the State of New York is hereby repealed, and a new section 104.1 is added thereto, to be effective upon filing with the Secretary of state, to read as follows:

MUNICIPAL CODE ADDENDUM

RULES AND REGULATIONS PERTAINING TO CITY OF AUBURN AND TOWN OF OWASCO, CAYUGA COUNTY, RE: PUBLIC WATER SAFETY

Section 104.1 City of Auburn and Town of Owasco, Cayuga County.

(a) Application. The rules and regulations set forth in this section, duly made and adopted in accordance with the provisions of Sections 1100-1107 of the Public Health Law, shall apply to Owasco Lake and its tributaries, which is a source of the public water supply for both the city of Auburn and the town of Owasco, Cayuga County, New York, and to all watercourses tributary thereto or which may ultimately discharge into said lake.

(b) Definitions.

(1) Agricultural associated animal waste shall mean manure obtained from agricultural industries.

(2) Agricultural associated animal waste area shall mean land used for the deposition of agricultural associated animal waste on the surface of the ground for fertilization purposes.

(3) Agricultural associated animal waste storage area shall mean land used for the temporary or permanent deposition of agricultural associated animal waste where said deposition is not directly for the purpose of fertilization.

(4) Chloride salt shall mean the solid compounds or solutions of potassium chloride (commonly used as fertilizer) calcium chloride (commonly used for winter-road maintenance) or sodium chloride (commonly used for water-softener regeneration).

(5) Herbicide shall mean any substance used to destroy or inhibit plant growth.

(6) Human excreta shall mean human feces and urine.

(7) Junkyard shall mean an area where two or more unregistered old or secondhand motor vehicles are being accumulated for purposes of disposal, resale of used parts, or reclaiming certain materials such as metal, glass, fabric and/ or the like.

WATER SERVICE

(8) Lake shall mean Owasco Lake.

(9) Linear distance shall mean the shortest horizontal distance from the nearest point of a structure or object to the optimum high water mark of the lake to the edge, margin or precipitous bank forming the optimum high water mark of a water course.

(10) Manure shall mean animal feces and urine.

(11) Nonagricultural associated animal waste shall mean manure obtained from nonagricultural industries.

(12) Optimum high water mark shall mean 717.13 feet above sea level using United States Geological Survey datum.

(13) Pesticide shall mean any substance used to destroy or inhibit pests such as rodents and insects.

(14) Pollutant shall mean dredge, spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, chemical waste, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, industrial and municipal waste and agricultural and nonagricultural associated animal waste.

(15) Radiation shall mean ionizing radiation, that is any alpha particle, beta particle, gamma ray, x-ray, neutron, high-speed proton and any other atomic particle producing ionization, but shall not mean any sound or radio wave or visible, infrared or ultraviolet light.

(16) Radioactive material shall mean any material in any form that emits radiation spontaneously.

(17) Refuse shall mean all putrescible and nonputrescible wastes including garbage, manure, rubbish, ashes, incinerator residue, street cleanings, dead animals, offal and solid commercial and industrial wastes.

(18) Refuse disposal area shall mean land used for the depositing of refuse except that it shall not include the land used for the depositing of refuse from a single family, a number of which is the owner, occupant or lessee or said land, or any part of a farm on which only agricultural associated animal wastes resulting from the operation of such farm are deposited.

(19) Sewage shall mean any liquid or solid waste matter from a domestic, commercial, private or industrial establishment which is normally carried off in sewers or waste pipes.

(20) Sewage disposal system shall mean any system used for disposing of sewage, and includes treatment works.

(21) Toxic substance shall mean any toxic substance as so defined by subdivision two of section 4801 of the Public Health Law.

(22) Treatment works shall mean any treatment plant, sewer, disposal field, lagoon, pumping station, septic system, constructed drainage ditch or surface water intercepting ditch, incinerator, or area devoted to sanitary landfills or other works not specifically mentioned in this paragraph, installed for the purpose of treating, neutralizing, stabilizing or disposing of sewage.

(23) Watercourse shall mean every spring, stream, marsh or channel of water of any kind numbered on the latest Owasco Lake Watershed Base Map of the Central New York Regional Planning and Development Board.

(24) Watershed shall mean the entire drainage area contributing water to Owasco Lake.

(25) Water supply shall mean the public water supply of both the city of Auburn and town of Owasco, New York, from Owasco Lake.

(c) General Prohibitions. No person, including State agencies or political subdivisions having jurisdiction, shall perform any act or grant any permit or approval which may result in the contravention of the standards for raw water quality as contained in part 170 of Title 10 (Health) of the Official Compilation of Codes, Rules and Regulations of the State of New York (10 NYCRR Part 170.)

(d) Specific prohibitions.

(1) Agricultural associated animal waste area. No agricultural associated animal waste area shall be located within a 250 foot linear distance of the lake or watercourse. Beyond that distance such area shall be maintained in such manner that surface run-off will not carry agricultural associated animal waste directly into the lake or watercourse.

(2) Cemeteries. No interment of a human body shall be made within a 250 foot linear distance of the lake or watercourse.

(3) Chloride salt. No chloride salt shall be stored within a 500 foot linear distance of the lake or watercourse except in weatherproof buildings or watertight vessels.

(4) Herbicides and pesticides. No herbicides or pesticides shall be stored, discharged, applied or allowed to enter into the lake or watercourse unless a permit to do so has been obtained from the appropriate State agency having jurisdiction.

(5) Human excreta and sewage.

(i) No human excreta or sewage shall be deposited or allowed to escape into Owasco Lake or any watercourse on the watershed.

(ii) No human excreta or sewage shall be deposited or spread upon the surface of the ground at any point on the watershed. Composted sludge, pursuant to a permit issued by an appropriate State or local agency having jurisdiction, if any, shall be allowed.

(iii) No human excreta or sewage shall be buried in soil on the watershed unless deposited in trenches or pits at a linear distance of not less than 250 feet from the lake or watercourse with a minimum vertical distance of five feet from the bottom of any trench or pit to groundwater and covered with not less than one foot of soil in such a manner as to effectually prevent its being washed into the lake or watercourse by rain or melting snow.

(iv) No privy receptacle or facilities of any kind for the deposit, movement, treatment or storage of human excreta or sewage shall be constructed, placed, maintained or allowed to remain a 100 foot linear distance of the lake or watercourse except (a) watertight receptacles; (b) water-flushed toilets connected by a watertight pipe to a sewage disposal system that has been approved by the appropriate State Agency having jurisdiction over such facilities; and (c) a properly designed, constructed and operated treatment works that been approved by the appropriate State agency having jurisdiction over such facility.

(v) No portion of the seepage unit (title field, seepage pit or equivalent) or a subsurface sewage disposal system shall be constructed, placed or rebuilt within a 100 foot linear distance of the lake or watercourse. All systems constructed must have a vertical distance of at least two feet from the lowest portion of the system to the high water mark. An exemption may be granted by the County Health Department for the repair of an existing system within 100 linear feet of the lake or watercourse.

(vi) Every watertight receptacle used for containing human excreta or sewage shall be emptied when the receptacle is filled to within six inches of the top.

(vii) In emptying a watertight receptacle or in transferring its contents to a transportable receptacle, all necessary care shall be exercised to prevent contamination of the lake or watercourse. All such transportable receptacles shall be provided with drip-proof connections and tight-fitting covers which are securely fastened when transporting wastes to the place of ultimate disposal. The contents of the watertight receptacles shall be disposed of in accordance with subparagraph (iii) of this paragraph or at a properly designed, constructed and operated sewage disposal system that has been approved by the appropriate State agency having jurisdiction over such facility.

(viii) Before any existing sewage disposal system is altered or any new sewage disposal system is constructed on the watershed, the plans in relation thereto shall have been first approved by the

appropriate State agency having jurisdiction over such facility. Standards for waste treatment works are published from time to time by the appropriate State agency having jurisdiction over such facility and subparagraph (v) of this paragraph shall comprise the criteria to approve any proposed disposal system.

(ix) When an existing subsurface sewage disposal system fails, the entire system must be inspected and the site thoroughly evaluated in a manner acceptable to the appropriate State or county health agency having jurisdiction over such facility, prior to modifications or alterations to the existing system .

(x) No sewage or polluted liquid of any kind shall be discharged or allowed to flow beneath the surface of the ground on the watershed except into watertight pipes connected to a sewage disposal system or holding tank approved in accordance with subparagraph (iv) of this paragraph.

(xi) In-house composting facilities of the type that make use of human excreta *, washwaters and sink wastes will be acceptable provided that properly designed systems for the disposal of gray water are included within the plans for their constructions and are approved by the appropriate State or county health agency having jurisdiction over such facilities.

(6) Junkyards. No junkyard shall be permitted within a 100 foot linear distance of the lake or watercourse.

(7) Manure. Manure shall not be field spread within 75 feet of the lake or watercourse unless it is plowed underground on the same day it is spread.

(8) Radioactive material. No radioactive material of any quantity shall be buried or in any other manner disposed of within the Owasco Lake Watershed.

(9) Refuse. No refuse shall be deposited on or beneath the surface of ground within a 250 foot linear distance of the lake or watercourse.

(10) Refuse disposal area. No new refuse disposal areas shall be located within 500 feet of the lake or watercourse. All refuse disposal areas on the watershed shall comply with the regulations governing their operation as outlined by Part 360 of Title 6 of the Official Compilation of Codes, Rules and regulations of the State of New York.

*So in original.

(11) Structures. No hut, tent, shelter, or building of any kind, except a waterworks structure, shall be permitted on the water or ice within 500 feet of any water supply intake by either the City of Auburn or the Town of Owasco.

(12) Toxic Substances. No container used for the storage of toxic substances shall be buried beneath the surface of the ground within a 500 foot linear distance of the lake or watercourse, except as otherwise permitted by the provisions of subparagraph (x) of Paragraph (5) of this subdivision.

(13) Other wastes. No pollutant of any kind shall be discharged, deposited, or allowed to flow into the lake or watercourse or on or beneath the surface of the ground or watershed within 500 feet of the lake or watercourse, except as otherwise permitted by the provisions of subparagraph (x) of paragraph (5) of this subdivision. This restriction shall not apply to the effluent from a treatment works installed in accordance with plans which have been first submitted to and approved by the appropriate State agency having jurisdiction over such as facilities.

(e) Inspection. The Mayor and Council of Auburn and the town board of the town of Owasco or any person or persons charged with the maintenance or supervision of the public water supply system shall by its officers or their duly appointed representative make regular and thorough inspections of the reservoir, watercourses and watershed to ascertain compliance with the rules and regulations set forth in this section. It shall be the further duty of the aforesaid local governments to promptly notify the State Commissioner of

Health of such violations. The aforesaid local governments shall report to the State Commissioner of Health in writing annually, prior to the 30th day of January, the results of the regular inspections made during the preceding year. The report shall state the number of inspections which were made, the number of violations found, the number of notices served, the number of violations abated and the general condition of the watershed at the time of the last inspection.

(f) Penalties for Violations. Penalties for violations of this section shall be those specified by Section 1103 of the Public Health Law.